HyIntensity Fiber Laser™

HFL010™
HFL015™
HFL020™
HFL030™

Instruction Manual

807090 – Revision 3

Hypertherm®

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For your records

Serial number: _____

Purchase date: _____

Distributor: _____

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Maintenance notes:

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HyIntensity Fiber Laser
HFL010, HFL015, HFL020, and HFL030

Instruction Manual

(P/N 807090)

Revision 3 – November, 2012

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Introduction

The Hypertherm HFL015 Fiber Laser consists of 4 assemblies.

1. HFL015 Fiber Laser Supply, part number 051023

   Note: The HFL015 fiber laser supply, part number 051023, was certified to IEC 61010-1 Safety requirements for electrical equipment for measurement, control, and laboratory use which covers electrical safety.

2. Fiber Laser Gas Console, part number 051024
3. Fiber Laser Head Controller, part number 051026
4. Fiber Laser Head LF150, part number 051025

“Machine builder” in this context is meant to include any person that integrates the Hypertherm HFL015 Fiber Laser into their final laser cutting system.

The Hypertherm HFL015 Fiber Laser is designed as COMPONENTS FOR INCORPORATION into a laser cutting system for industrial and manufacturing environments. The machine builder is responsible for proper adherence to any and all laser and machine safety regulations and certifications for the laser cutting system designed and manufactured by the machine builder. If required by local code, the machine builder or customer shall make arrangements for the final laser cutting system to be inspected and approved for compliance with local codes and standards by an accredited testing laboratory or third party expert acceptable to the regulatory authority having jurisdiction for the final installation.

Laser beam cutting is a thermal cutting process that uses heat from a laser beam with high-pressure assist gas to augment the removal of metal material. There are general hazards associated with metal cutting and specific hazards using lasers for metal cutting that need to be evaluated and mitigated. The following information provided with the Hypertherm HFL015 fiber laser is intended to inform the machine builder and the body responsible for the implementation of workplace and laser safety at the installed site of their responsibilities for safe design, installation and use. The appropriate local codes and standards for the final installation shall be consulted. Should any information in this document be in contravention to local codes and standards, the local codes and standards shall take precedence.

HFL015 fiber laser intended for use in laser cutting systems

The Fiber Laser as sold by Hypertherm is a component intended for sale to machine builders designing and installing the final laser cutting systems. The machine builder has to mount the laser head and enclose the beam and fiber laser cable in a manner that satisfies all applicable standards and regulations. The machine builder has responsibility for the safe design, safe installation, safe use and safe maintenance of the final laser cutting system including but not limited to the provisions to prevent access to the fiber laser beam in the final laser cutting system.

All equipment shall be installed in compliance with the local regulations (electrical safety, laser safety, workplace safety, etc.) and any verification required by local regulatory authorities having jurisdiction for the site(s) where the final laser cutting system with Hypertherm Fiber Laser components are installed and operated. Voltages inside the Hypertherm HFL015 Fiber Laser Supply enclosure are sufficient to cause fatal injury. The equipment shall be installed by competent and qualified personnel in accordance with the final laser cutting system instructions. In addition to these instructions, ANSI Z136.1 and IEC EN 60825-1 are the recommended primary sources for laser safety information.

Operating instructions, guidelines, and rules

Instructions, guidelines, and rules covering operation and maintenance of final laser system, supplied by the machine builder shall be made available to the laser safety officer and operator and shall be strictly followed. This document for the Hypertherm fiber laser components may supplement but does not satisfy this requirement for the final laser cutting system documentation.

Note 1: In addition to the machine builders's instructions and these instructions, the following references may be of assistance:

- EN 60825-1 - Safety of laser products -- Part 1: Equipment classification and requirements
- ANSI Z136.1; American National Standard for Safe Use of Lasers
- The Laser Institute of America's (LIA) Guide for the Selection of Laser Eye Protection;
- LIA's Laser Safety Manual is designed to help those responsible for laser safety at their facility.
- US Code of Federal Regulation of 21CFR1040.10 and 21CFR1040.11 for a complete laser product,
- The USA Occupational Safety Health Administration's (OSHA) Technical Manual, Section III, Chapter 6, "Laser Hazards"

Note 2: The following reference documents provide basic requirements for metal cutting

- In Canada, CAN/CSA-W117.2-06 Safety in welding, cutting, and allied processes
- In the USA, see ANSI Z49.1:2005 Safety in welding, cutting, and allied processes

Note 3: The following reference documents will help determine welding and cutting particulate/fume sampling:

- ANSI/AWS F1.1 for airborne particulates;
- ANSI/AWS F1.2 for fume generation rates and total fume emission
- ANSI/AWS F1.3 for contaminants.

Protection of personnel

Good housekeeping with areas free from trip and fall hazards shall be maintained in the workplace so that the final laser cutting system, automated and semi-automated material transport machines, fiber laser and electrical cables, and other apparatus do not create a hazard to operators, service and other personnel including visitors. Appropriate safeguards and warning signs shall be provided to prevent slips, falls, electric shock, burns, inhalation of gases and fumes, and exposure to noise, vibration and heat. Refer to the Safety and Compliance Manual published by Hypertherm for Plasma Cutting Systems which covers many of the same hazards for metal cutting and protection of personnel in the workplace except for Laser Safety aspects which are covered in ANSI Z136.1 and IEC EN 60825-al.

Note: The employer should conduct a physical demands analysis to ensure that any personal protective equipment does not create a health hazard (e.g., neck , back and wrist problems associated with prolonged or repetitive use)

Laser safety officer

A Laser Safety Officer (LSO) shall be appointed at each facility using a fiber laser for welding or cutting. The duties and responsibilities of the LSO should be as outlined in ANSI Z136.1, Section 1.3 in the US or other laser safety regulations applicable to the OEM laser cutting systems at the final installation site.

Note: *The LSO is responsible for ensuring that all operators are properly trained and fully aware of the safe operation and hazards of operating a laser welding or cutting system. The LSO is also responsible for communicating and enforcing safety procedures to ensure all personnel (operator, service and visitors) understand the theory of operation for the OEM laser cutting end product and site safety instructions before entering a restricted area or room where a laser can be operating.*

The Laser Safety Officer (LSO) shall with support from the final laser cutting system manufacturer conduct a hazard evaluation at the site that takes at least the following into consideration:

A. the potential hazards produced by the operation of the laser equipment;

B. the inherent hazards in the environment in which the equipment is to be operated;

C. the hazards that may occur with operation of the equipment in that environment; and

D. the individuals who may be affected by the hazards.

After completion of this hazard evaluation, the Laser Safety Officer (LSO) shall define the specific laser safety personal protective equipment requirements and procedures.

Condition of laser beam equipment

All laser beam equipment shall be maintained in good mechanical and electrical condition by competent or qualified maintenance personnel as specified by the machine builder. The operator shall report any equipment malfunction, defect, or safety hazard to the laser safety officer, and the use of the equipment shall be discontinued until its safeness has been ensured by the laser safety officer. Repairs shall be made only by competent or qualified maintenance personnel.

Laser safety

This product is a Class 4 laser capable of cutting metal. The Hypertherm HFL015 Fiber Laser is specifically designed for incorporation or integration into other equipment. As such, it DOES NOT MEET the full requirements for a stand-alone laser system as defined by 21 CFR 1040.10 and IEC/EN 60825-1. Within the EU, the equipment is supplied with a Certificate of Incorporation indicating harmonized standards considered in the design.

“Machine builder” in this context is meant to include any person that integrates the Hypertherm HFL015 Fiber Laser into their final laser cutting system, or any person who uses the Hypertherm HFL015 Fiber Laser in the form as supplied by Hypertherm.

The label shown below has been affixed to the HFL015 Fiber Laser Supply, part number 051023 to satisfy the US Code of Federal Regulations which indicates equipment does not need to comply with the requirements of 21CFR1040.10 and 21CFR1040.11 for a complete laser product, provided the equipment is labeled with a statement that it is designated for use solely as a component.

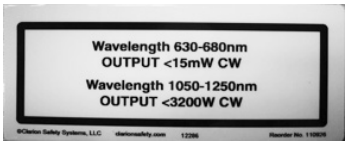
Laser safety warnings

It is the responsibility of the machine builder to meet all of the regulatory requirements for the final laser cutting system. Nonetheless, many of the electronic and labeling requirements have been incorporated into the Hypertherm HyIntensity Fiber Laser to facilitate the final laser cutting system compliance with regulatory requirements.

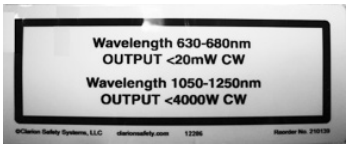
The following laser safety warning labels are located on the Hypertherm HyIntensity Fiber Laser when the Hypertherm HyIntensity Fiber Laser leaves the Hypertherm factory.

Labels on the front door

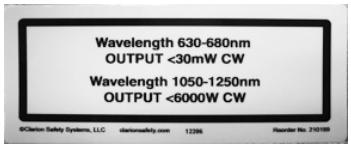
On the 1.0 kW laser
(HFL010)



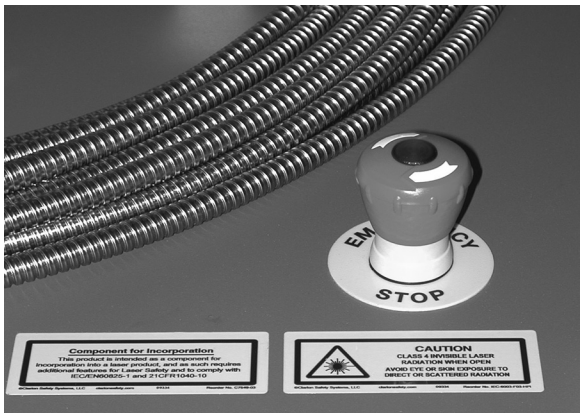
On the 1.5 kW laser
(HFL015)



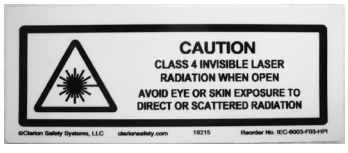
On the 2.0 kW laser
(HFL020)



On the 3.0 kW laser
(HFL030)

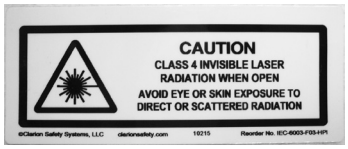


Labels on the top cover

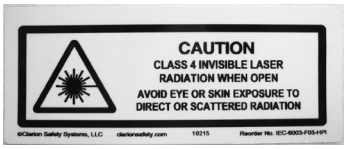


Label on the Beam delivery outlet

Label on the left side

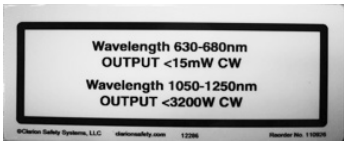


Label on the right side



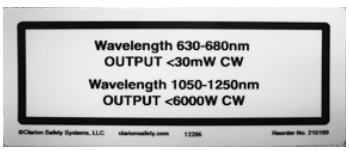
Labels on the rear door

On the 1.0 kW laser
(HFL010)



On the 1.5 kW laser
(HFL015)

On the 2.0 kW laser
(HFL020)



On the 3.0 kW laser
(HFL030)

Label on the laser head

During installation it is vital that the laser hazard is fully managed. In particular, the machine builder is required to implement the engineering requirements detailed in IEC/EN 60825-1. Based on the evaluation or certification of the final laser cutting system, additional laser safety warnings may be provided by the machine builder or by the laser safety officer at the installed site.

Health concerns

Personnel assigned to operate or maintain laser beam cutting equipment shall have been properly trained by the machine builders representative or by a qualified instructor and shall understand the safety requirements of metal cutting using lasers.

Laser safety eyewear (LSE)

Laser safety eyewear (LSE) is designed to reduce the amount of incident light of specific wavelengths to a safe level, while transmitting sufficient light for good vision. As LSE often looks alike in style and color, it is important to specifically check both the wavelength and optical density imprinted on all LSE prior to laser use, especially in multi-wavelength facilities where more than one laser may be located. In the USA reference to ANSI Z136.1 is recommended for the selection of appropriate eye wear to protect against reflections of laser radiation.

Acoustical noise

The noise generated by laser beam welding, cutting, or gouging may impair hearing. Hearing protection shall be worn where the noise level exceeds limits as specified by the regulatory authority having jurisdiction Since operators and nearby personnel can be exposed to noise levels in excess of 85 dB(A), it is important that their hearing be protected. The most direct way to control excessive noise is to reduce the intensity at the source or install barriers in the final laser cutting system between the source and the operator station(s). When engineering or administrative control methods fail to bring noise exposure within levels established by the appropriate regulatory authority having jurisdiction, personal protective devices such as earmuffs or earplugs shall be used. It is the responsibility of the machine builder and the body responsible for the implementation of workplace / laser safety at the installed site to measure the acoustical noise in application and ensure personnel are protected from noise levels that exceed limits.

Warning signs

Warning signs shall be posted in conspicuous areas to indicate laser and cutting hazards. The signs shall indicate the need for the appropriate types of protective equipment.

Gas, fumes and air quality

Fumes and gases are generated by removal of metal from the workpiece being cut during laser beam cutting. The body responsible for workplace / laser safety at the installed site needs to control the materials being cut. Before cutting any unfamiliar materials or using any unfamiliar cleaning materials, the Material Safety Data Sheet (MSDS) shall be read to determine whether any hazards may exist when the material removed will be converted to a gas by laser cutting.

Personnel shall not be exposed to concentrations of airborne contaminants above acceptable limits as established by the authority having jurisdiction. The most direct way to control fumes and gases is by ventilation. Air Quality permits may be needed to release fumes outside the building. Consult a local expert for information on local air quality permits, ventilation and fume extraction. Where ventilation alone cannot protect personnel, appropriate personal respiratory protection shall be used as required by the authority having jurisdiction. Where respirators are employed, requirements for the selection and use of respirators shall include, as a minimum, the following:

A. Written procedures for the proper care, use, maintenance, and storage of respirators shall be provided, and the employer shall ensure that these procedures are followed. These procedures shall be developed and set down in writing in consultation with the joint health and safety committee or the health and safety representative, as applicable; and made readily accessible, along with related schedules, to the welder and welding personnel.

B. The OEM laser cutting end product recommended maintenance and cleaning schedules and procedures shall be followed.

C. Adequate and suitable storage facilities for respirators shall be provided.

D. A person with the appropriate skills and knowledge shall be assigned to examine respirators and carry out the tests or procedures necessary to ensure that they serve their intended purpose; and ensure that the respirators fit the individual workers correctly and are appropriate for their intended purpose.

E. The employer shall provide training and instruction for workers and supervisors on the proper use, care, maintenance, and storage of respirators.

For fume and gases air sampling, where concentrations of airborne fume contaminants are to be determined by sampling of the atmosphere, sampling shall be tested using the NIOSH methodology, other recognized methods, or the guidelines of the authority having jurisdiction. When a helmet is worn, the samples shall be collected inside the helmet in the operator's breathing zone. The occupational exposure limits shall comply with the regulatory authority having jurisdiction. Contaminant and fume analysis in the lab is covered under two areas:

A. Total welding fume particulate (mg/m3).

B. An elemental analysis of each contaminant (mg/m3). The contaminant particulate and fume testing is important to determine the exposure risk to personnel.

Confined spaces

Confined spaces are defined specifically in the codes and regulations that apply to each work project. Confined spaces need to be considered when the access or egress of personnel is restricted and there is a potential for the accumulation of a hazardous gas, fume, vapor, and dust, or the development of an oxygen-deficient or oxygen-enriched atmosphere that is likely to affect the health and safety of a worker.

If needed, the body responsible for the implementation of workplace / laser safety at the installed site shall have written rescue procedures for confined space emergencies. Before the operator or service personnel enters a confined space to undertake any welding, cutting, or allied process, the personnel shall be informed of and understand the hazards of the confined space and receive instruction on safe procedures for entering, working in, and exiting from the confined space.

Before a person enters a confined space, a leak test should be done on all joints of any hose or pipelines that have the potential to introduce gases into the confined space. This leak test is done in order to eliminate the possibility of gases being introduced into the confined space.

Oxygen gas distribution for laser cutting

Oxygen distribution system including connections and valves shall be approved by the regulatory authority having jurisdiction.

- Each outlet on the service piping from which oxygen is withdrawn to supply a portable outlet header shall be equipped with a readily accessible shutoff valve.
- Each service outlet on portable outlet headers shall be provided with a check valve, a readily accessible shutoff valve, and a detachable outlet seal cap that is chained or otherwise attached to the body of the valve.
- Master shutoff valves for oxygen shall be provided at the entry end of the portable outlet header.
- Portable outlet headers for fuel gas service shall be provided with an approved hydraulic backpressure valve installed at the inlet and preceding the service outlets, unless an approved pressure-reducing regulator, an approved backflow check valve, or an approved hydraulic backpressure valve is installed at each outlet. Outlets provided on headers for oxygen service may be fitted for use with pressure-reducing regulators or for direct hose connection.
- Hose for oxygen-fuel gas service shall meet the requirements of RMA IP-7 and CGA E-1.
- Cylinder manifolds, shutoff valves, pressure-reducing regulators, backpressure valves, hoses and connections shall be installed under the supervision of someone properly trained in their assembly and use.

In North America, hose diameters of 19 mm (3/4 in) or smaller are color-coded green for oxygen and red for fuel gases (acetylene, liquefied petroleum gases (LPG), natural gas, hydrogen, etc.). Black hose is used for inert gases, compressed air, and water services.

Note: ISO standard colors are blue for oxygen hose and orange for LPG hose.

Public exhibitions and demonstrations

Safety precautions specific to welding and cutting performed at public demonstrations and exhibits shall protect viewers, demonstrators, and the public. Installation and operation of welding, cutting, and related equipment shall be under the supervision of a competent person designated to ensure the safety of the public. The site shall be so constructed, equipped, and operated as to minimize the possibility of injury to viewers at the site. Materials and equipment on-site shall be located so as not to interfere with evacuation of people during an emergency. Sites shall be provided with an appropriate type of portable fire extinguisher. Combustible materials at the site shall be shielded from flames, sparks, and molten metal or moved to a safe distance, i.e., 15 m (50 ft). The fire department shall be notified in advance of the public exhibition and demonstration. The public shall be shielded from flames, flying sparks, molten metal, harmful laser radiation, inhalation of hazardous concentrations of fumes and gases and contact with live electrical arts.

Large area viewing

For large area viewing, such as training, demonstrations, shows, and certain automatic laser welding and cutting operations, a large filter window or curtain may be used rather than individual helmets, hand shields, or goggles. It is important to specifically check both the wavelength and optical density for a large filter window or curtain. A combination of windows or curtains and laser safety eye wear (LSE) may be used.

Training

The laser safety and basic safety training shall be in accordance with the requirements of the authority having jurisdiction. The course contents should include, as a minimum, elements covering:

A. laser safety
B. basic safety
C. hazard identification, including:
    a. electrical hazards
    b. fire protection and prevention
    c. burns
    d. radiation
    e. fumes and gases
    f. noise
    g. explosions
D. hazard controls
E. personal protective equipment
F. process-specific welding and cutting safety
G. ergonomic issues
H. care and maintenance of OEM laser cutting end product

Additional training shall be provided on the following subjects if applicable to the nature of work being performed:

A. elevated work and fall protection
B. material handling (basic rigging, hoisting, forklift, etc.)
C. confined spaces
D. welding or cutting of drums and containers
E. work permit systems and policies

Introduction

Hypertherm maintains a global Regulatory Management System to ensure that products comply with regulatory and environmental requirements.

National and local safety regulations

National and Local safety regulations shall take precedence over any instructions provided with the product. The product shall be imported, installed, operated and disposed of in accordance with national and local regulations applicable to the installed site.

Certification test marks

Certified products are identified by one or more certification test marks from accredited testing laboratories. The certification test marks are located on or near the data plate.

Each certification test mark means that the product and its safety-critical components conform to the relevant national safety standards as reviewed and determined by that testing laboratory. Hypertherm places a certification test mark on its products only after that product is manufactured with safety-critical components that have been authorized by the accredited testing laboratory.

Once the product has left the Hypertherm factory, the certification test marks are invalidated if any of the following occurs:

- The product is modified in a manner that creates a hazard or non-conformance with the applicable standards.
- Safety-critical components are replaced with unauthorized spare parts.
- Any unauthorized assembly, or accessory that uses or generates a hazardous voltage is added.
- There is any tampering with a safety circuit or other feature that is designed into the product as part of the certification, or otherwise.

CE marking constitutes a manufacturer's declaration of conformity to applicable European directives and standards. Only those versions of Hypertherm products with a CE Marking located on or near the data plate have been tested for compliance with the European Low Voltage Directive and the European EMC Directive. EMC filters needed to comply with the European EMC Directive are incorporated within versions of the power supply with a CE Marking.

Certificates of compliance for Hypertherm products are available from the Downloads Library on the Hypertherm web site at

https://www.hypertherm.com.

Differences in national standards

Nations may apply different performance, safety or other standards. National differences in standards include, but are not limited to:

- Voltages
- Plug and cord ratings
- Language requirements
- Electromagnetic compatibility requirements

These differences in national or other standards may make it impossible or impractical for all certification test marks to be placed on the same version of a product. For example, the CSA versions of Hypertherm's products do not comply with European EMC requirements, and therefore do not have a CE marking on the data plate.

Countries that require CE marking or have compulsory EMC regulations must use CE versions of Hypertherm products with the CE marking on the data plate. These include, but are not limited to:

- Australia
- New Zealand
- Countries in the European Union
- Russia

It is important that the product and its certification test mark be suitable for the end-use installation site. When Hypertherm products are shipped to one country for export to another country; the product must be configured and certified properly for the end-use site.

Safe installation and use of shape cutting equipment

IEC 60974-9, titled Arc Welding Equipment – Installation and use, provides guidance in the safe installation and use of shape cutting equipment and the safe performance of cutting operations. The requirements of national and local regulations shall be taken into consideration during installation, including, but not limited to, grounding or

protective earth connections, fuses, supply disconnecting device, and type of supply circuit. Read these instructions before installing the equipment. The first and most important step is the safety assessment of the installation.

The safety assessment must be performed by an expert, and determines what steps are necessary to create a safe environment, and what precautions should be adopted during the actual installation and operation.

Procedures for periodic inspection and testing

Where required by local national regulations, IEC 60974-4 specifies test procedures for periodic inspection and after repair or maintenance, to ensure electrical safety for plasma cutting power sources built in conformity with IEC 60974-1. Hypertherm performs the continuity of the protective circuit and insulation resistance tests in the factory as non-operating tests. The tests are performed with the power and ground connections removed.

Hypertherm also removes some protective devices that would cause false test results. Where required by local national regulations, a label shall be attached to the equipment to indicate that it has passed the tests prescribed by IEC60974-4. The repair report shall indicate the results of all tests unless an indication is made that a particular test has not been performed.

Qualification of test personnel

Electrical safety tests for shape cutting equipment can be hazardous and shall be carried out by an expert in the field of electrical repair, preferably someone also familiar with welding, cutting, and allied processes. The safety risks to personnel and equipment, when unqualified personnel are performing these tests, may be much greater than the benefit of periodic inspection and testing.

Hypertherm recommends that only visual inspection be performed unless the electrical safety tests are specifically required by local national regulations in the country where the equipment is installed.

Residual current devices (RCDs)

In Australia and some other countries, local codes may require the use of a Residual Current Devices (RCD) when portable electrical equipment is used in the workplace or at construction sites to protect operators from electrical faults in the equipment. RCDs are designed to safely disconnect the mains electrical supply when an imbalance is detected between the supply and return current (there is a leakage current to earth). RCDs are available with both fixed and adjustable trip currents between 6 to 40 milliamperes and a range of trip times up to 300 milliseconds selected for the equipment installation, application and intended use. Where RCDs are used, the trip current and trip time on RCDs should be selected or adjusted high enough to avoid nuisance tripping during normal operation of the plasma cutting equipment and low enough in the extremely unlikely event of an electrical fault in the equipment to disconnect the supply before the leakage current under a fault condition can pose a life threatening electrical hazard to operators.

To verify that the RCDs continue to function properly over time, both the trip current and the trip time should be tested periodically. Portable electrical equipment and RCDs used in commercial and industrial areas in Australia and New Zealand are tested to the Australian standard AS/NZS 3760. When you test the insulation of plasma cutting equipment to AS/NZS 3760, measure the insulation resistance according to Appendix B of the standard, at 250 VDC with the power switch in the ON position to verify proper testing and to avoid the false failure of the leakage current test. False failures are possible because the metal oxide varistors (MOVs) and electromagnetic compatibility (EMC) filters, used to reduce emissions and protect the equipment from power surges, may conduct up to 10 milliamperes leakage current to earth under normal conditions.

If you have any questions regarding the application or interpretation of any IEC standards described here, you are required to consult with an appropriate legal or other advisor familiar with the International Electrotechnical standards, and shall not rely on Hypertherm in any respect regarding the interpretation or application of such standards.

Higher-level systems

When a system integrator adds additional equipment; such as cutting tables, motor drives, motion controllers or robots; to a Hypertherm plasma cutting system, the combined system may be considered a higher-level system. A higher-level system with hazardous moving parts may constitute industrial machinery or robotic equipment, in which case the OEM or end-use customer may be subject to additional regulations and standards than those relevant to the plasma cutting system as manufactured by Hypertherm.

It is the responsibility of the end-use customer and the OEM to perform a risk assessment for the higher-level system, and to provide protection against hazardous moving parts. Unless the higher-level system is certified when the OEM incorporates Hypertherm products into it, the installation also may be subject to approval by local authorities. Seek advice from legal counsel and local regulatory experts if you are uncertain about compliance.

External interconnecting cables between component parts of the higher level system must be suitable for contaminants and movement as required by the final end use installation site. When the external interconnecting cables are subject to oil, dust, water, or other contaminants, hard usage ratings may be required.

When external interconnecting cables are subject to continuous movement, constant flexing ratings may be required. It is the responsibility of the end-use customer or the OEM to ensure the cables are suitable for the application. Since there are differences in the ratings and costs that can be required by local regulations for higher level systems, it is necessary to verify that any external interconnecting cables are suitable for the end-use installation site.

Introduction

The Hypertherm Environmental Specification requires RoHS, WEEE and REACH substance information to be provided by Hypertherm's suppliers.

Product environmental compliance does not address the indoor air quality or environmental release of fumes by the end user. Any materials that are cut by the end user are not provided by Hypertherm with the product. The end user is responsible for the materials being cut as well as for safety and air quality in the workplace. The end user must be aware of the potential health risks of the fumes released from the materials being cut and comply with all local regulations.

National and local environmental regulations

National and local environmental regulations shall take precedence over any instructions contained in this manual.

The product shall be imported, installed, operated and disposed of in accordance with all national and local environmental regulations applicable to the installed site.

The European Environmental regulations are discussed later in *The WEEE Directive*.

The RoHS directive

Hypertherm is committed to complying with all applicable laws and regulations, including the European Union Restriction of Hazardous Substances (RoHS) Directive that restricts the use of hazardous materials in electronics products. Hypertherm exceeds RoHS Directive compliance obligations on a global basis.

Hypertherm continues to work toward the reduction of RoHS materials in our products, which are subject to the RoHS Directive, except where it is widely recognized that there is no feasible alternative.

Declarations of RoHS Conformity have been prepared for the current CE versions of Powermax plasma cutting systems manufactured by Hypertherm. There is also a "RoHS mark" on the Powermax CE versions below the "CE Marking" on the data plate of CE versions of Powermax series units shipped since 2006. Parts used in CSA versions of Powermax and other products manufactured by Hypertherm that are either out of scope or exempt from RoHS are continuously being converted to RoHS compliance in anticipation of future requirements.

Proper disposal of Hypertherm products

Hypertherm plasma cutting systems, like all electronic products, may contain materials or components, such as printed circuit boards, that cannot be discarded with ordinary waste. It is your responsibility to dispose of any Hypertherm product or component part in an environmentally acceptable manner according to national and local codes.

- In the United States, check all federal, state, and local laws.
- In the European Union, check the EU directives, national, and local laws. For more information, visit www.hypertherm.com/weee.
- In other countries, check national and local laws.
- Consult with legal or other compliance experts when appropriate.

The WEEE directive

On January 27, 2003, the European Parliament and the Council of the European Union authorized Directive 2002/96/EC or WEEE (Waste Electrical and Electronic Equipment).

As required by the legislation, any Hypertherm product covered by the directive and sold in the EU after August 13, 2005 is marked with the WEEE symbol. This directive encourages and sets specific criteria for the collection, handling, and recycling of EEE waste. Consumer and business-to-business wastes are treated differently (all Hypertherm products are considered business-to-business). Disposal instructions for the CE versions of Powermax plasma systems can be found at www.hypertherm.com/weee.

The URL is printed on the symbol-only warning label for each of these CE version Powermax series units shipped since 2006. The CSA versions of Powermax and other products manufactured by Hypertherm are either out of scope or exempt from WEEE.

The REACH regulation

The REACH regulation (1907/2006), in force since June 1, 2007, has an impact on chemicals available to the European market. The REACH regulation requirements for component manufacturers states that the component shall not contain more than 0.1% by weight of the Substances of Very High Concern (SVHC).

Component manufacturers and other downstream users, such as Hypertherm, are obligated to obtain assurances from its suppliers that all chemicals used in or on Hypertherm products will have a European Chemical Agency (ECHA) registration number. To provide chemical information as required by the REACH regulation, Hypertherm requires suppliers to provide REACH declarations and identify any known use of REACH SVHC. Any use of SVHC in amounts exceeding 0.1% w/w of the parts has been eliminated. The MSDS contains a full disclosure of all substances in the chemical and can be used to verify REACH SVHC compliance.

The lubricants, sealants, coolants, adhesives, solvents, coatings and other preparations or mixtures used by Hypertherm in, on, for, or with its shape cutting equipment are used in very small quantities (except the coolant) and are commercially available with multiple sources that can and will be replaced in the event of a supplier problem associated with REACH Registration or REACH Authorization (SVHCs).

Proper handling and safe use of chemicals

Chemical Regulations in the USA, Europe, and other locations require that Material Safety Data Sheets (MSDS) be made available for all chemicals. The list of chemicals is provided by Hypertherm. The MSDS are for chemicals provided with the product and other chemicals used in or on the product. MSDS can be downloaded from the Downloads Library on the Hypertherm web site at https://www.hypertherm.com. On the Search screen, insert MSDS in the document title and click on Search.

In the USA, OSHA does not require Material Safety Data Sheets for articles such as electrodes, swirl rings, retaining caps, nozzles, shields, deflectors and other solid parts of the torch.

Hypertherm does not manufacture or provide the materials that are cut and has no knowledge whether the fumes released from materials that are cut will pose a physical hazard or health risk. Please consult with your supplier or other technical advisor if you need guidance concerning the properties of the material you will cut using a Hypertherm product.

Fumes emission and air quality

Note: The following information on air quality is intended for general information only and should not be used as a substitute for reviewing and implementing applicable government regulations or legal standards in the country where the cutting equipment will be installed and operated.

In the USA, the National Institute for Occupational Safety and Health (NIOSH) Manual of Analytical Methods (NMAM) is a collection of methods for sampling and analyzing contaminants in workplace air. Methods published by others, such as OSHA, MSHA, EPA, ASTM, ISO or commercial suppliers of sampling and analytical equipment, may have advantages over NIOSH methods.

For example, ASTM Practice D 4185 is a standard practice for the collection, dissolution, and determination of trace metals in workplace atmospheres. The sensitivity, detection limit, and optimum working concentrations for 23 metals are listed in ASTM D 4185. An industrial hygienist should be used to determine the optimum sampling protocol, considering analytical accuracy, cost, and optimum sample number. Hypertherm uses a third party industrial hygienist to perform and interpret air quality testing results taken by air sampling equipment positioned at operator stations in Hypertherm buildings where plasma cutting tables are installed and operated.

Where applicable, Hypertherm also uses a third party industrial hygienist to obtain air and water permits.

If you are not fully aware and up to date on all applicable government regulations and legal standards for the installation site, you should consult a local expert prior to purchasing, installing, and operating the equipment.

Introduction

Hypertherm's CE-marked equipment is built in compliance with standard EN60974-10. The equipment should be installed and used in accordance with the information below to achieve electromagnetic compatibility.

The limits required by EN60974-10 may not be adequate to completely eliminate interference when the affected equipment is in close proximity or has a high degree of sensitivity. In such cases it may be necessary to use other measures to further reduce interference.

This cutting equipment is designed for use only in an industrial environment.

Installation and use

The user is responsible for installing and using the cutting equipment according to the manufacturer's instructions.

If electromagnetic disturbances are detected then it shall be the responsibility of the user to resolve the situation with the technical assistance of the manufacturer. In some cases this remedial action may be as simple as earthing the cutting circuit, see *Earthing of the work piece*. In other cases, it could involve constructing an electromagnetic screen enclosing the power source and the work complete with associated input filters. In all cases, electromagnetic disturbances must be reduced to the point where they are no longer troublesome.

Assessment of area

Before installing the equipment, the user shall make an assessment of potential electromagnetic problems in the surrounding area. The following shall be taken into account:

a. Other supply cables, control cables, signaling and telephone cables; above, below and adjacent to the cutting equipment.

b. Radio and television transmitters and receivers.

c. Computer and other control equipment.

d. Safety critical equipment, for example guarding of industrial equipment.

e. Health of the people around, for example the use of pacemakers and hearing aids.

f. Equipment used for calibration or measurement.

g. Immunity of other equipment in the environment. User shall ensure that other equipment being used in the environment is compatible. This may require additional protection measures.

h. Time of day that cutting or other activities are to be carried out.

The size of the surrounding area to be considered will depend on the structure of the building and other activities that are taking place. The surrounding area may extend beyond the boundaries of the premises.

Methods of reducing emissions

Mains supply

Cutting equipment must be connected to the mains supply according to the manufacturer's recommendations. If interference occurs, it may be necessary to take additional precautions such as filtering of the mains supply.

Consideration should be given to shielding the supply cable of permanently installed cutting equipment, in metallic conduit or equivalent. Shielding should be electrically continuous throughout its length. The shielding should be connected to the cutting mains supply so that good electrical contact is maintained between the conduit and the cutting power source enclosure.

Maintenance of cutting equipment

The cutting equipment must be routinely maintained according to the manufacturer's recommendations. All access and service doors and covers should be closed and properly fastened when the cutting equipment is in operation. The cutting equipment should not be modified in any way, except as set forth in and in accordance with the manufacturer's written instructions.

Cutting cables

The cutting cables should be kept as short as possible and should be positioned close together, running at or close to the floor level.

Equipotential bonding

Bonding of all metallic components in the cutting installation and adjacent to it should be considered.

However, metallic components bonded to the workpiece will increase the risk that the operator could receive a shock by touching these metallic components and the electrode (nozzle for laser heads) at the same time.

The operator should be insulated from all such bonded metallic components.

Earthing of the workpiece

Where the workpiece is not bonded to earth for electrical safety, nor connected to earth because of its size and position, for example, ship's hull or building steel work, a connection bonding the workpiece to earth may reduce emissions in some, but not all instances. Care should be taken to prevent the earthing of the workpiece increasing the risk of injury to users, or damage to other electrical equipment. Where necessary, the connection of the workpiece to earth should be made by a direct connection to the workpiece, but in some countries where direct connection is not permitted, the bonding should be achieved by suitable capacitances selected according to national regulations.

Note: The cutting circuit may or may not be earthed for safety reasons. Changing the earthing arrangements should only be authorized by a person who is competent to assess whether the changes will in crease the risk of injury, for example, by allowing parallel cutting current return paths which may damage the earth circuits of other equipment. Further guidance is provided in IEC 60974-9, Arc Welding Equipment, Part 9: Installation and Use.

Screening and shielding

Selective screening and shielding of other cables and equipment in the surrounding area may alleviate problems of interference. Screening of the entire cutting system may be considered for special applications.

Attention

Genuine Hypertherm parts are the factory-recommended replacement parts for your Hypertherm system. Any damage or injury caused by the use of other than genuine Hypertherm parts may not be covered by the Hypertherm warranty, and will constitute misuse of the Hypertherm Product.

You are solely responsible for the safe use of the Product. Hypertherm does not and cannot make any guarantee or warranty regarding the safe use of the product in your environment.

General

Hypertherm, Inc. warrants that its Products shall be free from defects in materials and workmanship for the specific periods of time set forth herein and as follows: if Hypertherm is notified of a defect (i) with respect to the plasma power supply within a period of two (2) years from the date of its delivery to you, with the exception of Powermax brand power supplies, which shall be within a period of three (3) years from the date of delivery to you, and (ii) with respect to the torch and leads within a period of one (1) year from its date of delivery to you, and with respect to torch lifter assemblies within a period of one (1) year from its date of delivery to you, and with respect to Automation products one (1) year from its date of delivery to you, with the exception of the EDGE Pro CNC and ArcGlide THC, which shall be within a period of two (2) years from the date of delivery to you, and (iii) with respect to HyIntensity fiber laser components within a period of two (2) years from the date of its delivery to you, with the exception of laser heads and beam delivery optical cables, which shall be within a period of one (1) year from its date of delivery to you.

This warranty shall not apply to any Powermax brand power supplies that have been used with phase converters. In addition, Hypertherm does not warranty systems that have been damaged as a result of poor power quality, whether from phase converters or incoming line power. This warranty shall not apply to any product which has been incorrectly installed, modified, or otherwise damaged.

Hypertherm provides repair, replacement or adjustment of the Product as the sole and exclusive remedy, if and only if the warranty set forth herein properly is invoked and applies. Hypertherm, at its sole option, shall repair, replace, or adjust, free of charge, any defective Products covered by this warranty which shall be returned with Hypertherm's prior authorization (which shall not be unreasonably withheld), properly packed, to Hypertherm's place of business in Hanover, New Hampshire, or to an authorized Hypertherm repair facility, all costs, insurance and freight pre paid by the customer. Hypertherm shall not be liable for any repairs, replacement, or adjustments of Products covered by this warranty, except those made pursuant to this paragraph and with Hypertherm's prior written consent.

The warranty set forth above is exclusive and is in lieu of all other warranties, express, implied, statutory, or otherwise with respect to the Products or as to the results which may be obtained therefrom, and all implied warranties or conditions of quality or of merchantability or fitness for a particular purpose or against infringement. The foregoing shall constitute the sole and exclusive remedy for any breach by Hypertherm of its warranty.

Distributors/OEMs may offer different or additional warranties, but Distributors/OEMs are not authorized to give any additional warranty protection to you or make any representation to you purporting to be binding upon Hypertherm.

Patent indemnity

Except only in cases of products not manufactured by Hypertherm or manufactured by a person other than Hypertherm not in strict conformity with Hypertherm's specifications and in cases of designs, processes, formulae, or combinations not developed or purported to be developed by Hypertherm, Hypertherm will have the right to defend or settle, at its own expense, any suit or proceeding brought against you alleging that the use of the Hypertherm product, alone and not in combination with any other product not supplied by Hypertherm, infringes any patent of any third party. You shall notify Hypertherm promptly upon learning of any action or threatened action in connection with any such alleged infringement (and in any event no longer than fourteen (14) days after learning of any action or threat of action), and Hypertherm's obligation to defend shall be conditioned upon Hypertherm's sole control of, and the indemnified party's cooperation and assistance in, the defense of the claim.

Limitation of liability

In no event shall Hypertherm be liable to any person or entity for any incidental, consequential direct, indirect, punitive or exemplary damages (including but not limited to lost profits) regardless of whether such liability is based on breach of contract, tort, strict liability, breach of warranty, failure of essential purpose, or otherwise, and even if advised of the possibility of such damages.

National and local codes

National and local codes governing plumbing and electrical installation shall take precedence over any instructions contained in this manual. In no event shall Hypertherm be liable for injury to persons or property damage by reason of any code violation or poor work practices.

Liability cap

In no event shall Hypertherm's liability, if any, whether such liability is based on breach of contract, tort, strict liability, breach of warranties, failure of essential purpose or otherwise, for any claim, action, suit or proceeding (whether in court, arbitration, regulatory proceeding or otherwise) arising out of or relating to the use of the Products exceed in the aggregate the amount paid for the Products that gave rise to such claim.

Insurance

At all times you will have and maintain insurance in such quantities and types, and with coverage sufficient and appropriate to defend and to hold Hypertherm harmless in the event of any cause of action arising from the use of the products.

Transfer of rights

You may transfer any remaining rights you may have hereunder only in connection with the sale of all or substantially all of your assets or capital stock to a successor in interest who agrees to be bound by all of the terms and conditions of this Warranty. Within thirty (30) days before any such transfer occurs, you agree to notify in writing Hypertherm, which reserves the right of approval. Should you fail timely to notify Hypertherm and seek its approval as set forth herein, the Warranty set forth herein shall be null and void and you will have no further recourse against Hypertherm under the Warranty or otherwise.

Section 1

SPECIFICATIONS

Fiber laser supply

Overview

The HyIntensity Fiber Laser (HFL) is a laser system based on all solid state components. The fiber laser supply contains two to six laser engines and a beam combiner unit. Incoming electricity is converted to optical power by single emitter based pump laser diodes in each engine, which is converted to a high brightness infrared (non-visible) laser beam. Light from each of the laser engines enters the beam combiner unit which funnels the light into a single output fiber. This configuration has a wall plug electrical to optical output power efficiency greater than 28%. All of the optical components are water cooled to provide stable operation. A dehumidifier in the fiber laser supply maintains the humidity level inside the cabinet enclosure.

Fiber laser supplies	
Part number	**Description**
051041	HFL010 — 1.0 kW fiber laser supply, with the fiber coupling unit, 400-480 VAC, 50/60 Hz
051042	HFL010 — 1.0 kW fiber laser supply, without the fiber coupling unit, 400-480 VAC, 50/60 Hz
051023	HFL015 — 1.5 kW fiber laser supply, with the fiber coupling unit, 400-480 VAC, 50/60 Hz
051043	HFL015 — 1.5 kW fiber laser supply, without the fiber coupling unit, 400-480 VAC, 50/60 Hz
051039	HFL020 — 2.0 kW fiber laser supply, with the fiber coupling unit, 400-480 VAC, 50/60 Hz
051044	HFL020 — 2.0 kW fiber laser supply, without the fiber coupling unit, 400-480 VAC, 50/60 Hz
051048	HFL030 — 3.0 kW fiber laser supply, with the fiber coupling unit, 440-480 VAC 50/60 Hz
051053	HFL030 — 3.0 kW fiber laser supply, without the fiber coupling unit, 440-480 VAC 50/60 Hz
051049	HFL030 — 3.0 kW fiber laser supply, with the fiber coupling unit, 380-400 VAC 50/60 Hz
051052	HFL030 — 3.0 kW fiber laser supply, without the fiber coupling unit, 380-400 VAC 50/60 Hz

Requirements

Electrical

HFL010, 015, 020 Input power ..... 400-480 VAC, 50/60 Hz (+/- 10%), 3 phase, 10 KVa
HFL030 (051048 and 051053) Input power ..... 440-480 VAC, 50/60 Hz (+/- 10%), 3 phase, 15 KVa
HFL030 (051049 and 051052) Input power ..... 380-400 VAC, 50/60 Hz (+/- 10%), 3 phase, 15 KVa

Note: The customer should permanently wire the fiber laser supply using a 3 phase, 30 amp disconnect.

Input/output (I/O)

Discrete I/O ..... Out: permanently wired, +24 VDC relay, 100 mA
In: optically isolated, +24 VDC
Analog I/O ..... 0-10 VDC

Coolant ..... See *Chiller requirements* later in this section.

Environmental

This equipment is intended for indoor use only
Operating temperature range ..... 0° C to 40° C (32° F to 104° F)
Humidity ..... 95% relative humidity, non-condensing
Altitude ..... 2000 m (6562 feet) maximum

Safety interlocks

External emergency stop (E-Stop) switch with (2) NO contacts (see the *Installation* section for details)
External door interlock switch with (2) NO contacts
Key switch that is only removable in the OFF position
Momentary switch with Indicator and (1) NO contact

Personal protection equipment

Safety glasses ..... OD 7+ @1040 – 1100 nm
Machine guards ..... Proper guards installed to protect against diffuse and specular laser reflections

Optical specifications

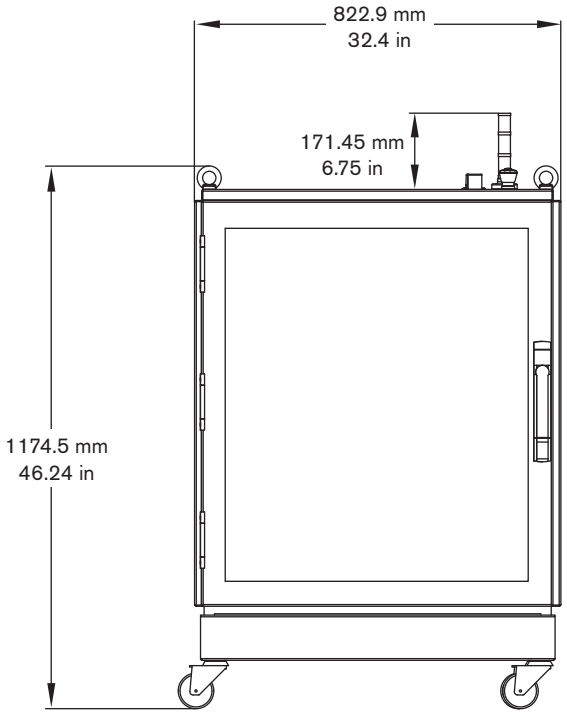
Cutting laser

Operating mode	Continuous wave (CW)
Beam shape	Circular
Wavelength	1070 nm (+/- 10 nm)
Rated output power (CW):	
HFL010	1000 watts
HFL015	1500 watts
HFL020	2000 watts
HFL030	3000 watts
Beam diameter at the focusing lens	6-8 mm with the 60 mm collimator 10-12 mm with the 100 mm collimator
Focusing lens	150 mm effective focal length (EFL)
Laser classification	Class 4

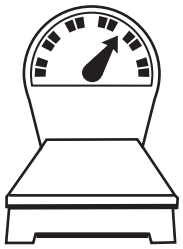
Pointing laser

Operating mode	Continuous wave (CW)
Beam shape	Circular
Wavelength	630 – 680 nm
Rated output power (CW)	
HFL010	<10 mW
HFL015	<15 mW
HFL020	<20 mW
HFL030	<30 mW
Beam diameter at the focusing lens	6
Beam diameter	9 mm
Laser classification	Class 3B

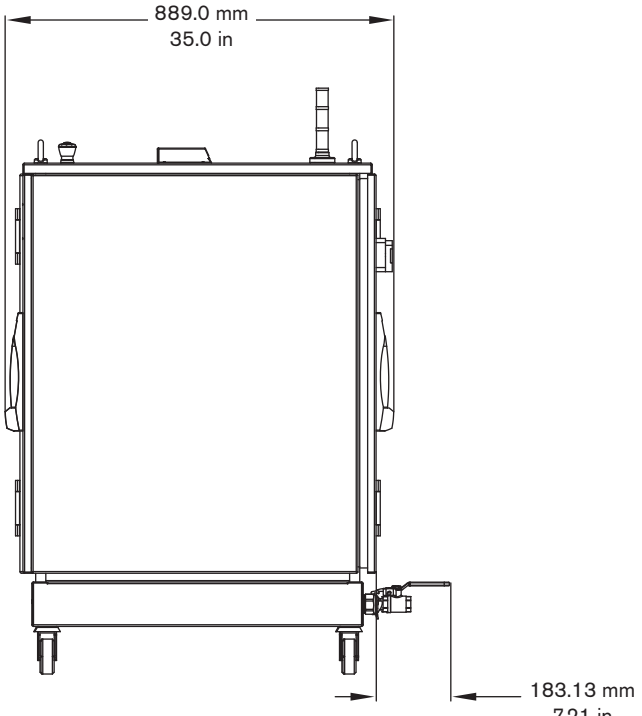
Dimensions – HFL010, HFL015, and HFL020



Front view

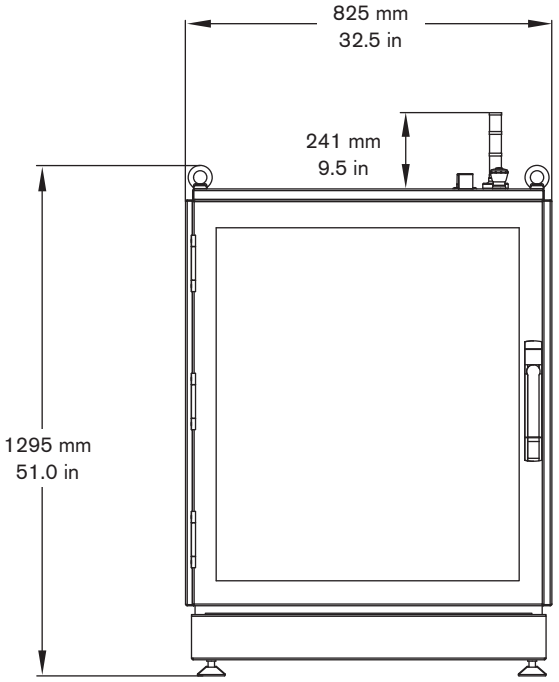


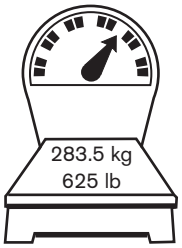
HFL010 — 185 kg (410 lbs)
HFL015 — 204 kg (450 lbs)
HFL020 — 226 kg (500 lbs)



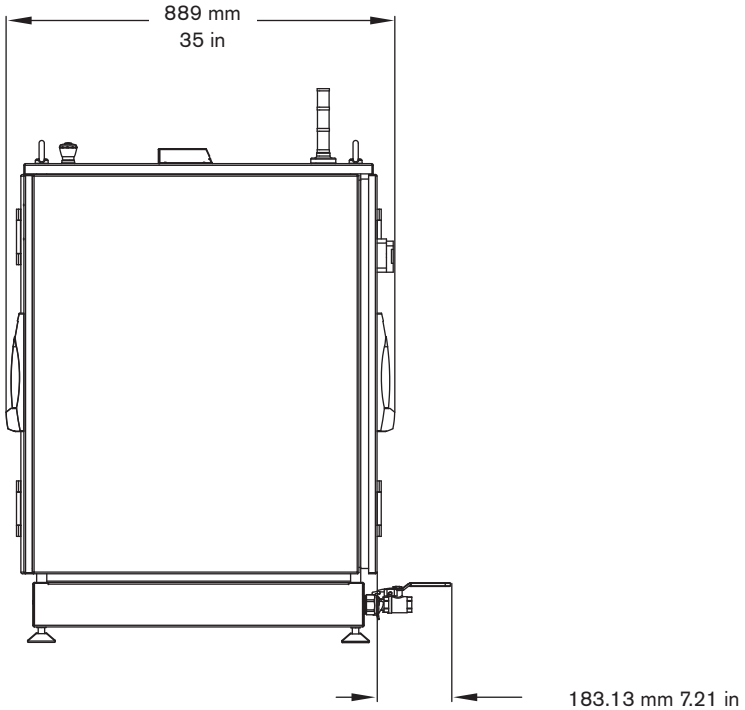
Side view

Dimensions – HFL030





Front view



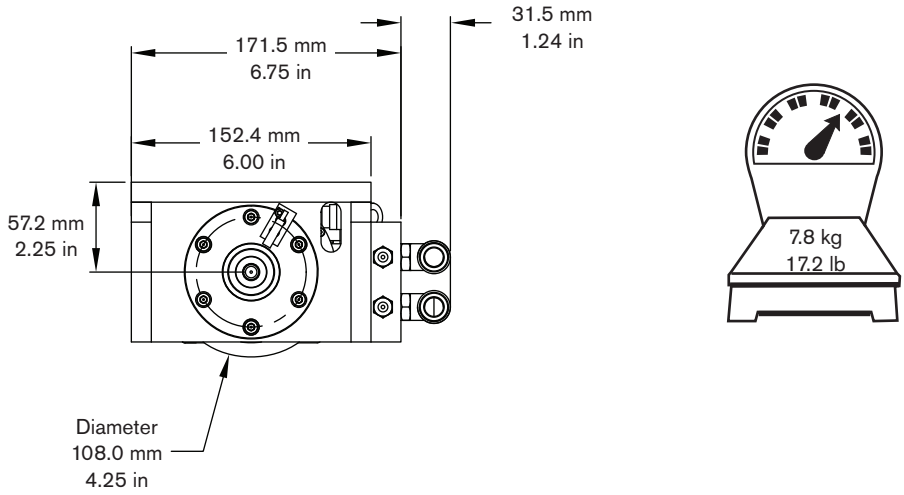
Side view

LF150 laser head – 051025

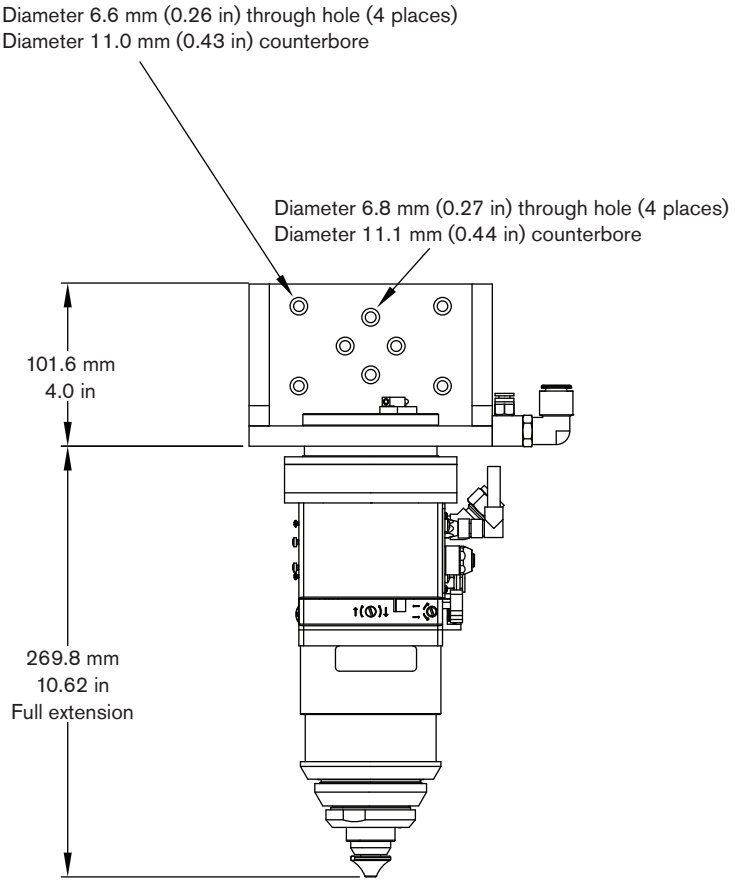
Overview

The LF150 is designed to process material with the HyIntensity Fiber Laser cutting system. The optical design accommodates one 35 mm diameter lens at 150 mm EFL to cover the intended material type and thickness range. Capacitive height sensing between the nozzle and the work piece allows accurate and responsive height positioning. The laser head is protected by a collision mount for lateral and vertical collisions between the nozzle and work piece. The optical path between the collimator and laser head is sealed to prevent particulate and moisture contamination of the optical surfaces. A single cable connects the laser head to the laser head controller and all process signals are communicated back to the fiber laser supply over the Hypernet communications link.

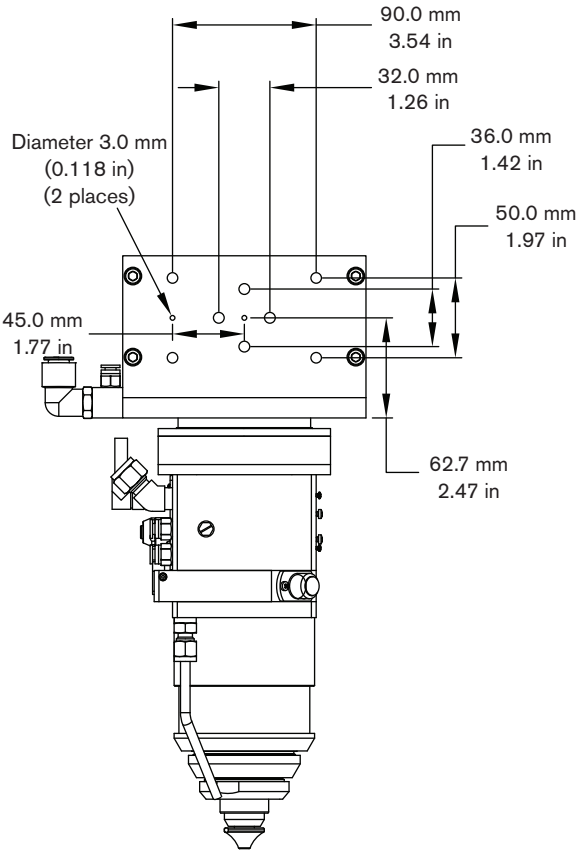
Mounting dimensions



Top view



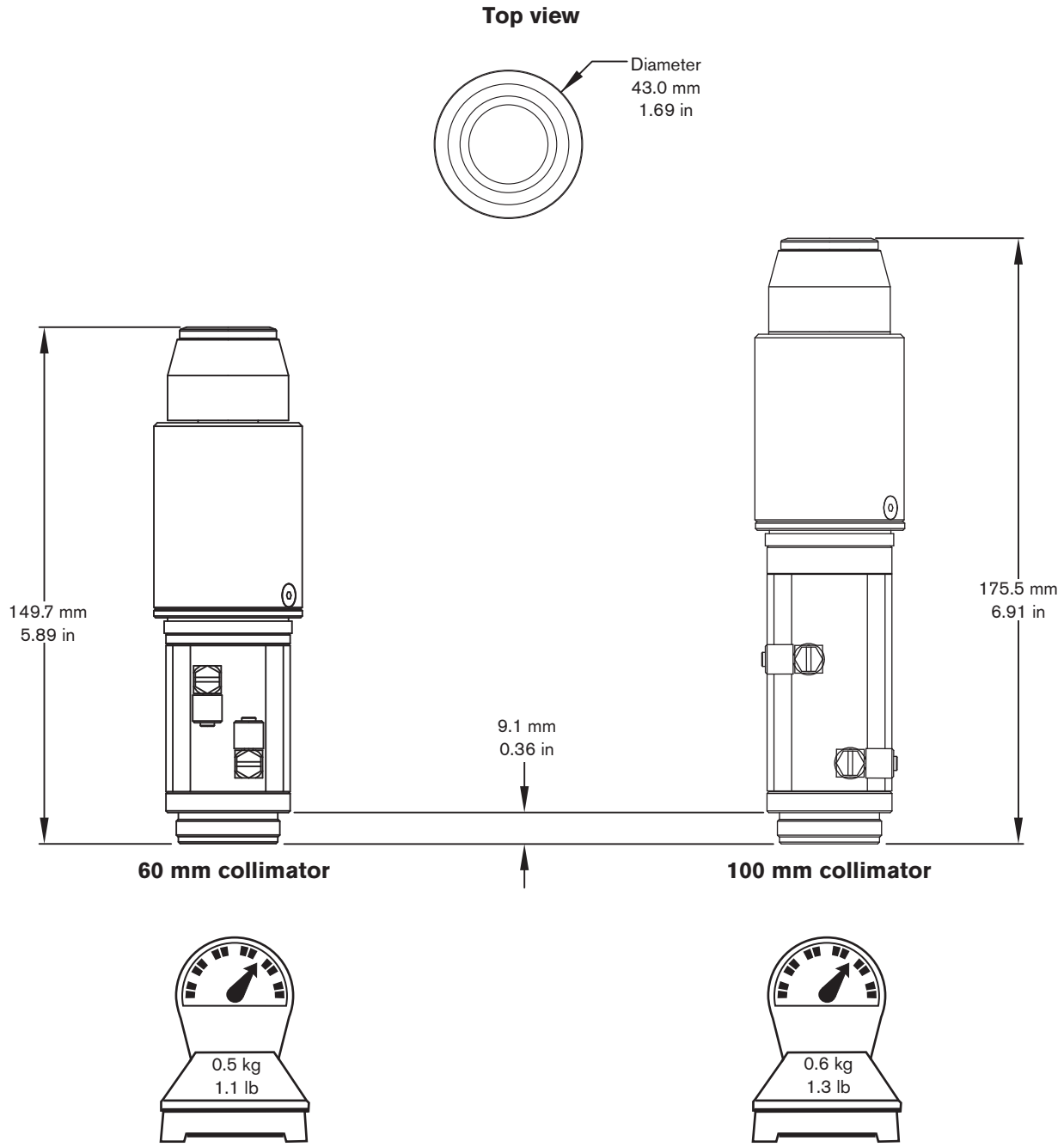
Front view



Rear view

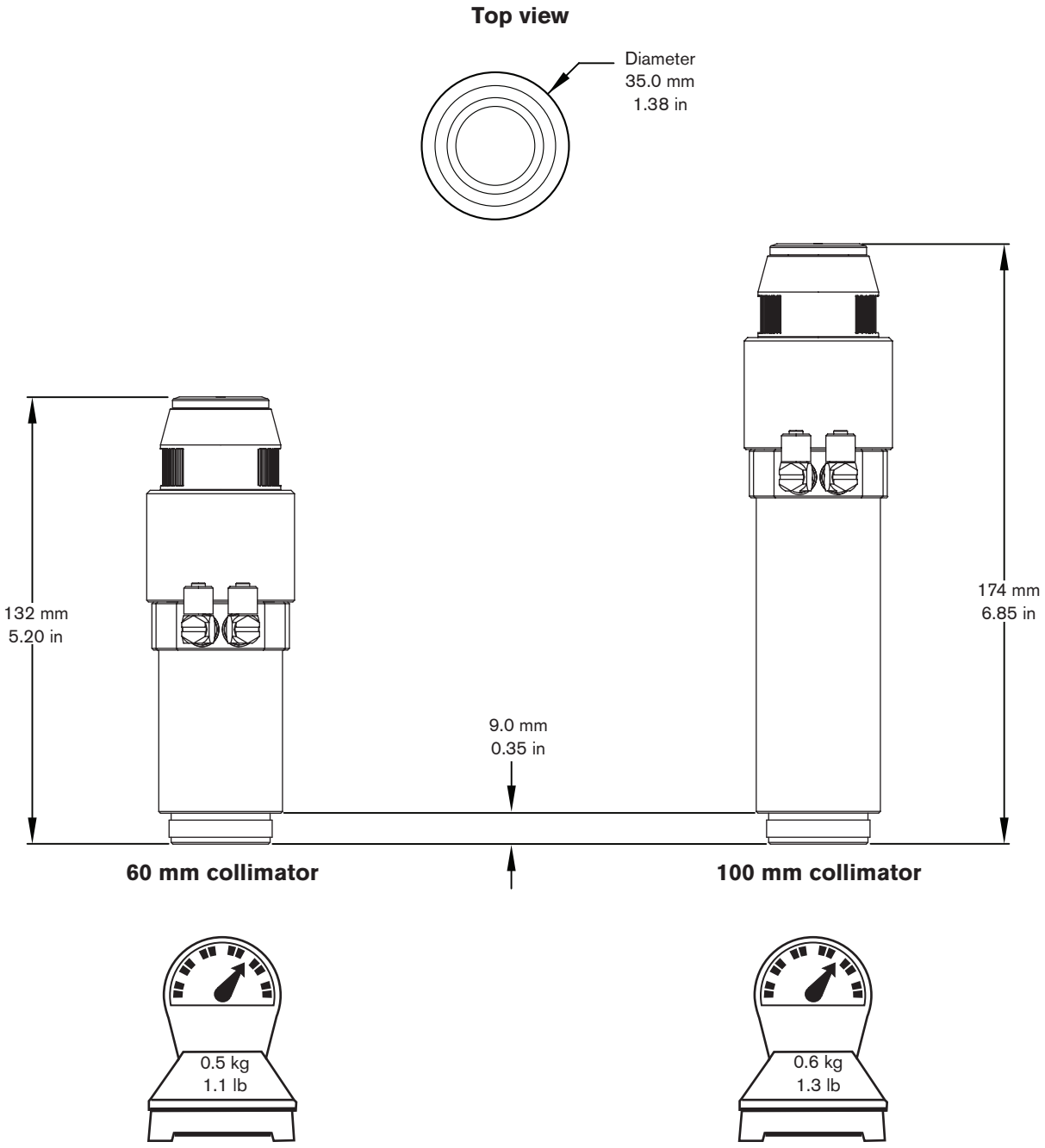
Collimator dimensions

The collimator is installed onto the laser head in the *Installation* section of this manual



Collimator dimensions

The collimator is installed onto the laser head in the *Installation* section of this manual



System gas requirements

Caution:

5 µm filtration is required on oxygen and nitrogen supply lines. Failure to use an acceptable filter can cause poor cut quality and damage to the laser system.

Gas quality and pressure requirements			
Gas type	**Quality**	**Pressure +/- 10%**	**Flow rate**
O_2 oxygen*	99.95% pure Clean, dry, oil-free	800 kPa / 8 bar 116 psi	170 slpm 360 scfh
N_2 nitrogen*	99.5% pure Clean, dry, oil-free	2.7 MPa / 27 bar 400 psi	1600 slpm 3400 scfh
Air*	** Clean, dry, oil-free per ISO 8573-1 Class 1.4.2	900 kPa / 9 bar 130 psi	***250 slpm 530 scfh

* Oxygen, nitrogen, and air are required to be connected at all times

** ISO standard 8573-1 Class 1.4.2 requirements are:

- Particulates – no more than 100 particles per cubic meter of air at a size of 0.1 to 0.5 microns in the largest dimension and 1 particle per cubic meter of air at a size of 0.5 to 5.0 microns in the largest dimension.
- Water – the pressure dew point of the humidity must be less than or equal to 3° C (37.4° F).
- Oil – the concentration of oil can be no more than 0.1 mg per cubic meter of air.

*** If air will not be used as a cut gas, the required pressure and flow rate of the air supply can be reduced:

- Pressure: 500 kPa / 5 bar / 75 psi
- Flow rate: 25 slpm / 53 scfh

Chiller requirements

Caution:

The cooling system must have a filter that allows the coolant to meet the specifications for particles shown below. Failure to use a filter capable of meeting the particle requirements can cause damage to expensive optical components and could be cause for denial of warranty claims on these components.

Coolant

Acceptable types of coolant	Distilled water Drinkable tap water Water/glycol mixture (see “Usage of inhibitors/additives” below) Deionized water is NOT allowed
Particles	< 100 µm in diameter.
Conductivity	50 – 500 microSiemens/cm
pH	5.5 – 9.0
Usage of inhibitors/additives	Usage of inhibitors or additives is allowed if the mixture meets specifications regarding particles, conductivity, and pH. As an example, Hypertherm torch coolant (028872) in 70/30 proportion is allowed
Maximum pressure	5.4 bar (80 psi)
Fitting connections	3/4 in female NPT
Coolant temperature range	25° C (+/– 5° C)

Flow rates

HFL010 (1.0 kW) laser	20 liters (5 gal) per minute minimum
HFL015 (1.5 kW) laser	40 liters (10 gal) per minute minimum
HFL020 (2.0 kW) laser	40 liters (10 gal) per minute minimum
HFL030 (3.0 kW) laser	40 liters (10 gal) per minute minimum

Cooling capacity

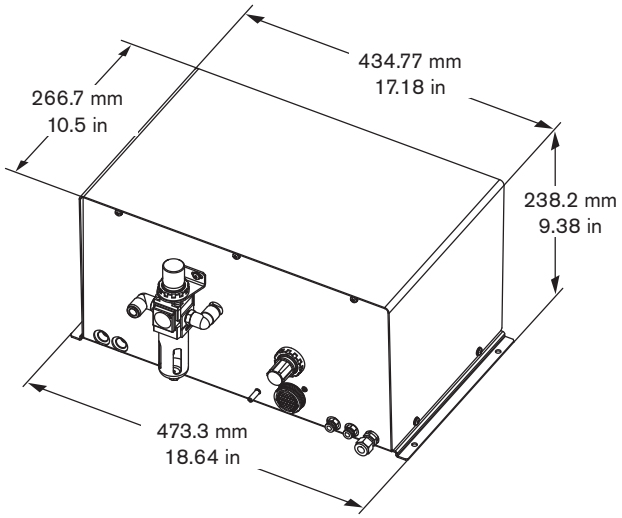
HFL010 (1.0 kW) laser	5 kW (17,100 BTU/hr)
HFL015 (1.5 kW) laser	8 kW (27,300 BTU/hr)
HFL020 (2.0 kW) laser	10 kW (34,125 BTU/hr)
HFL030 (3.0 kW) laser	12 kW (40,946 BTU/hr)

Gas control console – 051024

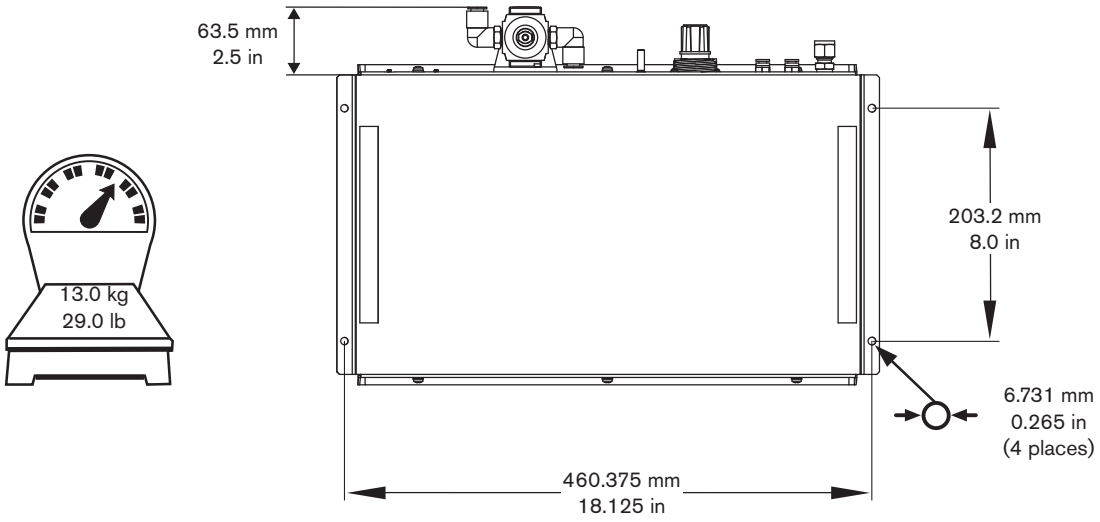
Overview

The gas console manages the selection of the cut gas and sets its pressure. It also sets the flow rate/pressure of the air supplied to the purge and side-jet ports of the laser head. It contains proportional valves, solenoid valves, pressure transducers, hoses and fittings necessary to perform these functions.

- The maximum recommended length for supply hoses from the gas supply to the gas console is 50 m (150 ft).
- The minimum recommended inner diameter (ID) of the air and oxygen supply hoses is 10 mm (3/8 in).
- The minimum recommended ID of the nitrogen supply hose is 12 mm (1/2 in).
- The maximum hose length from the gas console to the laser head is 10 m (33 ft).
- The maximum cable length from the gas console to the laser head controller is 10 m (33 ft)



Fitting	Size
Air	1/4 in BSPT (female)
Oxygen (O_2) and nitrogen (N_2)	1/4 in NPT (female)
Side jet	1/8 in NPT (female)
Purge	1/8 in NPT (female)
Cut gas	1/4 in NPT (female)

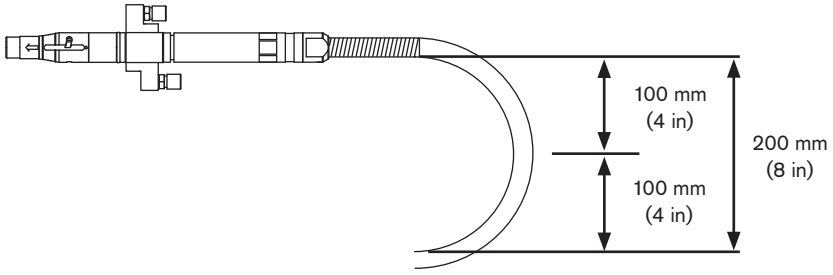


Beam delivery optical cable (BDO)

The optical power from the fiber laser supply is delivered through the fiber optics in the Beam delivery optical cable. Because of the small face area and the high power levels, cleanliness of the input and output optical surfaces is critical to component lifetime and proper operation. Each surface should be inspected, with the magnifier that was supplied with the system, whenever they are removed from their receptacles. To prevent contamination and chipping, the optical surfaces should not be touched.

Note: If cleaning is necessary, see the *Cleaning Procedure* on page 4-4.

Caution: **The minimum bend radius of the Beam delivery optical cable is 100 mm (4 in). The fiber can be damaged if the radius is any smaller.**

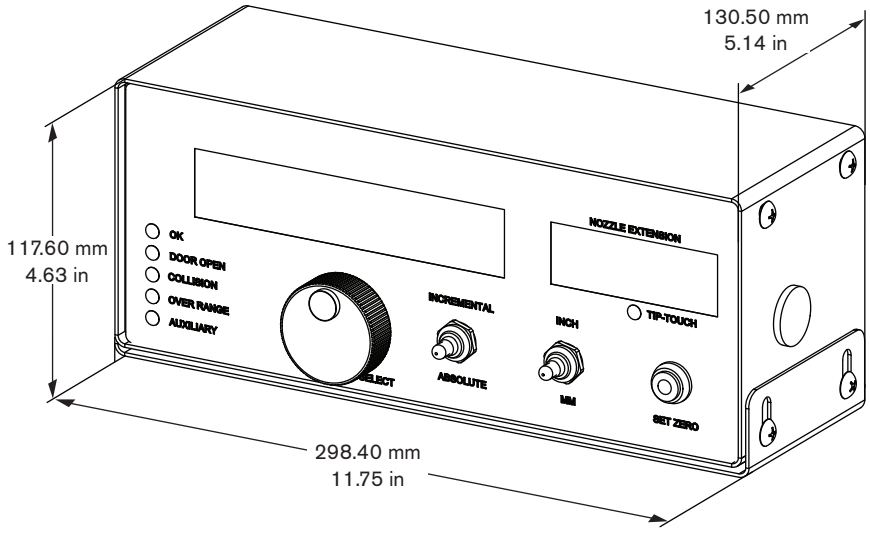


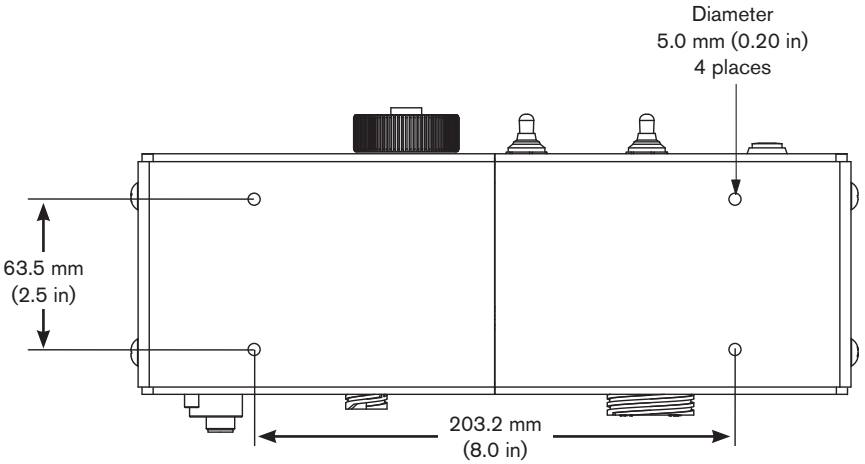
Diameter = 2 x radius = 200 mm (8 in)

Laser head controller – 051026

Overview

The laser head controller includes a liquid crystal display (LCD), operating switches, and a rotary/push knob selector for laser setup and control.





Laser head controller mounting bracket dimensions

CNC Requirements

Hypertherm CNC

AC input power

100-240 VAC 50/60 Hz

CNC

EDGE Pro CNC or MicroEDGE Pro with Integrated Sensor THC interface

Z axis lifter

Hypertherm Sensor THC

CNC I/O Interface

All of the CNC I/O signals are communicated over Hypernet to the fiber laser cable connector through a standard Hypernet port

Generic CNC

Z axis lifter

- Modified to allow mounting of fiber laser head bracket
- Capable of moving fiber laser head (7.8 kg / 17.2 lbs)

CNC I/O interface

Physical connectors: Phoenix contact part numbers 1772405 and 1772418

CNC digital outputs (0-24 VDC sourcing opto-isolators from CNC to laser controller, 24 VDC = active [on])

Fault acknowledge/reset (rising edge triggered)	Required
Digital beam	Required
Pointing laser enable	Required
Corner power pulsing enable	Optional
Side jet	Optional
Air select (off = O_2, on = air)	Required
N_2 select	Required

CNC digital inputs (Normally Open [NO] isolated 24 VDC relay contacts from laser controller to the CNC)

Laser fault	Required
Pointing laser status	Optional
Laser head fault	Required
Nozzle contact	Required
Over range (>10 mm)	Optional
Gas control fault	Required

CNC analog outputs to laser controller (0 – 10 VDC)

Laser power set point (0 – maximum output power in watts)	Required
Corner power (duty cycle) set point (1 – 99%)	Optional
Assist gas pressure set point (Air/O_2 = 0 – 130 psi, N_2 = 0 – 500 psi)	Required

CNC analog input from laser controller (0 – 10 VDC)

Capacitive height sensor voltage (scaling 1 volt per mm)	Required for auto height control

Section 2

INSTALLATION

Upon receipt

- Verify that all system components on your order have been received. Contact your supplier if any items are missing.
- Inspect the system components for any physical damage that may have occurred during shipping. If there is evidence of damage, refer to *Claims.* All communications regarding claims must include the model number and serial number located on the rear of the power supply.

Claims

Claims for damage during shipment – If your unit was damaged during shipment, you must file a claim with the carrier. Hypertherm will furnish you with a copy of the bill of lading upon request. If you need additional assistance, call Customer Service listed in the front of this manual, or your authorized Hypertherm distributor.

Claims for defective or missing merchandise – If any of the merchandise is defective or missing, contact your supplier. If you need additional assistance, call Customer Service listed in the front of this manual, or your authorized Hypertherm distributor.

Installation requirements

All installation and service of the electrical and plumbing systems must conform to national and local electrical and plumbing codes. This work should be performed only by qualified, licensed personnel.

Direct any technical questions to the nearest Hypertherm Technical Service Department listed in the front of this manual, or your authorized Hypertherm distributor.

Noise levels

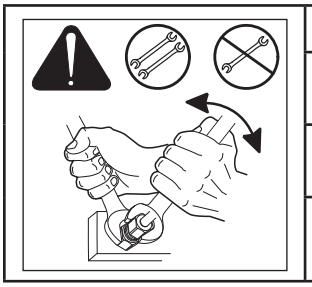
Acceptable noise levels as defined by national and local codes may be exceeded by this laser system. Always wear proper ear protection when cutting. Any noise measurements taken are dependant on the specific environment in which the system is used. See also Noise can damage hearing in the Safety section of this manual. Specific information by product can be found in the Hypertherm downloads library at:

https://www.hypertherm.com/Xnet/library/DocumentLibrary.jsp

Select the product you are looking for from the Product Type drop down menu, choose “Regulatory” from the Category drop down menu, and choose “Acoustical Noise Data Sheets” from the Sub Category drop down menu. Hit Submit.

Placement of system components

- Place all system components in position prior to making electrical, gas, and interface connections. Use the diagram in this section for component-placement guidelines.
- Ground all system components to earth. See Recommended grounding and shielding practices in this section for details.
- To prevent leaks in the system, tighten all gas and water connections as shown below:



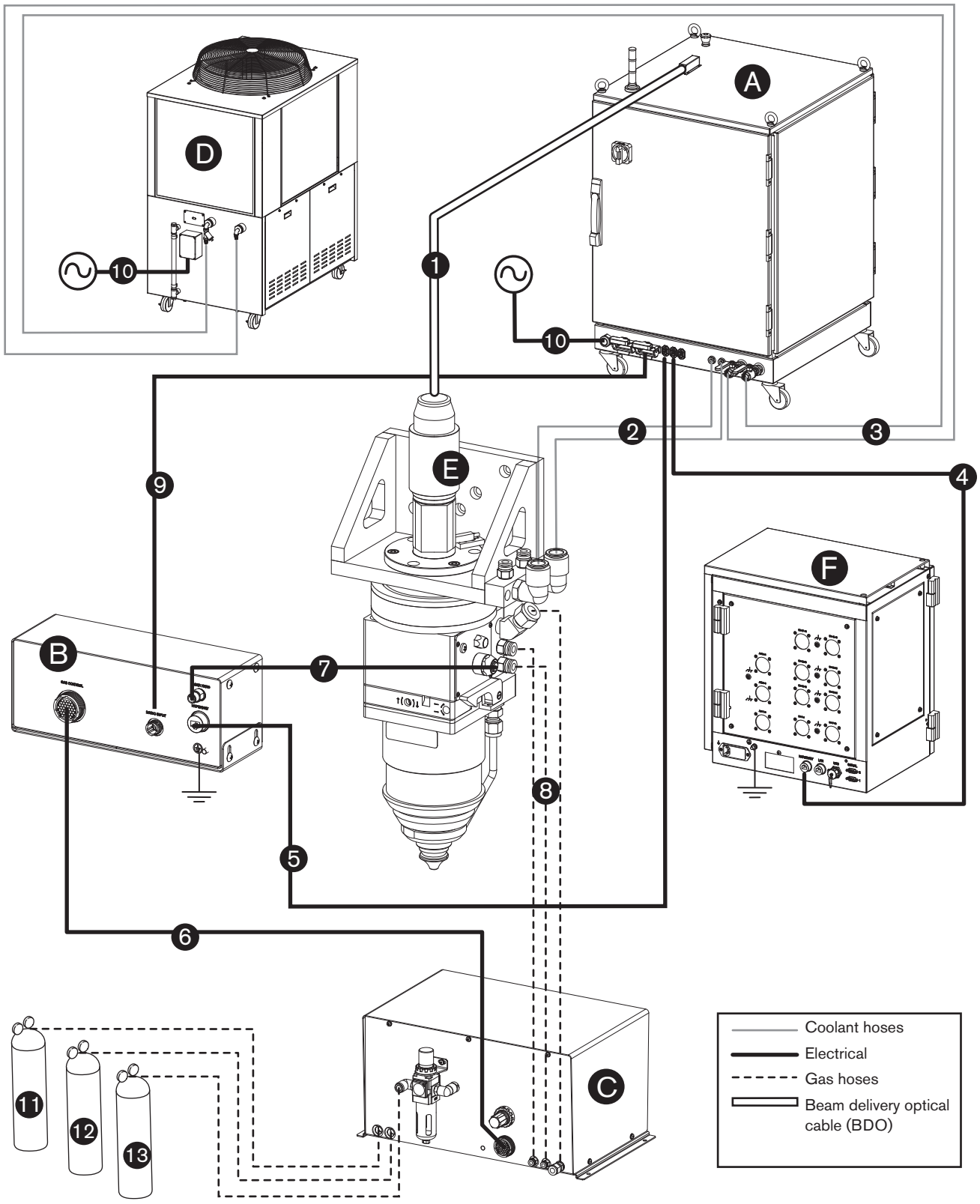
Torque specifications			
Gas or water hose size	**kgf – cm**	**lbf – in**	**lbf – ft**
Up to 10 mm (3/8 in)	8.6 – 9.8	75 – 85	6.25 – 7
12 mm (1/2 in)	41.5 – 55	360 – 480	30 – 40

Site preparation before startup

Before beginning laser welding or cutting operations, all connections to the final laser cutting system shall be checked to make certain they are properly made in accordance with the laser cutting system instructions and local regulations.

- All indicator and warning lights shall be checked.
- Signage shall be posted to give adequate warning.
- Shielding shall be in place at all times to capture and stop any errant beams.
- A lockable disconnect switch may need to be provided in the electrical wiring to the component fiber laser power supply and locked out when not in use. The emergency stop circuit with a red emergency stop actuator with a yellow background is also provided.
- All doors and panels which prevent access to the laser beam in the final laser cutting system and control panels, accessible at the production floor level, shall be tested for proper shutdown before startup and kept locked or interlocked to prevent access by unauthorized people.
- A door to access panels shall be considered locked if a key, wrench, or other tool is required to open it. A periodic functional test of safety interlocks for proper shutdown shall be made by the laser safety officer inaccordance with local regulations and the final laser cutting system instructions.

Installation requirements



System diagram using a Hypertherm CNC

System components

Ⓐ Fiber laser supply

Ⓑ Laser head controller

Ⓒ Gas control console

Ⓓ Chiller (customer supplied)

Ⓔ Laser head

Ⓕ CNC (customer supplied)

Ⓖ Lifter (not shown, customer supplied)

Cables and hoses

❶ Beam delivery optical cable (Beam delivery optical cable)

❷ Coolant hoses: fiber laser supply to the laser head

❸ Coolant hoses: fiber laser supply to the chiller (customer supplied)

❹ Hi-flex Hypernet cable: fiber laser supply to CNC (for use with the EdgePro or MicroEDGE Pro)

❺ Hi-flex Hypernet cable: fiber laser supply to laser head controller

❻ Gas control cable: gas control console to laser head controller

❼ I/O cable: laser head controller to laser head

❽ Gas hoses: gas control console to laser head

❾ Power cable: laser head controller* (customer supplied)

Power cables (customer-supplied)

❿ Main power cables

Supply gas hoses (customer supplied)

⓫ Oxygen

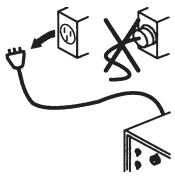
⓬ Nitrogen

⓭ Air

* Kit 228629 includes sockets and backshell

Recommended grounding and shielding practices

DANGER
ELECTRIC SHOCK CAN KILL



Disconnect electrical power before performing any maintenance. All work requiring the removal of the power supply cover must be performed by a qualified technician.
See Section 1 of the laser/plasma system instruction manual for more safety precautions.

Introduction

This document describes the grounding and shielding necessary to protect a laser/plasma cutting system installation against radio frequency interference (RFI) and electromagnetic interference (EMI) noise. It addresses the three grounding systems described below. There is a diagram on page 3-10 for reference.

Note: These procedures and practices are not known to succeed in every case to eliminate RFI/EMI noise issues. The practices listed here have been used on many installations with excellent results, and we recommend that these practices be a routine part of the installation process. The actual methods used to implement these practices may vary from system to system, but should remain as consistent as possible across the product line.

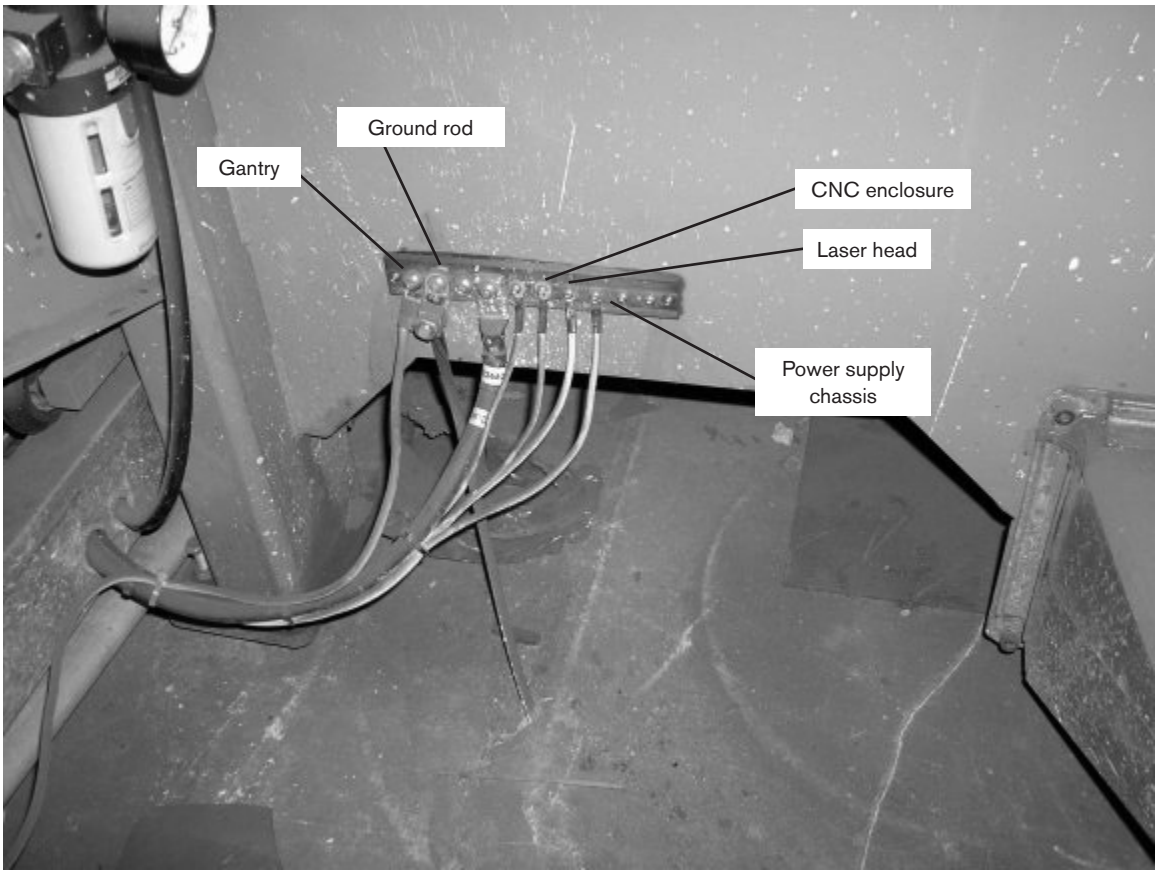
Types of grounding

A. The safety (PE) or service ground. This is the grounding system that applies to the incoming line voltage. It prevents a shock hazard to any personnel from any of the equipment, or the work table. It includes the service ground coming into the laser/plasma power supply and other systems such as the CNC controller and the motor drivers, as well as the supplemental ground rod connected to the work table. In the laser/plasma circuits, the ground is carried from the laser/plasma power supply chassis to the chassis of each separate console through the interconnecting cables.

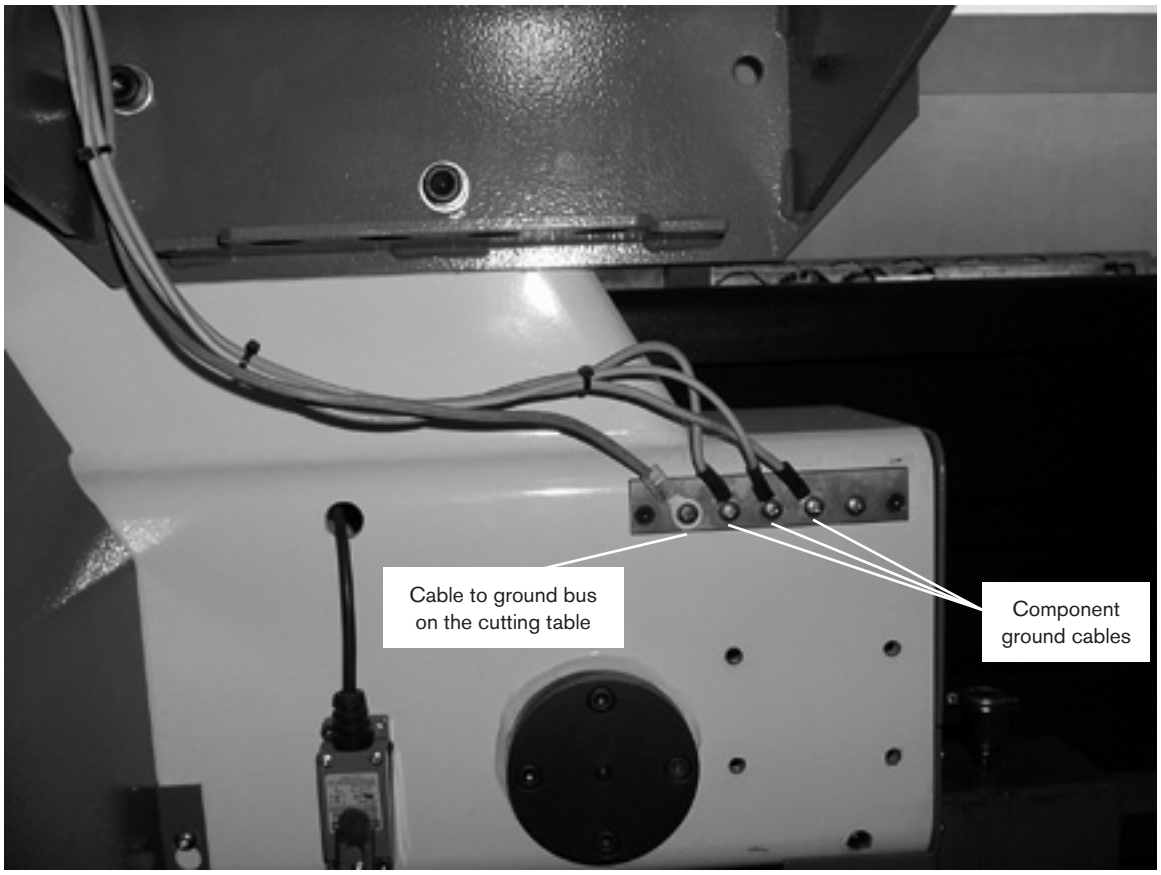
B. RFI and EMI grounding and shielding. This is the grounding system that limits the amount of electrical “noise” emitted by the laser/plasma and motor drive systems. It also limits the amount of noise that is received by the CNC and other control and measurement circuits. This grounding/shielding process is the main target of this document.

Steps to take

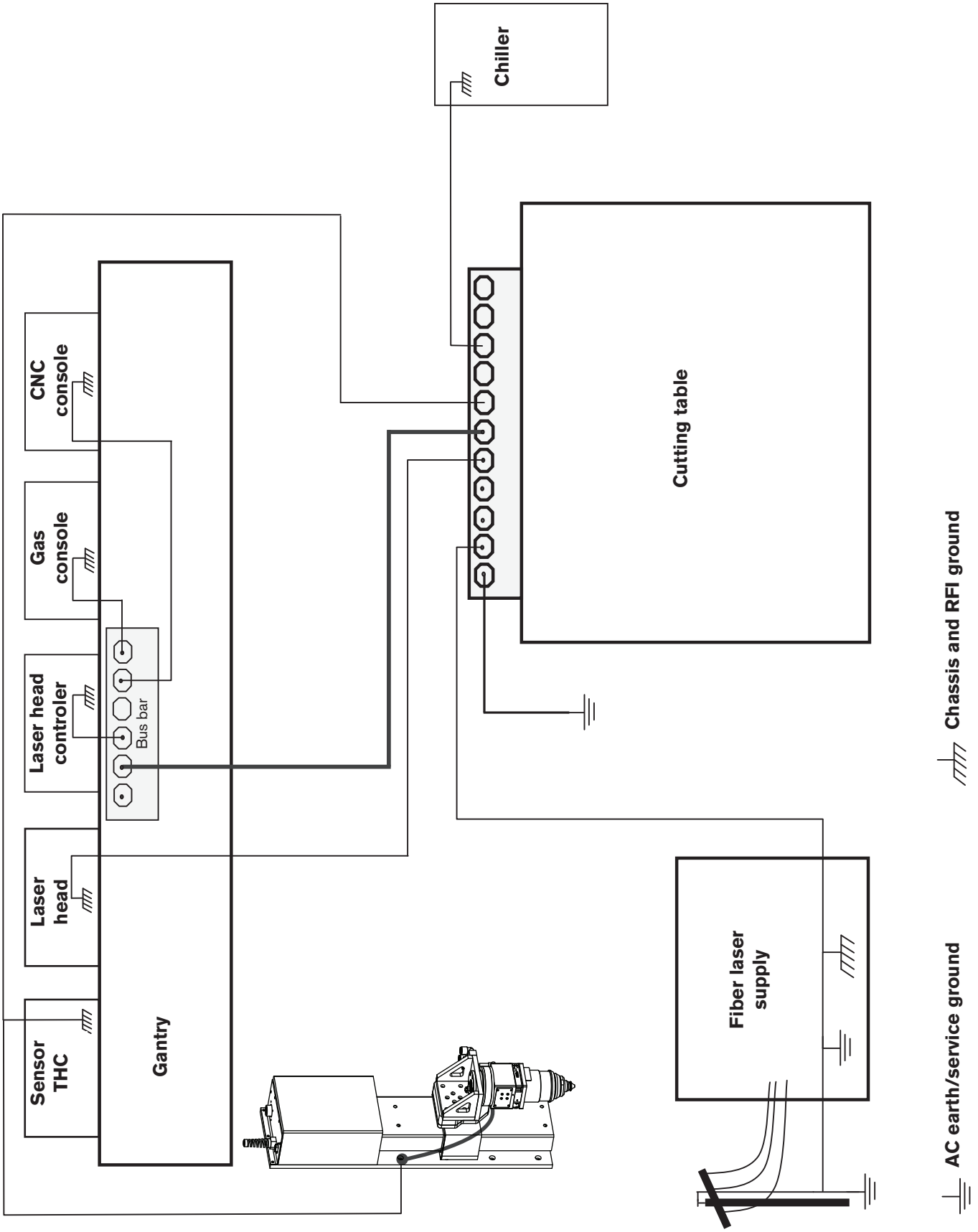
1. Unless noted, use only 6 AWG (16 mm2) welding cable (Hypertherm part no. 047040) for the EMI ground cables shown on the diagram.
2. The cutting table is used for the common, or star, EMI ground point and should have threaded studs welded to the table with a copper bus bar mounted on them. A separate bus bar should be mounted on the gantry as close to each drive motor as possible. If there are drive motors at each end of the gantry, run a separate EMI ground cable from the far drive motor to the gantry bus bar. The gantry bus bar should have a separate, heavy EMI ground cable (4 AWG [21.2 mm2] part no. 047031) to the table bus bar. The EMI ground cables for the torch lifter and the RHF console must each run separately to the table ground bus.
3. A ground rod that meets all applicable local and national electrical codes must be installed within 6 m (20 ft) of the table. This is a PE ground and should be connected to the ground bus on the cutting table with 6 AWG (16 mm2) green/yellow grounding cable (Hypertherm part number 047121) or equivalent. All PE grounds are shown on the diagram in green.
4. For the most effective shielding, use the Hypertherm CNC interface cables for I/O signals, serial communication signals, power supply-to-power supply multi-drop connections, and interconnections between all parts of the Hypertherm system.
5. All hardware used in the ground system must be brass or copper. The only exception is that the studs welded to the table for mounting the ground bus can be steel. Under no circumstances should aluminum or steel hardware be used.
6. AC power, PE, and service grounds must be connected to all equipment according to local and national codes.
7. Each Hypertherm component, as well as any other CNC or motor-drive cabinet or enclosure, must have a separate ground cable to the common (star) point on the table. This includes the ignition console, even if it is bolted to the power supply or to the cutting machine.
8. The laser head holder and the breakaway mechanism – the part mounted to the lifter, not the part mounted on the torch – must be connected to the stationary part of the lifter with copper braid at least 12.7 mm (1/2 in) wide. A separate cable must run from the lifter to the bus bar on the gantry. The valve assembly should also have a separate ground connection to the gantry bus bar.
9. If the gantry runs on rails that are not welded to the table, then the rails need to be connected with a ground cable from each end of both rails to the table. These need not go to the common (star) point, but could take the shortest path to the table.
10. All other signals (analog, digital, serial, encoder) should run in twisted pairs inside a shielded cable. Connectors on these cables should have a metal housing and the shield, not the drain, should be connected to the metal housing of the connectors at each end of the cable. Never run the shield or the drain through the connector on any of the pins.



Example of a good cutting table ground bus. The picture above shows the connection from the gantry ground bus, the connection from the ground rod, the CNC enclosure, the laser head, and the fiber laser supply chassis.



Example of a good gantry ground bus. It is bolted to the gantry, close to the motor. All of the individual ground cables from the components mounted on the gantry go to the bus. A single heavy cable then goes from the gantry ground bus to the ground bus bolted to the table.



Grounding diagram (some systems will not include all the components shown)

Ⓐ Placement of the fiber laser supply

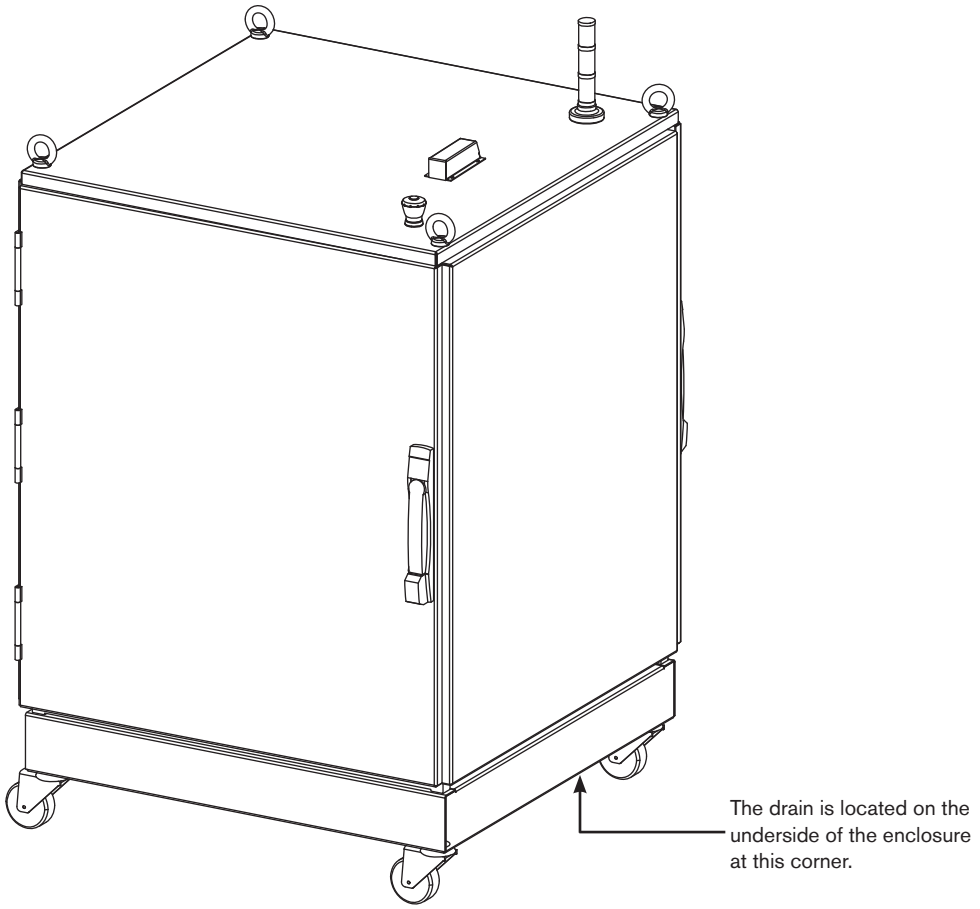
DANGER
ELECTRICAL SHOCK CAN KILL

Remove all electrical connections to the laser power supply before moving or positioning. Transporting the fiber laser supply can cause personal injury and equipment damage.

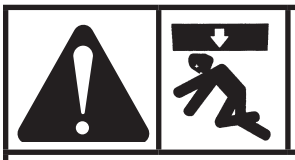
The fiber laser supply can be moved by forklift but the forks must be long enough to extend the entire length of the base. Take care when lifting so that the underside of the fiber laser supply, and the drain that comes through the underside of the fiber laser supply (HFL010, HFL015, and HFL020 only), are not damaged.

- Place the fiber laser supply in an area that is free of excessive moisture, has proper ventilation, and is relatively clean. Allow 1 m (3 ft) on all sides of the fiber laser supply for servicing.
- Do not place the power supply on an incline greater than 10° to prevent it from toppling.

Note: The graphic below shows the enclosure for the HFL010, HFL015, and HFL020



Lifting the fiber laser supply



DANGER

The fiber laser supply weighs between 185 kg and 283.5 kg (410 lbs and 625 lbs). 1 or 2 person manual lifting could cause injury. Use appropriate lifting aids and techniques when moving a fiber laser supply.

The customer understands and assumes exclusive responsibility for supplying personnel trained and qualified to operate forklifts, cranes, hoists and other lifting devices to lift or move the fiber laser. All movement of the fiber laser supply must be done in compliance with applicable local laws and regulations. All handling equipment must be evaluated for each application and inspected and tested before each use. The fiber laser supply can be moved by forklift, but the forks must be long enough to extend the entire length of the base. Take care when lifting so that the underside of the fiber laser supply is not damaged. The customer agrees to observe and ensure compliance with the following:

- The straps and other handling equipment must comply with applicable local standards, laws and regulations.
- The rated capacity, design factor, and efficiency rating of the lifting system, including straps sold by Hypertherm, may be affected by wear, misuse, overloading, corrosion, deformation, intentional alteration, age, and other use conditions.
- An inspection of the straps by qualified personnel should be conducted before each use. Worn or damaged straps may not be used, nor may they be altered or modified in any way.
- All 4 loops at the ends of the straps must be securely and properly attached to the lifting mechanism.
- The fiber laser supply is a nonsymmetrical load; make sure that an analysis by a qualified person is performed properly to balance the load to prevent tipping and overloading of any one strap.
- All enclosure panels must be securely fastened before lifting the fiber laser supply.
- The lifting mechanism must be rated for the appropriate weight and be suitable for the strap size.
- Each strap should pass through all 4 lifting eyelets in the top of the fiber laser supply and should not be twisted, constricted, bunched or pinched.
- Straps shall not be shortened or lengthened by knotting, twisting, choker hitching, or other means.
- The fiber laser supply should be lifted slowly, not more than 203 mm (8 in) above the floor, to insure that the weight is evenly distributed.
- The fiber laser supply should be moved slowly to prevent sudden acceleration and deceleration when moving.
- Access to the area should be restricted when moving or lifting to prevent injury of personnel if the fiber laser supply shifts or tips.
- Personnel should never be allowed to place themselves or any part of the body under the equipment, or between the equipment and walls or other solid objects.

- Store straps in a proper manner such that they are not subjected to mechanical, chemical, or ultraviolet damage, or to extreme temperatures.

The body responsible for the workplace where the equipment is to be installed needs to make sure all applicable local regulations are followed, and Hypertherm assumes no responsibility or liability therefor. The customer assumes exclusive responsibility for ensuring that all local laws and regulations are followed, including those applicable to the use of equipment and work place conditions.

WARNING

- **Operation and maintenance of automated equipment involves potential hazards.**
- **Only authorized service personnel should perform this service.**
- **REMOVE ALL POWER TO THE FIBER LASER SUPPLY ENCLOSURE BEFORE BEGINNING PROCEDURE.**
- **Warning undesired results may occur if these instructions are not followed exactly in order without skipping any steps**

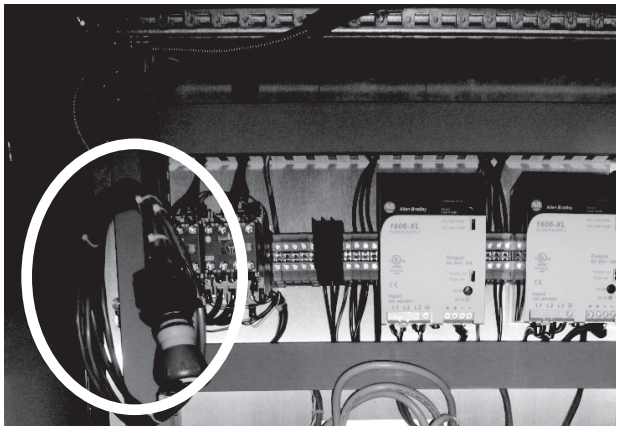
Fiber laser supply preparation

General information

The installations on the following pages should be performed before making any other connections to the fiber laser supply.

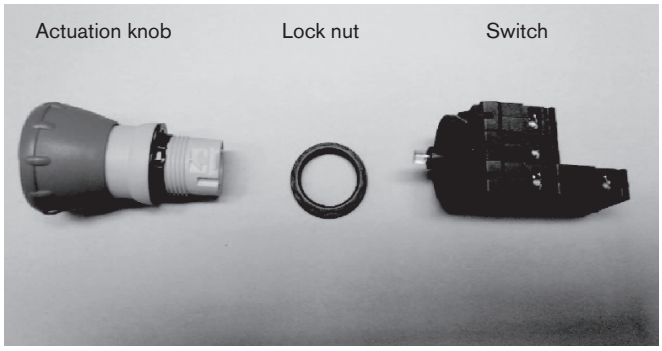
Emergency stop (E-Stop) switch installation

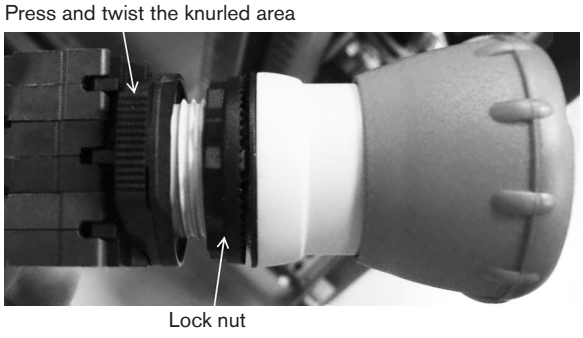
1. Open the fiber laser supply enclosure front door and locate the E-Stop switch assembly.



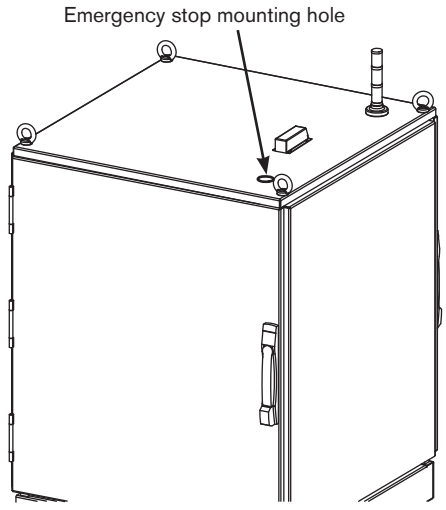
E-Stop switch assembly location

2. Remove the actuation knob and lock-nut from the E-Stop switch assembly.

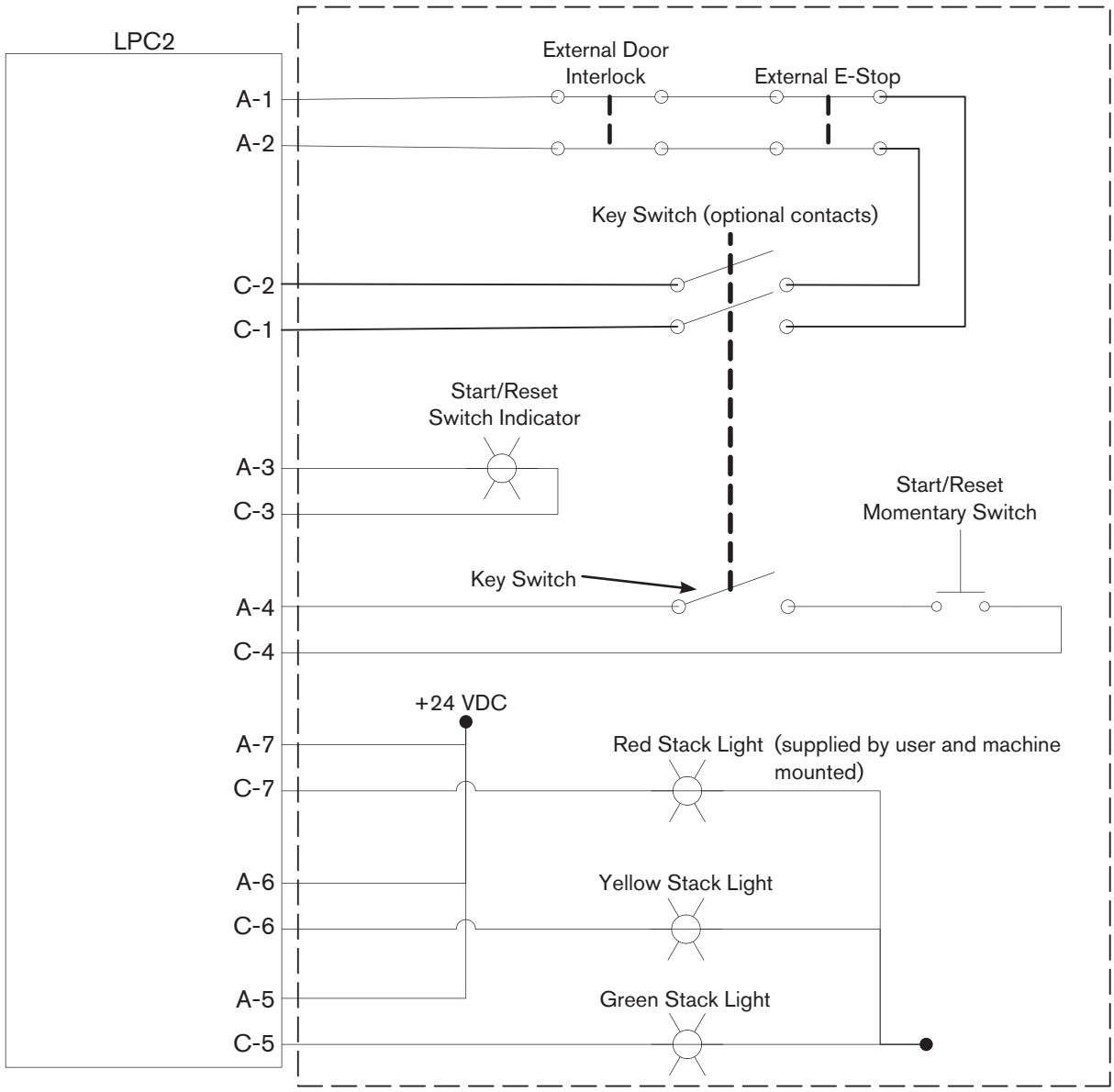




3. Place the actuation knob into the “EMERGENCY STOP” mounting hole on the top of the fiber laser supply enclosure, and use the lock nut to secure the E-stop actuation knob to the top of the enclosure.
4. Align the switch’s contact base thumb ring with the arrow on the actuation knob and press.



Electrical diagram for external safety switches



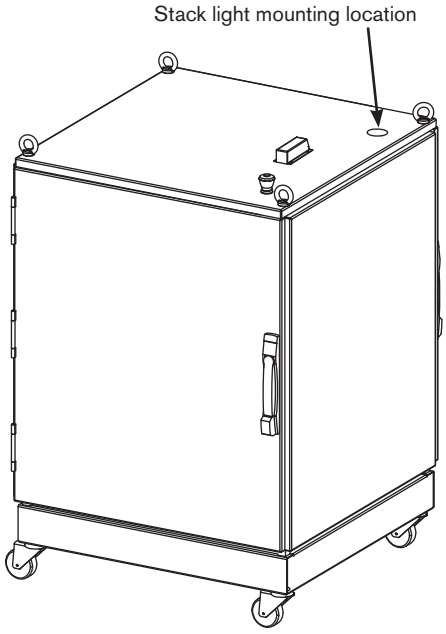
Recommended components:

E-Stop switch – Rockwell Automation part numbers 800FP-LMT44, 800F-PN3R, and (2) 800F-X01
Start/Reset switch – Rockwell Automation part numbers 800FP-LF3, 800F-PN3G, and 800F-X01
Key switch – Rockwell Automation part numbers 800FP-KM21 and 800F-X10
Stack light – Rockwell Automation part numbers 855D-P00SC20B24Y3Y5L4

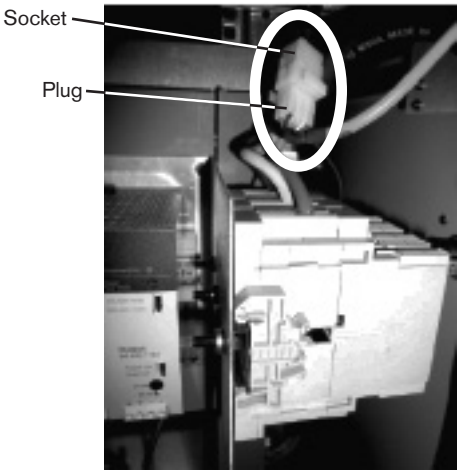
= Customer supplied components

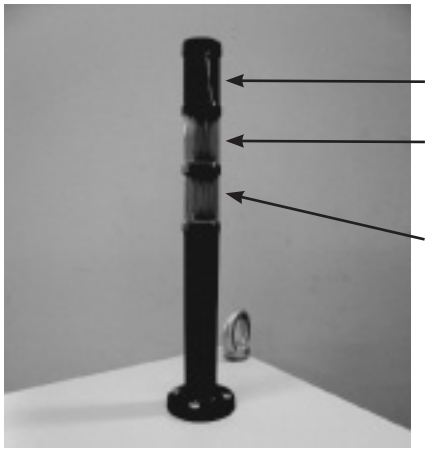
Stack Light installation

1. Open the rear door of the fiber laser supply enclosure and locate the cardboard box on the bottom left below the power interconnect panel.
2. Remove the stack light, gasket and mounting hardware from the cardboard box.
3. Mount the stack light to the top of the enclosure, at the location shown, using the hardware included.



4. Connect the plug on the end of the yellow cable from the stack light to the socket located directly above the incoming power disconnect switch.





Stack light color descriptions

Red flashing = Laser is on. All safety precautions must be followed.

Yellow = The laser may come on at any time. All safety precautions must be followed.

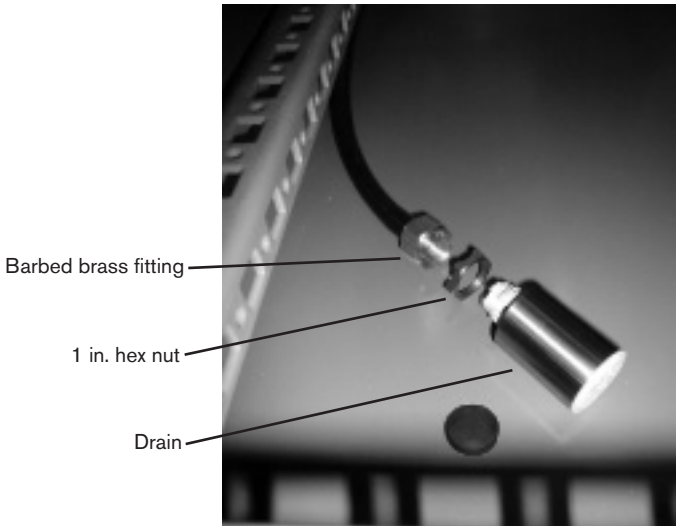
Green = Safe

Dehumidifier drain installation

Note: This procedure does not need to be perfomed if you have an HFL030 system

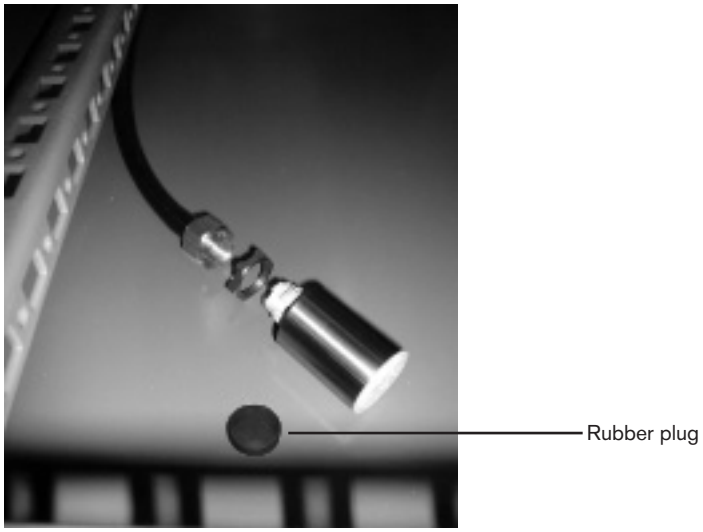
1. Open the rear door of the fiber laser supply enclosure and locate the dehumidifier drain assembly that is secured to the enclosure frame with a cable tie. Cut the cable tie and remove the hose from the drain assembly.

Hose and drain assembly location



Drain assembly parts

2. Remove the small rubber plug from the hole in the bottom of the fiber laser supply enclosure.



Plug location

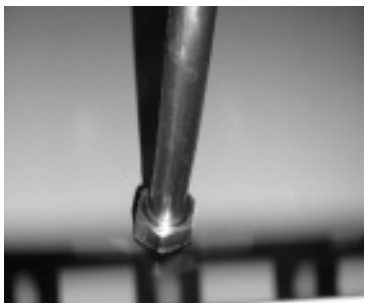
3. Insert the threaded end of the drain through the hole in the bottom of the laser supply enclosure from underneath the enclosure and secure it with the 1 in hex nut. Tighten the nut just enough to compress the black gasket using a 1 in. open end wrench.

Install drain

4. Fasten the barbed brass fitting onto the end of the drain device. DO NOT OVERTIGHTEN!

Install brass fitting

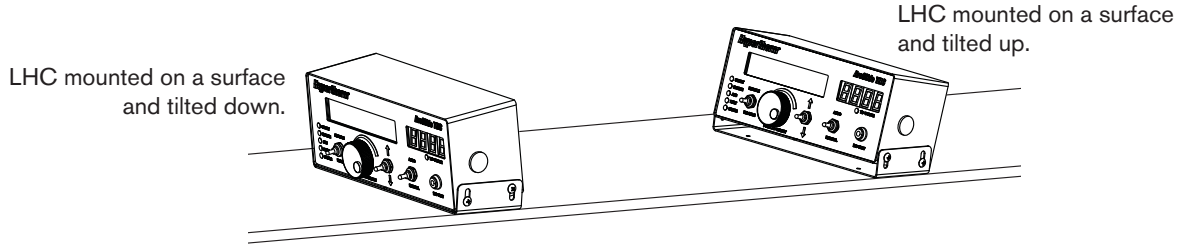
5. Push the drain hose onto the barbed fitting to complete the assembly procedure.

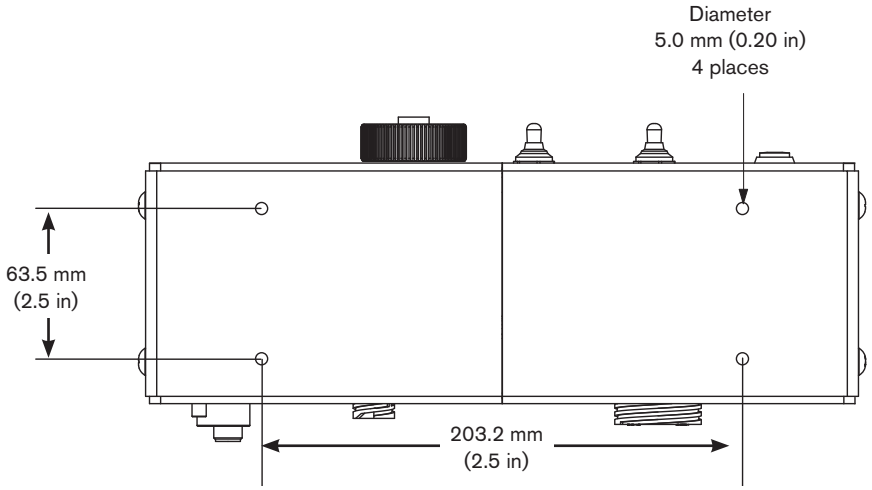


Install drain hose

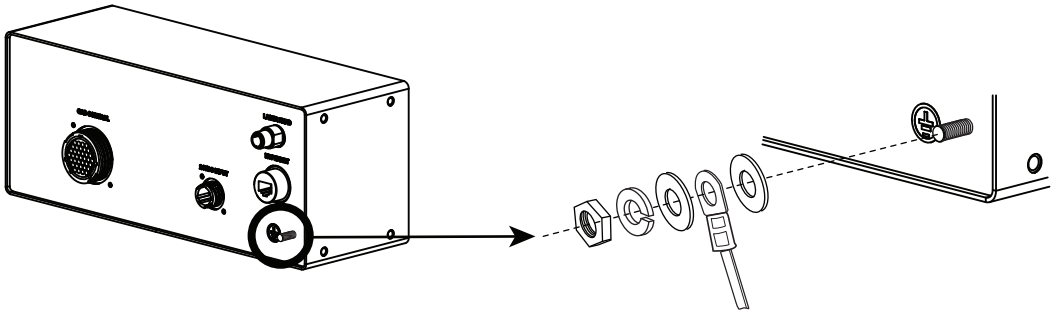
B Mounting the laser head controller (LHC)

The mounting brackets on the LHC allow for a variety of mounting options. It can be installed under or on another piece of equipment, and level or tilted. The LHC should be mounted in a location on the gantry that allows the operator to see the display when changing the nozzle extension on the laser head and during cutting.





Laser head controller mounting bracket dimensions

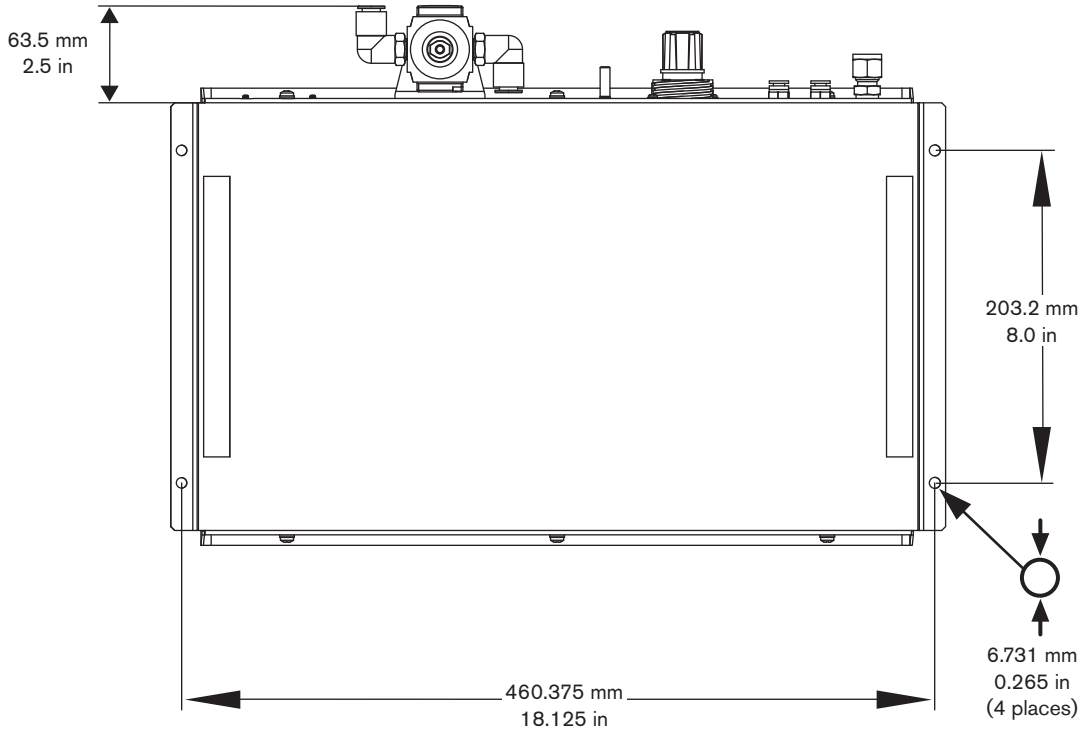


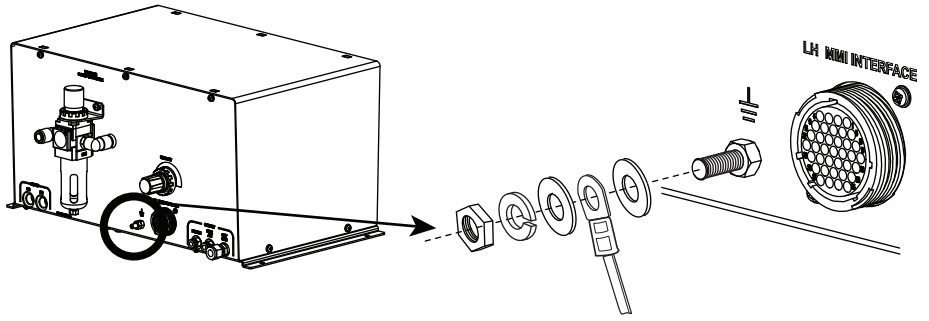
Laser head controller grounding

C Mounting the gas console

The gas console is usually mounted on the gantry to allow visibility to the operator. Additionally, the cutting gas supply line between the console and laser head should be kept as short as possible to reduce pressure loss with a maximum hose length of 10 m (30 ft). The supply lines to the gas console must be sized appropriately to support the required pressures and flow rates for each gas.

The gas console for the laser cutting process is designed to cover the normal operating parameters for the assist gas needed for laser cutting of mild steel, stainless steel, and aluminum. Additional outputs from the gas console are provided for cooling of the laser head and a side jet for piercing of thicker materials. A supply of oxygen, nitrogen, and air is required for proper operation, and the requirements are outlined in the Specifications section. To achieve the required dynamic assist gas pressure performance for laser cutting, the maximum length of hose between the gas console and the laser head is 10 m (30 ft). Use the 10 m (30 ft) hose (024874) supplied with this system.





Gas console grounding

D Chiller considerations

Caution:

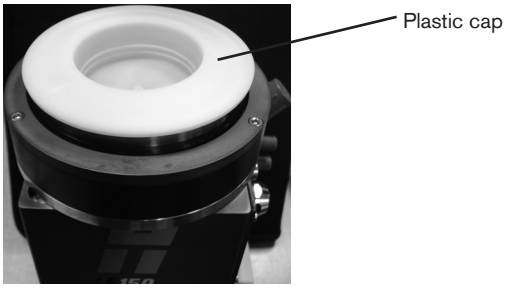
The cooling system must have a filter that allows the coolant to meet the specifications for particles shown below. Failure to use a filter capable of meeting the particle requirements can cause damage to critical optical components and could be cause for denial of warranty claims on these components.

- The chiller is supplied by the customer and must meet the minimum requirements as stated in the Specifications section of this manual.
- The chiller should be placed close to the fiber laser supply.
- Delivery lines should be sized to prevent excessive pressure drops along the lines. 20 mm (3/4 in) inside diameter or larger is recommended for line lengths less than 10 m (30 ft). Longer lengths may require hoses with a larger diameter.
- Prevent unexpected kinking, pinching, or other restrictions in the supply and return lines.
- Coolant lines should be protected from abrasion or punctures.
- Place the chiller in an area that is free of excessive moisture, has proper ventilation, and is relatively clean. Allow 1 m (3 ft) of space on all sides of the chiller for ventilation and service.
- Do not place the chiller on an incline greater than 10° (with the wheels locked) to prevent it from toppling.
- Use reinforced Tygon, copper, stainless steel or PVC, for the plumbing. Use sizes appropriate to achieve the necessary flow rates.
- Refer to the manual that came with your chiller for operation and maintenance information.

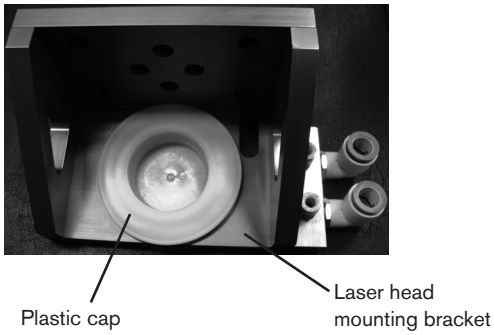
E Mounting the laser head

Install the laser head mounting bracket

The laser head is shipped with a plastic cap covering the main opening. To protect the optics inside the laser head, the cap must remain in place unless you are told to remove it.

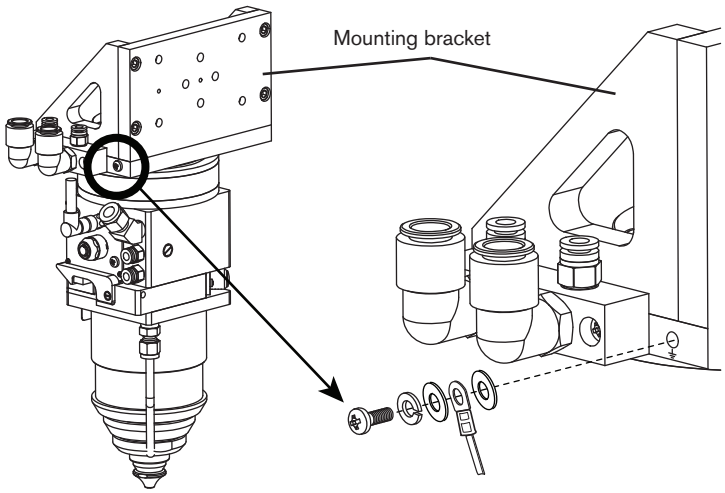


Briefly remove the plastic cap from the laser head and Install the laser head mounting bracket onto the laser head using the 3 bolts provided. Immediately cover the hole in the laser head mounting bracket with the plastic cap after the mounting bracket is installed.



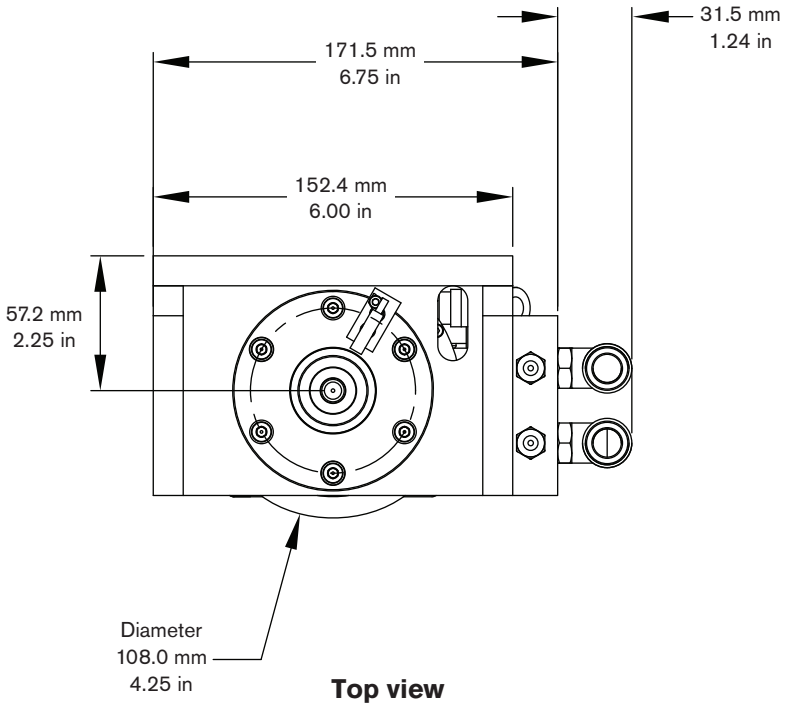
Laser head grounding

The laser head and mounting bracket must be properly earth grounded for stable operation. An M6 x 1 thread is provided on the side of the mounting bracket to connect an earth ground wire that should be tied to the machine earth ground.

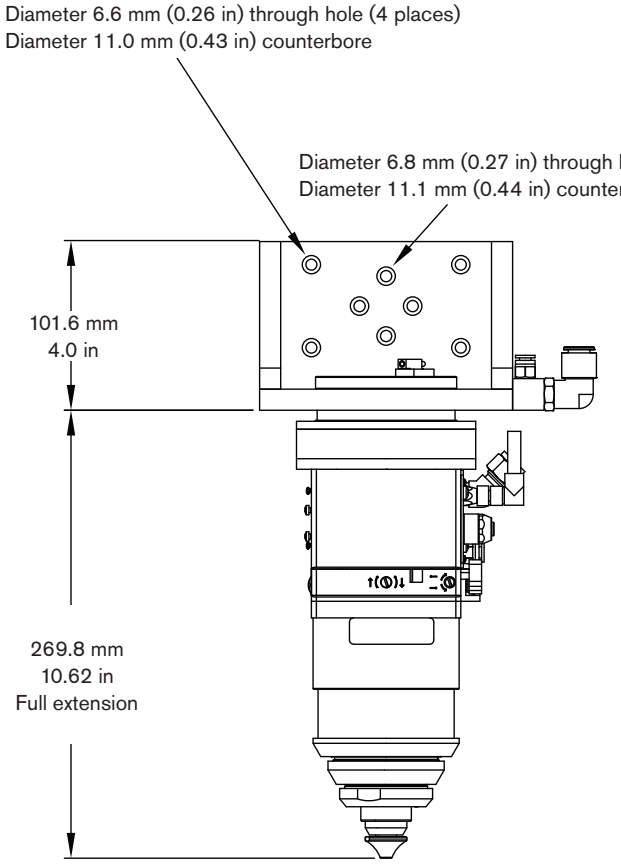


Ground connection

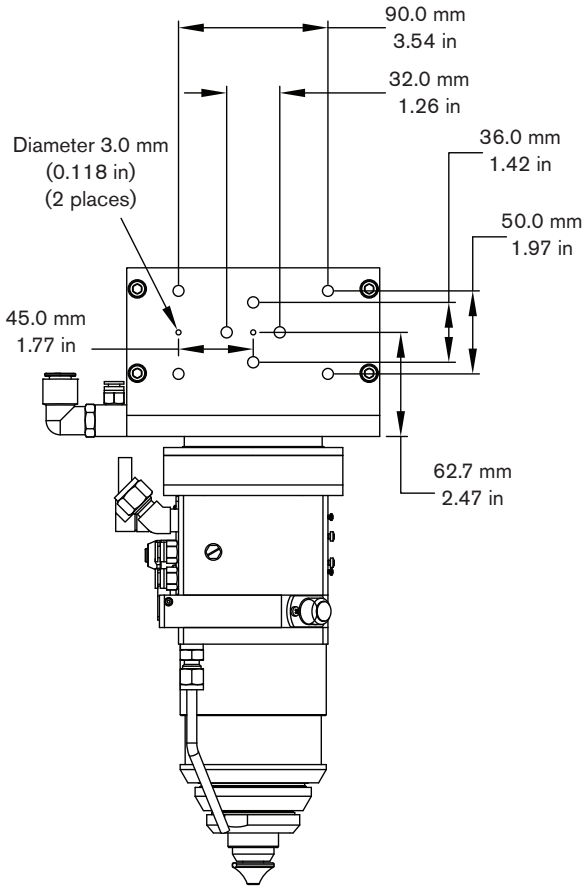
Laser head mounting dimensions



Top view



Front view

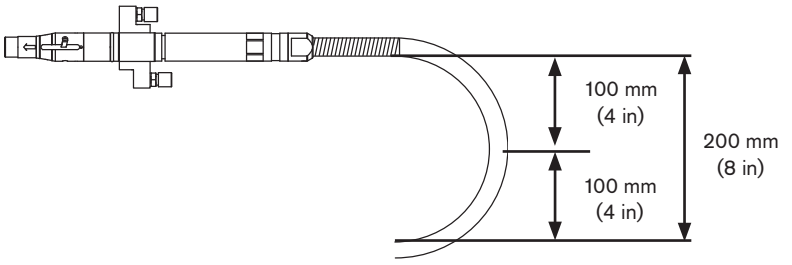


Rear view

❶ Beam delivery optical cable connection

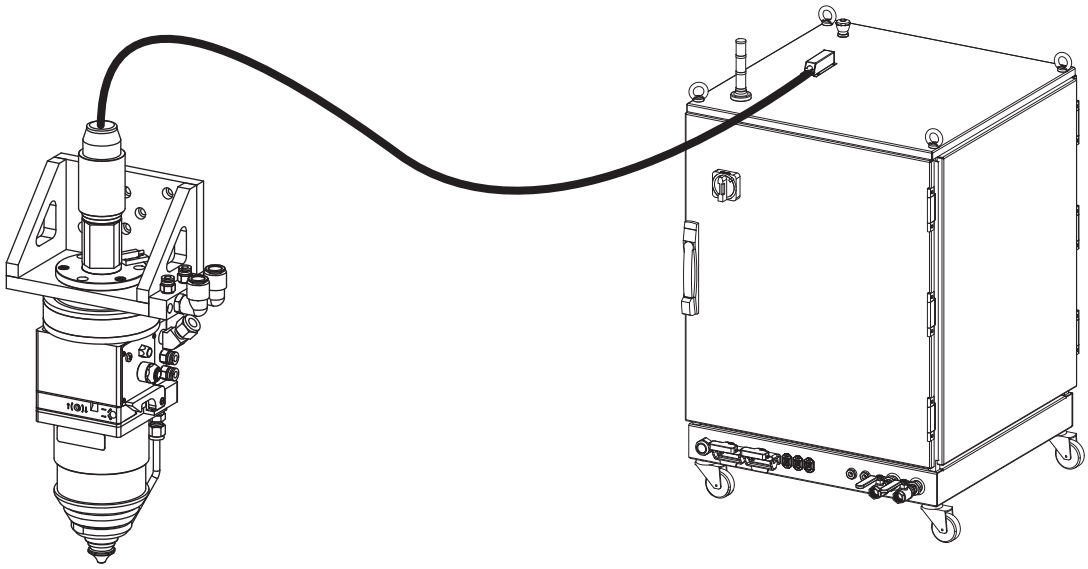
The optical power from the fiber laser supply is delivered through the beam delivery optical cable/optics. Because of the small surface area and the high power levels, cleanliness of the input and output optical surfaces is critical to component lifetime and proper operation. The optical surface at the bayonet end of the Beam delivery optical cable should be inspected, with the magnifier that was supplied with the system, before installation and whenever it is removed from the collimator. To prevent contamination and chipping, the optical surface should not be touched. See page 4-4 for details of the inspection and cleaning procedure.

Caution: **The minimum bend radius of the Beam delivery optical cable is 100 mm (4 in). The fiber can be damaged if the radius is any smaller.**



Diameter = 2 x radius = 200 mm (8 in)

Beam delivery optical cable part numbers	
Part number	**Length**
051029	10 m (33 ft) 100 micron
051030	20 m (65.5 ft) 100 micron
051045	20 m (65.5 ft) 200 micron



General Precautions

The Beam delivery optical cable is placed in a protective foam tray on top of the fiber laser supply enclosure for shipping. This cable is rugged and flexible, but it must be unpacked and handled carefully to prevent damage to the delicate optical fiber inside.

The following precautions are recommended at all times:

- Do not remove the black protective cap from the end of the Beam delivery optical cable until instructed to do so later in these instructions
- At least two people should be involved in handling the Beam delivery optical cable.
- The cable exits the fiber laser supply enclosure at the top through a strain relief block; do not attempt to push or pull the cable at this point.
- The end of the beam delivery optical cable that attaches to the laser head is the “fiber bayonet”; when not attached to the laser head, this end should have the protective cap installed and be supported by hand at all times. Do not allow it to swing freely while handling the beam delivery optical cable as this component is heavy and can cause the flexible cable to bend sharply and damage the optical fiber.
- Do not exceed the minimum short-term bend radius of the cable, 100 mm (4 in).

Unpacking Instructions

1. Carefully lift the entire coil of the beam delivery optical cable out of and above the foam tray and slide the tray out from under the beam delivery optical cable. If the beam delivery optical cable enters the tray through a hole instead of a slot, it will be necessary to carefully uncoil the entire length of the beam delivery optical cable in order to remove the foam tray. See instructions in steps 3 and 4 for uncoiling the beam delivery optical cable.
2. Place the beam delivery optical cable back on top of the fiber laser supply enclosure inside the four retaining brackets as shown in the picture to the right.

3. Uncoil the desired length of beam delivery optical cable one loop at a time.
4. As each loop is uncoiled, make sure to relieve torsion in the beam delivery optical cable; if residual torsion is allowed to build up, the beam delivery optical cable may twist unexpectedly. Usually, torsion can be relieved by twisting the free end of the beam delivery optical cable 360 degrees for each loop uncoiled from the bundle.
5. For temporary, overhead installation of the beam delivery optical cable, support it every 1-2 m (3.3-6.6 feet)
6. Attach the beam delivery optical cable to the collimator at the laser head according to the beam delivery optical cable installation instructions in this section.
7. Carefully inspect the entire beam delivery optical cable to ensure that all bends are maintained at a radius greater than 100 mm (4 in).

Beam delivery optical cable installation

WARNING

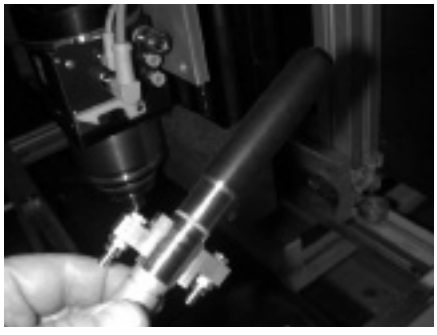
- **Operation and maintenance of automated equipment involves potential hazards.**
- **Only authorized service personnel should perform this service.**
- **REMOVE ALL POWER TO THE FIBER LASER SUPPLY ENCLOSURE BEFORE BEGINNING PROCEDURE.**
- **Undesired results may occur if these instructions are not followed exactly in order, or if any steps are not completed.**

1. Carefully route the beam delivery optical cable from the fiber laser supply enclosure through the protective cable trays of the machine frame to the laser head.

   Note 1: Sometimes it is not possible to rotate the bayonet on the beam delivery optical cable to align the red dots on the collimator and the bayonet, after it has been routed to the laser head, without creating excessive torsional tension on the cable. In this case remove the 3 Allen head cap screws that attach the laser head adaptor to the laser head mounting bracket. Then rotate the collimator so that the red dots can be aligned without putting excessive twist to the delivery fiber and reinstall the 3 Allen head cap screws. The laser head adaptor can be rotated in 120 degree increments to relieve excess torsion on the beam delivery optical cable.

2. Inspect the entire path of the beam delivery optical cable and verify that the minimum bend radius specification of 100 mm (4 in). is not violated and that there are no pinch points that could damage the Beam delivery optical cable during machine motion.
3. Verify that there is enough length in the beam delivery optical cable at the Laser Head to allow for the motion of the lifter axis while raising and lowering the laser cutting head
4. Temporarily secure the end of the beam delivery optical cable near the laser head until it is time to connect it to the collimator.

Note Do not remove the black protective cap from the end of the beam delivery optical cable until instructed to do so later in these instructions



Collimator installation

The collimator is a precision optical device that aligns the diverging beam from the Beam delivery optical cable into a parallel or collimated beam.

WARNING

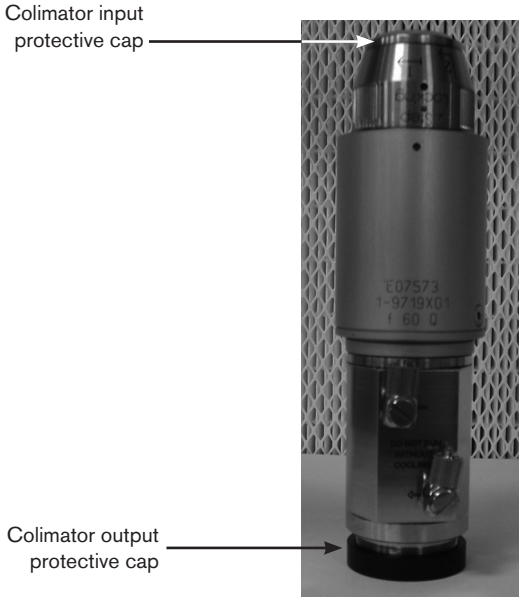
Remove all power to the fiber laser supply enclosure before beginning the installation.

Caution: **Any dust, debris, or moisture inside the collimator can cause damage to the equipment. Be extremely careful to avoid any contamination.**

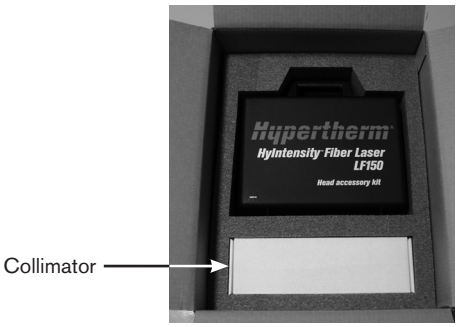
Caution: **Remove the focusing lens in the laser head before installing the collimator to prevent any debris from falling onto the lens. Any debris on the lens can cause damage.**

General precautions

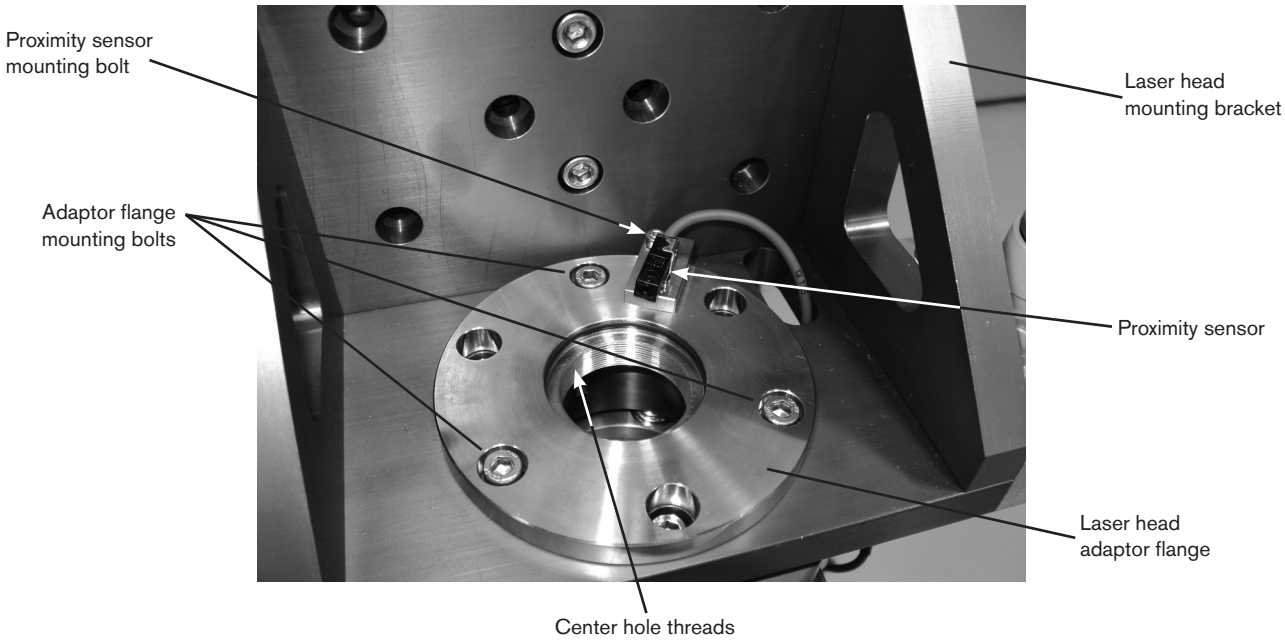
- DO NOT remove the collimator from its original packaging until instructed to do so later in this document.
- DO NOT remove the clear protective cap (shown below) from the input end of the collimator until instructed to do so later in these instructions.
- DO NOT remove the black protective cap (shown below) from the output end of the collimator until instructed to do so later in these instructions.



The collimator is shipped in the same box as the LF150 laser head and the head accessory kit

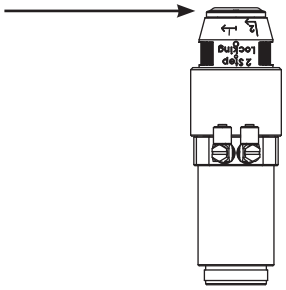


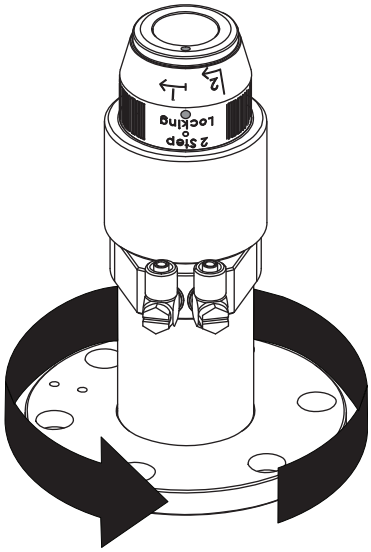
1. Remove the Proximity sensor before installing the collimator.
   a. Verify that the the focusing lens is not installed in the laser head
   b. Remove the collimator proximity sensor from the laser head adaptor flange by loosening the mounting bolt with a 2.5mm hex wrench and then sliding the proximity sensor out from under it. Refer to the picture below for the location of the proximity sensor and mounting bolt. Retighten the proximity sensor mounting bolt after removing the proximity sensor.Remove the laser head adaptor flange from the laser head mounting bracket by removing the three adaptor flange mounting bolts (shown above).

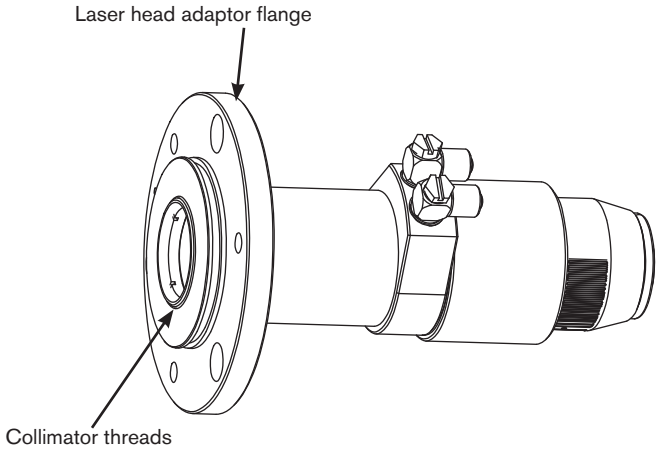


2. Inspect the threads in the center hole of the laser head adaptor flange for any dirt or debris and clean them if necessary.
3. Remove the collimator from the original packaging.
4. Inspect the outside of the collimator for any dust or debris before proceeding. If any dust or debris is present, use clean dry compressed air or a lens cleaning tissue to remove it.

5. Carefully remove the protective caps from both ends of the collimator and inspect the inside of the collimator for any dust, debris, or filmy residue. If any dust, debris, or residue is present the collimator must be inspected and cleaned by properly trained personnel before use.
6. Reinstall the clear protective cap onto the input end of the colimator.
7. Hold the collimator in a vertical position with the clear protective cap pointing up and carefully install the laser head adaptor flange onto the collimator by threading it onto the collimator as shown below. Turn the adaptor flange by hand until tight.

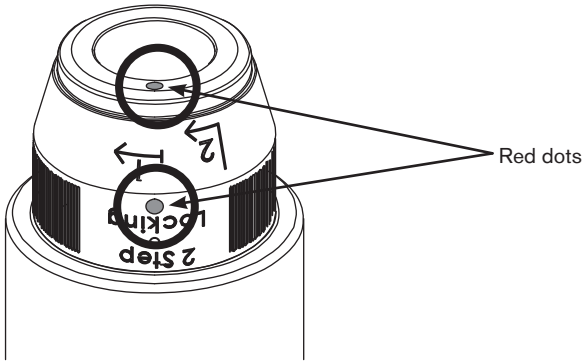






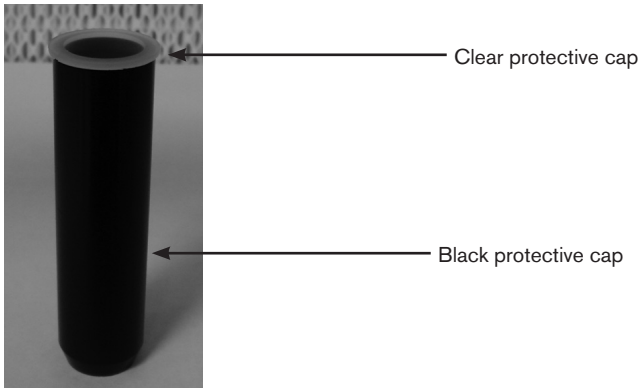
Note 1: When the flange is properly installed onto the collimator the threads on the collimator extend slightly beyond the bottom of the flange. See the figure above.

8. Verify that the locking ring on the top of collimator is in the unlocked position. The locking ring is in the unlocked position when the red dots are aligned.

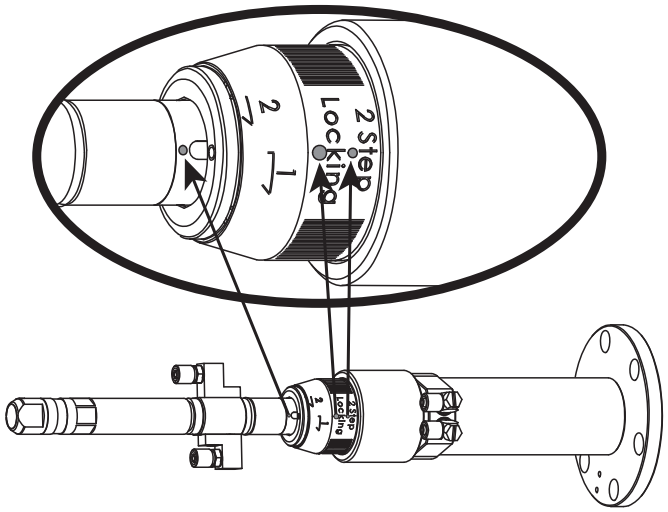


Caution: **Lint and powder free gloves must be worn for the remainder of this procedure to prevent damage to optical surfaces**

9. Put on lint and powder free gloves for the remainder of this procedure.
10. Visually inspect the outside of the bayonet connector on the Beam delivery optical cable for any dust or debris before proceeding. If any dust or debris exists, use clean dry compressed air or a lens cleaning tissue to remove it.
11. Carefully remove the black protective cap from the Beam delivery optical cable and visually inspect the quartz block for any dust, debris or filmy residue. If any dust, debris or filmy residue is present the Beam delivery optical cable must be cleaned by properly trained personnel before using. Reference the “Cleaning the quartz block” in the maintenance section of the Fiber Laser Instruction manual for additional information. Reinstall the black protective cap on the Beam delivery optical cable after inspection or cleaning.
12. With the help of an assistant, hold the bayonet connector of the Beam delivery optical cable in a horizontal position and carefully remove the black protective cap.
13. With the help of an assistant, hold the collimator in a horizontal position and carefully remove the clear protective cap from the input end.
14. Insert the clear protective cap into the black protective cap (shown below) and place these into the Head Accessory kit for future use.



15. Locate the red alignment dots on the bayonet and the collimator. Rotate the collimator to align the red dots as shown and carefully insert the bayonet into the collimator and turn the locking ring clockwise to lock the devices together.



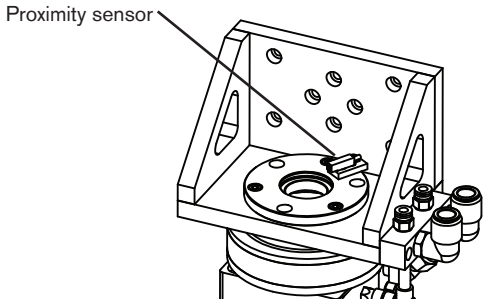
16. Rotate the collimator and laser head adaptor flange assembly to align it to the mounting holes in the laser head that will minimize the twisting of the Beam delivery optical cable. Install and tighten the three mounting bolts with a 4 mm hex wrench.

Collimator proximity sensor

The collimator proximity sensor assembly is mounted on the top of the bracket to ensure the beam is not enabled with the collimator removed. The sensor is connected to the laser head by a 3 conductor cable.

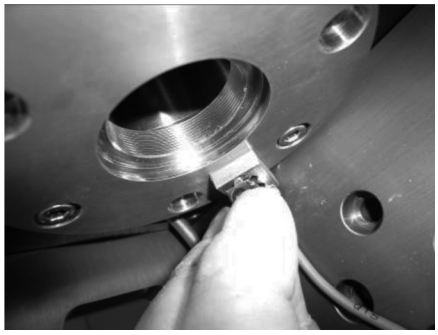
Note: The collimator should be installed before the proximity switch. The collimator is not shown in the pictures below for clarity.

1. With the mounting screw slightly loose, insert the “Y” shaped tab under the screw head.

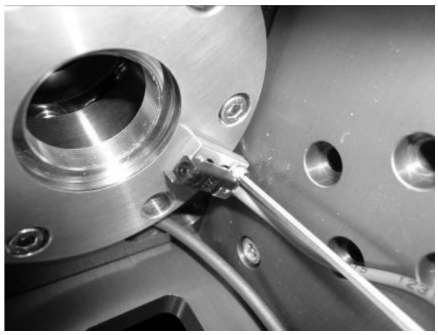


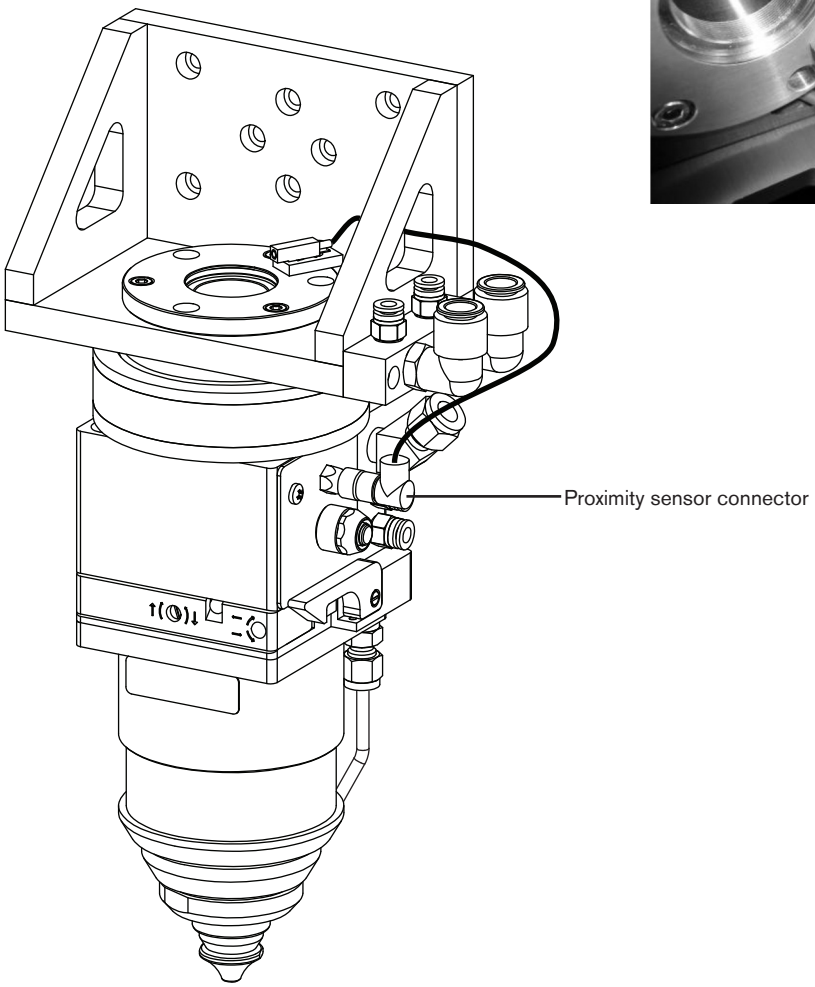
2. With the mounting screw slightly loose, insert the “Y” shaped tab under the screw head.

3. Align the tab on the proximity sensor bracket with the mounting hole on the laser head adaptor flange and insert the tab into the hole.



4. Tighten the mounting screw.
5. Connect the proximity sensor cable to the proximity sensor assembly and laser head as shown below.



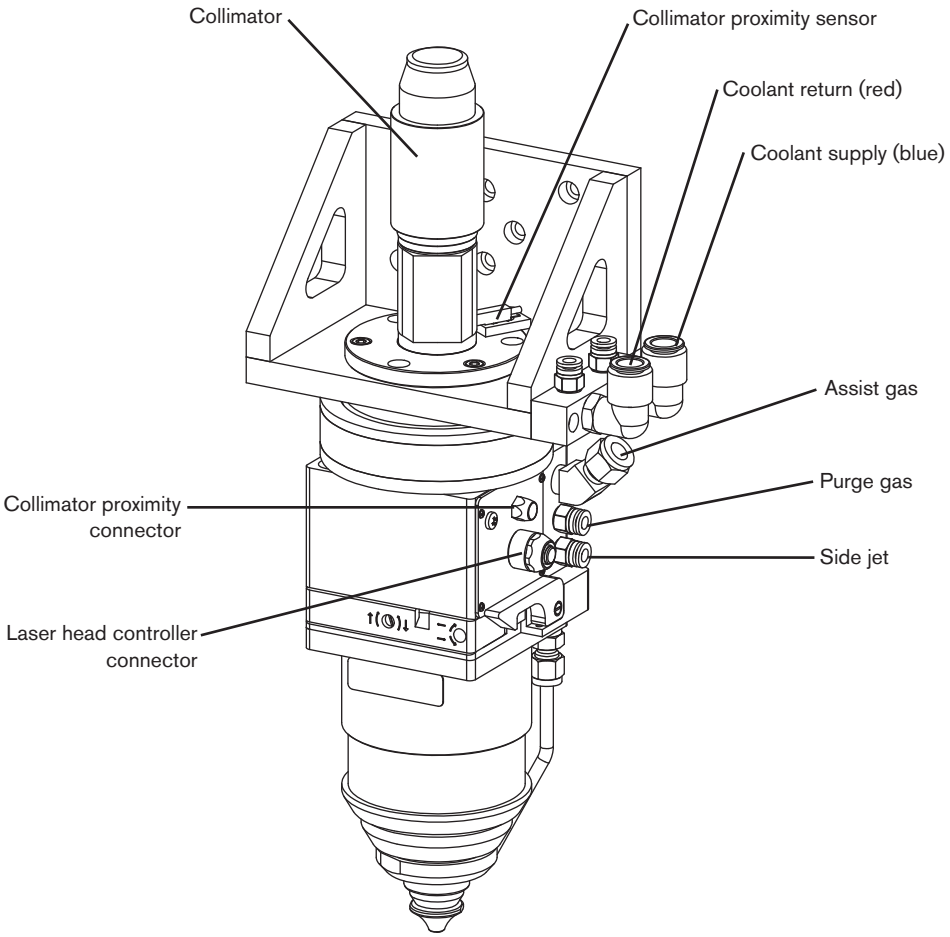


6. Turn on the power to the system. The orange indicator light on the proximity switch will illuminate if the switch was installed properly.

Note: The lens holder must be installed in the laser head to power the proximity switch.

Proximity sensor connector pin-outs		
Pin	**Color**	**Signal**
1	Brown	VDC Common
3	Blue	PNP proximity output
4	Black	15 VDC proximity input

Laser head connectors

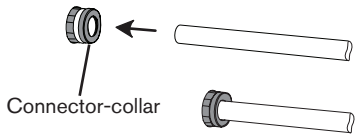


Coolant hose connections

The color coded water cooling hoses need to run from the back of the fiber laser supply enclosure to the laser head manifold. Excessive bends or kinks need to be avoided to allow proper cooling water flow. The manifold fittings are push-to-connect fittings to allow easy installation of the hoses. Make sure the ends of the hoses are cut cleanly to avoid damaging the o-ring seals inside the fittings. To install the hoses, push them firmly into the fittings and test the installation with a gentle pull on the hose to make sure it is secured.

Note: The connectors for the gas and coolant lines are push-to-connect fittings.

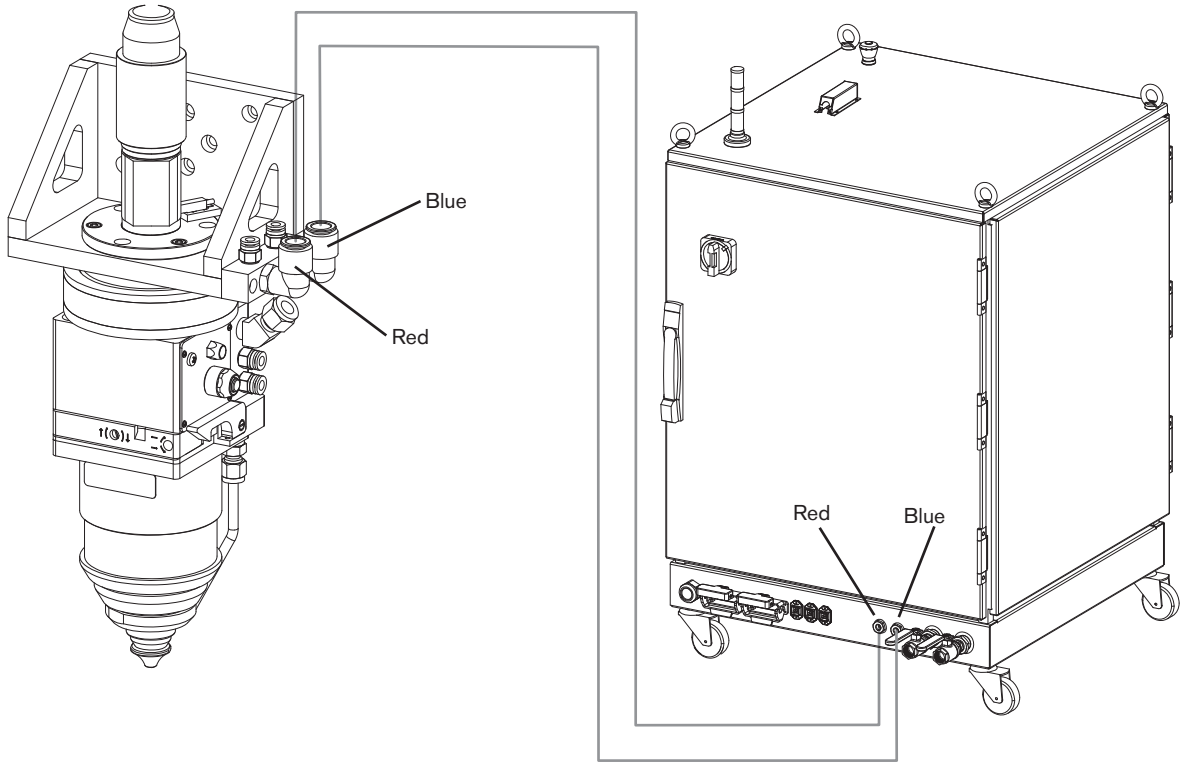
To make a connection, push the hose fitting into the appropriate connector until it stops, 12 mm (0.472 in).



To disconnect a fitting, push the connector-collar toward the torch, and pull the hose away from the torch.

❷ Fiber laser supply to laser head

Hoses included in this system
Blue hose: 12 mm outside diameter
Red hose: 12 mm outside diameter



Beam delivery optical cable and collimator coolant hoses

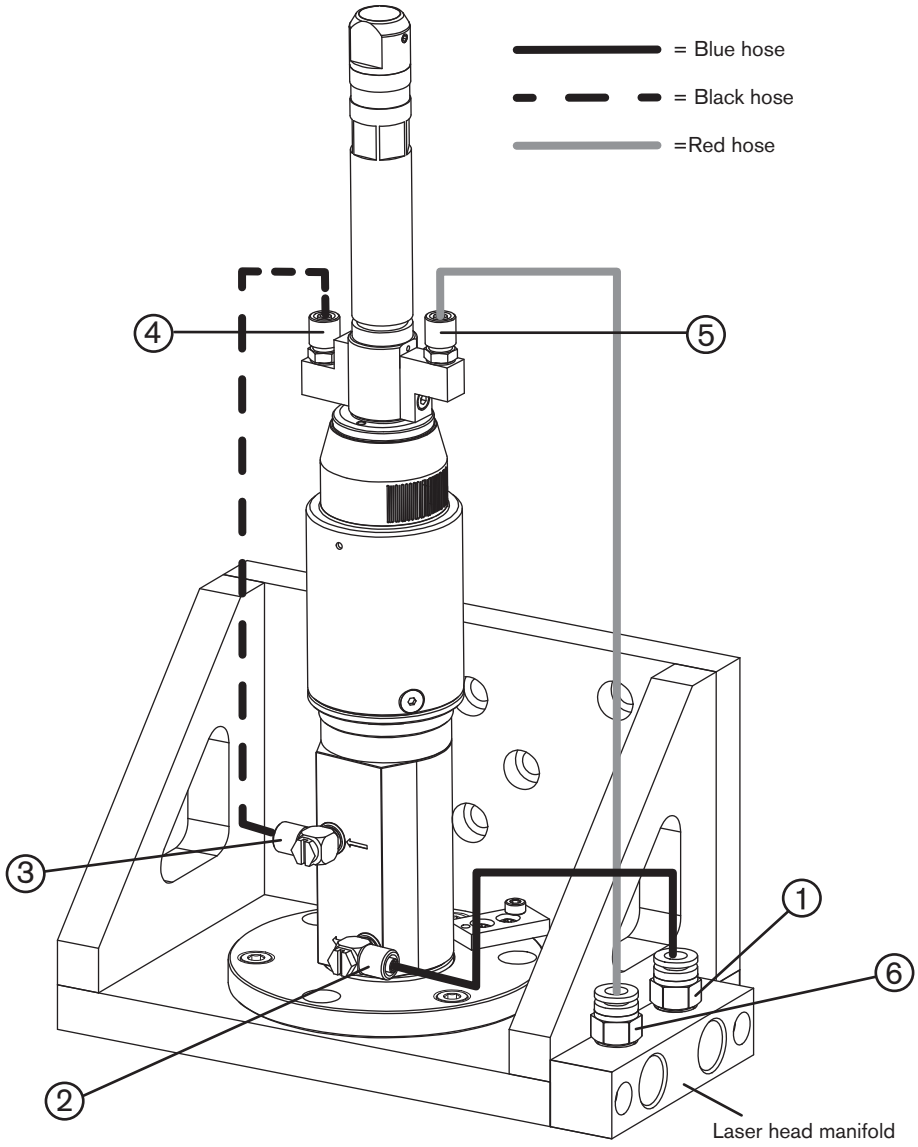
Proper cooling of the delivery cable is critical to long life and proper operation of the beam delivery optical cable.

Note: Previous versions of the collimators and bayonets had water IN and water OUT marked near the connections. The newer versions of the collimators and bayonets do not have the connections marked. The instructions below still identify the connections as they are marked on the older versions for clarity and consistency. The sequence of the connections is not critical.

Caution: 	**The coolant hoses must be connected as shown in the steps below. Failure to make the proper connections can result in damage to laser components.**

1. Insert the blue 6 mm hose into the blue 6 mm supply fitting on the laser head manifold.
2. Connect the other end of the blue 6 mm hose to the WATER IN fitting on the collimator.
3. Insert the black 6 mm hose into the WATER OUT fitting on the collimator.
4. Connect the other end of the black 6 mm hose to the WATER IN fitting on the bayonet.
5. Insert the red 6 mm hose into the WATER OUT fitting on the bayonet.
6. Connect the other end of the red 6 mm hose to the red 6 mm return fitting on the laser head manifold.

Hoses included with the system
Blue hose: 6 mm outside diameter
Red hose: 6 mm outside diameter
Black hose: 6 mm outside diameter

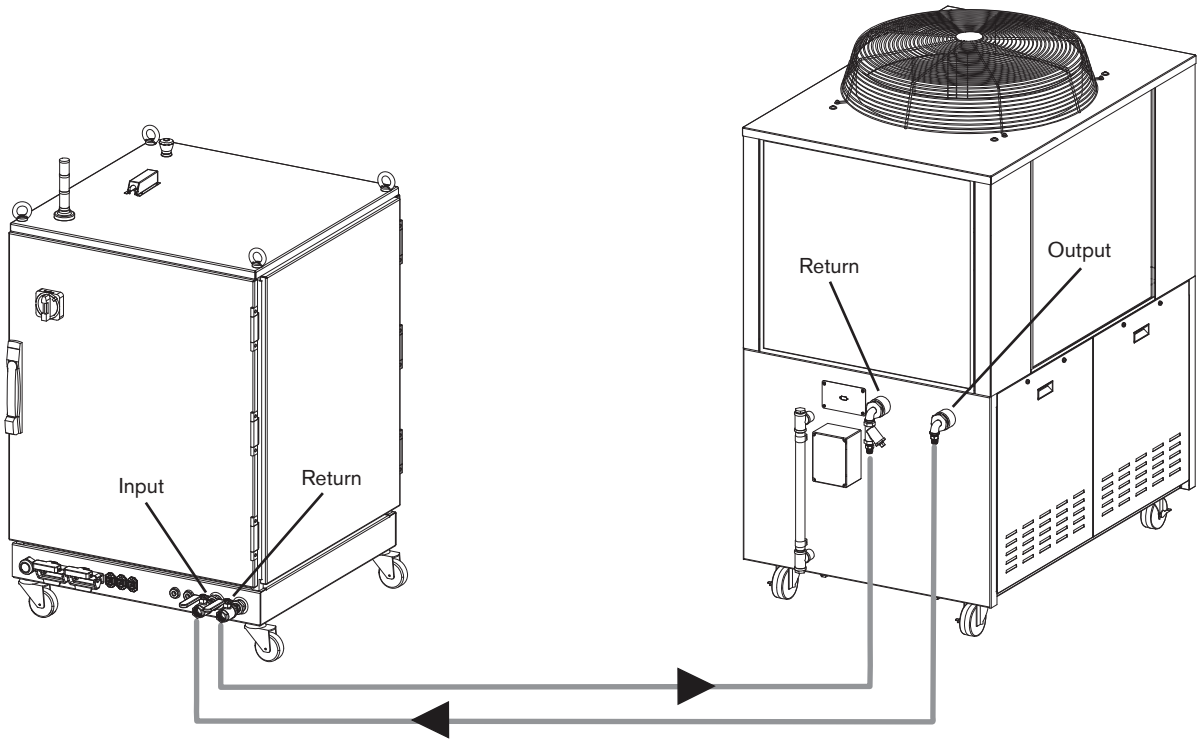


Beam delivery optical cable and collimator coolant hoses

❸ Fiber laser supply to chiller

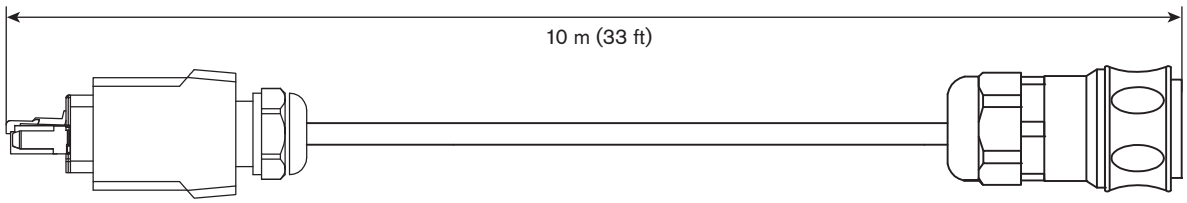
Note 1: This plumbing is customer supplied. Reinforced Tygon, copper, stainless steel, or PVC pipe is recommended. Steel and rubber should not be used.

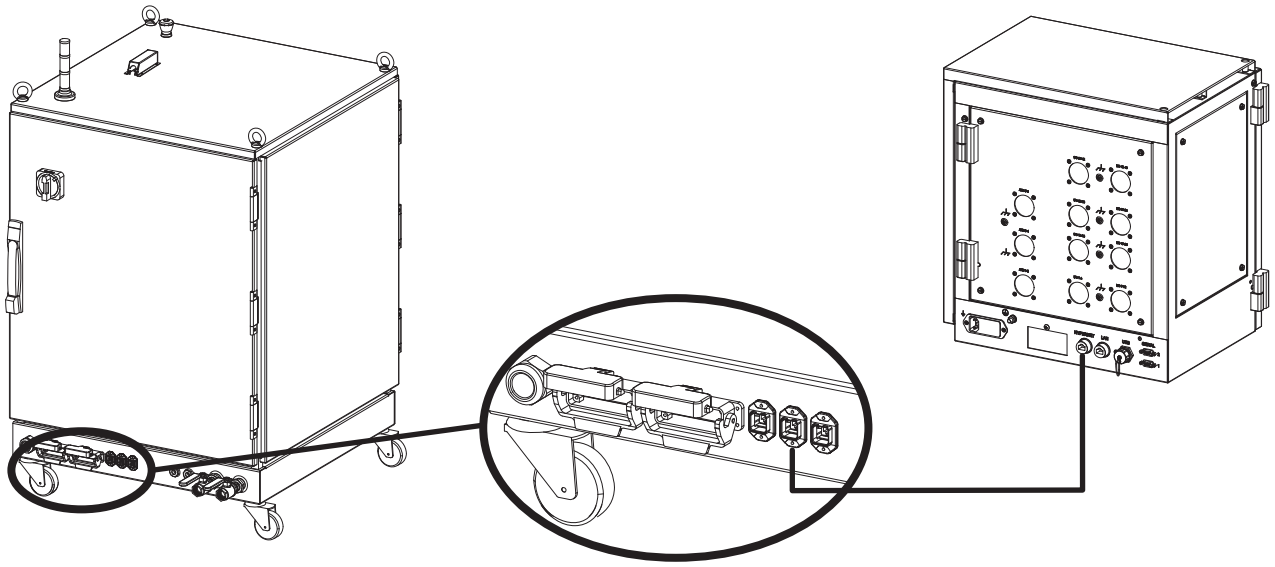
Note 2: The use of a water filter is recommended to meet the water/coolant purity specifications. See *Chiller requirements* in the *Specifications* section of this manual.



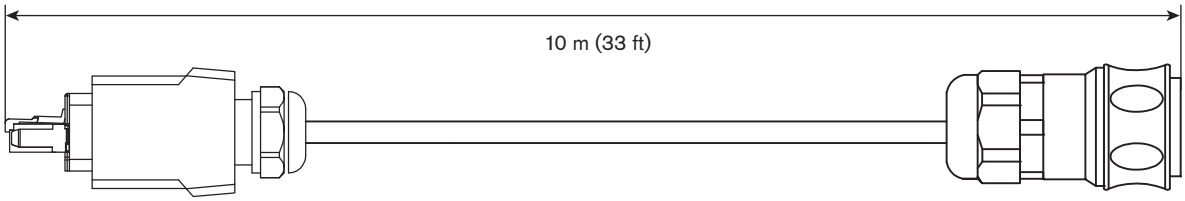
Cable connections

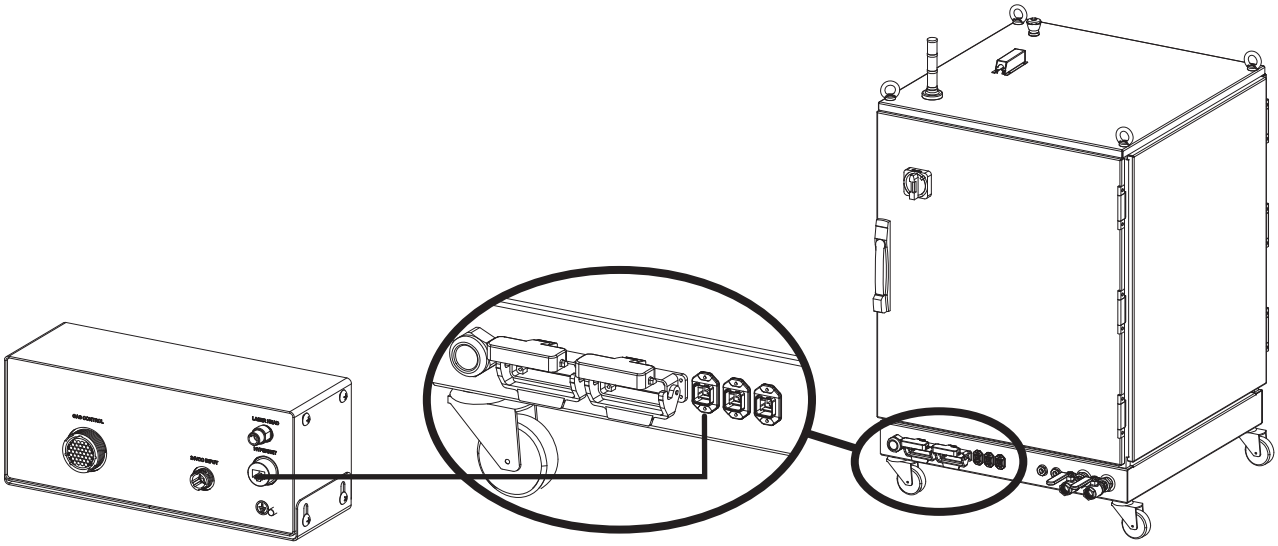
❹ Hypernet cable: fiber laser supply to a Hypertherm CNC – 223171





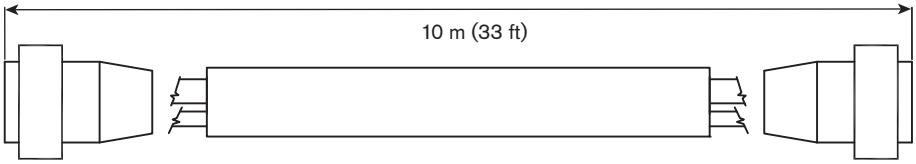
❺ Hypernet cable: fiber laser supply to laser head controller – 223171





❻ Gas console control cable – 223138

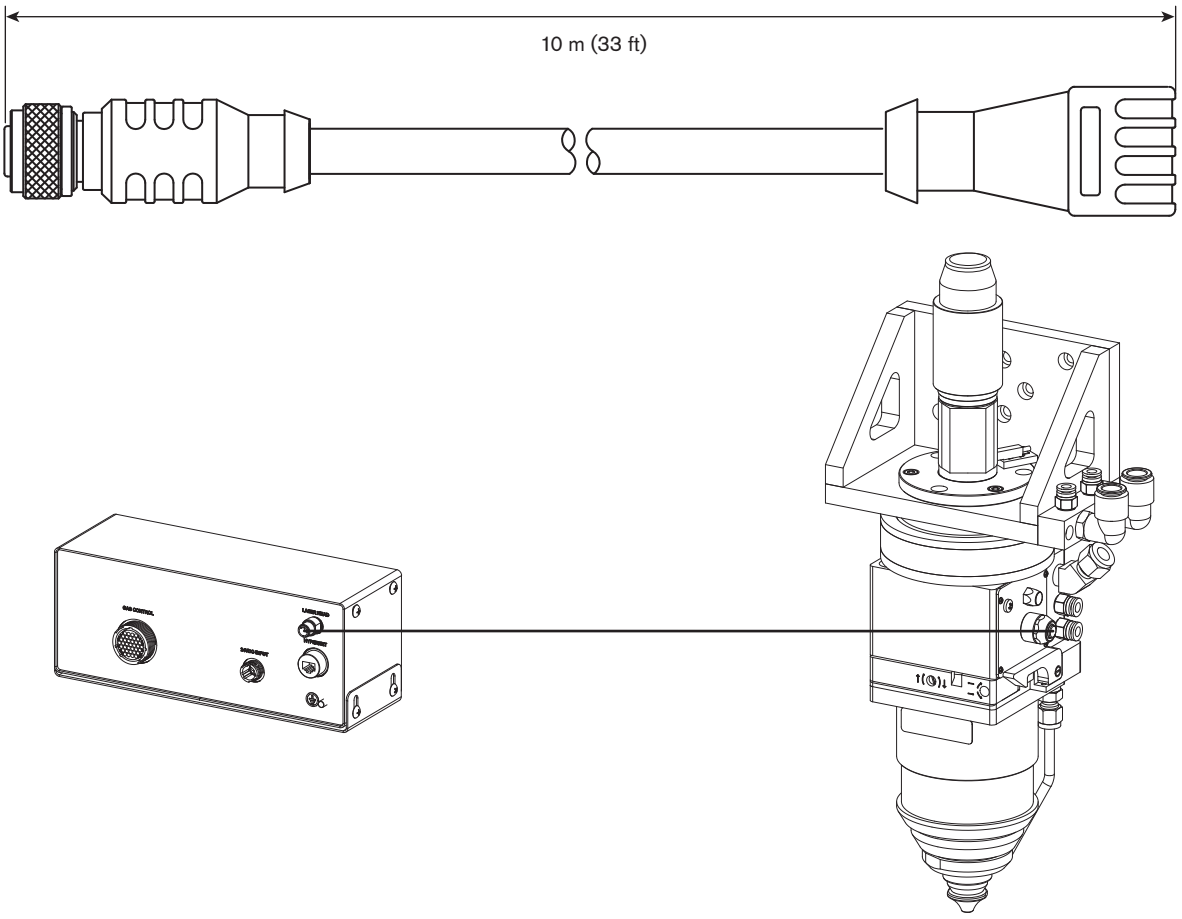
This cable connects from the laser head controller to the gas console.



Laser head gas control connector pin-outs	
Pin	**Description**
1	O_2/air pressure feedback
2	Common
11	Chassis
3	N_2/air pressure feedback
4	Common
11	Chassis
12	O_2/air pressure setpoint
10	Common
11	Chassis
14	N_2/air pressure setpoint
13	Common
16	Chassis
17	Gas fault +24 VDC
15	Common
16	Chassis
23	N_2 valve
6	Common
16	Chassis
24	Air valve
8	Common
16	Chassis
25	Side jet
22	Common
16	Chassis
26	Purge
33	Common
16	Chassis
35	+24 VDC
34	Common
37	Chassis

❼ Laser head I/O cable – 223169

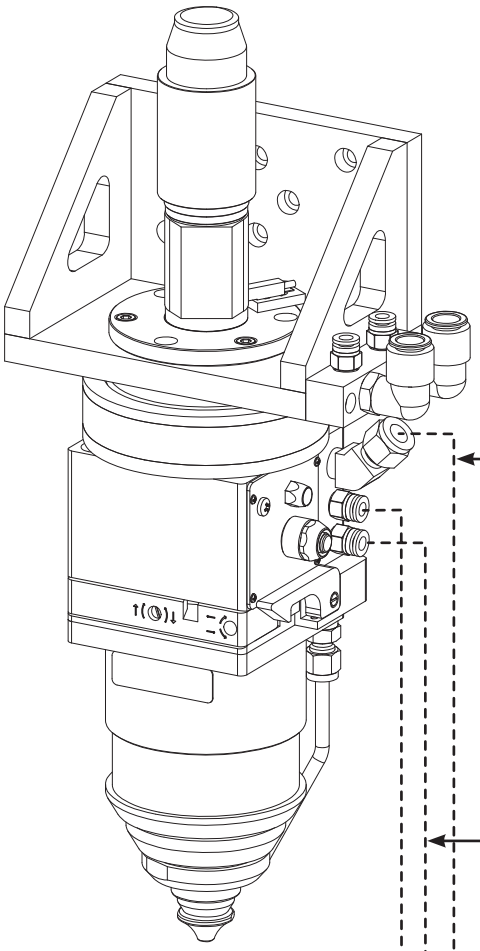
This cable connects from the laser head controller to the laser head.



Laser head controller I/O connector pin-outs	
Pin	**Signal**
1	Common
2	Capacitive height sense
3	Common
4	Spare
5	Common
6	+15 VDC
7	–15 VDC
8	Nozzle extension
9	Lens door
10	Collision
11	Tip touch
12	+10 VDC

❽ Gas hoses

Gas control console to laser head



Cut gas hose included with system

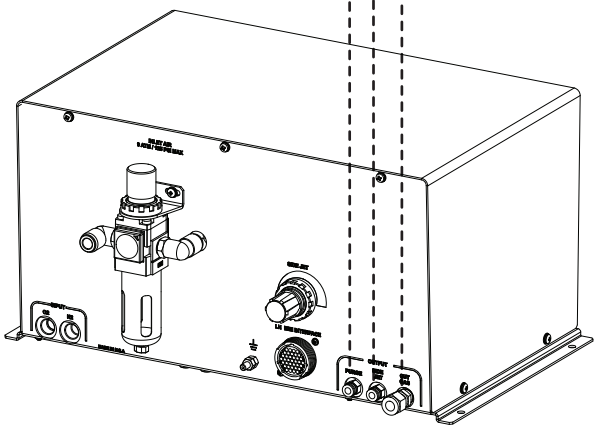
10 m (33 ft)
9.5 mm (3/8 in) internal diameter, thermoplastic hose.
3/8 in tube adaptor end connections.
Minimum bend radius is 2.5 cm

Side-jet hose included with system

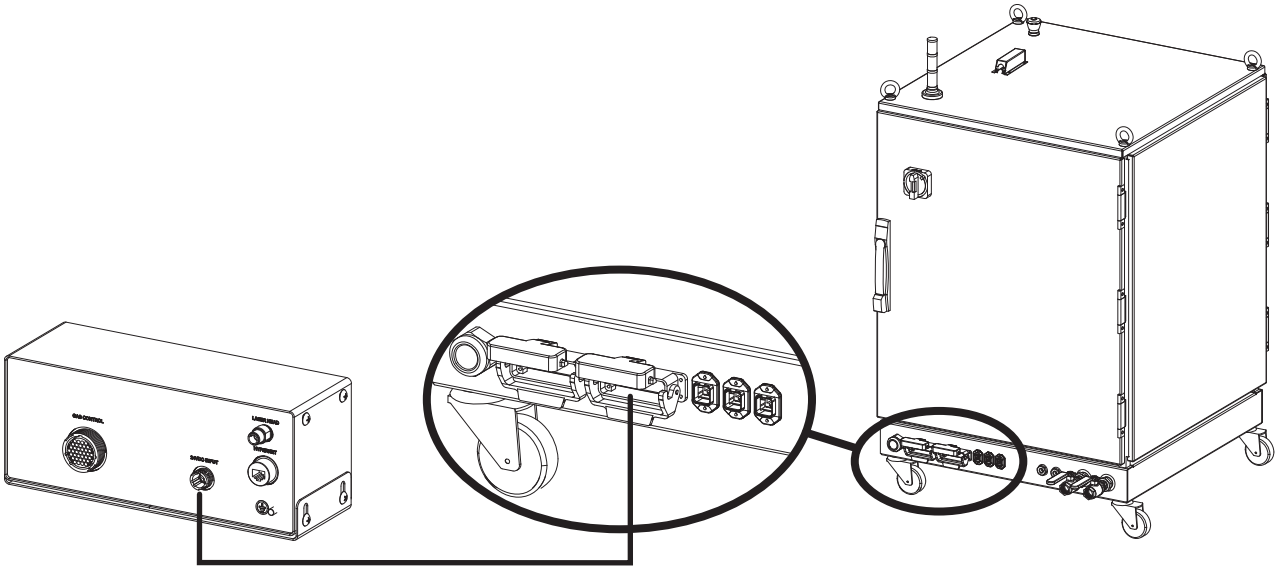
10 m (33 ft) black
6 mm outside diameter

Purge hose included with system

10 m (33 ft), White
6 mm outside diameter

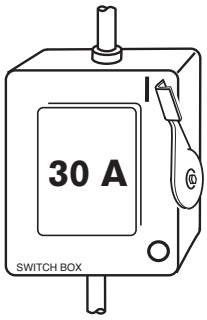


❾ Laser head controller power cable – (customer supplied)



Laser head controller power connector pin-outs		
CPC Pin	**LPC2 Pin**	**Signal**
1	A9	24 VDC
2	C9	Common
3	NC	NC
4	Shield screw on connector housing	Shield

Line disconnect switch



The line disconnect switch serves as the supply-voltage disconnecting (isolating) device. Install this switch near the power supply for easy access by the operator. The switch should be fused for 30 amps, 480 VAC.

Installation must be performed by a licensed electrician and according to applicable national and local codes.

The switch should:

- Isolate the electrical equipment and disconnect all live conductors from the supply voltage when in the “OFF” position
- Have one “OFF” and one “ON” position clearly marked with “O” (OFF) and “I” (ON)
- Have an external operating handle capable of being locked in the “OFF” position
- Contain a power-operated mechanism that serves as an emergency stop
- Have slow-blow fuses installed for the proper breaking capacity

⑩ Main power cables (fiber laser supply and chiller)

Wire sizes vary based on the distance of the receptacle from the main box. The fiber laser supply must be permanently connected using rigid or flexible metallic conduit. 10 AWG wire rated for use in conduit is recommended. Installation must be performed by a licensed electrician.

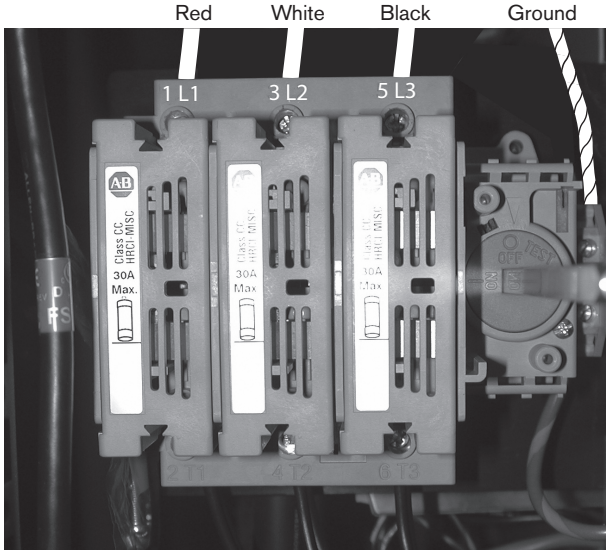
Connect the power

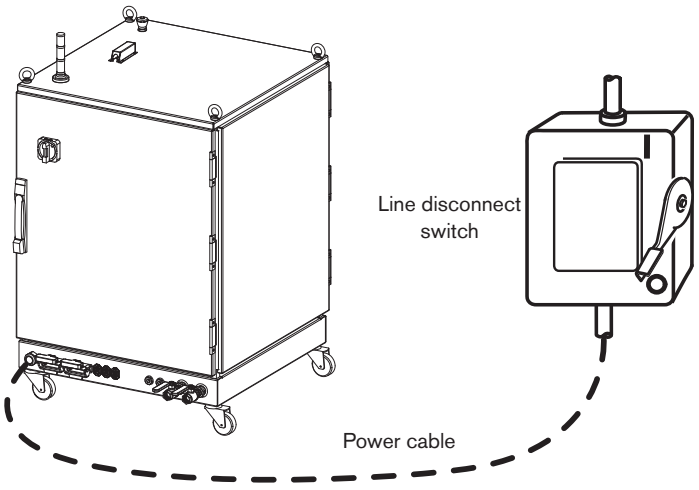
DANGER
ELECTRICAL SHOCK CAN KILL

The line disconnect switch must be in the OFF position before making the power cable connections. In the U.S., use a "lock-out/tag-out" procedure until installation is complete. In other countries, follow appropriate national and local safety procedures.

1. Insert the power cable through the strain relief at the rear of the fiber laser supply.
2. Open the rear door of the fiber laser supply enclosure and locate the main power terminal block.
3. Connect the power leads to the terminals as shown below.
4. **Verify that the line disconnect switch is in the OFF position and remains in the OFF position for the remainder of the installation of the system.**
5. Connect the power cord leads to the line disconnect switch following national and local electrical codes.

Wire colors
L1 = Red
L2 = White
L3 = Black
(PE) Earth ground = Green/Yellow





Gas requirements

The customer must furnish all gases and gas-supply regulators for the system. Use a high-quality, 2-stage pressure regulator located within 30 m (100 ft). of the gas console. See gas regulators in this section for recommendations. See the *Specification section* for gas and flow specifications.

Note: Oxygen, air and nitrogen are required for all systems. Air is used as a purge gas.

Caution:

Gas supply pressures not within the specifications in Section 2 can cause poor cut quality, poor consumable life and operational problems.
If the purity level of the gas is too low or if there are leaks in the supply hoses or connections:

- **Cut speeds can decrease**
- **Cut quality can deteriorate**
- **Cutting thickness capability can decrease**
- **Parts life can shorten**

Gas regulators

Low-quality gas regulators do not provide consistent supply pressures and can result in poor cut quality and system operation problems. Use a high-quality, 1-stage, gas regulator to maintain consistent gas supply pressure, if using liquid cryogenic or bulk storage. Use a high-quality, 2-stage, gas regulator to maintain consistent gas supply pressure from high pressure gas cylinders.

The high-quality gas regulators listed below are available from Hypertherm and meet U.S. Compressed Gas Association (CGA) specifications. In other countries, select gas regulators that conform to national or local codes.

Two-stage regulator

Single stage regulator

Part Number	Description	Quantity
128544	**Kit: Oxygen, 2-stage ***	**1**
128547	**Kit: Air, 2-stage**	**1**
128548	**Kit: 1-stage (for use with cryogenic liquid nitrogen or oxygen)**	**1**
022037	Oxygen, 2-stage	1
022040	Air, 2-stage	1
022041	Line regulator, 1-stage	1

* Kits include appropriate fittings

Supply gas plumbing

Rigid copper plumbing or suitable flexible hose may be used for all gas supplies, but they must meet the pressure requirements (see section 1, *Specifications*). Do not use steel or aluminum pipe.
After installation, pressurize the entire system and check for leaks.
Recommended hose diameters are 10 mm (3/8 in) for lengths < 25 m (82 ft) and 12 mm (1/2 in) for lengths > 25 m (82 ft).

For flexible-hose systems, use a hose designed for inert gas to carry air, nitrogen.

Caution:

When connecting the gas console to the supply gases, make sure that all hoses, hose connections and fittings are acceptable for use with oxygen. Installation must be made in accordance with national and local codes.

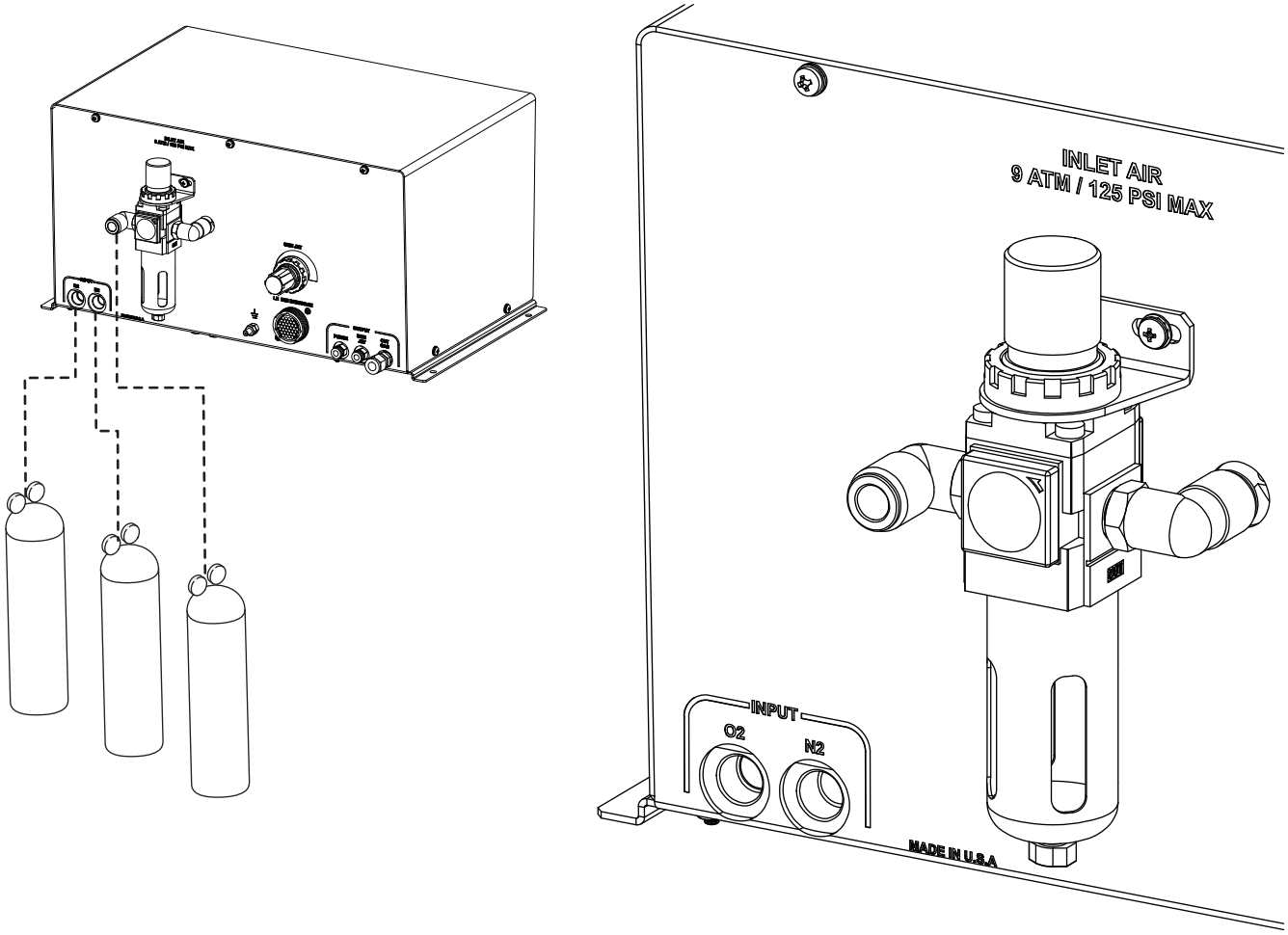
WARNING
CUTTING WITH OXYGEN CAN CAUSE FIRE OR EXPLOSION

Cutting with oxygen as the assist gas can cause a potential fire hazard due to the oxygen-enriched atmosphere that it creates. As a precaution, Hypertherm recommends that an exhaust ventilation system be installed when cutting with oxygen.
Flashback arrestors are required (unless not available for specific gases or required pressures) to prevent fire from propagating to supply gas.

Connect the supply gases

Connect the supply gases to the gas console.

Fitting	Size
O_2	1/4 in NPT female*
N_2	1/4 in NPT female**
Air	10 mm OD, push-to-connect



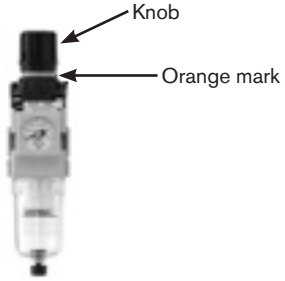
* The customer must furnish gas supply hoses for the system. Recommendations for appropriate fittings/adaptors and supply gas hoses can be provided by Hypertherm if necessary. Oxygen hoses in various lengths are available from Hypertherm.

** The nitrogen hose for use with the fiber laser system must be rated for a working pressure of at least 28 bar (400 psi).

Initial setup

The gas console should be delivered with the proper settings from the factory. However, since a minimum air pressure is required for several functions, the setting of the air inlet regulator should be checked at initial install.

1. After connecting the air hose, turn on the compressed air supply (see System gas requirements in *Section 1* for pressure and flow rate requirements).
2. Read the set pressure of the air supplied by the regulator to the gas console on the gauge embedded in the body of the regulator; it should read 0.5 ± 0.05 MPa (75 ± 7.5 psi). If necessary, use the knob on the regulator to set the regulator outlet pressure to the correct value. Be sure to unlock the knob before adjusting the pressure and lock it after setting the pressure. Failure to follow this procedure can cause damage to the knob and the outlet pressure may fluctuate.
   - Pull the pressure regulator knob to unlock it. You can visually verify this by the "orange mark" that appears in the gap.
   - Push the pressure regulator knob to lock it. When the knob is not easily locked, turn it left and right a little and then push it (when the knob is locked, the "orange mark" disappears as the gap is closed).



F CNC setups

This manual will cover the details of connecting a Hypertherm CNC to a HyIntensity fiber laser supply. The details of connecting a Hypertherm CNC to other components such as I/O modules and drive amplifiers are covered in the CNC manual and will not be duplicated here. Please refer to the CNC manual for this information.

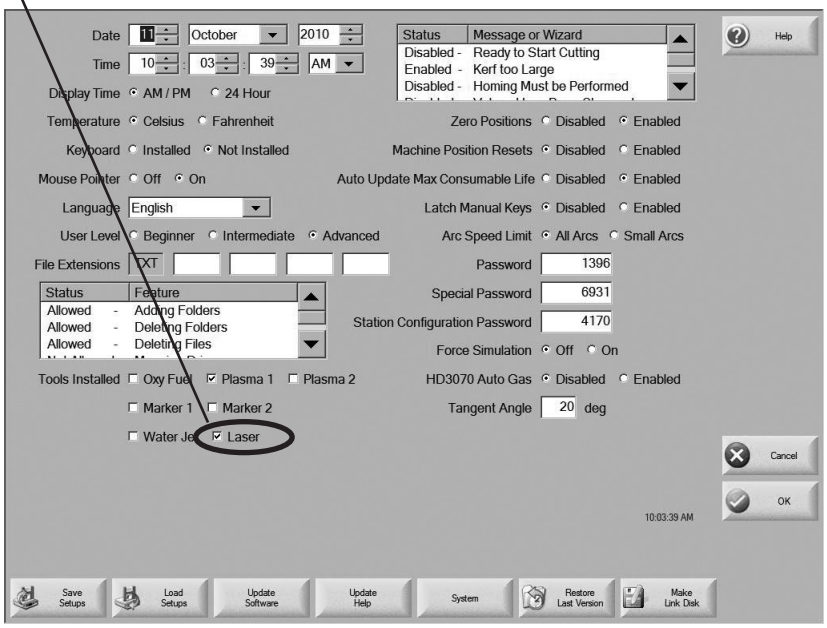
Note: The HFL030 requires Phoenix software version 9.73 or higher for proper functionality

Communications between the CNC and the fiber laser supply can be established with a Hypernet digital link.

A separate operator panel, provided by the user and located where the operator can access it easily, is required to provide the functionality of enabling the fiber laser supply. The required components are a keyed interlock, emergency stop pushbutton (with 2 normally open contacts), a momentary pushbutton (with optional light to indicate that the safety circuit is activated), and a manual enable to clear laser faults, such as interlock or status faults. See *Electrical diagram for external safety switches* earlier in this section.

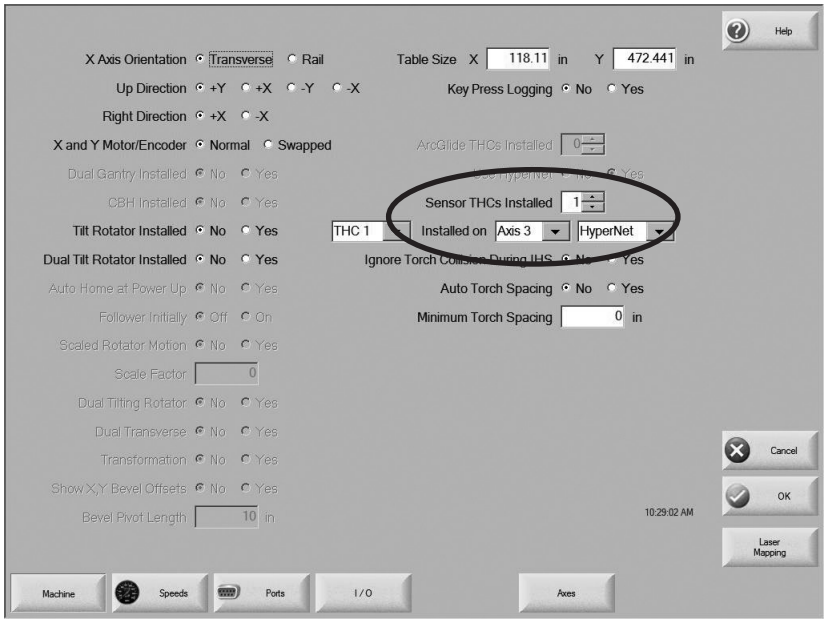
Hypertherm CNC setup

1. Select Laser as one of the Tools Installed on the Special Setups screen and click the OK button.

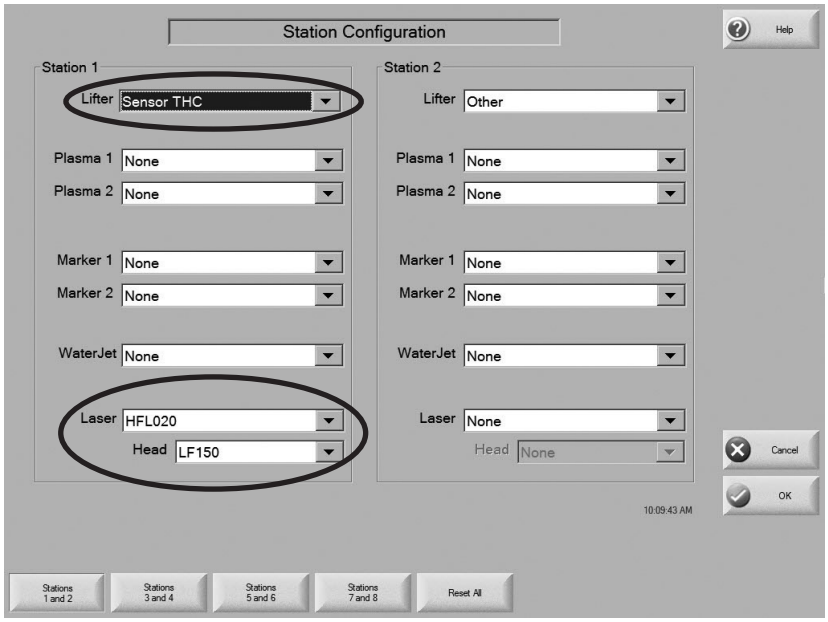


2. Click on the Machine Setup button on the next screen.

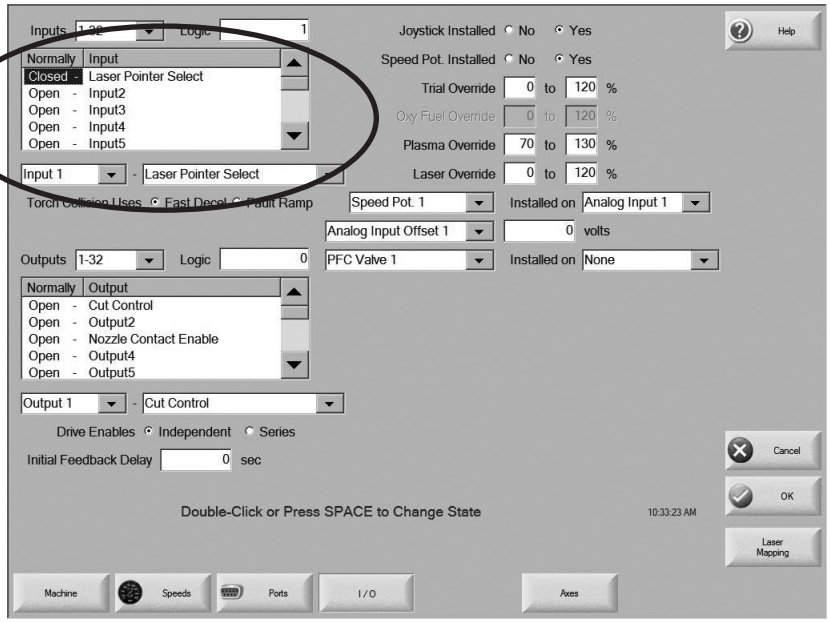
3. On the Machine Setups screen, set the number of Sensor THC's installed, the THC physical axis, and select Hypernet. Changes in the capacitive height sense are communicated over Hypernet instead of an analog input.



4. On the Station Configuration screen, select Sensor THC as the lifter, HFL010, HFL015, HFL020, or HFL030 as the Laser and LF150 as the Head. Selecting an HFL as the laser activates Hypernet communications and laser-specific I/O.

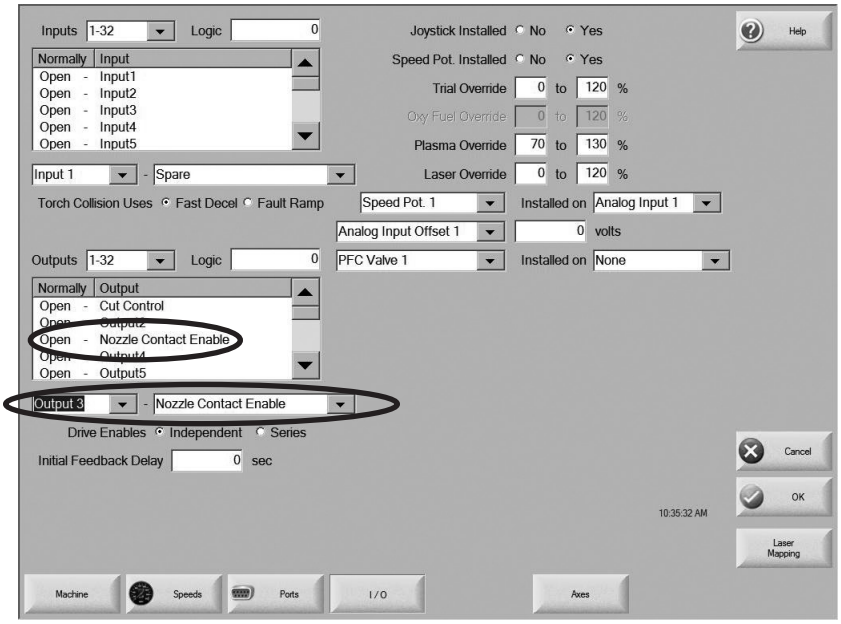


5. On the I/O screen, select the Laser Pointer Select input and set it to Normally Closed. This will turn on the pointing laser in the HFL. If a customer wants the ability to turn on and off the pointing laser they will need to wire a switch to the input the Laser Pointer Select is mapped to.

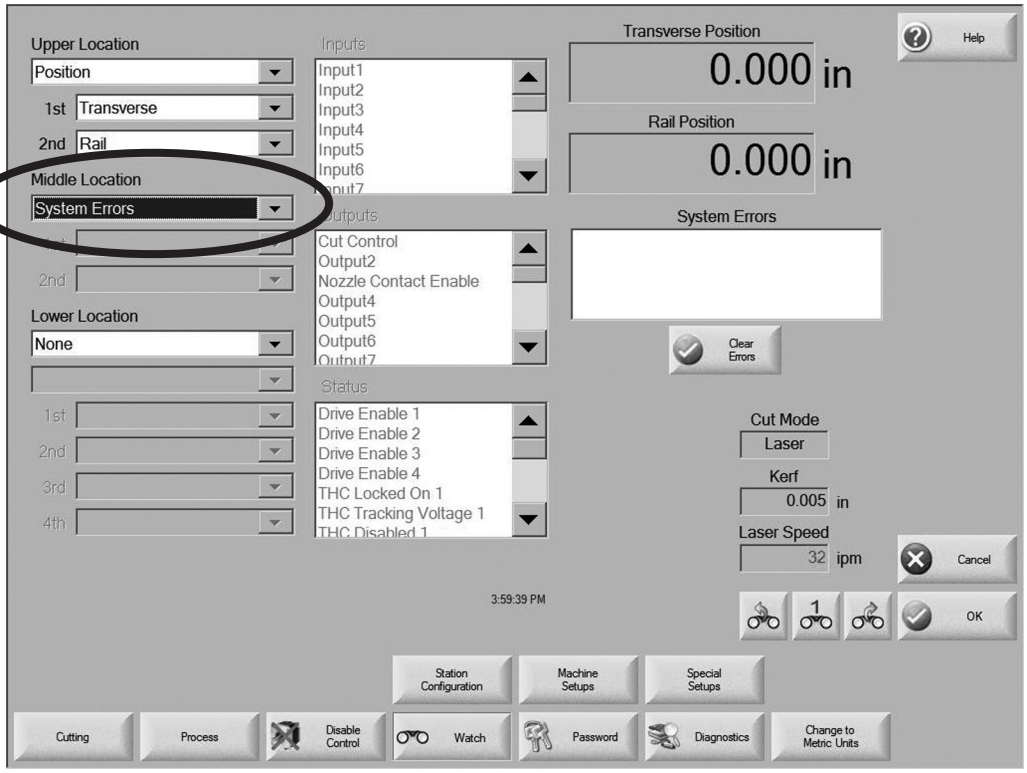


6. On the I/O screen, select the Nozzle Contact Enable output and set it to Normally Open. This is required for the initial height sense (IHS) to work properly.

Note: If you have more than one tool installed (for example: Laser and Plasma) all of the Nozzle Contact Sense inputs must be set to Normally Open.



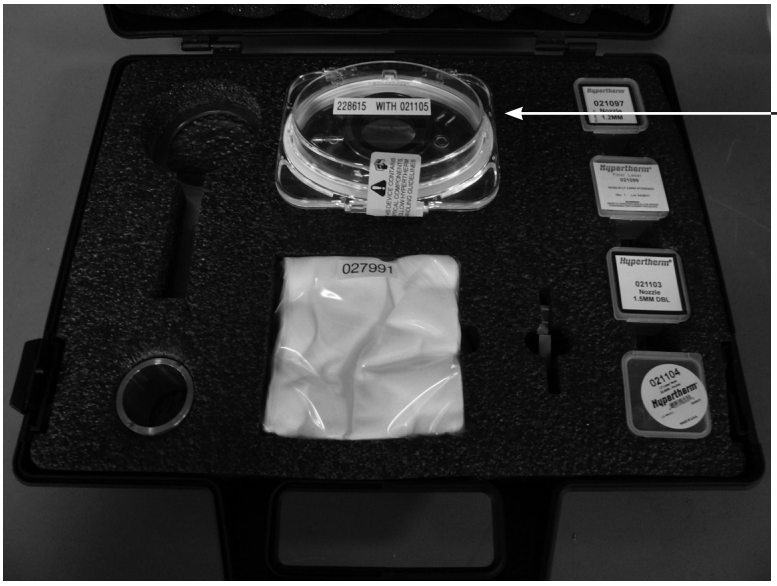
From the main CNC screen go to Setups and select Watch Window. Set-up a watch window that displays system errors. This allows access to the clear errors button so that faults can be cleared. See *set-up screens* in the CNC manual for details.



Lens assembly installation

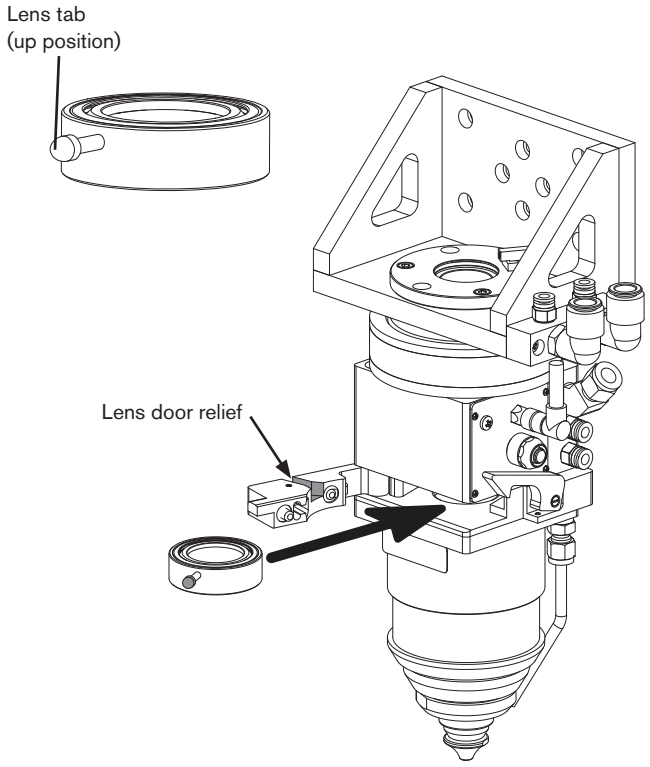
General precautions

- DO NOT remove the cutting lens from its protective case until instructed to do so later in this document.
- The cutting lens should always be stored in the protective case when it is not installed in the laser head.

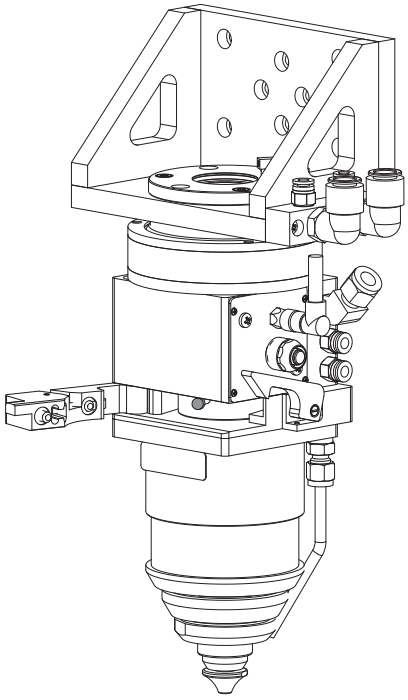


1. Inspect the outside of the lens door on the laser cutting head for any dust or debris before continuing. If any dust or debris is present, use clean dry compressed air or a lens cleaning tissue to remove it.
2. Open the lens door on the laser head by lifting up on the lens door latch.
3. Remove the cutting lens from its protective package and visually inspect both sides of the lens for any dust or debris before conyinuing. If any dust or debris is present, use clean dry compressed air or a lens cleaning tissue to remove it. See the lens inspection and lens cleaning instructions in the *maintenance* section of this manual for complete instructions.

Caution: **Using a lens with ANY dust, debris, or spots can damage the lens. See Lens Inspection and Lens cleaning in the *Maintenance* section of this manual.**



Lens into lens bay

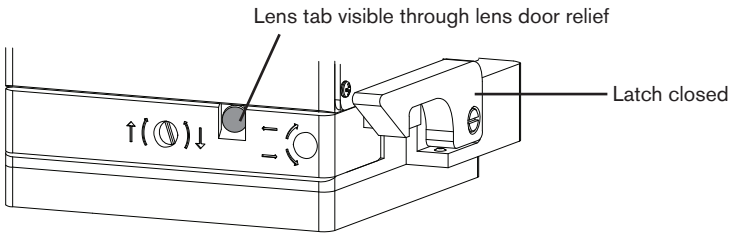


Lens tab aligned with lens door relief

4. Orient the lens assembly with the lens tab in the up position and slide it into the lens bay. The lens door will not close with the lens tab in the down position.
5. Align the lens tab with the lens door relief to allow the door to close.

Continued on next page

6. Close and latch the lens door securely.



Lens door closed and latched

7. The laser beam should be centered before any cutting is attempted. See the beam centering procedure in the *Set up and operation* section of this manual for complete instructions.

Note: The upper and lower lens seals are designed to operate dry, do not lubricate.

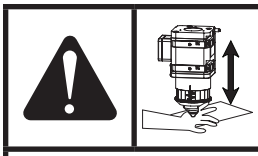
Section 3

SET-UP AND OPERATION

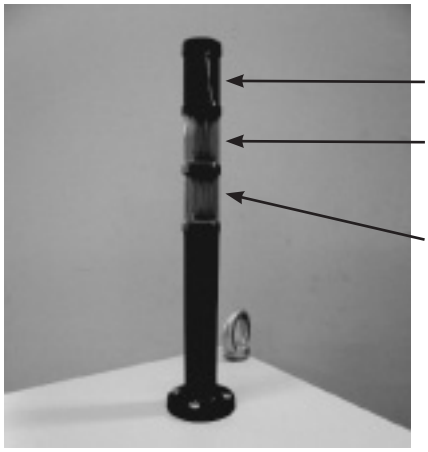
Safe operation

	**DANGER**
Visible or invisible radiation (class IV) can be present when the laser head door is open. Avoid eye and skin exposure to direct and scattered radiation. Always follow safety precautions specified in the Safety section of this manual.	

	**DANGER**
Never put fingers or hands in the path of the beam. Visible and invisible radiation are emitted from the nozzle aperture.	

	**DANGER**
Never put fingers or hands between the material that is being cut and the laser head enclosure. Moving parts can cause severe crush injuries.	

	**WARNING**
It is the user's responsibility to know what materials are being cut. Do not cut metal or other materials coated with or containing toxic substances, such as zinc (galvanized), lead, cadmium, beryllium or asbestos unless the area is well ventilated and the operator wears an air-supplied respirator. The coatings and any metals containing these elements can produce toxic fumes when cut.	



Stack light color descriptions

Red flashing = Laser is on. All safety precautions must be followed.

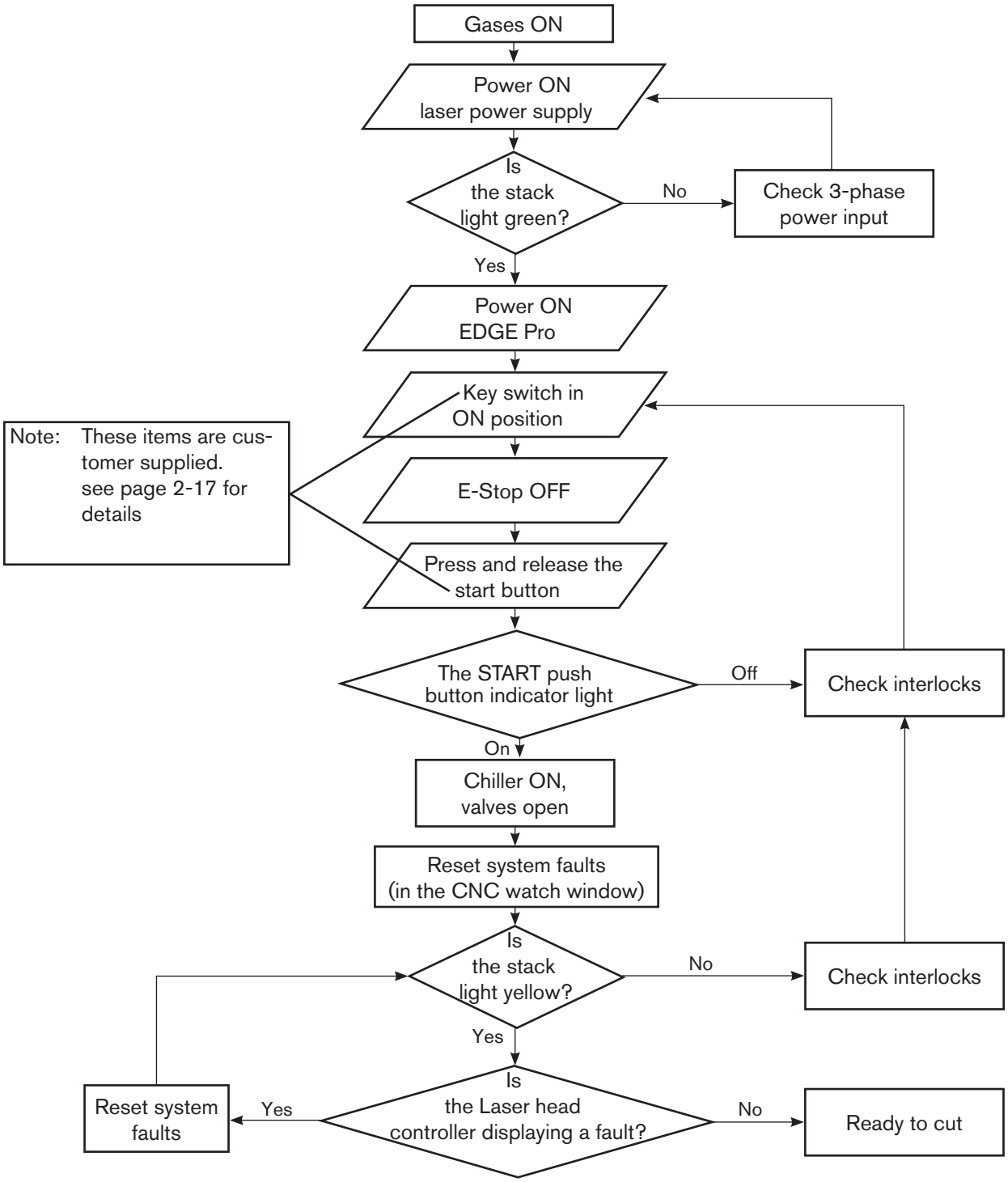
Yellow = The laser may come on at any time. All safety precautions must be followed.

Green = Safe

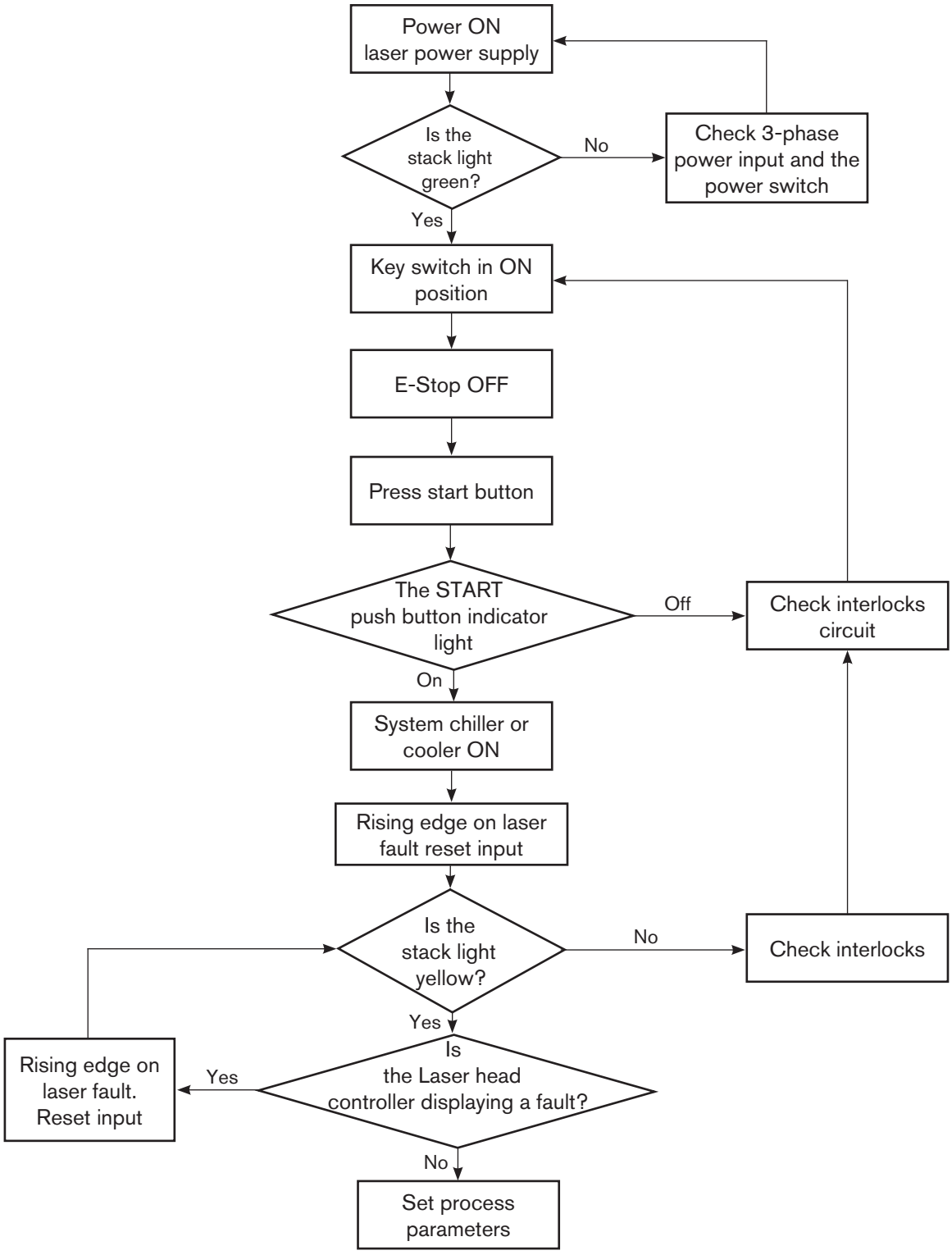
Sequence of operation with a Hypertherm CNC

WARNING

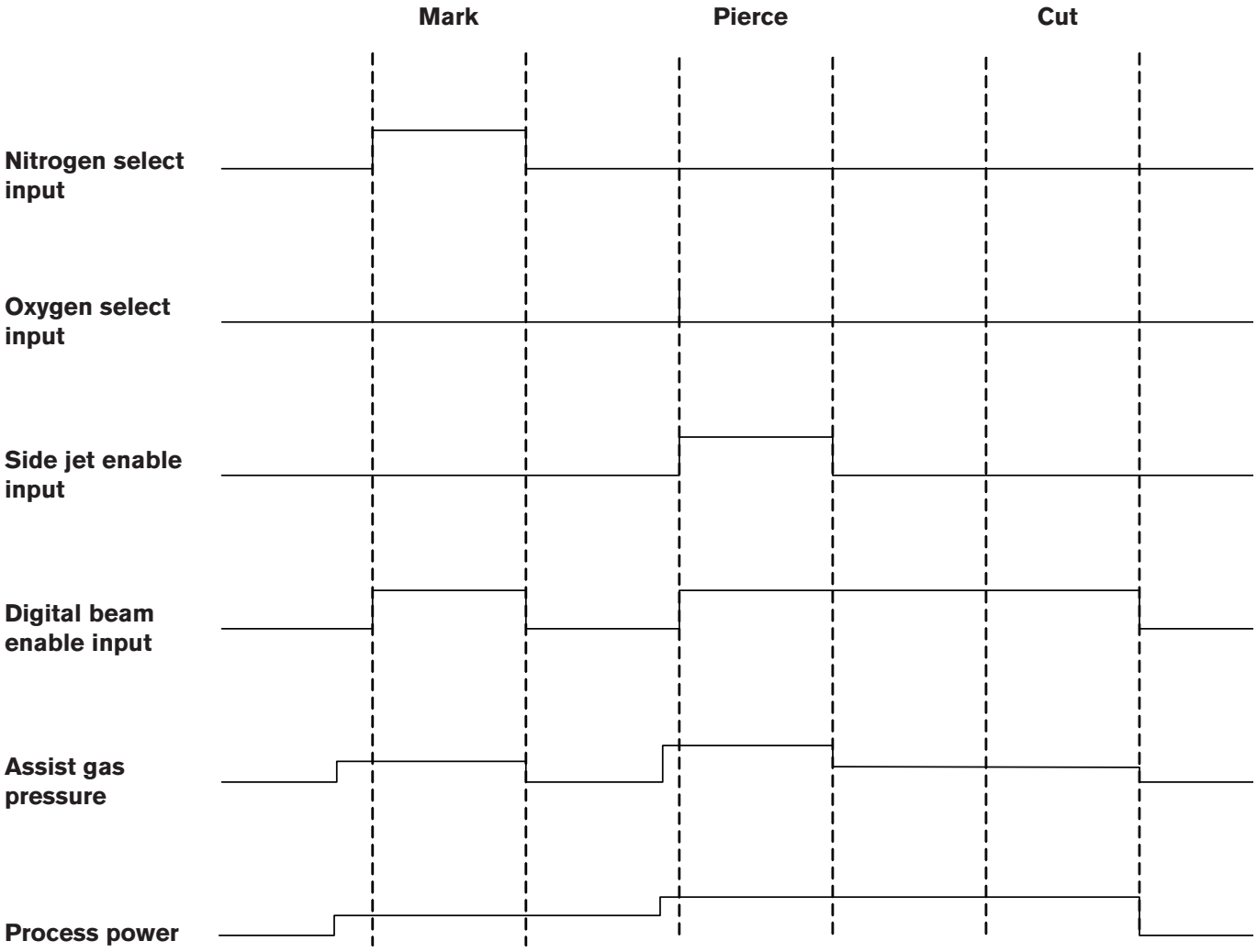
Always use personal protective equipment when working on or around laser equipment. See the safety section in this manual for more details on safety and protective equipment.



Sequence of operation with a generic CNC

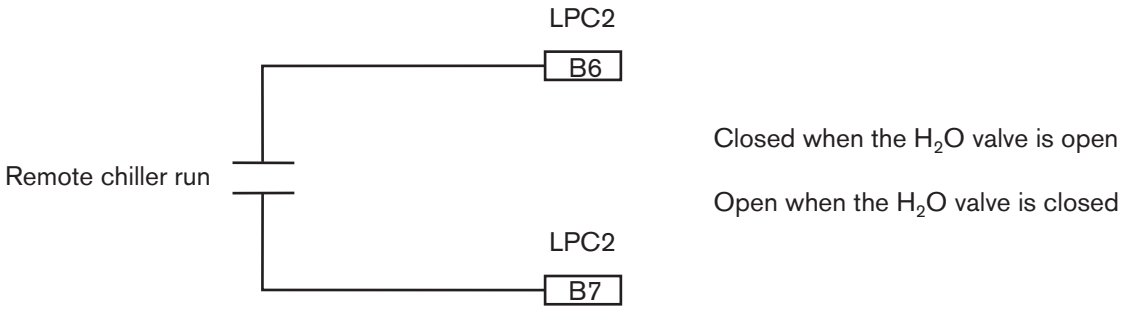


Marking and cutting mild steel with a generic CNC



H_2O valve

The laser power controller uses an electrically-actuated valve to control the water flow into the cabinet. This valve is turned off if the system has been in the beam OFF state for 15 minutes or if a leak has been detected. This ensures that there is no condensation on the water cooled components of the system. The valve is turned ON whenever the laser beam is on. When the H_2O valve is open the “Remote Chiller Run” contacts are closed. See the drawing below for an example of the recommended circuit.



Flow meters

The system contains three flow meters to monitor coolant flow. If the input flow is outside its operating range, the system goes to the fault state and disables the laser beam. If a cut is in progress and the system temperatures are within range, the system is allowed to finish the cut before going to the fault state.

If the flow to the fiber-to-fiber coupler is outside its operating range, the system goes to the fault state and turns off the laser beam.

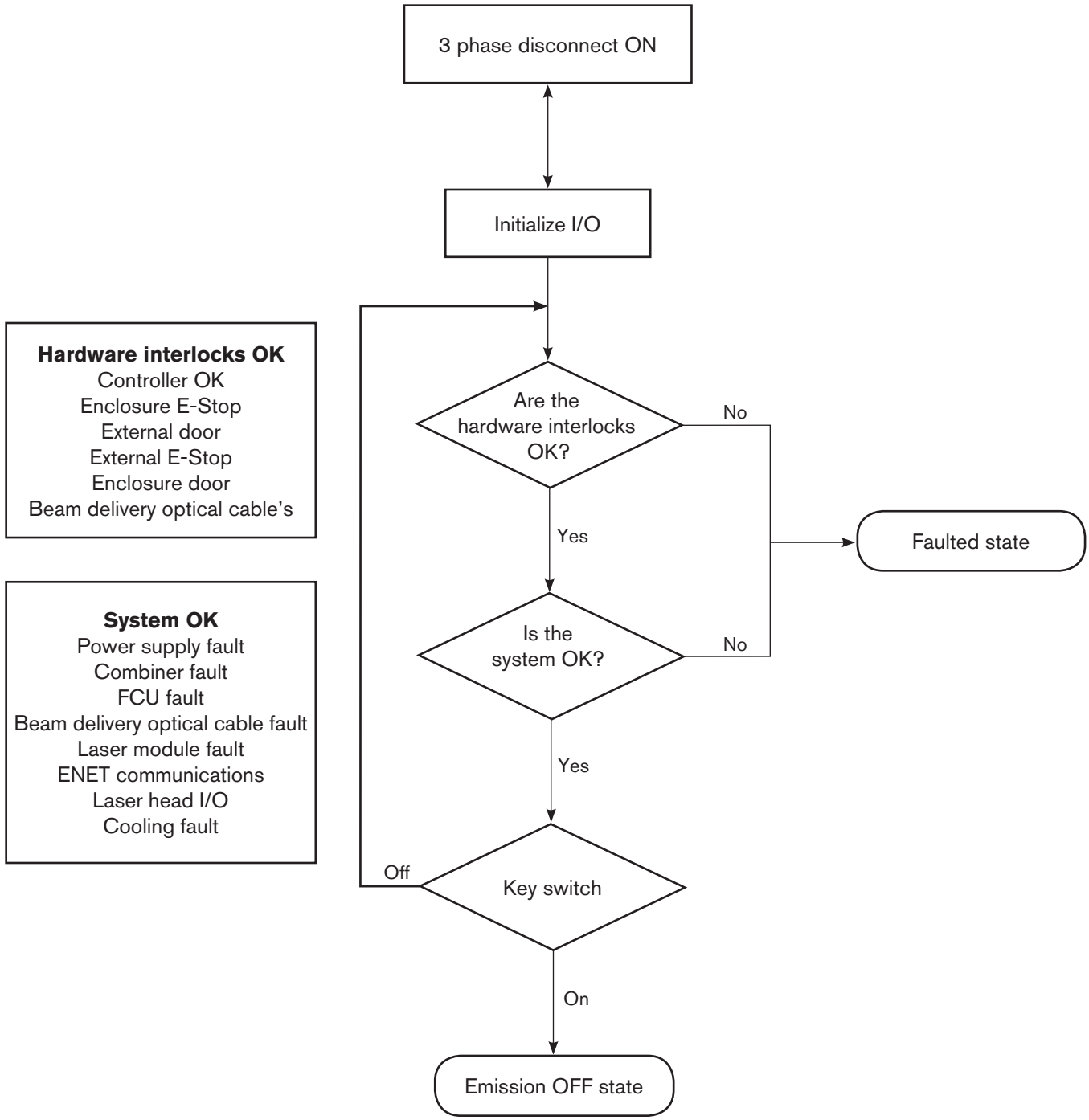
If the process fiber flow is outside its operating range, the system enters the fault state.

Fiber-to-fiber coupling unit

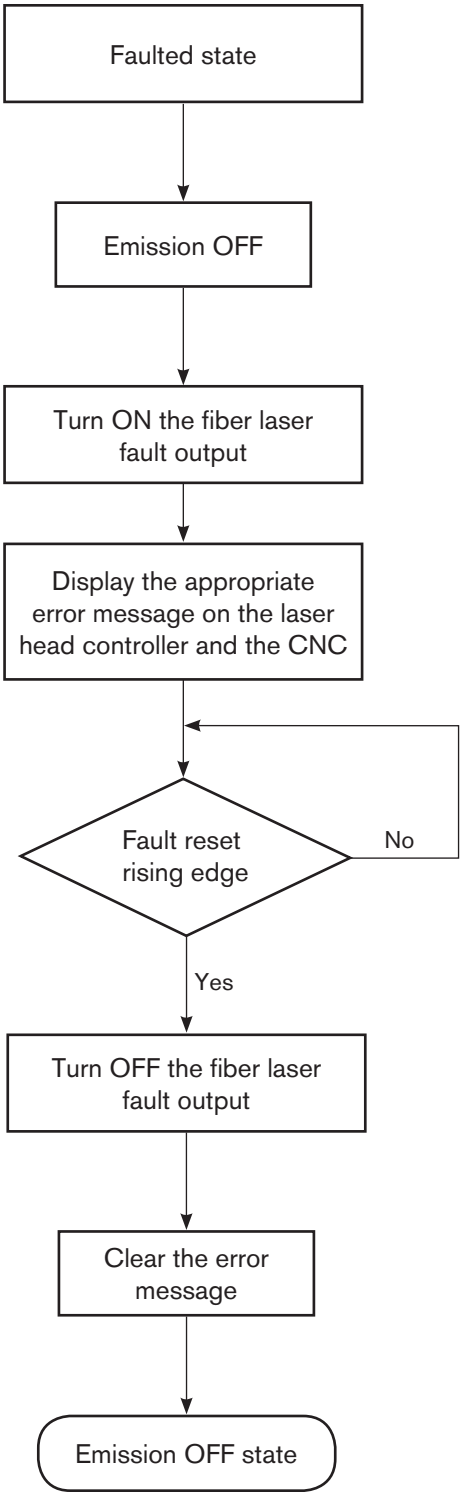
If the fiber-to-fiber coupling unit detects excessive humidity, the system will enter the fault state and disable the laser beam. The fiber-to-fiber coupling unit is part of the hardware in the Beam Delivery Optical circuit. If the input or output fiber resistance is outside the specified operating range, the circuit will drop the laser power supply contacts and the system will enter the fault state.

Laser power supply operation diagrams

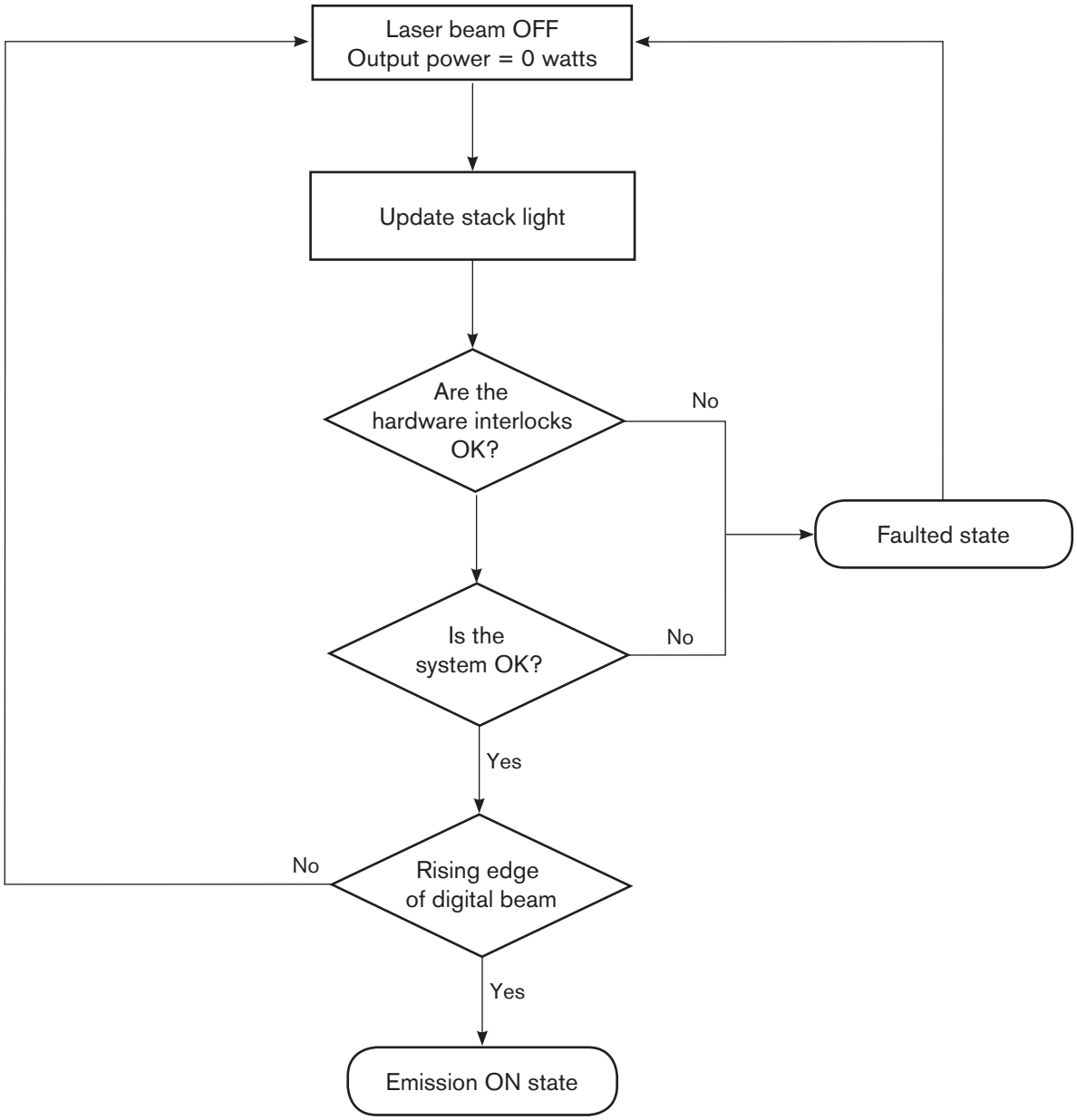
Power ON sequence



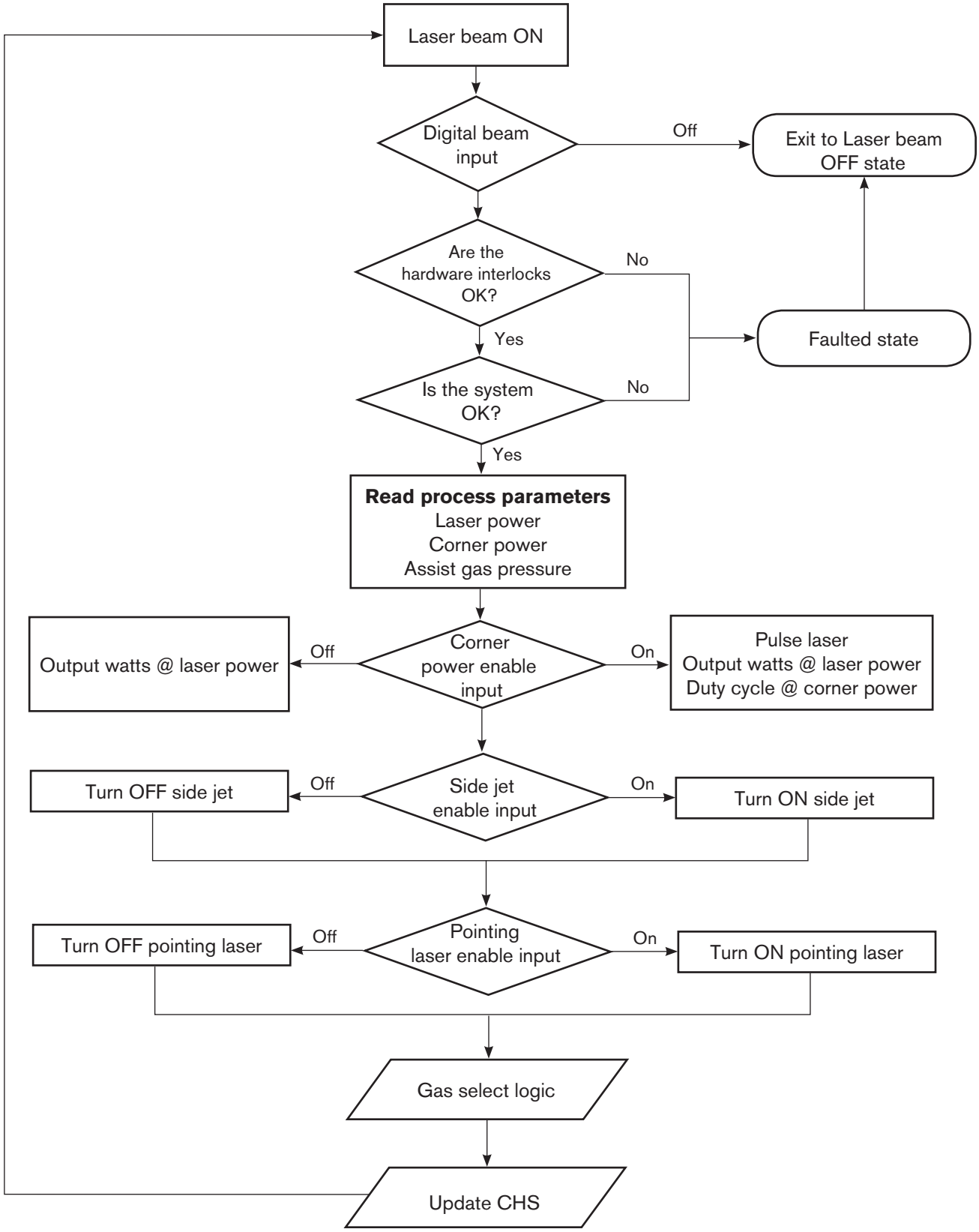
Laser power supply – faulted state



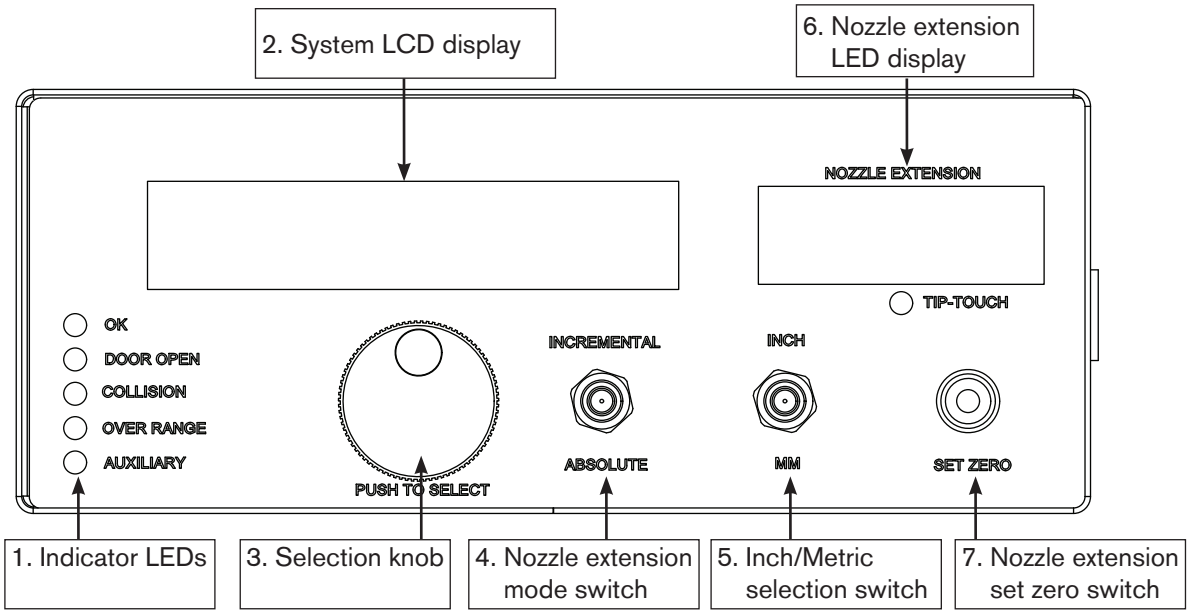
Laser power supply – laser beam OFF state



Laser power supply – laser beam ON state



Operating the laser head controller



1. Laser head LEDs:

- **OK:** Green indicates that the laser head controller has power and is operational.
- **Door Open:** Red indicates that the lens door is open, the cutting lens is not installed or the collimator is not installed. When this fault is active the beam is disabled.
- **Collision:** Red indicates that a head collision is detected. When this fault is active the beam is disabled.
- **Over Range:** Red indicates that the nozzle is greater than 10 mm from the plate.
- **Auxiliary:** Red indicates an assist gas low pressure fault.

Note: The collimator is sensed by a proximity sensor at the top of the cutting head. The proximity sensor has an orange indicator light that should be illuminated when the collimator is installed. See *Operating the laser head* for more details.

2. The laser head controller LCD display shows various system information.
3. The rotary selection knob is used to navigate LCD screens and edit parameters. Rotate the knob to move from one parameter to another on the screen and push the knob to select the parameter that needs to be adjusted.
4. The nozzle extension mode switch selects between incremental and absolute position display for the nozzle extension. The Absolute/Incremental switch is used to change the way the display shows the position of the nozzle extension. When the switch is in the Absolute position the nozzle extension displays the absolute position of the nozzle extension. When the switch is in the Incremental position the nozzle extension value is a positive or negative incremental position from the point that the set zero button was pressed.
5. The Inch/Metric selection switch is used to set the display to show the nozzle extension position in inches or millimeters.

- When the switch is in the INCH position the current nozzle extension is displayed in inches.
- When the switch is in the MM position the current nozzle extension is displayed in millimeters.

6. The nozzle extension LED display shows the position of the nozzle extension.
7. The nozzle extension set-to-zero switch is used to set the zero position of the nozzle extension when using the Incremental mode.

Navigating the Display Screen

There are three sets of information shown on the laser head controller display:

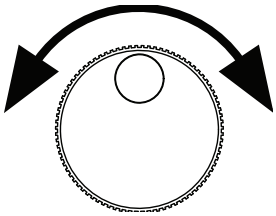
- The Main display screen provides status information about the fiber laser system.
- The configuration display screen allows the user to enter the set-ups, diagnostics, or calibration screens.
- The Diagnostics display screen provides status of system inputs and outputs for troubleshooting.

The display shows up to four lines at a time. The large knob (selection knob) below the LCD display allows you to scroll up and down through each display.

(Laser power)	(PWM display option)	(Gas selection)	(Output pressure)
(System state)	(System status)		
(System warning)			
<back>			<more>

Descriptions of the fields on the main display screen

Changing the value of a parameter:



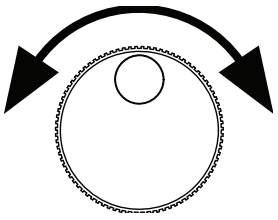
1. Rotate the selection knob to scroll to the parameter. The active parameter flashes.
2. Push the selection knob to select the parameter.
3. Rotate the selection knob to scroll through the value options for that parameter.
4. Push the selection knob when you have selected the appropriate option.

Note: The value reverts to the original entry if a new value is not selected in 5 seconds.

- Select <back> to return to the previous screen.
- Select <more> to advance to the next screen.
- The Setup Screen can be accessed by pressing the rotary wheel when the beam is off.

Laser head controller screen navigation

Typical operating screen

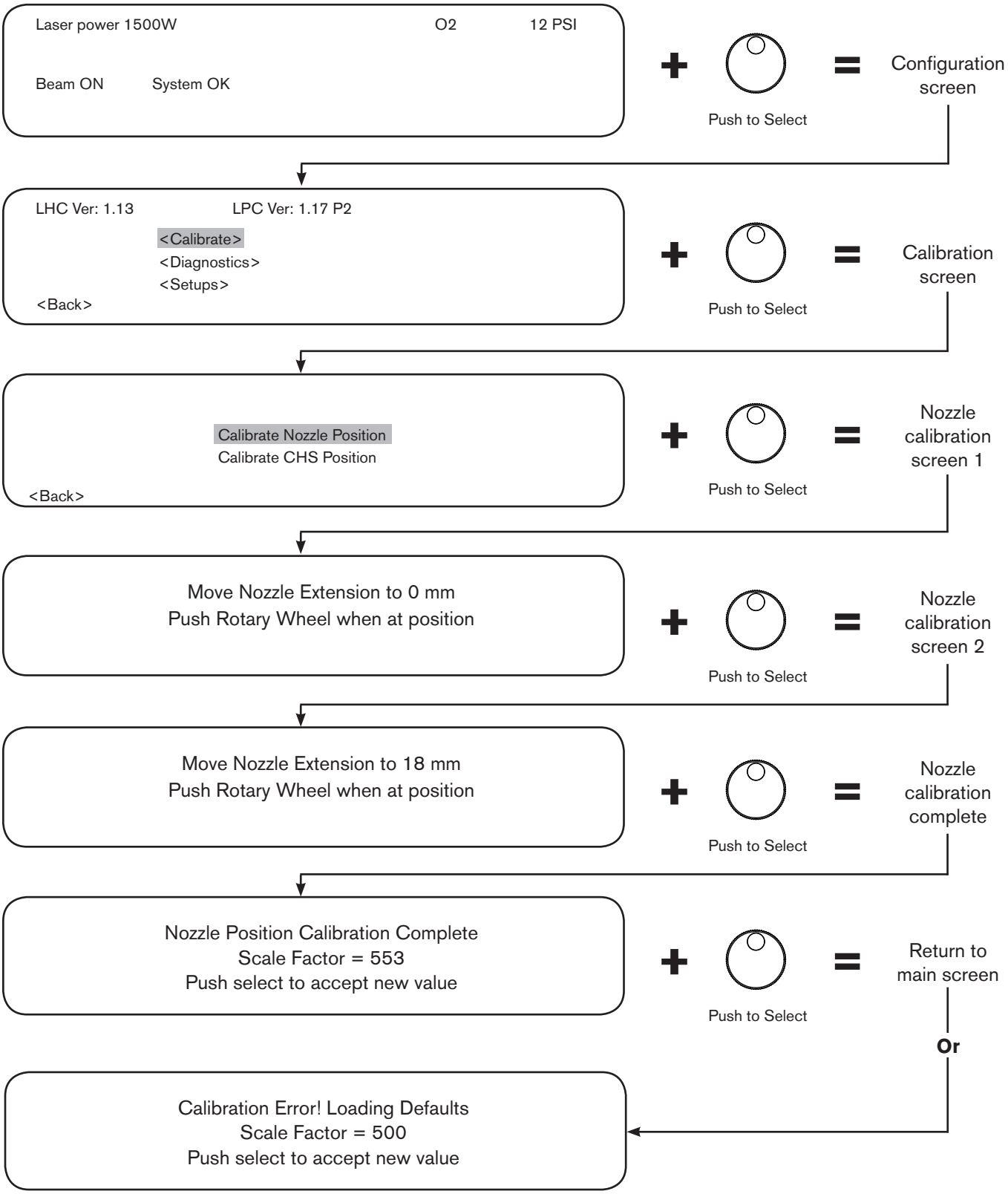


Operating parameters	
Laser head controller display screen field	**Value**
Laser Power	Current laser output power in watts
Pulse width modulation (PWM) display option	Corner power/duty cycle 0-100%
Gas Selection	AIR= compressed air O_2= oxygen N_2= nitrogen
Output Pressure	(Default) Output process gas pressure in PSI (Option) Output process gas pressure in mPA Note: Option selection is described on the previous page
System State	Beam ON Beam OFF Faulted Service
System Status	See *Error messages* in section 4 of this manual
System warning	A gas pressure warning is displayed when the gas pressure is 20% higher or lower than the setpoint

Information shown on the display is described in the following sections.

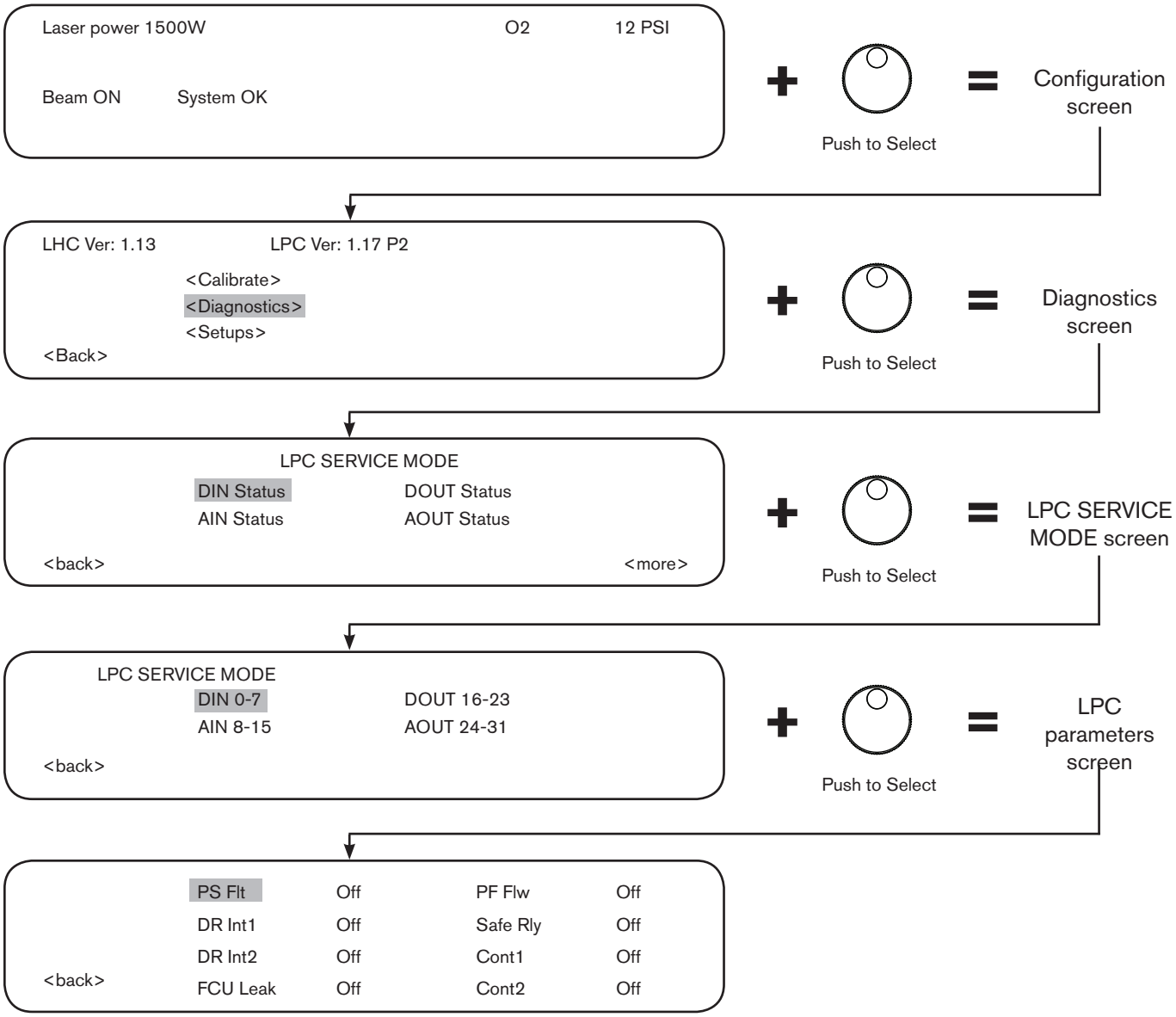
Calibration screen navigation

Note: The process shown below can also be followed to calibrate the CHS position by choosing “Calibrate CHS Position” instead of “Calibrate nozzle position.



Diagnostics screen navigation

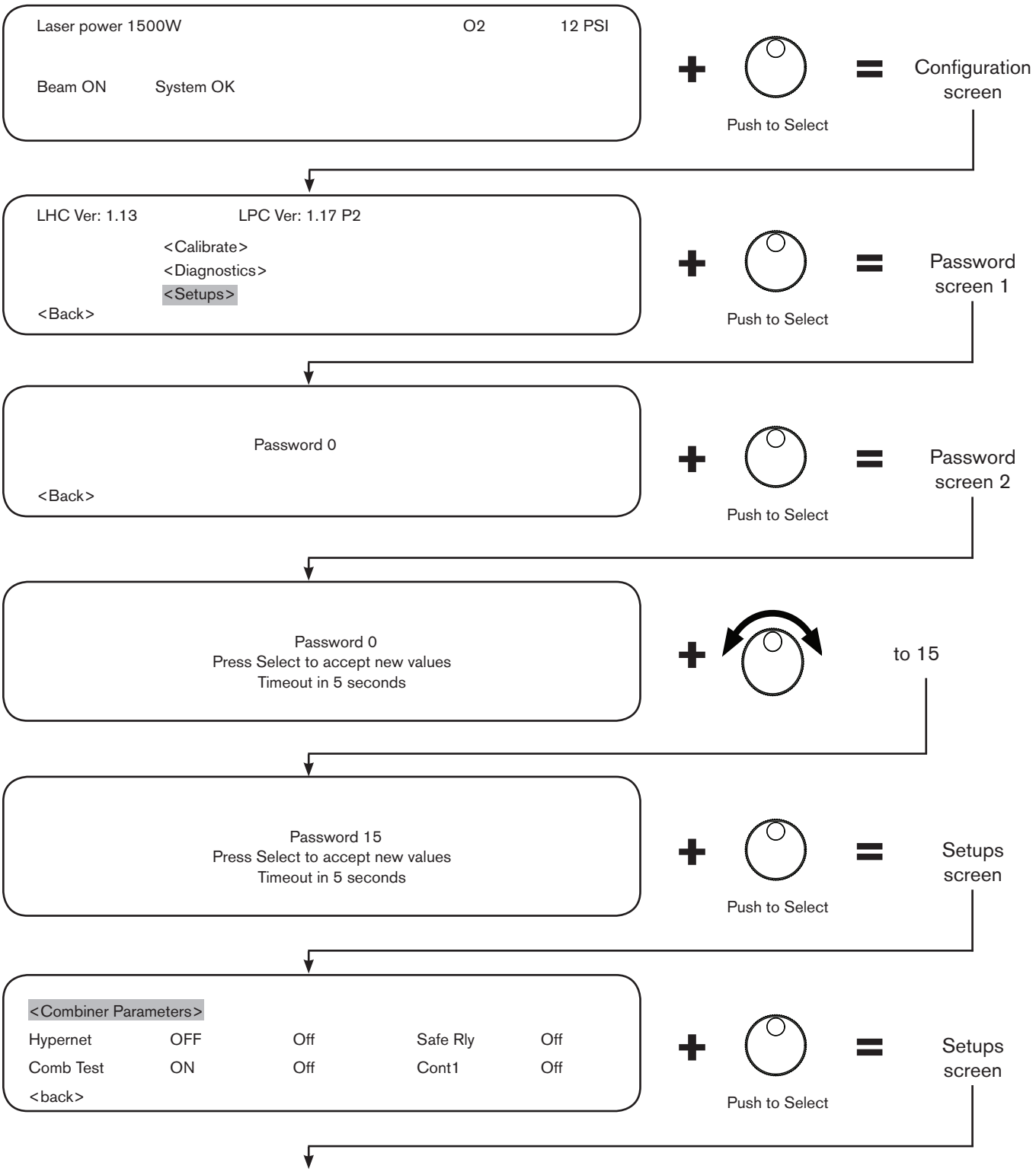
Note: The process shown below can also be followed to verify the parameters in the LHC SERVICE MODE by choosing “more” after verifying the LPC parameters.



Verify the LPC parameters on the screen shown above by comparing them with the data in the LPC service mode parameters tables at the end of section 4, *Maintenance,* of this manual. Verify the LHC parameters by comparing the values shown on the LHC diagnostics parameters screen with the data in the LHC diagnostic parameters tables at the end of section 4, *Maintenance,* of this manual.

Setup screen navigation

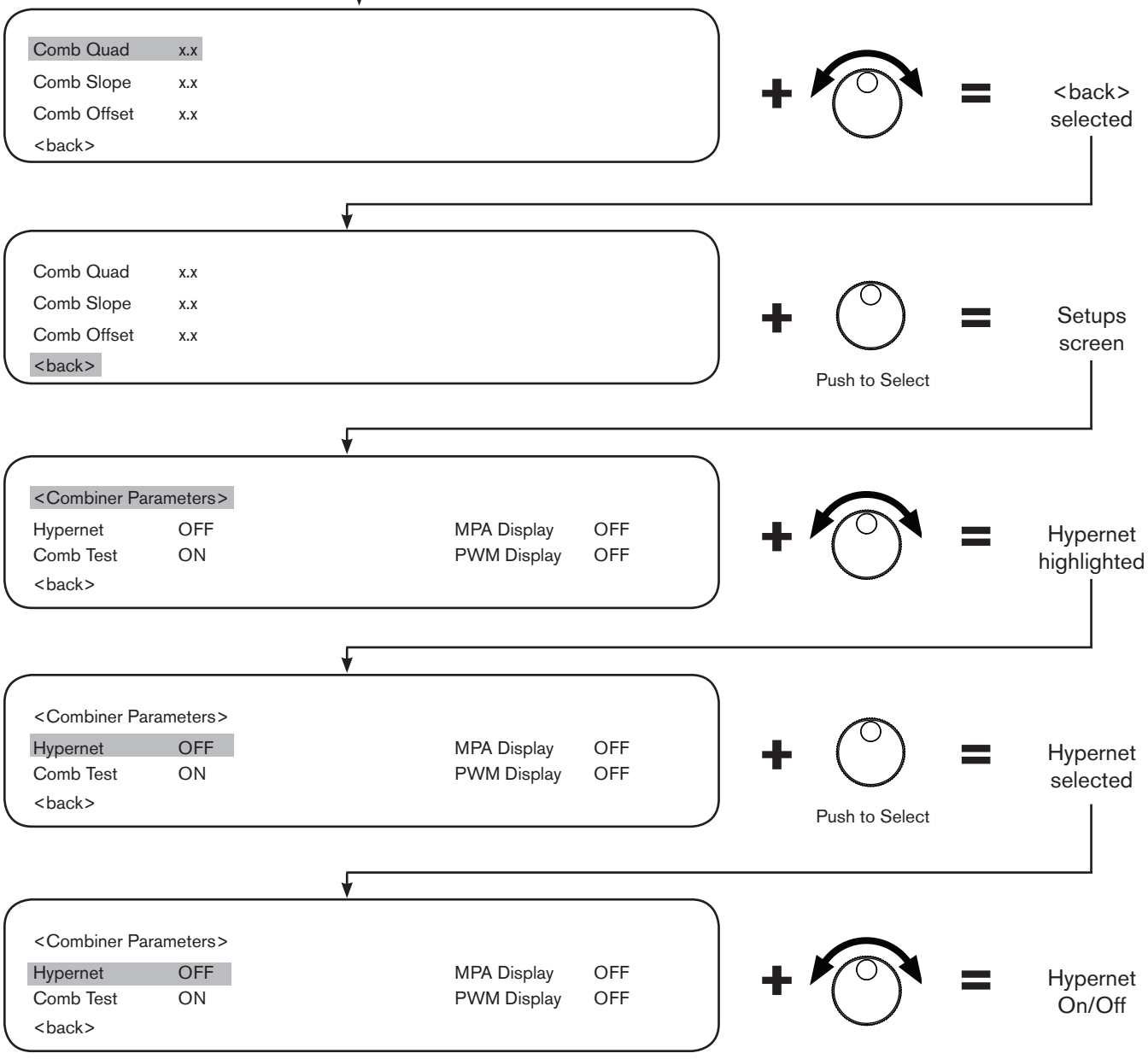
Note: The process shown below is used to verify the parameters in the Setups menus



Continued on the next page

Caution: **The values on the <Combiner Parameter> screen are set at the factory and should not be changed without instructions from the factory or from a Hypertherm technician.**

Continued from the previous page



Note: This process can also be followed to verify the parameters for Comb Test, MPA Display, and PWM Display by selecting each one and comparing the value on the screen with the table on page 3-21

Laser head controller faults

The LHC provides LED indicators to show the status for the following faults.

Fault	Cause
Tip touch	The tip touch lamp illuminates whenever the nozzle touches the workpiece or another large object.

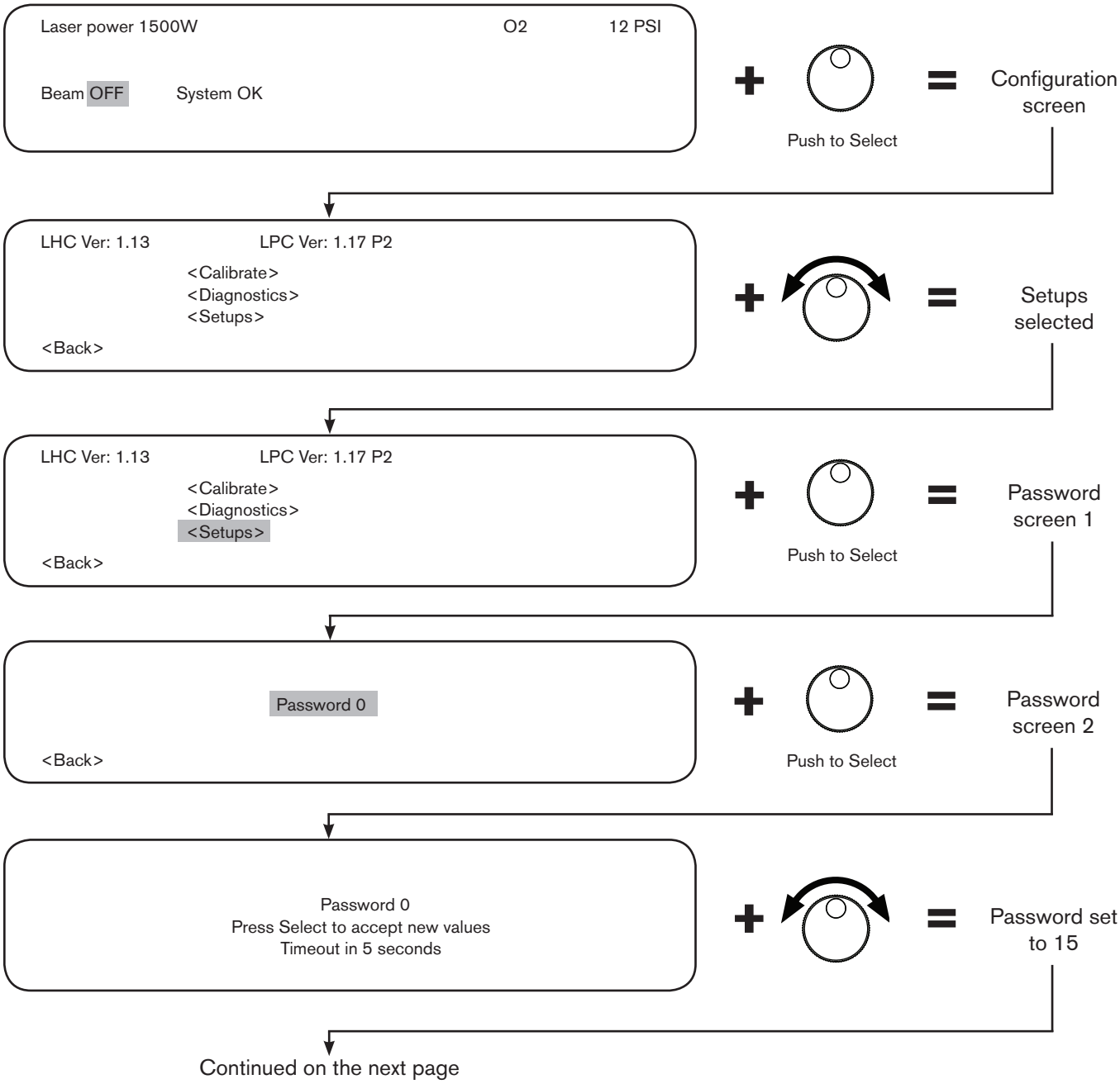
Door open	The door open fault occurs when:
	▪ The cutting head lens door is not latched.
	▪ The cutting lens holder is not inserted into the lens bay.
	▪ The signal from the proximity sensor is lost.
	  ▪ The collimator is not attached to the top of the mounting bracket or sensed by the proximity sensor. The proximity sensor has an orange indicator lamp that should be illuminated when the collimator is installed.
	▪ The lower end of the laser head is too hot.
	  ▪ The thermal sensor in the lower end of the cutting head has been activated above 135C. Check the temperature of the nozzle, nozzle adapter, and guard. CAUTION: THESE COMPONENTS COULD BE VERY HOT AND CAUSE BURNS. Over temperature in this region is usually caused by heating from the beam due to contaminated optics.

Collision	The collision fault indicates that the cutting head collision mount has been activated.
Over range	The over range indicator is illuminated when the capacitive height sensor is beyond its sensing range. It is normal for this to be illuminated when the cutting head is fully retracted and should extinguish as the cutting head approaches the plate and the nozzle-to-workpiece distance is less than 10 mm (3/8 in).

Laser head controller setup

The laser head controller must be configured for the appropriate type of communication with the CNC.

Note: The laser beam must be turned OFF on the main display screen (shown below) before starting to configure the laser head controller.



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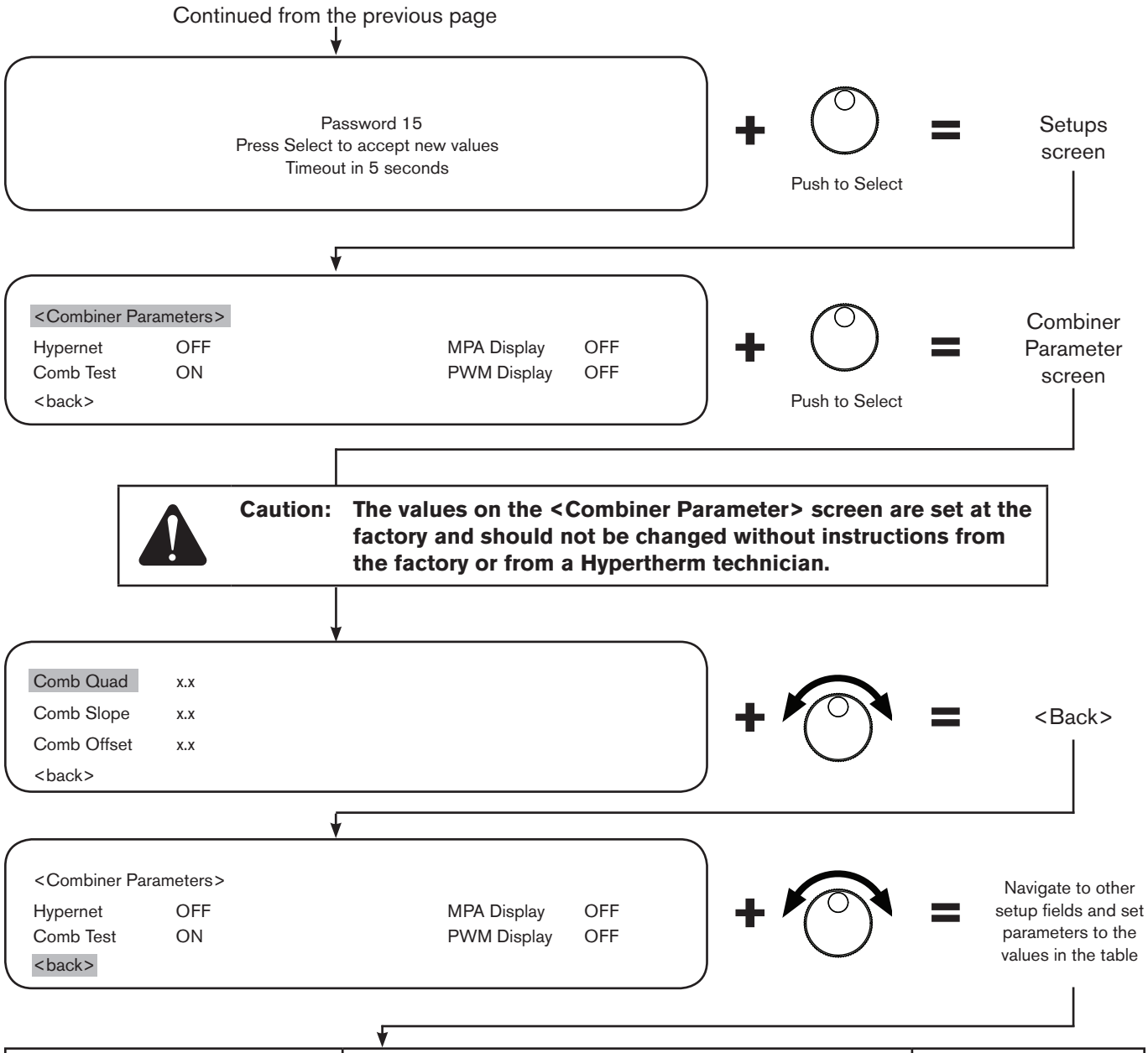


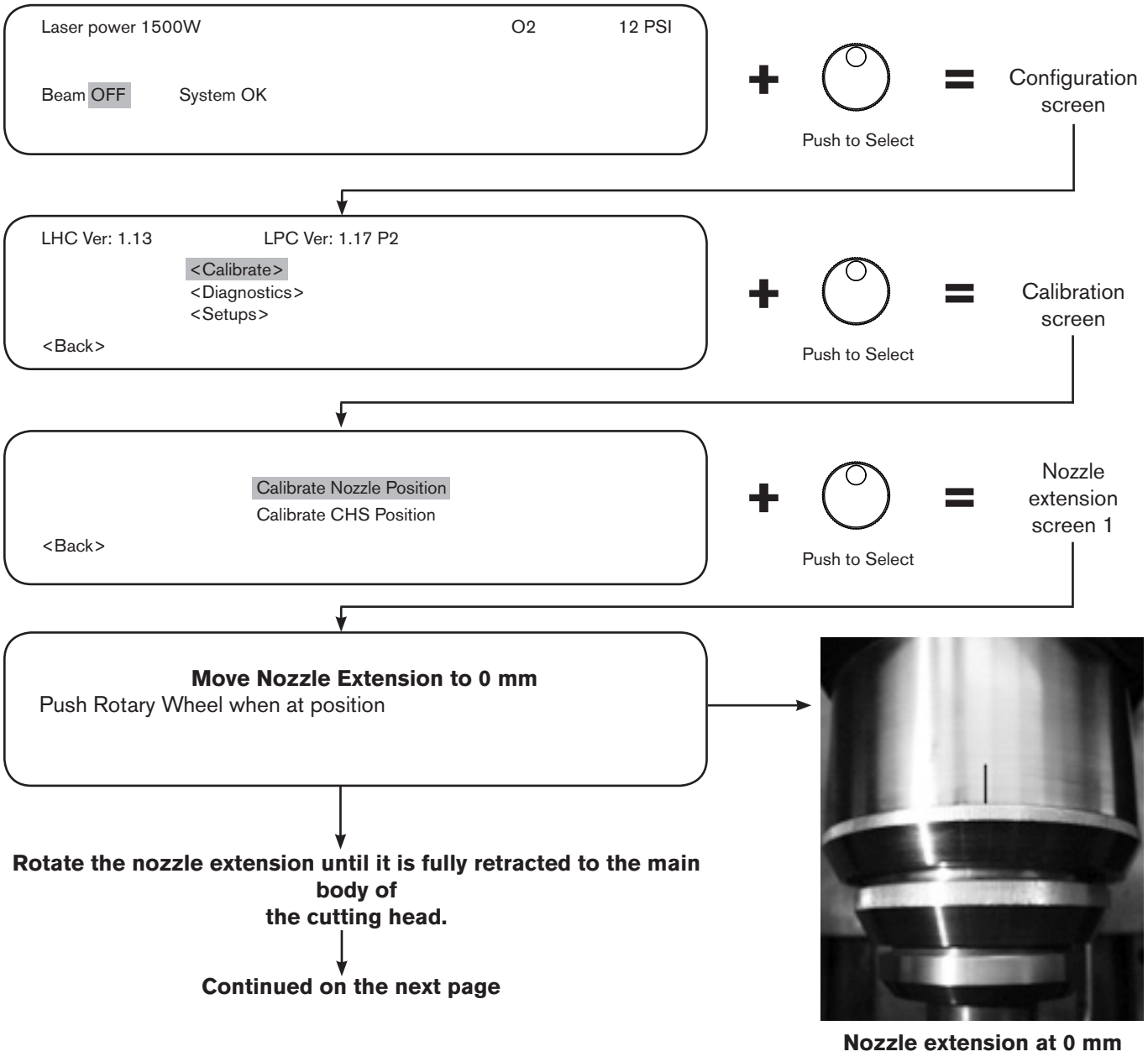
Setups field	Value	
Combiner Parameters	Combiner Quad Combiner Slope Combiner Offset	Values are set at the factory
Hypernet	ON when using a Hypertherm CNC OFF when using any other CNC	The user selects the value
Comb Test	ON = Combiner Stray light Sensor is active OFF = Combiner Stray light Sensor is not active	The user selects the value (Default = ON)
MPA Display	ON = Gas pressure value is converted to MPA OFF = Gas pressure value is shown in PSI	The user selects the value
PWM Display	ON = PWM Duty displayed on main screen OFF = PWM Duty is not displayed	The user selects the value

Calibration

Nozzle position calibration

The nozzle position calibration is a two-point calibration to adjust the position feedback for the nozzle position. Nozzle calibration should be performed at installation and any time that cut quality decreases.

To begin calibration verify that the main menu (shown below) is displayed on the laser head controller screen and follow the steps outlined below.



Nozzle extension at 0 mm

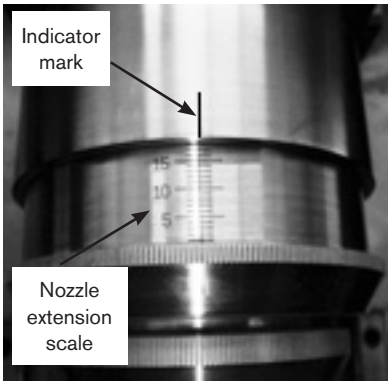
Continued from the previous page

Move Nozzle Extension to 0 mm
Push Rotary Wheel when at position

\+ ○ = Nozzle extension screen 2

Push to Select

Move Nozzle Extension to 18 mm
Push Rotary Wheel when at position



Nozzle extension at 18 mm

Move Nozzle Extension to 18 mm
Push Rotary Wheel when at position

\+ ○ = Calibration result

Push to Select

If the calibration was successful, the following message is displayed. The parameters will vary slightly for each system.

Nozzle Position Calibration Complete
Scale Factor = 553
Push select to accept new value

If there was a calibration error, the following message is displayed.

Calibration Error! Loading Defaults
Scale Factor = 500
Push select to accept new value

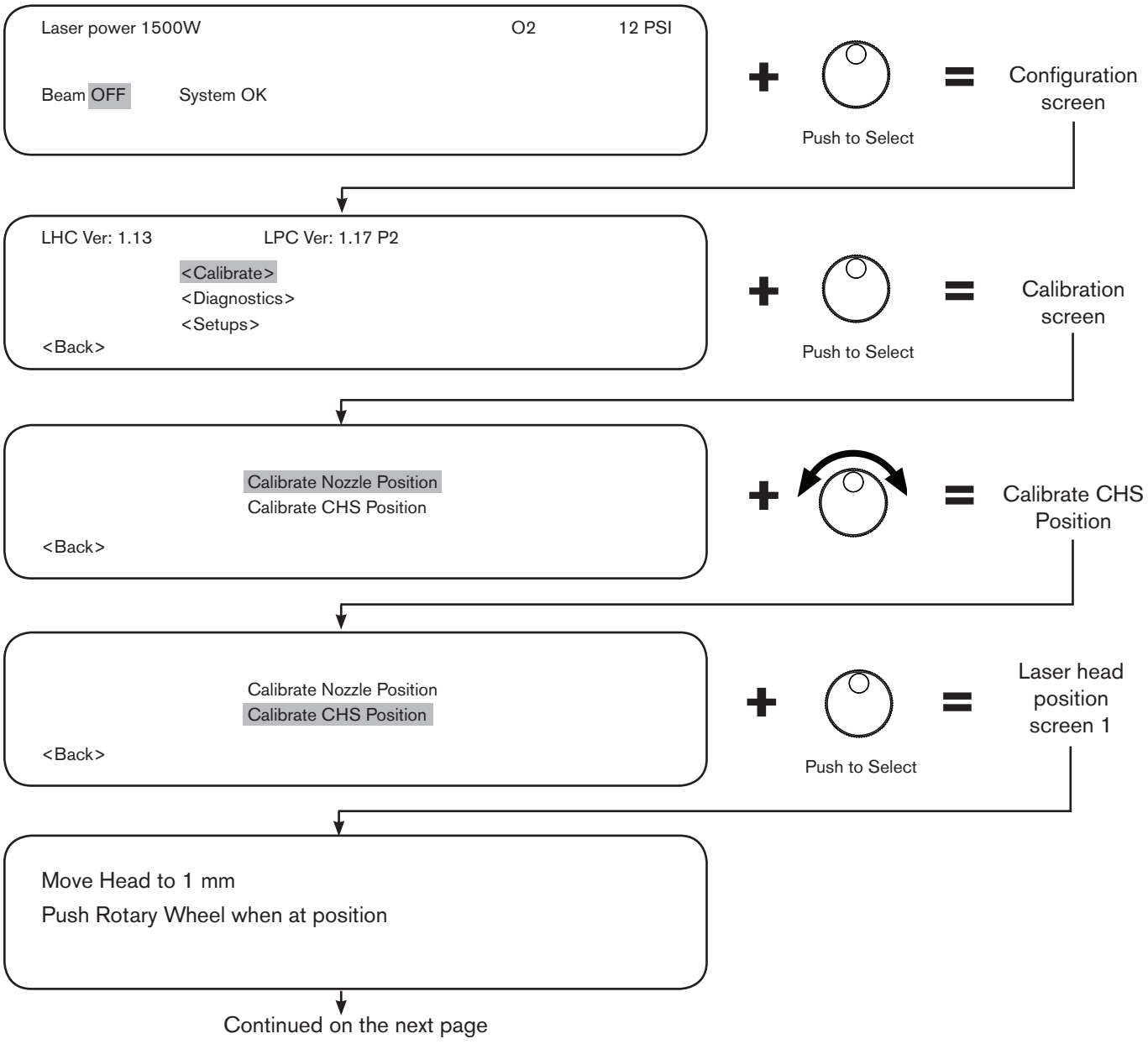
The calibration will fail if the controller does not detect a large enough voltage change, between the 0 mm and 18 mm nozzle extension positions.

Capacitive height sensor (CHS) calibration

The signal for the capacitive height sensor is linearized by the microprocessor in the laser head controller to produce an output voltage of 0 VDC to 10 VDC to achieve 0 to 10 mm of nozzle-to-work piece distance.

To calibrate CHS, you must perform two processes; one on the laser head controller and the other on the CNC.

To perform the CHS calibration on the laser head controller:



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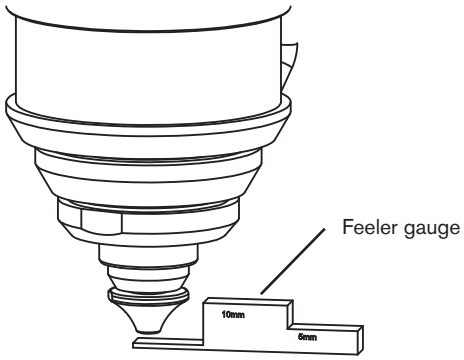
Position the cutting head over the material, away from the edges of the material, and move it down until the calibration feeler gauge rubs on the material and nozzle and the Tip Touch Indicator illuminates on the laser head controller. Avoid pressing down on the material and causing deflection and inaccuracies in the calibration.

When the 1 mm height is correct, remove the feeler gauge, and push the thumb wheel to set calibration height 1.



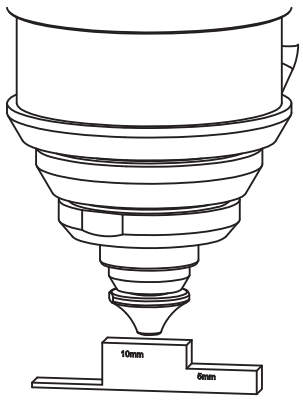
1 mm nozzle to workpiece distance

After the 1 mm calibration point is set the following screen will be displayed.

Move Head to 10 mm
Push Rotary Wheel when at position

Position the cutting head over the material, away from the edges of the material, and move it down until the calibration feeler gauge rubs on the material and nozzle and the Tip Touch Indicator illuminates on the laser head controller. Avoid pressing down on the material and causing deflection and inaccuracies in the calibration.

When the 10 mm height is correct, remove the feeler gauge, and push the thumb wheel to set calibration height 2.



10 mm nozzle to workpiece distance

Continued on the next page

After the rotary wheel is pushed the following message will be displayed if the calibration was successful. The parameters will vary slightly for each system.

```
CHS Calibration Complete
Gain = 1.1              Offset = 0.1
V 1 mm = 5.06           V 10 mm = -8.58
Push Select to accept the values
```

If there was an error during calibration, the following error message is displayed. Note that voltages may be different depending on the system.

```
Calibration Error! Loading Defaults

V 1 mm = 5.98           V 10 mm = -5.98
Push Select to accept the values
```

The calibration will fail if the controller does not detect a change in voltage of at least 2.5 volt between the 1 mm and the 10 mm positions. The default parameters will allow you to run the system but CHS position feedback will not be accurate and the head will need to be positioned manually.

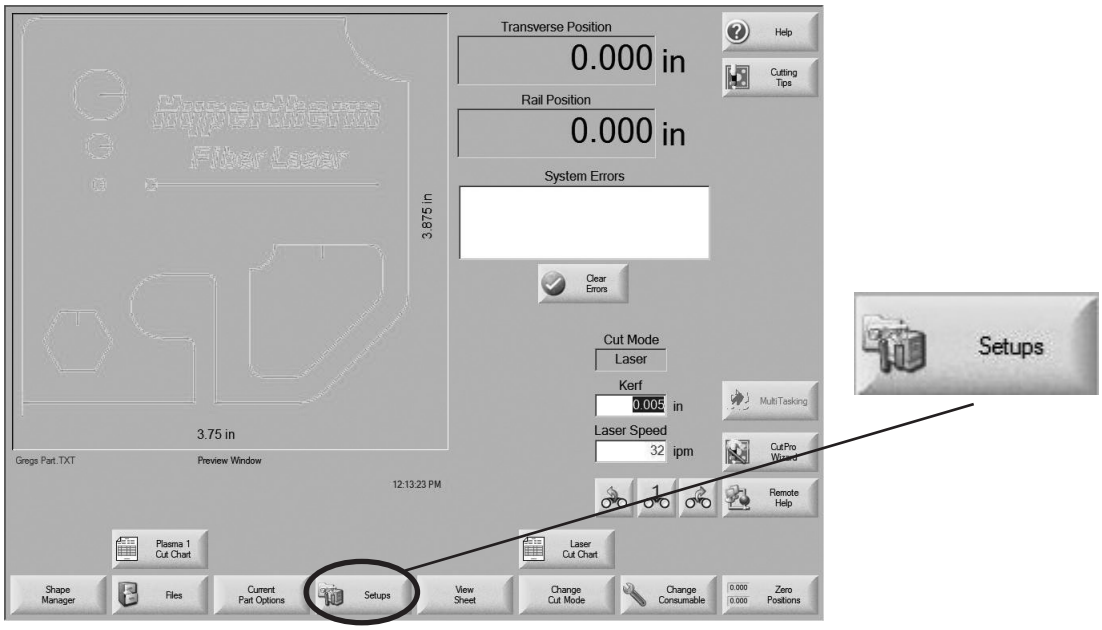
If the calibration feeler gauge is not available, you can use the nozzle extension adjustment (2 mm per rotation) to set the nozzle to workpiece distance. To use this method:

1. Move the laser head down carefully until the nozzle is just touching the work piece.
2. Rotate the nozzle extension 1/2 turn to retract the nozzle 1 mm from the work piece. Use the menu on the laser head controller to set the 1 mm calibration point.
3. Rotate the nozzle extension another 4-1/2 turns to set the distance to 10 mm and use the menu to set the 10 mm calibration point.

If the calibration fails, check the tightness of the nozzle adapter nut and the condition of the nozzle adapter insulating washer. Repeat the calibration procedure as necessary and whenever the nozzle adapter is removed or replaced.

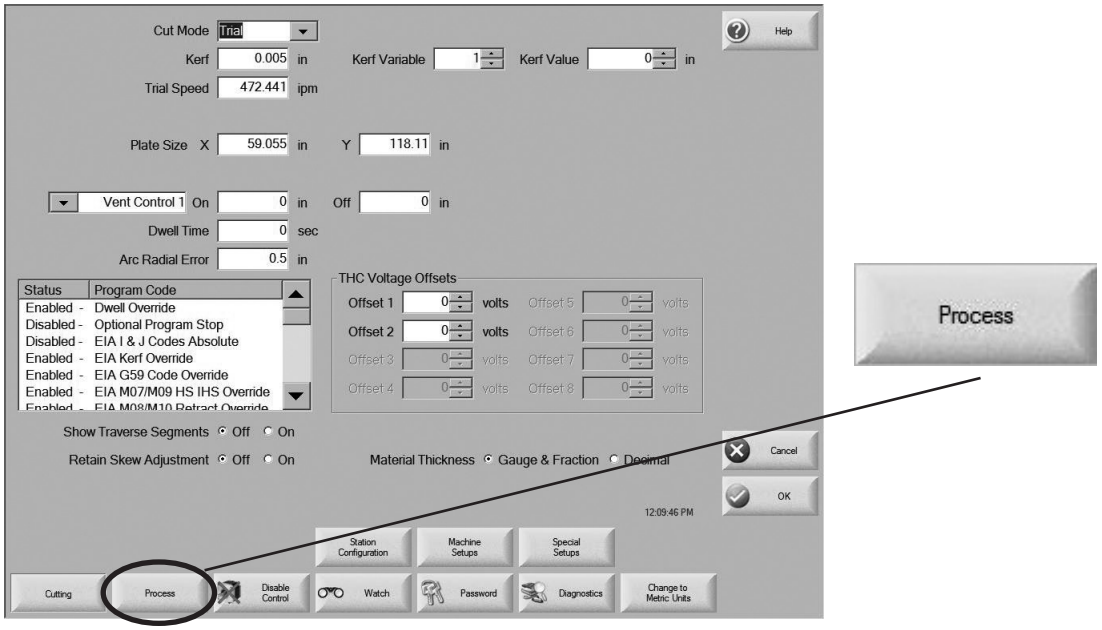
To perform the CHS calibration on a Hypertherm CNC:

1. Position the laser head over a flat solid area on the material to be cut, but not near the edges.
2. Select Setups on the Main screen.



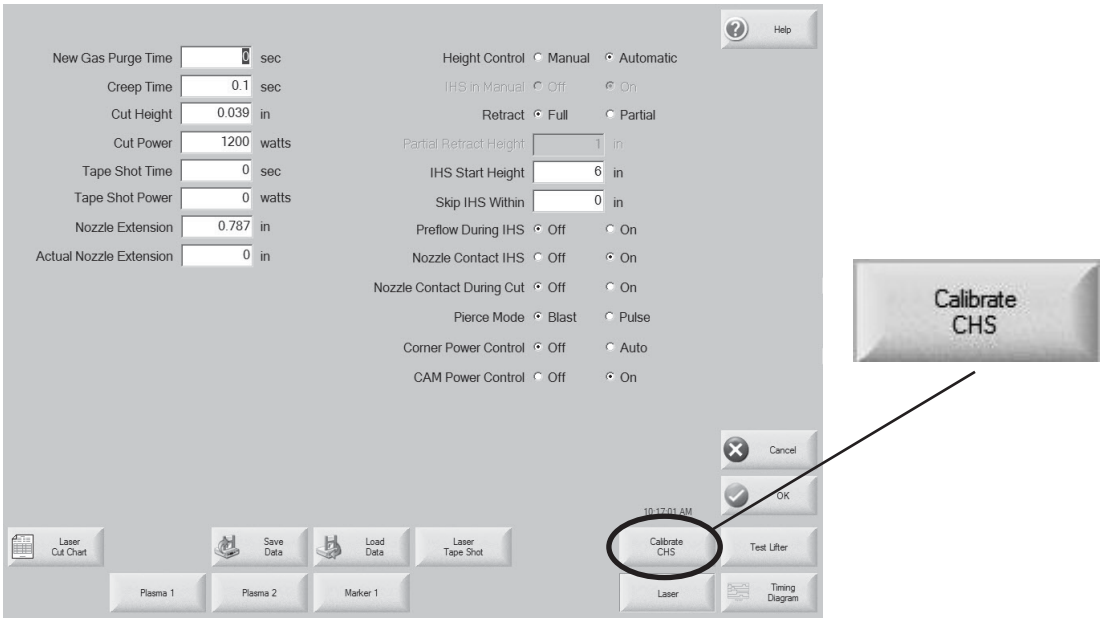
Main screen

3. Select Process on the Setups screen.



Setups screen

4. Select Calibrate CHS on the process screen.



Laser process screen

5. Follow the instructions displayed on the screen.
6. If the maximum height detected is within a range of 0.36 in - 0.44 in (9 to 11 mm) the calibration is complete. If the maximum height detected is outside the range, refer to *Troubleshoot CHS calibration errors* in the *Maintenance* section of this manual.

Laser head operation

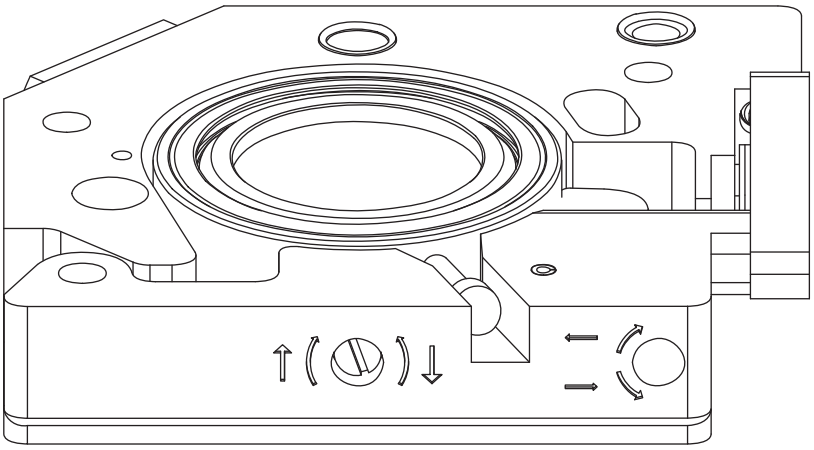
Pointing laser

Turn on the pointing laser (see *CNC setups* in section 2 of this manual for specific information on the pointing laser) to verify that the beam is not obstructed when it exits the cutting head nozzle. Place the nozzle extension near 18 mm and install a 2 mm nozzle in the cutting head. Place a sheet of white paper below the nozzle to verify that the red beam exits the nozzle.

Beam centering

Place a sheet of white paper below the nozzle and adjust the “front to back” and the “left to right” lens adjustment screws to align the beam in the center of the nozzle orifice. For more precise beam centering, use the *tape shot procedure* described in this section.

- Rotate the “front to back” screw clockwise to move the lens toward the back of the cutting head, or counterclockwise to move the lens toward the front of the cutting head.
- Rotate the “left to right” screw clockwise to move the lens toward the left, or counterclockwise to move the lens to the right.



Front to back Left to right

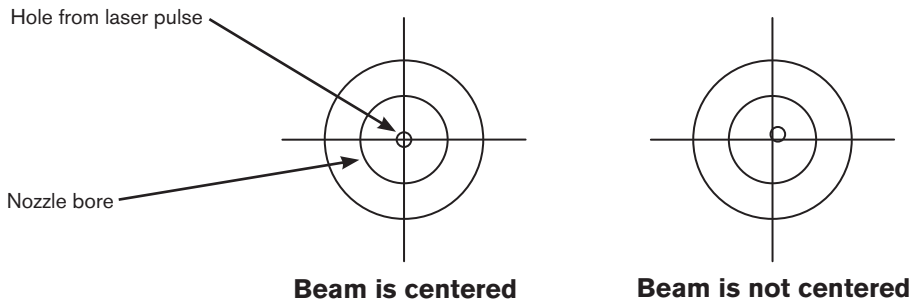
Hypertherm CNC beam centering

Using the “Tape shot” method for beam centering

This method allows for very precise and accurate adjustment of beam centering within the nozzle bore. Use the information on the following pages to prepare for and run the Tape shot procedure.

Tape shot procedure

1. Turn OFF the laser beam and verify that it is in a disabled state.
2. Apply a thin layer of ink or other colored marking material to the face of the nozzle. An ink pad works well for this purpose.
3. Affix a small piece of adhesive tape to the face of the nozzle. Any type of tape may be used. Firmly press the tape onto the face of the nozzle and note its orientation. Be careful not to slide the tape when you press it onto the face of the nozzle.
4. Re-enable the laser.
5. Pulse the laser ON for a short duration (10-30 milliseconds) at low power (100-200 W) using the method described below. You may need to vary the duration and power settings to determine the optimum settings for creating a small, clean hole in the tape.
6. Remove the tape and inspect it using the magnifying loupe provided with the laser system or other magnifying glass. The hole created by the laser pulse should be clearly visible inside the center of the nozzle bore on the tape. The nozzle bore will be visible because of the ink that was applied to the nozzle.
7. If inspecting the tape reveals that adjustment is necessary, use the beam centering procedure on the previous page to move the focusing lens in the same direction in which you wish to move the laser beam (if the laser hole is too close to the front of the nozzle, move the lens back).

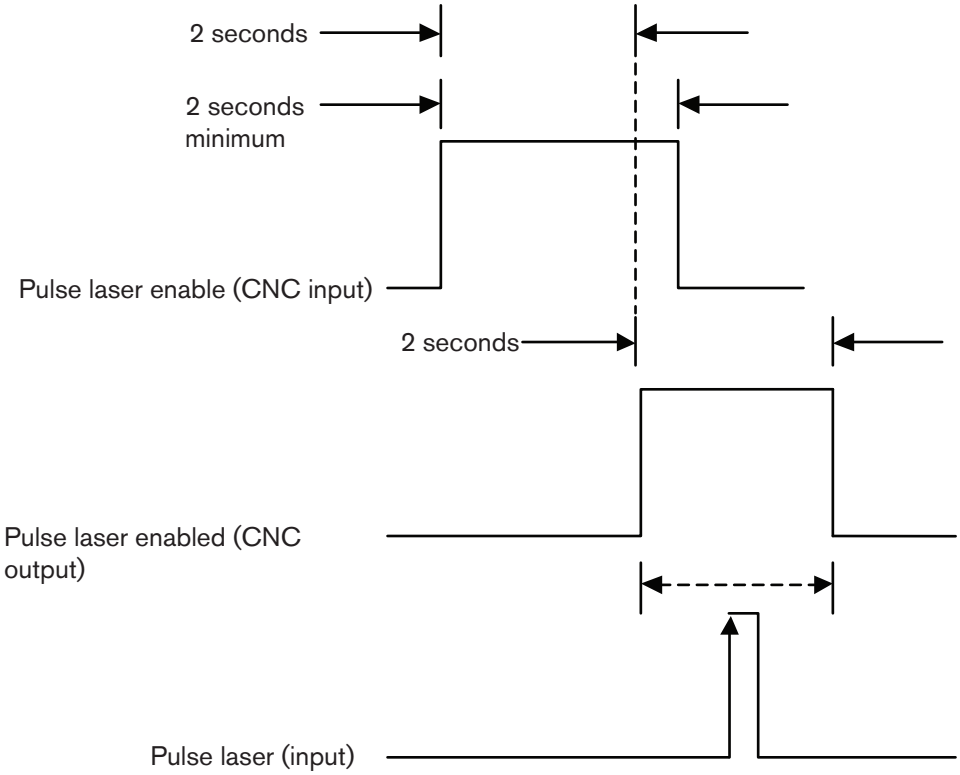


8. Repeat steps 1 – 7 until the beam is centered in the nozzle bore.

Hypertherm CNC interface

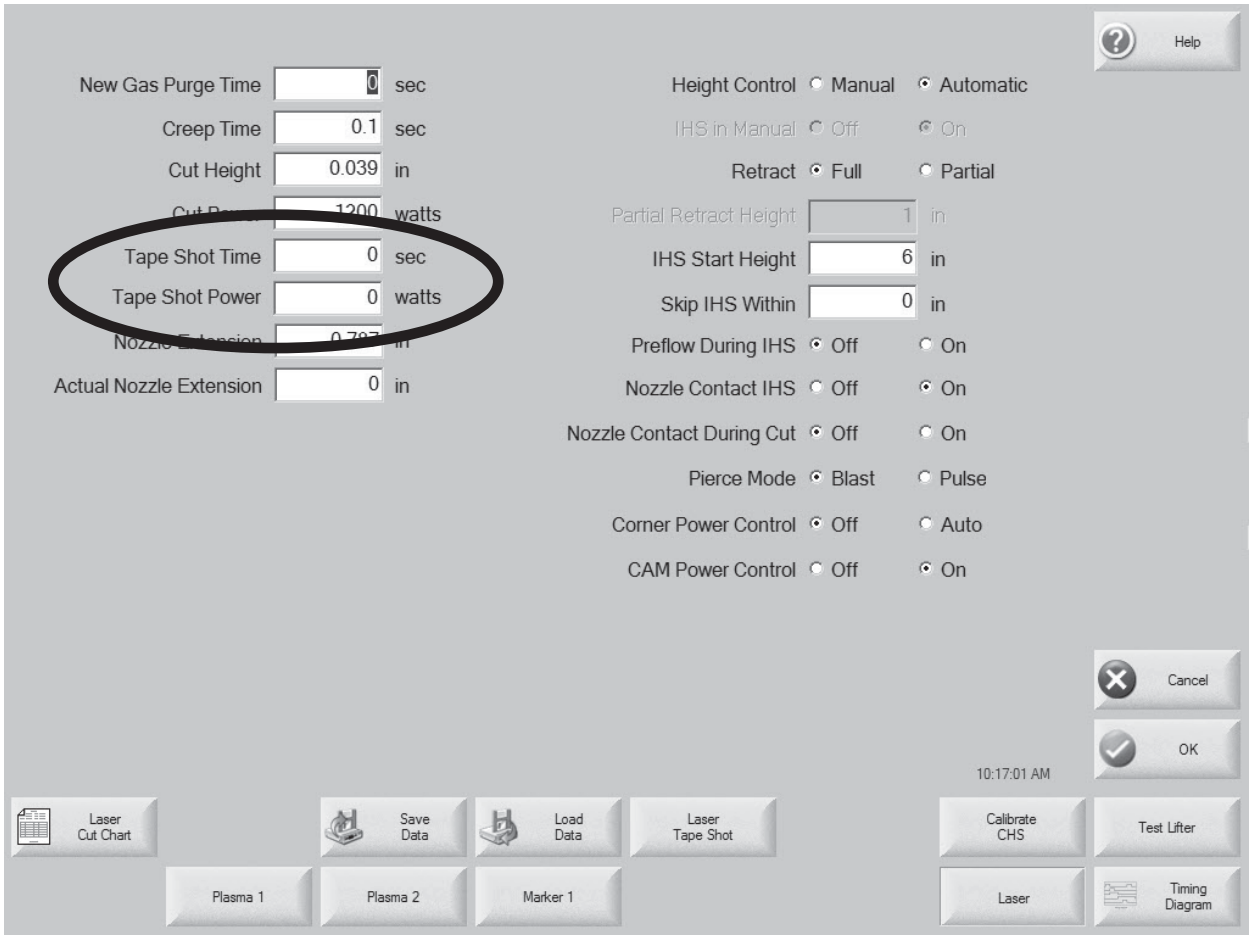
The Hypertherm CNC provides a built in interface for generating single laser pulses. This process uses the following digital inputs and outputs:

- **Pulse Laser Enable (input)** – Set active for 2 seconds to enable pulsing.
- **Pulse Laser Enabled (output)** – this output becomes active once pulsing is enabled. This may be used to activate an indicator LED as an example.
- **Pulse Laser (input)** – Once pulse is enabled, an inactive-active transition on this input will pulse the laser. A momentary push-button may be used to generate this transition. The transition must appear within two seconds after pulsing is enabled or pulsing becomes disabled and will need to be enabled again.



Setting pulse laser time and pulse laser power

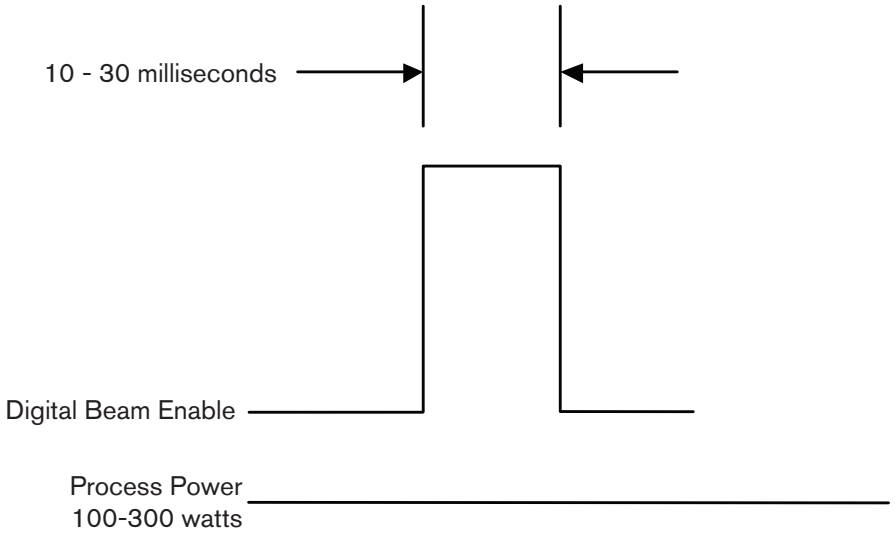
The Pulse Laser Time and Pulse Laser Power parameters are set on the process screen of a Hypertherm CNC. See the diagram below.



Process screen showing pulse power and duration values

Generic CNC beam centering

The desired laser pulse can be generated by using the Digital Beam Enable (to set the pulse duration that is needed) and the Process Power (to set the power level that is needed).



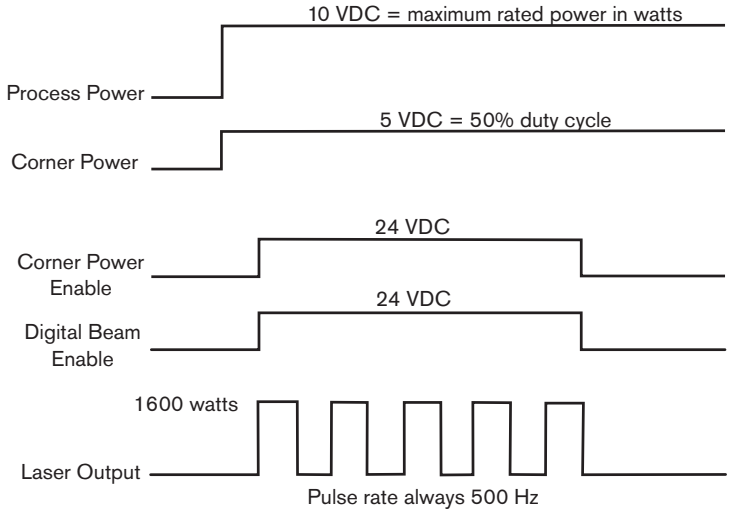
Pulsing the fiber laser using a generic CNC

Pulsing the laser using the integrated Pulse Width Modulation (PWM)

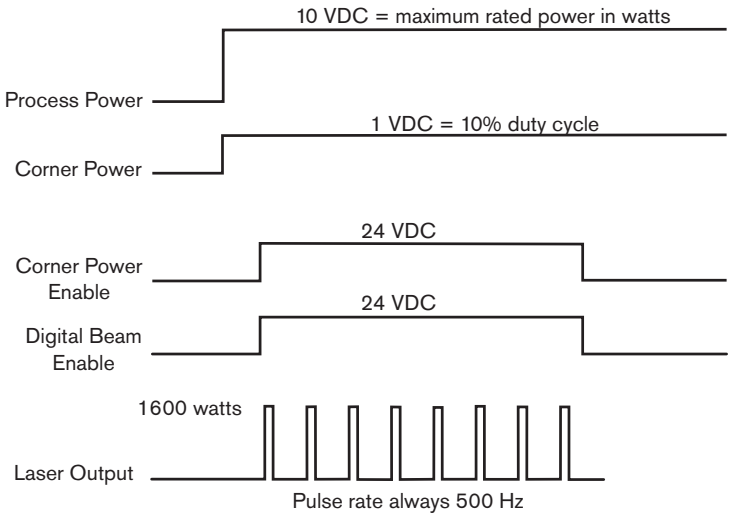
1. Set the Process Power between 0 and 10 volts (0-100% of rated power in watts)
2. Set the Corner Power/PWM duty cycle. 0-10 volts = 0-100% PWM duty cycle
3. Set corner Pulsing Enable Input
4. Turn ON Digital Beam Enable

The laser will always pulse at 500 Hz using this mode

Note: You can change level of Process Power or Corner Power at any time during beam on. Pulsing Process Power or Corner Power in this mode is not recommended.



50% duty cycle at 100% power

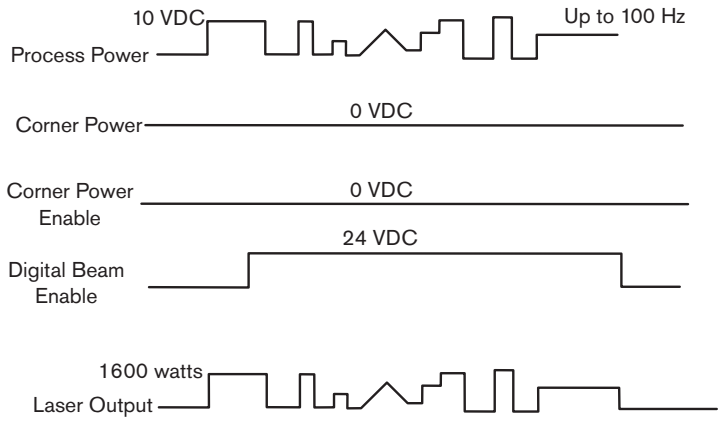


10% duty cycle at 100% power

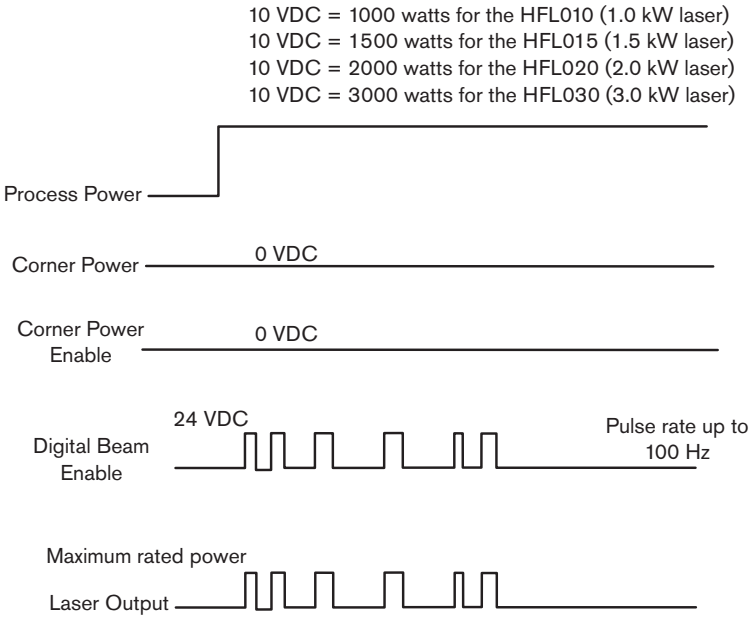
Pulsing the laser with a custom waveform

The CNC can pulse Process Power from 0 to 10 volts up to 100 Hz. This allows the user to create any waveform desired for pulsing.

Set Corner Pulsing Enabled to 0 volts = OFF for this mode.



Custom waveform



Digital beam enable

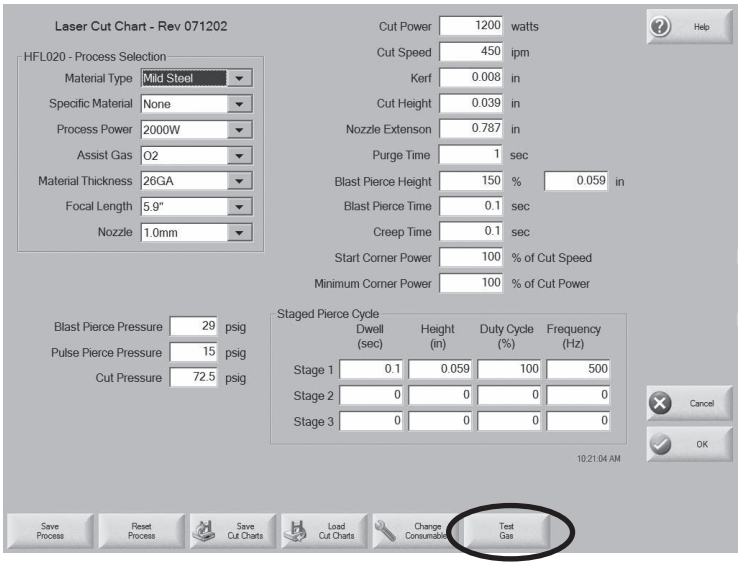
Gas console operation

The gas console is an automated piece of equipment that requires very little operator intervention during normal operation. All of the functions of the gas console are automatically controlled by the CNC. The CNC also receives feedback regarding cut gas pressure and any errors from the gas console. Proportional valves can be checked using the “Test Gas” feature of the Hypertherm CNC. For a generic CNC, skip steps 1 – 3 below and send appropriate gas selection and gas pressure set point commands to the LPC I/O interface and check the output values as shown in step 4 below.

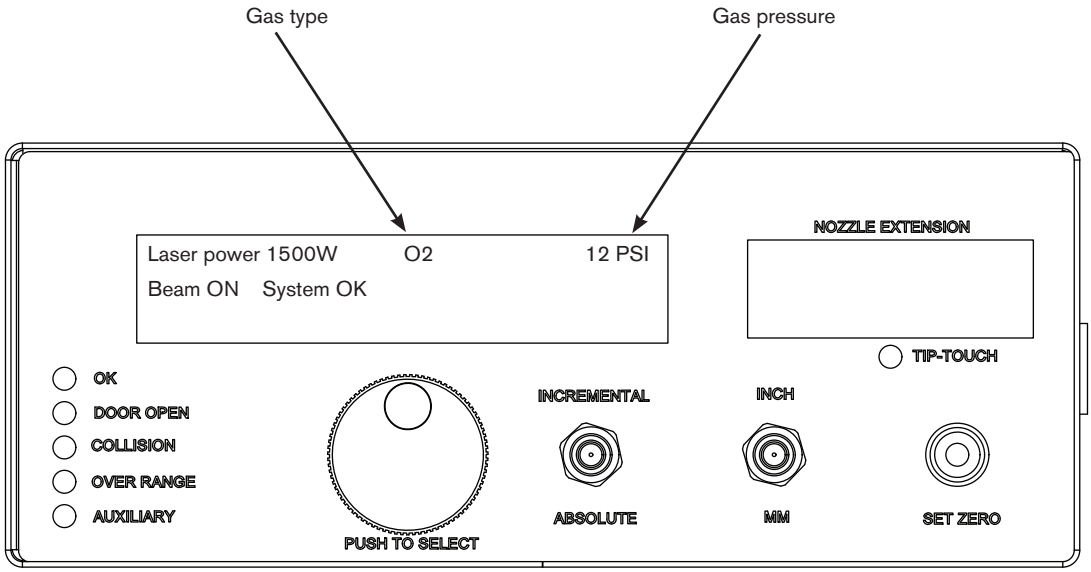
Note: The system must be in Laser cut mode (vs. Trial mode) in order for the test gas to work properly

Test cut gas pressures

1. Access the “Laser Cut Chart” screen on the Hypertherm CNC.
2. Select the desired cut chart, or set the assist gas type, pierce pressure and cut pressure.
3. Push the “Test Gas” button. See the figure to the right.
4. The gas type and pressure are displayed on the main screen of the laser head controller. The values shown on the screen should be the same as the values in the cut chart, within 5% or 1 psi, whichever is greater.



Laser cut chart screen

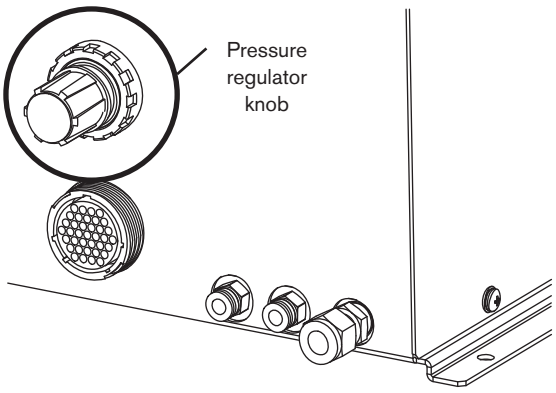


Laser head controller

Adjust side jet pressure

For cutting mild steel thicker than 3 mm, the side jet quickly clears molten material from the pierce location and helps create clean pierce holes. An optimum pressure setting for the side jet is critical. If the pressure is too low, the molten material is not effectively cleared and the pierce hole can be too large. If the pressure is too high, the oxygen in the side jet can cause uncontrolled burning at the pierce location and the pierce hole may be too large. The side jet gas pressure can be increased or decreased by turning the pressure regulator clockwise or counter clockwise respectively.

- Pull the pressure regulator knob to unlock. An orange mark appears in the gap when the pressure regulator knob is unlocked.
- Turn the knob clockwise to increase side jet pressure or counterclockwise to decrease the side jet pressure.
- Push the pressure regulator knob to lock. If it is difficult to lock the knob, turn it left and right a little and then push it again. The orange mark will no longer be visible when the knob is locked.

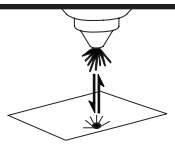


Note: The side jet pressure is set to 0.3 MPa (3.0 bar, 43.5 psi) at the factory.

Focal position

The cutting head is designed to focus the laser at the nozzle exit when the nozzle extension is set to 18 mm. The actual focus position can vary due to factors such as optic contamination and collimator adjustments.

Verify the focal position by making a series of test cuts using thin (~1 mm) stainless or aluminum with a nitrogen assist gas. Start with the nozzle extension at 28 mm. Make test cuts approximately 50 mm (2 in) long with a 1 mm nozzle-to-workpiece distance. Decrease the nozzle extension setting by 1 mm for each test cut until the nozzle extension setting is 14 mm. Examine the series of cuts to choose the thinnest kerf and it will determine the setting for the focal position on the material surface. This position can be set as a relative zero using the laser head controller (see laser head controller in the this section for more information).



CAUTION

Highly reflective material can cause the beam to be reflected back through the beam delivery system when the focus is near the surface of the workpiece, causing a significant increase in laser power that can cause catastrophic failure of components.

Laser Cutting

Mild steel – oxygen assisted

Laser cutting of mild steel with an oxygen assist gas is the most common, and perhaps the most complicated laser processing application. Both the laser beam and the reaction between the oxygen and the iron in the steel provide the required power to melt the material at the proper rate for the thickness being cut. As the material thickness increases, the cutting speed needs to decrease at a rate that is not linear with the material thickness. For example, 10 mm material will in general be cut at a speed that is less than half the speed for 5 mm material. The assist gas serves to blow the liquid material out of the cut zone, so if the oxygen pressure is too low the material will not be removed quickly enough. But since the reaction rate also depends on the oxygen pressure, too much oxygen can cause excessive burning and flood the kerf with more liquid than can be removed. It is this balance of assist gas pressure and cut speed that need to be maintained for proper cutting.

The laser beam's focal position also has a large affect on the cutting process. If the focus is too close to the surface, the kerf becomes too narrow and the assist gas cannot flow properly through the kerf to remove the liquid. If the focus is too far above the surface, the kerf becomes too wide and there is not enough power to sustain the desired cut speed. If the focus is too low in the material, the laser beam focus can vaporize the liquid which alters the gas and liquid flow, disrupting the proper balance between the assist gas pressure and the cut speed.

Other factors can also affect the cutting process. The composition of the steel, surface condition, plate temperature, oxygen purity, and laser power distribution can all impact the cut quality and speed for a given thickness. The relative importance of these factors increases with plate thickness. Once conditions have been established for proper cutting, controlling the repeatability of these factors as much as possible will help ensure a consistent process.

Piercing thicker mild steel is a key element to reducing cycle times and enabling proper cut initiation. There are several methods for piercing mild steel. The simplest method is to place the nozzle at pierce height, turn on the assist gas, and then turn on the laser at full power to pierce the material. This method creates a pierce hole in the material that is about twice the nozzle diameter and leaves some material around the top edge of the pierce hole. The surrounding material will be quite hot after the pierce, so you either need a lead-in that is about 1.0 – 1.5 times the material thickness or a delay of a few seconds before starting the cut.

A second method is to pulse the laser and drill through the material. This method creates a pierce hole about the same size as the laser beam and does not heat up the surrounding material as much as the previous method. However, the pierce time will be about 1 second for each mm of material thickness, so it can take quite a while in thicker material. This method is generally preferred when you need to cut a feature with dimensions that are about the same as the material thickness, such as a 10 mm diameter hole in 10 mm thick mild steel.

The third method is to use a side jet to help control the piercing process. With this method the side jet blows away the molten material as it exits the pierce hole and also controls the oxygen concentration interacting with the liquid steel. This method is faster than the pulse piercing method and forms a smaller hole than the blast method, so less heat is transferred to the surrounding material. This process is dependent on the side jet direction and pressure, so proper and stable aiming of the jet is required.

The cut charts in the CNC provide a general guideline for the starting point of a particular thickness.

Mild steel – air and nitrogen assisted

Cutting mild steel with nitrogen as the assist gas is similar to cutting stainless with nitrogen as the assist gas (refer to the section below). Air cutting of mild steel can be utilized on thin material [<1 mm (.04 in)]. The air pressures are typically between those used for oxygen and nitrogen cutting and the resulting cut edge is a little rougher than either oxygen or nitrogen cutting.

Stainless steel – nitrogen assisted

Stainless steel is most commonly cut with high pressure nitrogen as the assist gas to leave a cut edge that is free of oxides which would promote corrosion. Typical parameters for cutting stainless steel with a laser place the focus at a point between the midpoint and the bottom of the plate. Assist gas pressures are usually quite high, ranging from 10 bar (150 psi) for thin material, up to about 18 bar (260 psi) for thicker material. The most common cutting defects when cutting stainless steel are the formation of plasma which leads to a failure of the cut and well adhered dross on the part and the skeleton. Because the fiber laser beam can achieve a smaller focus than most industrial CO_2 lasers, the kerf needs to be wide enough to provide a sufficient assist gas flow to allow the molten material to be expelled. The cut charts in the CNC can provide a good starting point for optimization of the cutting process.

Piercing stainless steel is quite simple using a method similar to the blast method of mild steel. However, since an inert gas is used, there is no over-burning of the surrounding material and the material temperature does not impact the cutting process. The assist gas pressure for piercing is usually lower than the cutting pressure to help prevent plasma formation during the pierce. After the pierce is complete, a creep process is usually required to establish the cutting kerf geometry, otherwise the cut can be unstable or lost.

Aluminum – nitrogen assisted

The process of laser cutting aluminum is very similar to stainless steel with a few minor differences. Since the thermal conductivity of aluminum is higher, cut speeds will be lower for the same thickness material. Also, dross is usually harder to eliminate by adjusting the cutting process parameters. Luckily it easily removed from aluminum because of the material softness so minor deburring may be utilized. Assist gas pressures and focal positions are similar to those of stainless cutting.

Optimizing fiber laser cut quality

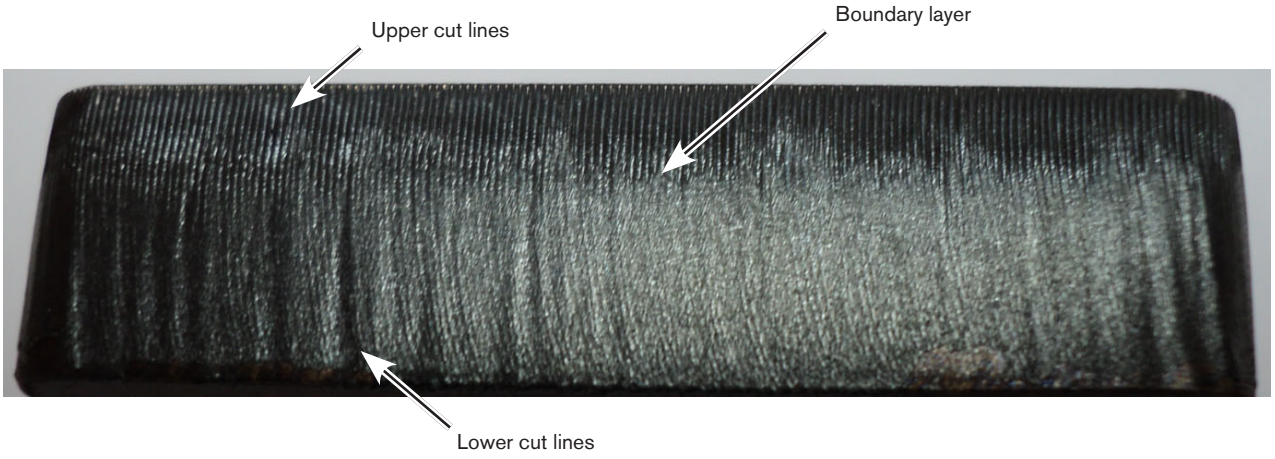
This section describes how to adjust the fiber laser system to optimize cut quality.

Note: This revision of the manual includes cutting tips for 6 mm mild steel. Future revisions will include additional thicknesses of mild steel as well as aluminum and stainless steel.

Surface of a laser cut

Laser-cut parts always exhibit a characteristic grooved pattern on the cut edge. These grooves are known as cut lines, or striations, and do not affect the edge quality when the proper cutting parameters and material are used. These cut lines can be further defined as upper and lower cut lines. The upper cut lines exist on the laser beam entrance side and the lower cut lines exist on the laser beam exit side of the cut edge. The upper and lower cut lines are separated by what is known as the boundary layer. The picture below shows an acceptable cut edge that is magnified to clearly show the upper and lower cut lines as well as the boundary layer.

Notice that the upper cut lines are shallower and more periodic than the lower cut lines. The uniqueness of these cut



lines is valuable for identifying and correcting cut quality problems. Cut lines can indicate incorrect cutting parameters such as focus position, assist gas pressure, cut height, and cut speed.

General steps for optimizing laser cut quality

Follow the steps below to optimize the cut quality for any material. The cut parameters can be adjusted in the [~ insert where the parameters are found in the Phoenix screen} Phoenix screen.

5. Use the cut chart that closely matches the material type and thickness you are cutting. To open the cut chart on your Hypertherm CNC, press the Laser Cut Chart button on the main screen.
6. Use a test part that has some interior and exterior features.
7. Verify that the lens is clean and in good condition. See [~ Reviewers: please ignore. In the final document, there will be a cross-reference to the cleaning procedures in the HFL manual].
8. Verify that the nozzle is in good condition and that the beam is centered properly.
9. Adjust the nozzle extension up and down in increments of 1 mm until the cut quality decreases, then set the nozzle extension position to the middle of the range.
10. Adjust the gas pressure up and down in increments of 0.07 bar (1 psi) or until the cut quality decreases, then set the pressure to the middle of the range.
11. Increase the cut speed in increments of 5%. When the cut quality decreases, set the cut speed 10% slower.
12. Compare your laser cut to the pictures in the examples on the following pages. When you find an example of a bad cut that is similar to your cut, make adjustments according to the example.

Mild steel

This section describes how to adjust laser-cutting settings for certain thicknesses of mild steel.

Note: The cut chart in this section applies to a 2000 W system. Your cut chart may be different. You can compare your cut to the photos in these examples regardless of the power of your system.

Optimizing cut quality for 6 mm (0.25 inch) mild steel (oxygen assisted)

The following pages show 6 mm (0.25 inch) mild steel cut at factory settings and examples of the same part cut with one variable changed to produce a bad cut.

Note: The photos in the following examples are magnified four to eight times for clarity.

Example 1: Factory cut chart settings used

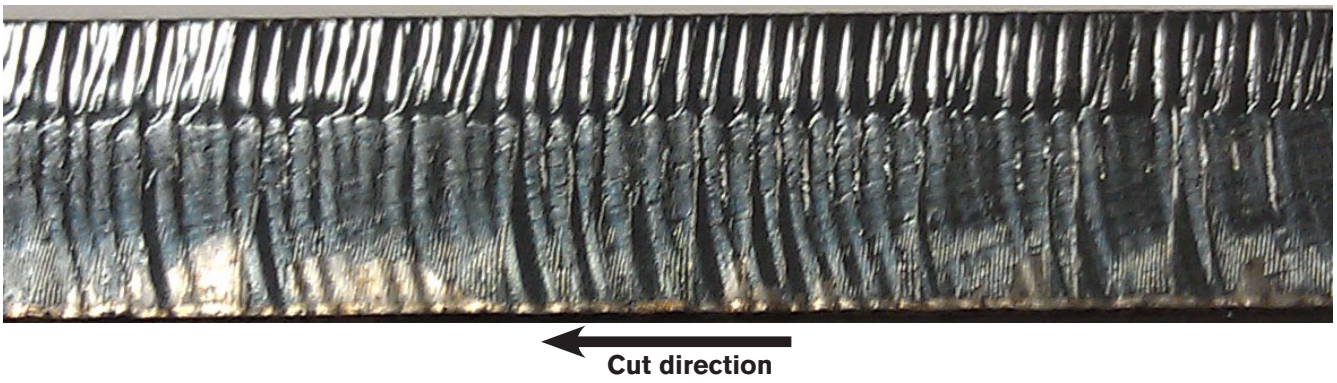
In this example, the chosen settings produce a good cut. The top of the cut is very uniform with short, well defined lines that slightly lead the cut. The bottom of the cut has very uniform vertical cut lines.

	Nozzle		Cut parameters					
Thickness	Type and size (mm)	Nozzle extension	Creep time	Cut pressure	Cut height	Kerf width	Cut power	Cut speed
6 mm (0.25 in.)	D1.5	23 mm	0.2 sec	0.55 bar (8 psi)	1 mm (0.04 in.)	0.35 mm (0.014 in.)	2000 W	1800 mm/min (72 in./min)

Example 2: Nozzle extension increased from 23 mm to 26 mm

In this example, the size of the laser beam at the top of the cut is too large, melting too much of the steel during cutting. The top cut lines are not uniform and too rough. The bottom cut lines are not uniform, are trailing the cut more, and are too rough.

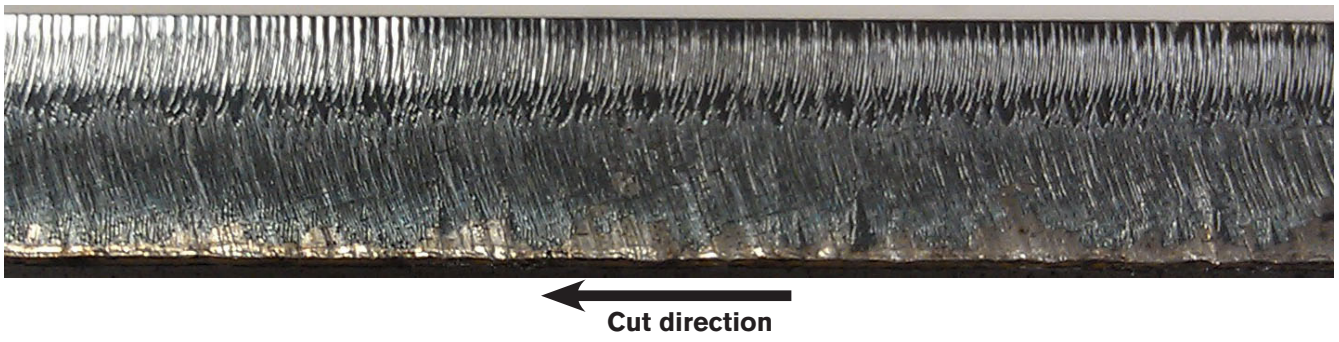
	Nozzle		Cut parameters					
Thickness	Type and size (mm)	Nozzle extension	Creep time	Cut pressure	Cut height	Kerf width	Cut power	Cut speed
6 mm (0.25 in.)	D1.5	**26 mm**	0.2 sec	0.55 bar (8 psi)	1 mm (0.04 in.)	0.35 mm (0.014 in.)	2000 W	1800 mm/min (72 in./min)



Example 3: Nozzle extension decreased from 23 mm to 21 mm

In this example, the size of the laser beam at the top of the cut is too small, causing a very narrow kerf. The top lines are very smooth and uniform. The bottom lines are trailing and the narrow kerf is not allowing enough oxygen to enter the cut.

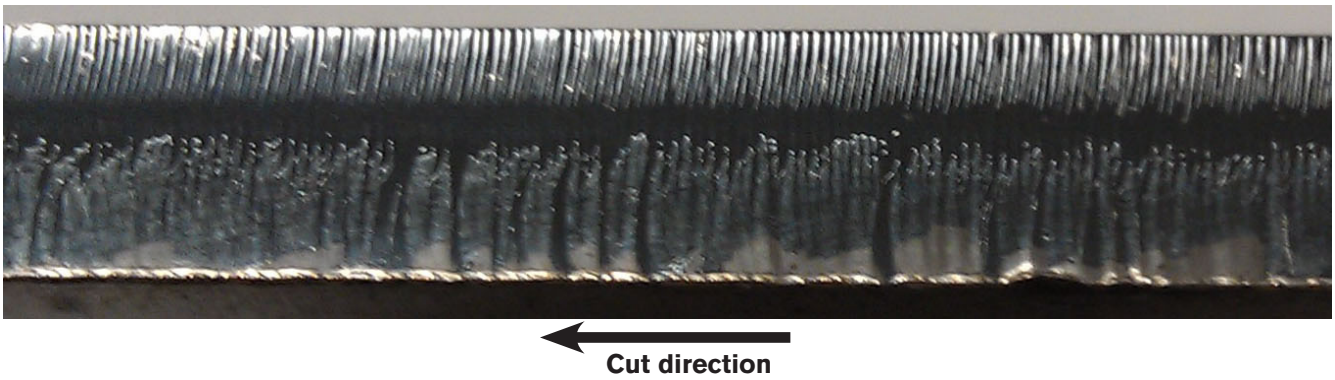
	Nozzle		Cut parameters					
Thickness	Type and size (mm)	Nozzle extension	Creep time	Cut pressure	Cut height	Kerf width	Cut power	Cut speed
6 mm (0.25 in.)	D1.5	**21 mm**	0.2 sec	0.55 bar (8 psi)	1 mm (0.04 in.)	0.35 mm (0.014 in.)	2000 W	1800 mm/min (72 in./min)



Example 4: Gas pressure increased from 0.55 bar (8 psi) to 0.83 bar (12 psi)

In this example, too much oxygen is causing the cut to become too hot. Both the top and bottom lines are too deep and not uniform.

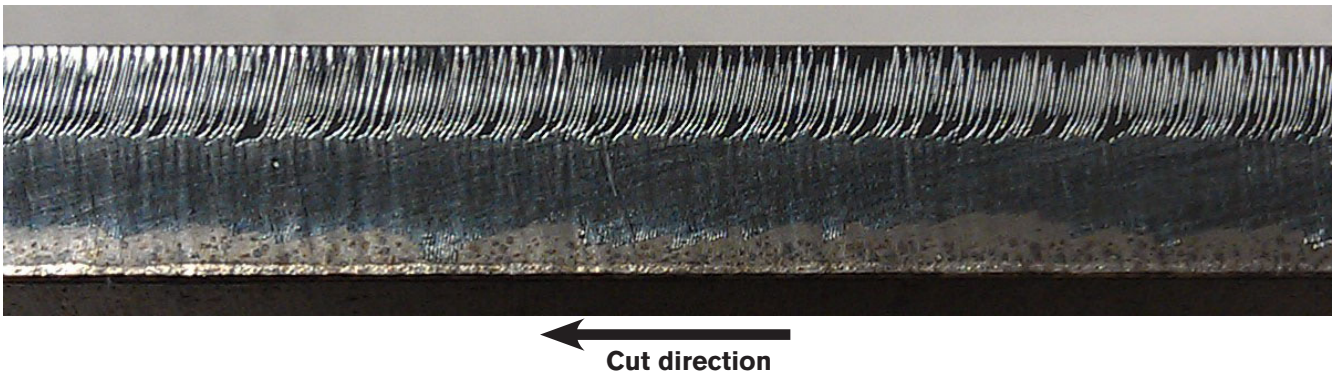
	Nozzle		Cut parameters					
Thickness	Type and size (mm)	Nozzle extension	Creep time	Cut pressure	Cut height	Kerf width	Cut power	Cut speed
6 mm (0.25 in.)	D1.5	23 mm	0.2 sec	**0.83 bar (12 psi)**	1 mm (0.04 in.)	0.35 mm (0.014 in.)	2000 W	1800 mm/min (72 in./min)



Example 5: Gas pressure decreased from 0.55 bar (8 psi) to 0.41 bar (6 psi)

In this example, there is not enough oxygen to keep up with the cutting process. The top lines are leading too much, the bottom lines are very smooth, there is not enough oxygen to cut consistently, and there is no oxidation on the bottom of the cut.

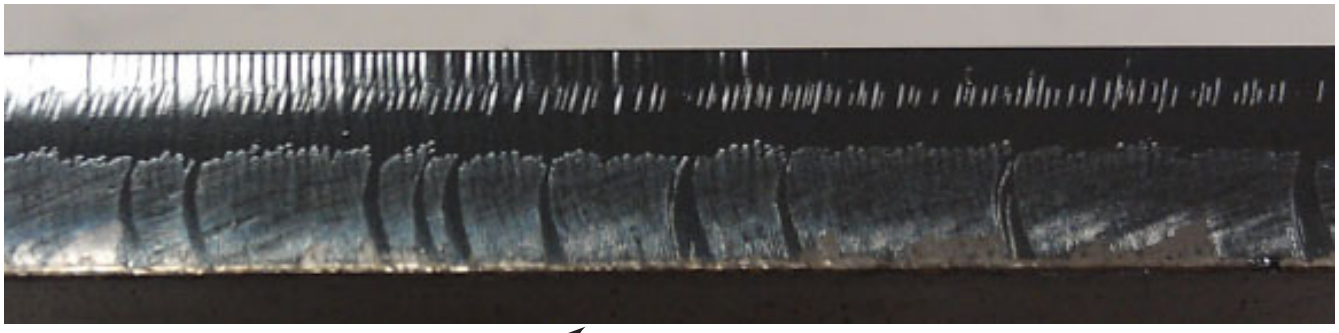
	Nozzle		Cut parameters					
Thickness	Type and size (mm)	Nozzle extension	Creep time	Cut pressure	Cut height	Kerf width	Cut power	Cut speed
6 mm (0.25 in.)	D1.5	23 mm	0.2 sec	**0.41 bar (6 psi)**	1 mm (0.04 in.)	0.35 mm (0.014 in.)	2000 W	1800 mm/min (72 in./min)



Example 6: Cut speed increased from 1800 mm/min (72 in./min) to 2080 mm/min (82 in./min)

In this example, the top lines are not bad. However, the bottom lines are trailing and inconsistent. Also, there is a lack of oxygen at the bottom of the cut.

	Nozzle		Cut parameters					
Thickness	Type and size (mm)	Nozzle extension	Creep time	Cut pressure	Cut height	Kerf width	Cut power	Cut speed
6 mm (0.25 in.)	D1.5	23 mm	0.2 sec	0.55 bar (8 psi)	1 mm (0.04 in.)	0.35 mm (0.014 in.)	2000 W	**2080 mm/min (82 in./min)**

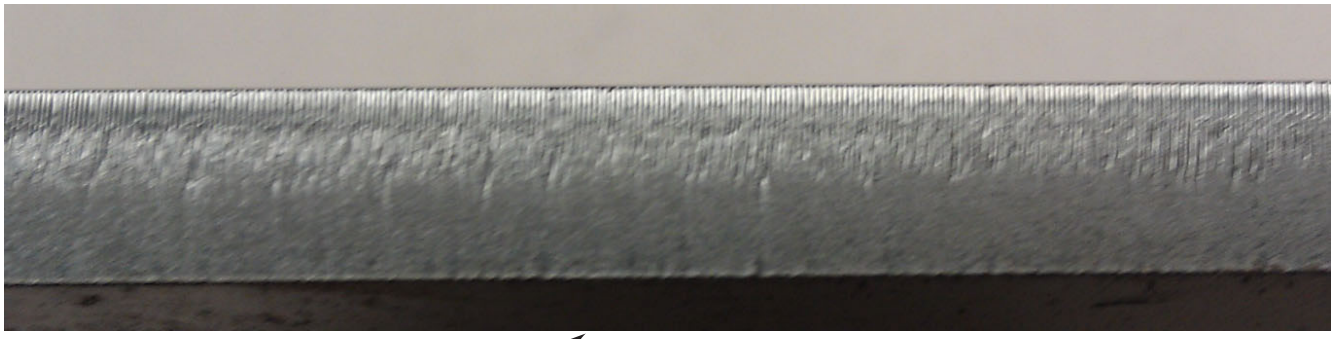


Cut direction

Example 7: Cut speed decreased from 1800 mm/min (72 in./min) to 1016 mm/min (40 in./min)

In this example, the cut is very consistent from the top to the bottom. However, decreasing the cut rate reduces productivity. The operator needs to reach a balance between cut quality and productivity.

	Nozzle		Cut parameters					
Thickness	Type and size (mm)	Nozzle extension	Creep time	Cut pressure	Cut height	Kerf width	Cut power	Cut speed
6 mm (0.25 in.)	D1.5	23 mm	0.2 sec	0.55 bar (8 psi)	1 mm (0.04 in.)	0.35 mm (0.014 in.)	2000 W	**1016 mm/min (40 in./min)**

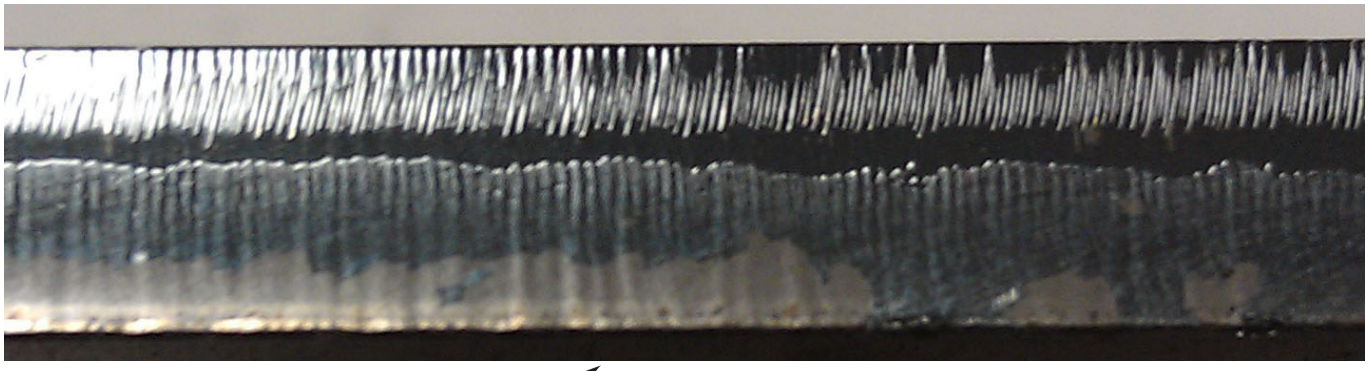


Cut direction

Example 8: Nozzle size increased from D1.5 to D2.0

In this example, too much oxygen enters the cut. The top lines are not uniform in length, and the bottom lines are also not as uniform.

Thickness	Nozzle		Cut parameters					
	Type and size (mm)	Nozzle extension	Creep time	Cut pressure	Cut height	Kerf width	Cut power	Cut speed
6 mm (0.25 in.)	**D2.0**	23 mm	0.2 sec	0.55 bar (8 psi)	1 mm (0.04 in.)	0.35 mm (0.014 in.)	2000 W	1800 mm/min (72 in./min)

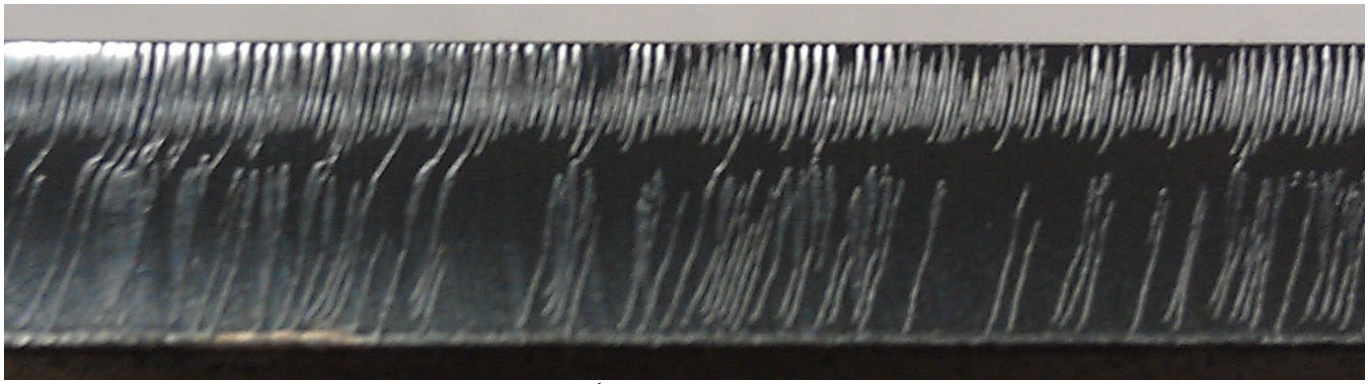


Cut direction

Example 9: Nozzle size decreased from D1.5 to D1.2

In this example, too little oxygen enters the cut. The top lines are leading too much, and the bottom lines are trailing too much and not uniform.

Thickness	Nozzle		Cut parameters					
	Type and size (mm)	Nozzle extension	Creep time	Cut pressure	Cut height	Kerf width	Cut power	Cut speed
6 mm (0.25 in.)	**D1.2**	23 mm	0.2 sec	0.55 bar (8 psi)	1 mm (0.04 in.)	0.35 mm (0.014 in.)	2000 W	1800 mm/min (72 in./min)

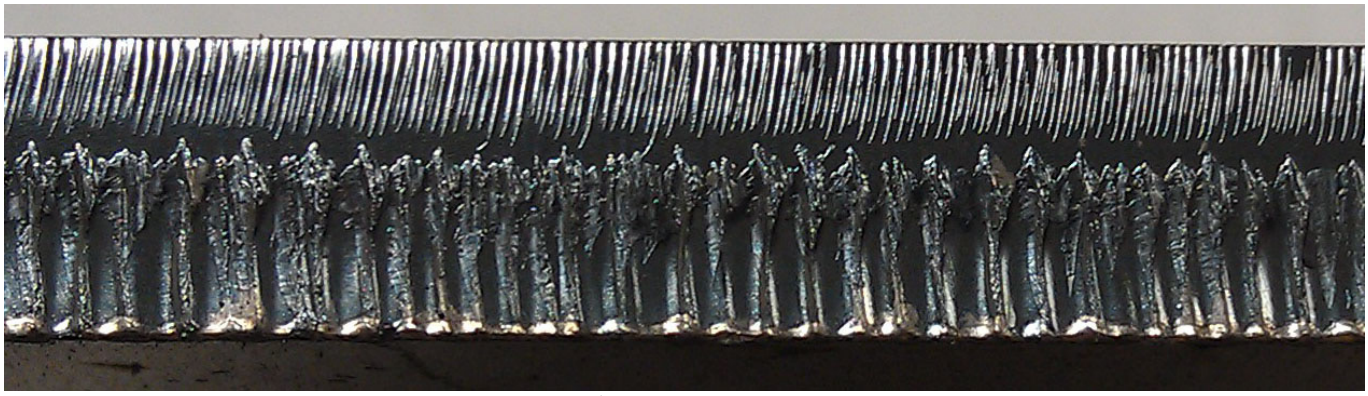


Cut direction

Example 10: Nozzle type changed from D1.5 to 1.5

In this example, the oxygen focuses on the cut differently than the D1.5 nozzle and does not stay as pure. The top lines are too deep and not uniform. The bottom lines are too deep.

	Nozzle		Cut parameters					
Thickness	Type and size (mm)	Nozzle extension	Creep time	Cut pressure	Cut height	Kerf width	Cut power	Cut speed
6 mm (0.25 in.)	**1.5**	23 mm	0.2 sec	0.55 bar (8 psi)	1 mm (0.04 in.)	0.35 mm (0.014 in.)	2000 W	1800 mm/min (72 in./min)

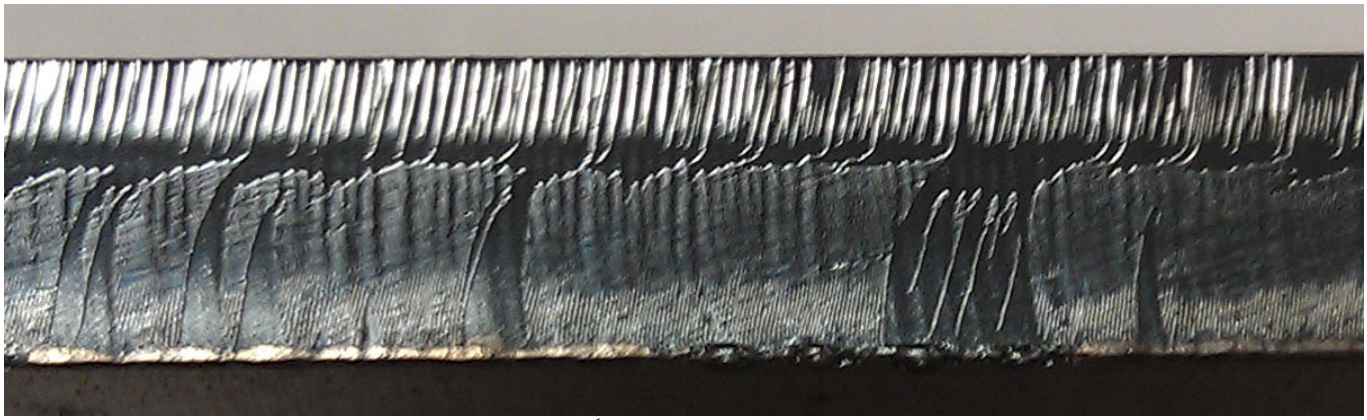


Cut direction

Example 11: Cut height increased from 1 mm (0.04 inch) to 2 mm (0.08 inch)

In this example, the cut height is too high. The top lines are leading and inconsistent, and the bottom lines are inconsistent.

	Nozzle		Cut parameters					
Thickness	Type and size (mm)	Nozzle extension	Creep time	Cut pressure	Cut height	Kerf width	Cut power	Cut speed
6 mm (0.25 in.)	D1.5	23 mm	0.2 sec	0.55 bar (8 psi)	**2 mm (0.08 in.)**	0.35 mm (0.014 in.)	2000 W	1800 mm/min (72 in./min)

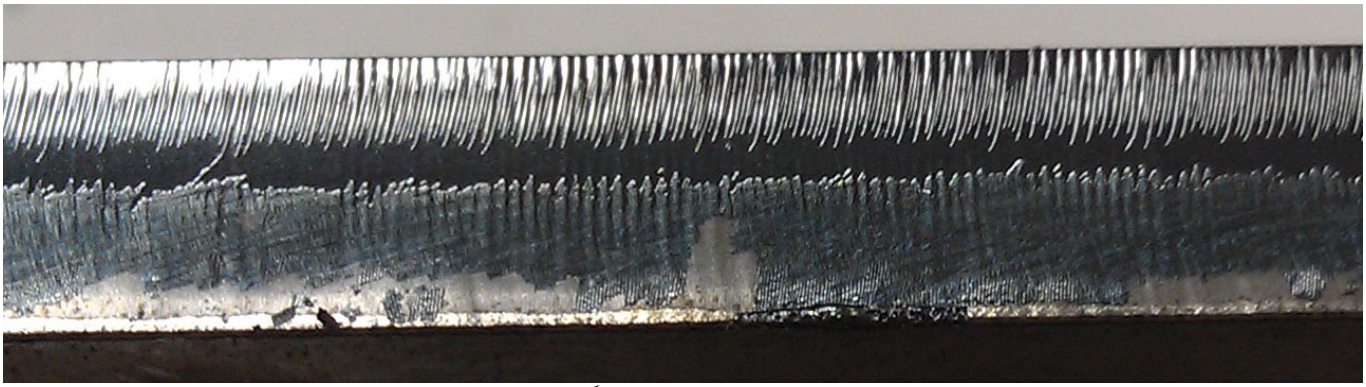


Cut direction

Example 12: Cut height decreased from 1 mm (0.04 inch) to 0.5 mm (0.02 inch)

In this example, the cut height is too low. The top lines are not uniform, and the bottom lines are trailing too much.

	Nozzle		Cut parameters					
Thickness	Type and size (mm)	Nozzle extension	Creep time	Cut pressure	Cut height	Kerf width	Cut power	Cut speed
6 mm (0.25 in.)	D1.5	23 mm	0.2 sec	0.55 bar (8 psi)	**0.5 mm (0.02 in.)**	0.35 mm (0.014 in.)	2000 W	1800 mm/min (72 in./min)

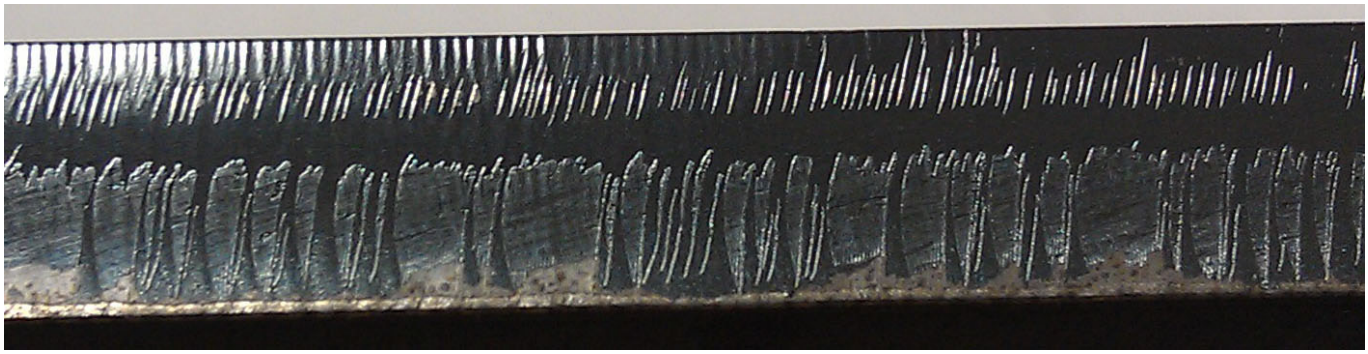


Cut direction

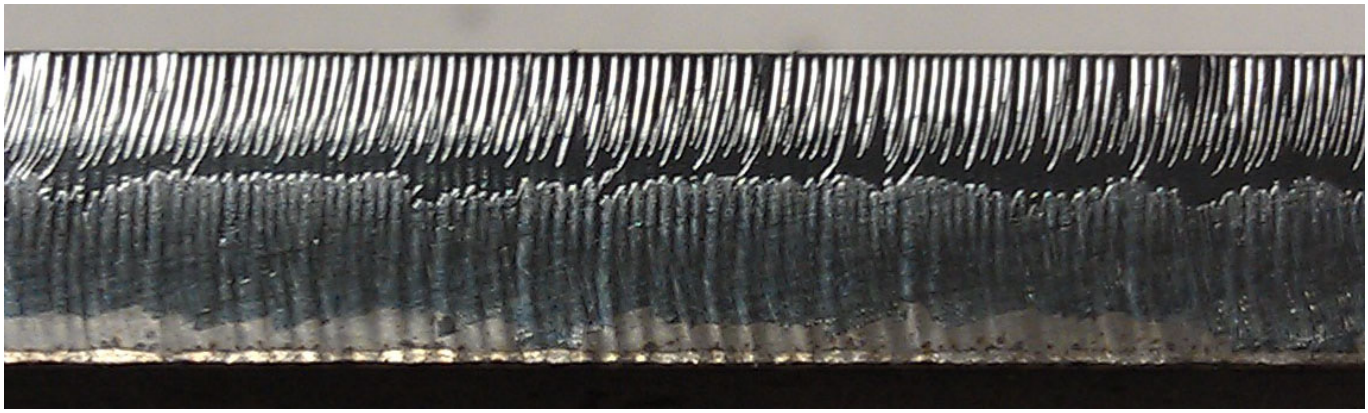
Example 13: Bad nozzle centering

In this example, the correct cut chart was used, but the nozzle is not centered. The photos below are opposite sides of the same part. The cut edge is different depending on the cut direction.

	Nozzle		Cut parameters					
Thickness	Type and size (mm)	Nozzle extension	Creep time	Cut pressure	Cut height	Kerf width	Cut power	Cut speed
6 mm (0.25 in.)	D1.5	23 mm	0.2 sec	0.55 bar (8 psi)	1 mm (0.04 in.)	0.35 mm (0.014 in.)	2000 W	1800 mm/min (72 in./min)



Cut direction



Cut direction

Consumables

Part number	Description
021105	Lens: 150 mm focal length, 35 mm outside diameter
021096	Standard nozzle: 1.0 mm
021097	Standard nozzle: 1.2 mm
021098	Standard nozzle: 1.5 mm
021099	Standard nozzle: 2.0 mm
021100	Standard nozzle: 2.5 mm
021101	Standard nozzle: 3.0 mm
021102	Dual nozzle: 1.2 mm
021103	Dual nozzle: 1.5 mm
021104	Dual nozzle: 2.0 mm
021106	Dual nozzle: 2.5 mm
104516	Nozzle adapter
104517	Washer: Nozzle adapter
027991	Lens cleaning wipes
026910	O-ring: 35 mm x 2 mm
127275	Seal: 1.875 in (47.5 mm) outside diameter
228615	Lens holder: 150 mm effective focal length
127293	Lens spring (for use without the window)
104519	Washer: Lens (for use without the window)
228859	Fiber laser lens assembly (includes the lens)
104641	Lens cleaning fixture
021108	Lens window
127359	Lens spring (for use with the window)
104656	Lens washer (for use with the window)
127306	Lens tissue

Cut charts

- The cut charts show general settings for cutting. Settings may need to be changed for specific conditions and material compositions
- There are seperate cut charts for each type of laser power supply, 1.0 kW, 1.5 kW, 2.0 kW, and 3.0 kW

Note: Before cutting, check all settings and adjustments and check for damaged parts and worn consumables.

HFL010 (1.0 kW) Mild Steel* cut chart - Metric

Thickness	Nozzle			Pierce Parameters				Cut Parameters					
mm	Size and Type (mm)	Part Number	Extension (mm)	Height (mm)	Duty Cycle (%)	Time (sec)	Pressure (bar)	Creep Time (sec)	Pressure (bar)	Height (mm)	Kerf (mm)	Power (W)	Feedrate (mmpm)
Marking all thicknesses								0.0	1	3	0	150	3810
0.5	1.0	021096	20	1.5	100	0.2	2.00	0.1	5	1	0.2	1000	11000
1.0	1.0	021096	20	1.5	100	0.2	2.00	0.1	5	1	0.2	1000	8800
1.5	1.0	021096	20	1.5	100	0.2	2.00	0.1	5	1	0.2	1000	7000
2.0	1.0	021096	20	1.5	100	0.2	2.00	0.1	5	1	0.2	1000	4445
2.5	1.0	021096	24	3.0	100	0.5	0.55	0.1	0.55	1	0.35	1000	2900
3.0	1.0	021096	23	3.0	100	0.5	0.55	0.2	0.55	1	0.35	1000	2400
3.5	1.0	021096	23	3.0	100	0.5	0.55	0.2	0.55	1	0.35	1000	2000
4.0	D1.2	021102	23	3.0	100	0.5	0.55	0.2	0.55	1	0.35	1000	1800
5.0	D1.2	021102	23	3.0	100	0.5	0.55	0.2	0.55	1	0.35	1000	1500
6.0	D1.5	021103	23	4.5	90	2.0	0.50	0.2	0.55	1	0.35	1000	1150
8.0	D1.5	021103	23	4.5	90	3.0	0.50	0.3	0.55	1	0.35	1000	925
9.0	D2.0	021104	23	5.0	90	4.0	0.50	0.3	0.55	1	0.35	1000	825
10.0	D2.0	021104	23	5.0	90	4.0	0.50	0.5	0.55	1	0.35	1000	750

D = Dual flow nozzle
* Oxygen assist gas

HFL010 (1.0 kW) Mild Steel* cut chart - English

Thickness		Nozzle			Pierce Parameters				Cut Parameters					
Decimal (in)	Gauge and Fraction	Size and Type (mm)	Part Number	Extension (mm)	Height (in)	Duty Cycle (%)	Time (sec)	Pressure (psig)	Creep Time (sec)	Pressure (psig)	Height (in)	Kerf (in)	Power (W)	Feedrate (ipm)
Marking all thicknesses									0.0	15	0.12	0	150	150
0.018	26 GA	1.0	021096	20	0.06	100	0.2	30	0.1	75	0.04	0.008	1000	450
0.036	20 GA	1.0	021096	20	0.06	100	0.2	30	0.1	75	0.04	0.008	1000	375
0.048	18 GA	1.0	021096	20	0.06	100	0.2	30	0.1	75	0.04	0.008	1000	325
0.060	16 GA	1.0	021096	20	0.06	100	0.2	30	0.1	75	0.04	0.008	1000	275
0.075	14 GA	1.0	021096	20	0.06	100	0.2	30	0.1	75	0.04	0.008	1000	175
0.105	12 GA	1.0	021096	24	0.12	100	0.5	8	0.2	8	0.04	0.014	1000	115
0.125	1/8 in	1.0	021096	23	0.12	100	0.5	8	0.2	8	0.04	0.014	1000	85
0.135	10 GA	1.0	021096	23	0.12	100	0.5	8	0.2	8	0.04	0.014	1000	80
0.164	8 GA	D1.2	021102	23	0.12	100	0.5	8	0.2	8	0.04	0.014	1000	70
0.188	3/16 in	D1.2	021102	23	0.12	100	0.5	8	0.2	8	0.04	0.014	1000	65
0.250	1/4 in	D1.5	021103	23	0.18	90	2.0	7	0.2	8	0.04	0.014	1000	45
0.313	5/16 in	D1.5	021103	23	0.18	90	3.0	7	0.3	8	0.04	0.014	1000	36
0.375	3/8 in	D2.0	021104	23	0.20	90	4.0	7	0.5	8	0.04	0.014	1000	30

D = Dual flow nozzle
* Oxygen assist gas

HFL010 (1.0 kW) Stainless Steel* cut chart - Metric

Thickness	Nozzle			Pierce Parameters				Cut Parameters					
mm	Size and Type (mm)	Part Number	Extension (mm)	Height (mm)	Duty Cycle (%)	Time (sec)	Pressure (bar)	Creep Time (sec)	Pressure (bar)	Height (mm)	Kerf (mm)	Power (W)	Feedrate (mmpm)
Marking all thicknesses								0.0	1	3.0	0	150	3810
0.5	1.5	021098	20	1.5	100	0.2	3.0	0.1	12	0.5	0.2	1000	9000
1.0	1.5	021098	20	1.5	100	0.2	3.0	0.1	12	0.5	0.2	1000	6600
1.5	1.5	021098	20	1.5	100	0.2	3.0	0.1	13.6	0.5	0.2	1000	4500
2.0	1.5	021098	20	1.5	100	0.2	3.0	0.2	13.6	0.5	0.2	1000	3500
2.5	2.0	021099	20	2.0	100	0.5	3.0	0.3	13.6	0.5	0.2	1000	1900
3.0	2.0	021099	20	2.0	100	0.5	3.0	0.3	15.3	0.5	0.2	1000	1500
3.5	2.0	021099	20	2.0	100	0.5	3.0	0.3	15.3	0.5	0.2	1000	1400
4.0	2.5	021100	20	3.0	100	1.0	3.0	0.5	15.3	0.5	0.2	1000	1000
5.0	2.5	021100	20	3.0	100	1.0	3.0	1.0	15.3	0.5	0.2	1000	700
6.0	2.5	021100	20	3.0	100	2.0	3.0	1.0	18.7	1.0	0.2	1000	500

* Nitrogen assist gas

HFL010 (1.0 kW) Stainless Steel* cut chart - English

Thickness		Nozzle			Pierce Parameters				Cut Parameters					
Decimal (in)	Gauge and Fraction	Size and Type (mm)	Part Number	Extension (mm)	Height (in)	Duty Cycle (%)	Time (sec)	Pressure (psig)	Creep Time (sec)	Pressure (psig)	Height (in)	Kerf (in)	Power (W)	Feedrate (ipm)
Marking all thicknesses									0.0	15	0.12	0	150	150
0.018	26 GA	1.5	021098	20	0.06	100	0.2	45	0.1	175	0.02	0.008	1000	350
0.036	20 GA	1.5	021098	20	0.06	100	0.2	45	0.1	175	0.02	0.008	1000	280
0.048	18 GA	1.5	021098	20	0.06	100	0.2	45	0.1	200	0.02	0.008	1000	220
0.060	16 GA	1.5	021098	20	0.06	100	0.2	45	0.1	200	0.02	0.008	1000	175
0.075	14 GA	1.5	021098	20	0.06	100	0.2	45	0.2	200	0.02	0.008	1000	140
0.105	12 GA	2.0	021099	20	0.08	100	0.5	45	0.3	200	0.02	0.008	1000	75
0.125	1/8 in	2.0	021099	20	0.08	100	0.5	45	0.3	225	0.02	0.008	1000	60
0.135	10 GA	2.0	021099	20	0.08	100	0.5	45	0.3	225	0.02	0.008	1000	55
0.164	8 GA	2.5	021100	20	0.12	100	1.0	45	0.5	225	0.02	0.008	1000	40
0.188	3/16 in	2.5	021100	20	0.12	100	1.0	45	1.0	225	0.02	0.008	1000	30
0.250	1/4 in	2.5	021100	20	0.12	100	2.0	45	1.0	275	0.04	0.008	1000	20

* Nitrogen assist gas

HFL010 (1.0 kW) Aluminum* cut chart - Metric

Thickness	Nozzle			Pierce Parameters				Cut Parameters					
mm	Size and Type (mm)	Part Number	Extension (mm)	Height (mm)	Duty Cycle (%)	Time (sec)	Pressure (bar)	Creep Time (sec)	Pressure (bar)	Height (mm)	Kerf (mm)	Power (W)	Feedrate (mmpm)
Marking all thicknesses								0.0	1	3.0	0	350	3810
0.5	1.5	021098	20	2.0	100	2.0	3.0	0.2	13.6	0.5	0.2	1000	7500
1.0	1.5	021098	20	2.0	100	2.0	3.0	0.2	13.6	0.5	0.2	1000	5600
1.5	1.5	021098	20	2.0	100	2.0	3.0	0.5	13.6	0.5	0.2	1000	3800
2.0	2.0	021099	20	2.0	100	3.0	3.0	0.5	13.6	0.5	0.2	1000	2300
2.5	2.0	021099	20	2.0	100	4.0	3.0	0.7	13.6	0.5	0.2	1000	1900
3.0	2.0	021099	20	2.0	100	5.0	3.0	1.0	13.6	0.5	0.2	1000	1400

HFL010 (1.0 kW) Aluminum* cut chart - English

Thickness		Nozzle			Pierce Parameters				Cut Parameters					
Decimal (in)	Gauge and Fraction	Size and Type (mm)	Part Number	Extension (mm)	Height (in)	Duty Cycle (%)	Time (sec)	Pressure (psig)	Creep Time (sec)	Pressure (psig)	Height (in)	Kerf (in)	Power (W)	Feedrate (ipm)
Marking all thicknesses									0.0	15	0.12	0	350	150
0.018	26 GA	1.5	021098	20	0.08	100	2.0	45	0.2	200	0.02	0.008	1000	300
0.036	20 GA	1.5	021098	20	0.08	100	2.0	45	0.2	200	0.02	0.008	1000	220
0.048	18 GA	1.5	021098	20	0.08	100	2.0	45	0.2	200	0.02	0.008	1000	200
0.060	16 GA	1.5	021098	20	0.08	100	2.0	45	0.5	200	0.02	0.008	1000	150
0.075	14 GA	2.0	021099	20	0.08	100	3.0	45	0.5	200	0.02	0.008	1000	90
0.105	12 GA	2.0	021099	20	0.08	100	4.0	45	0.7	200	0.02	0.008	1000	75
0.125	1/8 in	2.0	021099	20	0.08	100	5.0	45	1.0	200	0.02	0.008	1000	50

* Nitrogen assist gas

HFL015 (1.5 kW) Mild Steel* cut chart - Metric

Thickness	Nozzle			Pierce Parameters				Cut Parameters					
mm	Size and Type (mm)	Part Number	Extension (mm)	Height (mm)	Duty Cycle (%)	Time (sec)	Pressure (bar)	Creep Time (sec)	Pressure (bar)	Height (mm)	Kerf (mm)	Power (W)	Feedrate (mmpm)
Marking all thicknesses								0.0	1	3	0	150	3810
0.5	1.0	021096	20	1.5	100	0.1	2.00	0.1	5	1	0.2	1000	11000
1.0	1.0	021096	20	1.5	100	0.1	2.00	0.1	5	1	0.2	1000	8800
1.5	1.0	021096	20	1.5	100	0.2	2.00	0.1	5	1	0.2	1000	7000
2.0	1.0	021096	20	1.5	100	0.2	2.00	0.1	5	1	0.2	1000	4445
2.5	1.0	021096	24	3.0	100	0.2	0.55	0.2	0.55	1	0.35	1500	3300
3.0	1.0	021096	24	3.0	100	0.5	0.55	0.2	0.55	1	0.35	1500	2800
3.5	1.0	021096	23	3.0	100	0.5	0.55	0.2	0.55	1	0.35	1500	2500
4.0	D1.2	021102	23	3.0	100	0.5	0.55	0.2	0.55	1	0.35	1500	2200
5.0	D1.2	021102	23	3.0	100	0.5	0.55	0.2	0.55	1	0.35	1500	2000
6.0	D1.5	021103	23	4.0	80	1.0	0.50	0.2	0.55	1	0.35	1500	1500
8.0	D1.5	021103	23	4.0	80	1.5	0.50	0.3	0.55	1	0.35	1500	1200
9.0	D2.0	021104	23	4.0	80	2.0	0.50	0.3	0.55	1	0.35	1500	1050
10.0	D2.0	021104	23	4.0	75	2.0	0.50	0.5	0.55	1	0.35	1500	1000
11.0	D2.0	021104	23	See staged Piercing Table				0.5	0.55	1	0.35	1500	860
12.0	D2.5	021106	23					0.5	0.55	1	0.35	1500	760

D = Dual flow nozzle
* Oxygen assist gas

Thicknes (mm)	Stage	Staged Pierce Parameters				
		Time (sec)	Height (mm)	Duty Cycle (%)	Frequency (Hz)	Pressure (bar)
11	1	5	7	60	500	0.5
	2	5	6	70	500	
	3	2	5	75	500	
12	1	6	7	60	500	0.5
	2	6	6	70	500	
	3	3	5	75	500	

HFL015 (1.5 kW) Mild Steel* cut chart - English

Thickness		Nozzle			Pierce Parameters				Cut Parameters					
Decimal (in)	Gauge and Fraction	Size and Type (mm)	Part Number	Extension (mm)	Height (in)	Duty Cycle (%)	Time (sec)	Pressure (psig)	Creep Time (sec)	Pressure (psig)	Height (in)	Kerf (in)	Power (W)	Feedrate (ipm)
Marking all thicknesses									0.0	15	0.12	0	150	150
0.018	26 GA	1.0	021096	20	0.06	100	0.1	30	0.1	75	0.04	0.008	1000	450
0.036	20 GA	1.0	021096	20	0.06	100	0.1	30	0.1	75	0.04	0.008	1000	375
0.048	18 GA	1.0	021096	20	0.06	100	0.1	30	0.1	75	0.04	0.008	1000	325
0.060	16 GA	1.0	021096	20	0.06	100	0.2	30	0.1	75	0.04	0.008	1000	275
0.075	14 GA	1.0	021096	20	0.06	100	0.2	30	0.1	75	0.04	0.008	1000	175
0.105	12 GA	1.0	021096	24	0.12	100	0.5	8	0.2	8	0.04	0.014	1500	130
0.125	1/8 in	1.0	021096	23	0.12	100	0.5	8	0.2	8	0.04	0.014	1500	110
0.135	10 GA	1.0	021096	23	0.12	100	0.5	8	0.2	8	0.04	0.014	1500	100
0.164	8 GA	D1.2	021102	23	0.12	100	0.5	8	0.2	8	0.04	0.014	1500	88
0.188	3/16 in	D1.2	021102	23	0.12	100	0.5	8	0.2	8	0.04	0.014	1500	80
0.250	1/4 in	D1.5	021103	23	0.16	85	1.0	7	0.2	8	0.04	0.014	1500	60
0.313	5/16 in	D1.5	021103	23	0.16	85	1.5	7	0.3	8	0.04	0.014	1500	48
0.375	3/8 in	D2.0	021104	23	0.16	85	2.0	7	0.5	8	0.04	0.014	1500	40
0.438	7/16 in	D2.0	021104	23	See Staged Piercing Table				0.5	8	0.04	0.014	1500	34
0.500	1/2 in	D2.5	021106	23					0.5	8	0.04	0.014	1500	30

D = Dual flow nozzle
* Oxygen assist gas

Thickness (in)	Stage	Staged Pierce Parameters				
		Time (sec)	Height (in)	Duty Cycle (%)	Frequency (Hz)	Pressure (psig)
7/16	1	5	0.28	60	500	7
	2	5	0.24	70	500	
	3	2	0.20	75	500	
1/2	1	6	0.28	60	500	7
	2	6	0.24	70	500	
	3	3	0.20	75	500	

HFL015 (1.5 kW) Stainless Steel* cut chart - Metric

Thickness	Nozzle			Pierce Parameters				Cut Parameters					
mm	Size and Type (mm)	Part Number	Extension (mm)	Height (mm)	Duty Cycle (%)	Time (sec)	Pressure (bar)	Creep Time (sec)	Pressure (bar)	Height (mm)	Kerf (mm)	Power (W)	Feedrate (mmpm)
Marking all thicknesses								0.0	1	3.0	0	150	3810
0.5	1.0	021096	19	1.5	100	0.2	12	0.1	12	0.5	0.2	1500	11000
1.0	1.0	021096	19	1.5	100	0.2	12	0.1	12	0.5	0.2	1500	9000
1.5	1.5	021098	19	1.5	100	0.2	10	0.1	13.6	0.5	0.2	1500	5500
2.0	1.5	021098	20	1.5	100	0.2	10	0.2	13.6	0.5	0.2	1500	5000
2.5	2.0	021099	20	2.0	100	0.5	3	0.3	13.6	0.5	0.2	1500	3300
3.0	2.0	021099	20	2.0	100	0.5	3	0.3	15.3	0.5	0.2	1500	2800
3.5	2.0	021099	19	2.0	100	0.5	3	0.3	15.3	0.5	0.2	1500	2500
4.0	2.0	021099	20	2.0	100	0.5	3	0.5	15.3	0.5	0.2	1500	1650
5.0	2.5	021100	20	3.0	100	0.5	3	1.0	15.3	0.5	0.2	1500	1200
6.0	2.5	021100	20	3.0	100	1.0	3	1.0	17.0	1.0	0.2	1500	700
8.0	2.5	021100	19	3.0	100	2.0	3	1.5	17.0	1.0	0.2	1500	450
9.0	2.5	021100	19	3.0	100	2.0	3	1.5	17.0	1.0	0.2	1500	360
10.0	2.5	021100	19	3.0	100	3.0	3	2.0	17.0	1.0	0.2	1500	300

* Nitrogen assist gas

HFL015 (1.5 kW) Stainless Steel* cut chart - English

Thickness		Nozzle			Pierce Parameters				Cut Parameters					
Decimal (in)	Gauge and Fraction	Size and Type (mm)	Part Number	Extension (mm)	Height (in)	Duty Cycle (%)	Time (sec)	Pressure (psig)	Creep Time (sec)	Pressure (psig)	Height (in)	Kerf (in)	Power (W)	Feedrate (ipm)
Marking all thicknesses									0.0	15	0.12	0	150	150
0.018	26 GA	1.0	021096	19	0.06	100	0.2	175	0.1	175	0.02	0.008	1500	450
0.036	20 GA	1.0	021096	19	0.06	100	0.2	175	0.1	175	0.02	0.008	1500	375
0.048	18 GA	1.2	021097	19	0.06	100	0.2	175	0.1	175	0.02	0.008	1500	300
0.060	16 GA	1.5	021098	19	0.06	100	0.2	150	0.1	200	0.02	0.008	1500	225
0.075	14 GA	1.5	021098	20	0.06	100	0.2	150	0.2	200	0.02	0.008	1500	200
0.105	12 GA	2.0	021099	20	0.08	100	0.5	45	0.3	200	0.02	0.008	1500	130
0.125	1/8 in	2.0	021099	20	0.08	100	0.5	45	0.3	225	0.02	0.008	1500	110
0.135	10 GA	2.0	021099	20	0.08	100	0.5	45	0.3	225	0.02	0.008	1500	100
0.164	8 GA	2.0	021099	20	0.08	100	0.5	45	0.5	225	0.02	0.008	1500	65
0.188	3/16 in	2.5	021100	20	0.12	100	0.5	45	1.0	225	0.04	0.008	1500	50
0.250	1/4 in	2.5	021100	20	0.12	100	1.0	45	1.0	250	0.04	0.008	1500	27
0.313	5/16 in	2.5	021100	19	0.12	100	2.0	45	1.5	250	0.04	0.008	1500	18
0.375	3/8 in	2.5	021100	19	0.12	100	3.0	45	2.0	250	0.04	0.008	1500	13

* Nitrogen assist gas

HFL015 (1.5 kW) Aluminum* cut chart - Metric

Thickness	Nozzle			Pierce Parameters				Cut Parameters					
mm	Size and Type (mm)	Part Number	Extension (mm)	Height (mm)	Duty Cycle (%)	Time (sec)	Pressure (bar)	Creep Time (sec)	Pressure (bar)	Height (mm)	Kerf (mm)	Power (W)	Feedrate (mmpm)
Marking all thicknesses								0.0	1	3.0	0	350	3810
0.5	1.5	021098	19	3	100	0.2	15.3	0.2	15.3	0.5	0.2	1500	10000
1.0	1.5	021098	19	3	100	0.2	15.3	0.2	15.3	0.5	0.2	1500	8500
1.5	1.5	021098	19	3	100	0.2	15.3	0.2	15.3	0.5	0.2	1500	6350
2.0	1.5	021098	19	3	100	0.2	15.3	0.2	15.3	0.5	0.2	1500	4500
2.5	2.0	021099	19	3	100	0.5	3.0	0.2	15.3	0.5	0.2	1500	3300
3.0	2.0	021099	20	3	100	0.5	3.0	0.2	15.3	0.5	0.2	1500	2300
3.5	2.0	021099	20	3	100	0.5	3.0	0.3	15.3	0.5	0.2	1500	1700
4.0	2.0	021099	20	3	100	0.5	3.0	0.4	15.3	0.5	0.2	1500	1200
5.0	2.5	021100	20	3	100	1.0	3.0	0.5	17.0	1.0	0.2	1500	850
6.0	2.5	021100	20	3	100	2.0	3.0	2.0	18.7	1.0	0.2	1500	500

* Nitrogen assist gas

HFL015 (1.5 kW) Aluminum* cut chart - English

Thickness		Nozzle			Pierce Parameters				Cut Parameters					
Decimal (in)	Gauge and Fraction	Size and Type (mm)	Part Number	Extension (mm)	Height (in)	Duty Cycle (%)	Time (sec)	Pressure (psig)	Creep Time (sec)	Pressure (psig)	Height (in)	Kerf (in)	Power (W)	Feedrate (ipm)
Marking all thicknesses									0.0	15	0.12	0	350	150
0.018	26 GA	1.5	021098	19	0.12	100	0.2	200	0.2	200	0.02	0.008	1500	400
0.036	20 GA	1.5	021098	19	0.12	100	0.2	200	0.2	200	0.02	0.008	1500	350
0.048	18 GA	1.5	021098	19	0.12	100	0.2	200	0.2	200	0.02	0.008	1500	325
0.060	16 GA	1.5	021098	19	0.12	100	0.2	200	0.2	200	0.02	0.008	1500	250
0.075	14 GA	1.5	021098	19	0.12	100	0.2	200	0.2	200	0.02	0.008	1500	180
0.105	12 GA	2.0	021099	19	0.12	100	0.5	45	0.2	200	0.02	0.008	1500	130
0.125	1/8 in	2.0	021099	20	0.12	100	0.5	45	0.2	200	0.02	0.008	1500	90
0.135	10 GA	2.0	021099	20	0.12	100	0.5	45	0.3	200	0.02	0.008	1500	70
0.164	8 GA	2.0	021099	20	0.12	100	0.5	45	0.5	200	0.02	0.008	1500	45
0.188	3/16 in	2.5	021100	20	0.12	100	1.0	45	0.5	250	0.04	0.008	1500	35
0.250	1/4 in	2.5	021100	20	0.12	100	2.0	45	2.0	275	0.04	0.008	1500	20

* Nitrogen assist gas

HFL020 (2.0 kW) Mild Steel* cut chart - Metric

Thickness	Nozzle			Pierce Parameters				Cut Parameters					
mm	Size and Type (mm)	Part Number	Extension (mm)	Height (mm)	Duty Cycle (%)	Time (sec)	Pressure (bar)	Creep Time (sec)	Pressure (bar)	Height (mm)	Kerf (mm)	Power (W)	Feedrate (mmpm)
Marking all thicknesses								0.0	1	3	0	150	3810
0.5	1.0	021096	20	1.5	100	0.1	2.00	0.1	5	1	0.2	1000	11000
1.0	1.0	021096	20	1.5	100	0.1	2.00	0.1	5	1	0.2	1000	8800
1.5	1.0	021096	20	1.5	100	0.2	2.00	0.1	5	1	0.2	1000	7000
2.0	1.0	021096	20	1.5	100	0.2	2.00	0.1	5	1	0.2	1000	4445
2.5	1.0	021096	24	3.0	100	0.2	0.55	0.2	0.55	1	0.35	2000	3900
3.0	1.0	021096	24	3.0	100	0.5	0.55	0.2	0.55	1	0.35	2000	3400
3.5	1.0	021096	23	3.0	100	0.5	0.55	0.2	0.55	1	0.35	2000	3200
4.0	D1.2	021102	23	3.0	100	0.5	0.55	0.2	0.55	1	0.35	2000	2900
5.0	D1.2	021102	23	3.0	100	0.5	0.55	0.2	0.55	1	0.35	2000	2500
6.0	D1.5	021103	23	4.0	80	1.0	0.50	0.2	0.55	1	0.35	2000	1800
8.0	D1.5	021103	23	4.0	80	1.5	0.50	0.3	0.55	1	0.35	2000	1400
9.0	D2.0	021104	23	4.0	80	2.0	0.50	0.3	0.55	1	0.35	2000	1250
10.0	D2.0	021104	23	4.0	80	2.0	0.50	0.5	0.55	1	0.35	2000	1150
11.0	D2.0	021104	23	See Staged Pierce Parameters				0.5	0.55	1	0.35	2000	990
12.0	D2.5	021106	23					0.5	0.55	1	0.35	2000	890
14.0	D2.5	021106	23					1.0	0.55	1	0.35	2000	710
15.0	D2.5	021106	23					1.0	0.55	1	0.35	2000	625
16.0	D2.5	021106	23					1.0	0.55	1	0.35	2000	575

D = Dual flow nozzle
* Oxygen assist gas

Thickness (mm)	Stage	Staged Pierce Parameters				
		Time (sec)	Height (mm)	Duty Cycle (%)	Frequency (Hz)	Pressure (bar)
11	1	3	7	50	500	0.5
	2	3	5	60	500	
	3	1	4	65	500	
12	1	3	7	50	500	0.5
	2	3	5	60	500	
	3	2	4	65	0	

Thickness (mm)	Stage	Staged Pierce Parameters				
		Time (sec)	Height (mm)	Duty Cycle (%)	Frequency (Hz)	Pressure (bar)
14	1	4	7	50	500	0.5
	2	3	5	60	500	
	3	1	4	65	500	
15	1	4	7	70	500	0.5
	2	4	6	75	500	
	3	2	4.5	80	500	
16	1	4	7	70	500	0.5
	2	4	6	75	500	
	3	3	4.5	80	500	

HFL020 (2.0 kW) Mild Steel* cut chart - English

Thickness		Nozzle			Pierce Parameters				Cut Parameters					
Decimal (in)	Gauge and Fraction	Size and Type (mm)	Part Number	Extension (mm)	Height (in)	Duty Cycle (%)	Time (sec)	Pressure (psig)	Creep Time (sec)	Pressure (psig)	Height (in)	Kerf (in)	Power (W)	Feedrate (ipm)
Marking all thicknesses									0.0	15	0.12	0	150	150
0.018	26 GA	1.0	021096	20	0.06	100	0.1	30	0.1	75	0.04	0.008	1000	450
0.036	20 GA	1.0	021096	20	0.06	100	0.1	30	0.1	75	0.04	0.008	1000	375
0.048	18 GA	1.0	021096	20	0.06	100	0.1	30	0.1	75	0.04	0.008	1000	325
0.060	16 GA	1.0	021096	20	0.06	100	0.2	30	0.1	75	0.04	0.008	1000	275
0.075	14 GA	1.0	021096	20	0.06	100	0.2	30	0.1	75	0.04	0.008	1000	175
0.105	12 GA	1.0	021096	24	0.12	100	0.5	8	0.2	8	0.04	0.014	2000	150
0.125	1/8 in	1.0	021096	23	0.12	100	0.5	8	0.2	8	0.04	0.014	2000	135
0.135	10 GA	1.0	021096	23	0.12	100	0.5	8	0.2	8	0.04	0.014	2000	125
0.164	8 GA	D1.2	021102	23	0.12	100	0.5	8	0.2	8	0.04	0.014	2000	115
0.188	3/16 in	D1.2	021102	23	0.12	100	0.5	8	0.2	8	0.04	0.014	2000	100
0.250	1/4 in	D1.5	021103	23	0.16	80	1.0	7	0.2	8	0.04	0.014	2000	72
0.313	5/16 in	D1.5	021103	23	0.16	80	1.5	7	0.3	8	0.04	0.014	2000	55
0.375	3/8 in	D2.0	021104	23	0.16	80	2.0	7	0.5	8	0.04	0.014	2000	46
0.438	7/16 in	D2.0	021104	23	See Staged Piercing Table				0.5	8	0.04	0.014	2000	39
0.500	1/2 in	D2.5	021106	23					0.5	8	0.04	0.014	2000	35
0.563	9/16 in	D2.5	021106	23					1.0	8	0.04	0.014	2000	28
0.625	5/8 in	D2.5	021106	23					1.0	8	0.04	0.014	2000	25

D = Dual flow nozzle
* Oxygen assist gas

Thickness (in)	Stage	Staged Pierce Parameters				
		Time (sec)	Height (in)	Duty Cycle (%)	Frequency (Hz)	Pressure (psig)
7/16	1	3	0.28	50	500	7
	2	3	0.20	60	500	
	3	1	0.16	65	500	
1/2	1	3	0.28	50	500	7
	2	3	0.20	60	500	
	3	2	0.16	65	500	

Thickness (mm)	Stage	Staged Pierce Parameters				
		Time (sec)	Height (in)	Duty Cycle (%)	Frequency (Hz)	Pressure (psig)
9/16	1	4	0.28	50	500	7
	2	3	0.20	60	500	
	3	2	0.16	65	500	
5/8	1	4	0.28	70	500	7
	2	4	0.24	75	500	
	3	3	0.18	80	500	

HFL020 (2.0 kW) Stainless Steel* cut chart - Metric

Thickness	Nozzle			Pierce Parameters				Cut Parameters					
mm	Size and Type (mm)	Part Number	Extension (mm)	Height (mm)	Duty Cycle (%)	Time (sec)	Pressure (bar)	Creep Time (sec)	Pressure (bar)	Height (mm)	Kerf (mm)	Power (W)	Feedrate (mmpm)
Marking all thicknesses								0.0	1	3.0	0	150	3810
0.5	1.2	021097	19	1.5	100	0.2	3	0.1	12	0.5	0.2	2000	15000
1.0	1.2	021097	19	1.5	100	0.2	3	0.1	12	0.5	0.2	2000	12500
1.5	1.5	021098	19	1.5	100	0.2	3	0.1	13.6	0.5	0.2	2000	8250
2.0	1.5	021098	20	1.5	100	0.2	3	0.2	13.6	0.5	0.2	2000	7000
2.5	2.0	021099	20	2.0	100	0.5	3	0.3	13.6	0.5	0.2	2000	4500
3.0	2.0	021099	20	2.0	100	0.5	3	0.3	15.3	0.5	0.2	2000	3800
3.5	2.0	021099	19	2.0	100	0.5	3	0.3	15.3	0.5	0.2	2000	3550
4.0	2.0	021099	19	2.0	100	0.5	3	0.5	15.3	0.5	0.2	2000	2500
5.0	2.0	021099	19	3.0	100	0.5	3	1.0	15.3	0.5	0.2	2000	2000
6.0	2.5	021100	19	3.0	100	1.0	3	1.0	15.3	1.0	0.2	2000	1150
8.0	2.5	021100	18	3.0	100	2.0	3	1.5	17.0	1.0	0.2	2000	760
9.0	2.5	021100	18	3.0	100	2.0	3	1.5	17.0	1.0	0.2	2000	625
10.0	2.5	021100	18	3.0	100	3.0	3	2.0	17.0	1.0	0.2	2000	560
11.0	2.5	021100	18	3.0	100	5.0	3	2.0	17.0	1.0	0.2	2000	400
12.0	2.5	021100	18	3.0	100	7.0	3	2.0	18.7	1.0	0.2	2000	250

* Nitrogen assist gas

HFL020 (2.0 kW) Stainless Steel* cut chart - English

Thickness		Nozzle			Pierce Parameters				Cut Parameters					
Decimal (in)	Gauge and Fraction	Size and Type (mm)	Part Number	Extension (mm)	Height (in)	Duty Cycle (%)	Time (sec)	Pressure (psig)	Creep Time (sec)	Pressure (psig)	Height (in)	Kerf (in)	Power (W)	Feedrate (ipm)
Marking all thicknesses									0.0	15	0.12	0	150	150
0.018	26 GA	1.2	021097	19	0.06	100	0.2	45	0.1	175	0.02	0.008	2000	600
0.036	20 GA	1.2	021097	19	0.06	100	0.2	45	0.1	175	0.02	0.008	2000	500
0.048	18 GA	1.5	021098	19	0.06	100	0.2	45	0.1	200	0.02	0.008	2000	375
0.060	16 GA	1.5	021098	19	0.06	100	0.2	45	0.1	200	0.02	0.008	2000	325
0.075	14 GA	1.5	021098	20	0.06	100	0.2	45	0.2	200	0.02	0.008	2000	275
0.105	12 GA	2.0	021099	20	0.08	100	0.5	45	0.3	200	0.02	0.008	2000	180
0.125	1/8 in	2.0	021099	20	0.08	100	0.5	45	0.3	225	0.02	0.008	2000	150
0.135	10 GA	2.0	021099	19	0.08	100	0.5	45	0.3	225	0.02	0.008	2000	140
0.164	8 GA	2.0	021099	19	0.08	100	0.5	45	0.5	225	0.02	0.008	2000	100
0.188	3/16 in	2.0	021099	19	0.12	100	0.5	45	1.0	225	0.04	0.008	2000	80
0.250	1/4 in	2.5	021100	19	0.12	100	1.0	45	1.0	225	0.04	0.008	2000	45
0.313	5/16 in	2.5	021100	18	0.12	100	2.0	45	1.5	250	0.04	0.008	2000	30
0.375	3/8 in	2.5	021100	18	0.12	100	3.0	45	2.0	250	0.04	0.008	2000	22
0.438	7/16 in	2.5	021100	18	0.12	100	5.0	45	2.0	250	0.04	0.008	2000	16
0.500	1/2 in	2.5	021100	18	0.12	100	7.0	45	2.0	275	0.04	0.008	2000	10

* Nitrogen assist gas

HFL020 (2.0 kW) Aluminum* cut chart - Metric

Thickness	Nozzle			Pierce Parameters				Cut Parameters					
mm	Size and Type (mm)	Part Number	Extension (mm)	Height (mm)	Duty Cycle (%)	Time (sec)	Pressure (bar)	Creep Time (sec)	Pressure (bar)	Height (mm)	Kerf (mm)	Power (W)	Feedrate (mmpm)
Marking all thicknesses								0.0	1	3.0	0	350	3810
0.5	1.5	021098	19	3	100	0.2	3.0	0.2	15.3	0.5	0.2	2000	14000
1.0	1.5	021098	19	3	100	0.2	3.0	0.2	15.3	0.5	0.2	2000	12500
1.5	1.5	021098	19	3	100	0.2	3.0	0.2	15.3	0.5	0.2	2000	10000
2.0	2.0	021099	19	3	100	0.2	3.0	0.2	15.3	0.5	0.2	2000	6900
2.5	2.0	021099	19	3	100	0.2	3.0	0.2	15.3	0.5	0.2	2000	5700
3.0	2.0	021099	20	3	100	0.3	3.0	0.2	15.3	0.5	0.2	2000	3800
3.5	2.0	021099	20	3	100	0.3	3.0	0.3	15.3	0.5	0.2	2000	2700
4.0	2.0	021099	20	3	100	0.5	3.0	0.4	15.3	0.5	0.2	2000	2200
5.0	2.0	021099	20	3	100	0.5	3.0	0.5	15.3	0.5	0.2	2000	1400
6.0	2.5	021100	20	3	100	2.0	3.0	2.0	18.7	1.0	0.2	2000	750

* Nitrogen assist gas

HFL020 (2.0 kW) Aluminum* cut chart - English

Thickness		Nozzle			Pierce Parameters				Cut Parameters					
Decimal (in)	Gauge and Fraction	Size and Type (mm)	Part Number	Extension (mm)	Height (in)	Duty Cycle (%)	Time (sec)	Pressure (psig)	Creep Time (sec)	Pressure (psig)	Height (in)	Kerf (in)	Power (W)	Feedrate (ipm)
Marking all thicknesses									0.0	15	0.12	0	350	150
0.018	26 GA	1.5	021098	19	0.12	100	0.2	45	0.1	200	0.02	0.008	2000	550
0.036	20 GA	1.5	021098	19	0.12	100	0.2	45	0.1	200	0.02	0.008	2000	500
0.048	18 GA	1.5	021098	19	0.12	100	0.2	45	0.2	200	0.02	0.008	2000	475
0.060	16 GA	1.5	021098	19	0.12	100	0.2	45	0.2	200	0.02	0.008	2000	375
0.075	14 GA	2.0	021099	19	0.12	100	0.2	45	0.2	200	0.02	0.008	2000	275
0.105	12 GA	2.0	021099	19	0.12	100	0.2	45	0.2	200	0.02	0.008	2000	225
0.125	1/8 in	2.0	021099	20	0.12	100	0.3	45	0.2	200	0.02	0.008	2000	150
0.135	10 GA	2.0	021099	20	0.12	100	0.5	45	0.3	200	0.02	0.008	2000	120
0.164	8 GA	2.0	021099	20	0.12	100	0.5	45	0.5	200	0.02	0.008	2000	65
0.188	3/16 in	2.0	021099	20	0.12	100	0.5	45	0.5	200	0.02	0.008	2000	55
0.250	1/4 in	2.5	021100	20	0.12	100	2.0	45	2.0	275	0.04	0.008	2000	30

* Nitrogen assist gas

HFL020 (2.0 kW) Brass* cut chart - Metric

Thickness	Nozzle			Pierce Parameters				Cut Parameters					
mm	Size and Type (mm)	Part Number	Extension (mm)	Height (mm)	Duty Cycle (%)	Time (sec)	Pressure (bar)	Creep Time (sec)	Pressure (bar)	Height (mm)	Kerf (mm)	Power (W)	Feedrate (mmpm)
0.5	1.5	021098	21	3	100	0.1	3.0	0.2	13.6	0.5	0.15	2000	10160
1.0	1.5	021098	21	3	100	0.1	3.0	0.2	13.6	0.5	0.15	2000	7000
1.5	1.5	021098	21	3	100	0.1	3.0	0.2	13.6	0.5	0.15	2000	4800
2.0	1.5	021098	21	3	100	0.2	3.0	0.2	13.6	0.5	0.15	2000	3300
2.5	2.0	021099	21	3	100	0.5	3.0	0.5	13.6	0.5	0.15	2000	1650
3.0	2.0	021099	21	3	100	0.5	3.0	0.5	13.6	0.5	0.15	2000	1500
3.5	2.0	021099	21	3	100	0.5	3.0	0.5	13.6	0.5	0.15	2000	1250
4.0	2.0	021099	21	3	100	0.5	3.0	1.0	13.6	0.5	0.15	2000	940
5.0	2.0	021099	21	3	100	0.5	3.0	1.0	13.6	0.5	0.15	2000	750

* Nitrogen assist gas

HFL020 (2.0 kW) Brass* cut chart - English

Thickness		Nozzle			Pierce Parameters				Cut Parameters					
Decimal (in)	Gauge and Fraction	Size and Type (mm)	Part Number	Extension (mm)	Height (in)	Duty Cycle (%)	Time (sec)	Pressure (psig)	Creep Time (sec)	Pressure (psig)	Height (in)	Kerf (in)	Power (W)	Feedrate (ipm)
0.018	26 GA	1.5	021098	21	0.12	100	0.1	45	0.2	200	0.02	0.008	2000	400
0.036	20 GA	1.5	021098	21	0.12	100	0.1	45	0.2	200	0.02	0.008	2000	275
0.048	18 GA	1.5	021098	21	0.12	100	0.1	45	0.2	200	0.02	0.008	2000	220
0.060	16 GA	1.5	021098	21	0.12	100	0.1	45	0.2	200	0.02	0.008	2000	190
0.075	14 GA	1.5	021098	21	0.12	100	0.2	45	0.2	200	0.02	0.008	2000	130
0.105	12 GA	2.0	021099	21	0.12	100	0.5	45	0.5	200	0.02	0.008	2000	65
0.125	1/8 in	2.0	021099	21	0.12	100	0.5	45	0.5	200	0.02	0.008	2000	60
0.135	10 GA	2.0	021099	21	0.12	100	0.5	45	0.5	200	0.02	0.008	2000	50
0.164	8 GA	2.0	021099	21	0.12	100	0.5	45	1.0	200	0.02	0.008	2000	37
0.188	3/16 in	2.0	021099	21	0.12	100	0.5	45	1.0	200	0.02	0.008	2000	30

* Nitrogen assist gas

HFL020 (2.0 kW) Copper* cut chart - Metric

Thickness	Nozzle			Pierce Parameters				Cut Parameters					
mm	Size and Type (mm)	Part Number	Extension (mm)	Height (mm)	Duty Cycle (%)	Time (sec)	Pressure (bar)	Creep Time (sec)	Pressure (bar)	Height (mm)	Kerf (mm)	Power (W)	Feedrate (mmpm)
0.5	1.5	021098	21	3	100	0.2	2.0	0.2	6.9	1.0	0.15	2000	20300
1.0	1.5	021098	21	3	100	0.2	2.0	0.2	6.9	1.0	0.15	2000	10160
1.5	1.5	021098	21	3	100	0.2	2.0	0.2	6.9	1.0	0.15	2000	4445
2.0	1.5	021098	21	3	100	0.2	2.0	0.2	6.9	1.0	0.15	2000	2150
2.5	1.5	021098	21	3	100	0.2	2.0	0.2	6.9	1.0	0.15	2000	1650
3.0	2.0	021099	21	3	100	0.5	2.0	0.3	6.9	1.0	0.15	2000	1150
3.5	2.0	021099	21	3	100	0.5	2.0	0.5	6.9	1.0	0.15	2000	1000
4.0	2.0	021099	21	3	100	1.0	2.0	1.0	6.9	1.0	0.15	2000	625

* Oxygen assist gas

HFL020 (2.0 kW) Copper* cut chart - English

Thickness		Nozzle			Pierce Parameters				Cut Parameters					
Decimal (in)	Gauge and Fraction	Size and Type (mm)	Part Number	Extension (mm)	Height (in)	Duty Cycle (%)	Time (sec)	Pressure (psig)	Creep Time (sec)	Pressure (psig)	Height (in)	Kerf (in)	Power (W)	Feedrate (ipm)
0.018	26 GA	1.5	021098	21	0.12	100	0.2	30	0.2	100	0.04	0.008	2000	800
0.036	20 GA	1.5	021098	21	0.12	100	0.2	30	0.2	100	0.04	0.008	2000	400
0.048	18 GA	1.5	021098	21	0.12	100	0.2	30	0.2	100	0.04	0.008	2000	300
0.060	16 GA	1.5	021098	21	0.12	100	0.2	30	0.2	100	0.04	0.008	2000	175
0.075	14 GA	1.5	021098	21	0.12	100	0.2	30	0.2	100	0.04	0.008	2000	85
0.105	12 GA	1.5	021098	21	0.12	100	0.2	30	0.2	100	0.04	0.008	2000	65
0.125	1/8 in	2.0	021099	21	0.12	100	0.5	30	0.3	100	0.04	0.008	2000	45
0.135	10 GA	2.0	021099	21	0.12	100	0.5	30	0.5	100	0.04	0.008	2000	40
0.164	8 GA	2.0	021099	21	0.12	100	1.0	30	1.0	100	0.04	0.008	2000	25

* Oxygen assist gas

HFL030 (3.0 kW) Mild Steel* cut chart - Metric

Thickness	Nozzle			Pierce Parameters				Cut Parameters					
mm	Size and Type (mm)	Part Number	Extension (mm)	Height (mm)	Duty Cycle (%)	Time (sec)	Pressure (bar)	Creep Time (sec)	Pressure (bar)	Height (mm)	Kerf (mm)	Power (W)	Feedrate (mmpm)
Marking all thicknesses								0.0	1	3	0	150	3810
0.5	1.0	021096	22	1.5	100	0.1	2.00	0.1	5	1	0.2	1000	11400
1.0	1.0	021096	22	1.5	100	0.1	2.00	0.1	5	1	0.2	1000	8800
1.5	1.0	021096	22	1.5	100	0.2	2.00	0.1	5	1	0.2	1000	7000
2.0	1.0	021096	23	1.5	100	0.2	2.00	0.1	5	1	0.2	1000	4445
2.5	1.0	021096	24	3.0	100	0.2	0.55	0.2	0.65	1	0.35	3000	4600
3.0	1.0	021096	24	3.0	100	0.5	0.55	0.2	0.65	1	0.35	3000	4200
3.5	1.0	021096	24.5	3.0	100	0.5	0.55	0.2	0.65	1	0.35	3000	3800
4.0	D1.2	021102	24	3.0	100	0.5	0.55	0.2	0.65	1	0.35	3000	3500
5.0	D1.2	021102	24	3.0	100	0.5	0.55	0.2	0.65	1	0.35	3000	3100
6.0	D1.2	021102	24	4.0	80	1.0	0.50	0.2	0.65	1	0.35	3000	2700
8.0	D1.5	021103	24	4.0	80	1.0	0.50	0.3	0.55	1	0.35	3000	1750
9.0	D1.5	021103	24	4.0	80	1.0	0.50	0.3	0.55	1	0.35	3000	1600
10.0	D2.0	021104	24	4.0	75	1.0	0.50	0.5	0.55	1	0.35	3000	1450
11.0	D2.0	021104	24	4.0	75	2.0	0.50	0.5	0.55	1	0.35	3000	1200
12.0	D2.5	021106	24.5	5.0	75	2.0	0.50	0.5	0.55	1	0.35	3000	1150
14.0	D2.5	021106	24.5	See Staged Piercing Table				1.0	0.55	1	0.35	3000	870
15.0	D2.5	021106	24.5					1.0	0.55	1	0.35	3000	800
16.0	D2.5	021106	24.5					1.0	0.55	1	0.35	3000	750
20.0	D2.5	021106	24.5					1.0	0.55	1	0.35	3000	600

D = Dual flow nozzle
* Oxygen assist gas

Thickness (mm)	Stage	Staged Pierce Parameters				
		Time (sec)	Height (mm)	Duty Cycle (%)	Frequency (Hz)	Pressure (bar)
14	1	2	5	60	500	0.5
	2	1	4	70	500	
	3	0	4	0	0	
15	1	2	5	60	500	0.5
	2	2	4	70	500	
	3	0	4	0	0	

Thickness (mm)	Stage	Staged Pierce Parameters				
		Time (sec)	Height (mm)	Duty Cycle (%)	Frequency (Hz)	Pressure (bar)
16	1	2	5	60	500	0.5
	2	2	5	70	500	
	3	1	4	80	500	
20	1	4	5	60	500	0.5
	2	4	5	70	500	
	3	2	4	80	500	

HFL030 (3.0 kW) Mild Steel* cut chart - English

Thickness		Nozzle			Pierce Parameters				Cut Parameters					
Decimal (in)	Gauge and Fraction	Size and Type (mm)	Part Number	Extension (mm)	Height (in)	Duty Cycle (%)	Time (sec)	Pressure (psig)	Creep Time (sec)	Pressure (psig)	Height (in)	Kerf (in)	Power (W)	Feedrate (ipm)
Marking all thicknesses									0.0	15	0.12	0	150	150
0.018	26 GA	1.0	021096	22	0.06	100	0.1	30	0.1	75	0.04	0.008	1000	450
0.036	20 GA	1.0	021096	22	0.06	100	0.1	30	0.1	75	0.04	0.008	1000	375
0.048	18 GA	1.0	021096	22	0.06	100	0.1	30	0.1	75	0.04	0.008	1000	325
0.060	16 GA	1.0	021096	22	0.06	100	0.1	30	0.1	75	0.04	0.008	1000	275
0.075	14 GA	1.0	021096	23	0.06	100	0.2	30	0.1	75	0.04	0.008	1000	175
0.105	12 GA	1.0	021096	24	0.08	100	0.2	8	0.2	10	0.04	0.014	3000	180
0.125	1/8 in	1.0	021096	24	0.12	100	0.3	8	0.2	10	0.04	0.014	3000	160
0.135	10 GA	1.0	021096	24.5	0.12	100	0.5	8	0.2	10	0.04	0.014	3000	150
0.164	8 GA	D1.2	021102	24	0.12	100	0.5	8	0.2	10	0.04	0.014	3000	135
0.188	3/16 in	D1.2	021102	24	0.12	100	0.5	8	0.2	10	0.04	0.014	3000	125
0.250	1/4 in	D1.2	021102	24	0.16	80	1.0	7	0.2	10	0.04	0.014	3000	100
0.313	5/16 in	D1.5	021103	24	0.16	80	1.0	7	0.3	8	0.04	0.014	3000	70
0.375	3/8 in	D1.5	021103	24	0.20	75	1.0	7	0.5	8	0.04	0.014	3000	60
0.438	7/16 in	D2.0	021104	24	0.20	75	2.0	7	0.5	8	0.04	0.014	3000	48
0.500	1/2 in	D2.5	021106	24	See Staged Piercing Table				0.5	8	0.04	0.014	3000	44
0.563	9/16 in	D2.5	021106	24.5					1.0	8	0.04	0.014	3000	34
0.625	5/8 in	D2.5	021106	24.5					1.0	8	0.04	0.014	3000	30
0.750	3/4 in	D2.5	021106	24.5					1.0	8	0.04	0.014	3000	26

D = Dual flow nozzle
* Oxygen assist gas

Thickness (in)	Stage	Staged Pierce Parameters				
		Time (sec)	Height (in)	Duty Cycle (%)	Frequency (Hz)	Pressure (psig)
1/2	1	1	0.20	60	500	7
	2	1	0.16	70	500	
	3	0	0.16	0	0	
9/16	1	2	0.20	60	500	7
	2	1	0.16	70	500	
	3	0	0.16	0	0	

Thickness (mm)	Stage	Staged Pierce Parameters				
		Time (sec)	Height (in)	Duty Cycle (%)	Frequency (Hz)	Pressure (psig)
5/8	1	2	0.20	60	500	7
	2	2	0.20	70	500	
	3	1	0.16	80	500	
3/4	1	4	0.20	60	500	7
	2	4	0.20	70	500	
	3	2	0.16	80	500	

HFL030 (3.0 kW) Stainless Steel* cut chart - Metric

Thickness	Nozzle			Pierce Parameters				Cut Parameters					
mm	Size and Type (mm)	Part Number	Extension (mm)	Height (mm)	Duty Cycle (%)	Time (sec)	Pressure (bar)	Creep Time (sec)	Pressure (bar)	Height (mm)	Kerf (mm)	Power (W)	Feedrate (mmpm)
Marking all thicknesses								0.0	1	3.0	0	150	12500
0.5	1.5	021098	22	1.5	100	0.2	3	0.1	12	0.5	0.2	3000	17750
1.0	1.5	021098	22	1.5	100	0.2	3	0.1	12	0.5	0.2	3000	15000
1.5	1.5	021098	22	1.5	100	0.2	3	0.1	13.6	0.5	0.2	3000	11000
2.0	1.5	021098	22	1.5	100	0.2	3	0.2	13.6	0.5	0.2	3000	9000
2.5	2.0	021099	20	2.0	100	0.5	3	0.3	13.6	0.5	0.2	3000	6750
3.0	2.0	021099	20	2.0	100	0.5	3	0.3	15.3	0.5	0.2	3000	6250
3.5	2.0	021099	20	2.0	100	0.5	3	0.3	15.3	0.5	0.2	3000	5250
4.0	2.0	021099	20	2.0	100	0.5	3	0.5	15.3	0.5	0.2	3000	4000
5.0	2.5	021100	20	3.0	100	0.5	3	1.0	15.3	0.5	0.2	3000	3000
6.0	2.5	021100	19	3.0	100	1.0	3	1.0	15.3	1.0	0.2	3000	2200
8.0	2.5	021100	18	3.0	100	1.5	3	1.5	17.0	1.0	0.2	3000	1200
9.0	2.5	021100	18	3.0	100	2.0	3	1.5	17.0	1.0	0.2	3000	900
10.0	2.5	021100	18	3.0	100	2.0	3	2.0	17.0	1.0	0.2	3000	800
11.0	2.5	021100	17	5.0	100	2.5	3	2.0	18.7	1.0	0.2	3000	600
12.0	2.5	021100	17	5.0	100	3.0	3	2.0	18.7	1.0	0.2	3000	500

* Nitrogen assist gas

HFL030 (3.0 kW) Stainless Steel* cut chart - English

Thickness		Nozzle			Pierce Parameters				Cut Parameters					
Decimal (in)	Gauge and Fraction	Size and Type (mm)	Part Number	Extension (mm)	Height (in)	Duty Cycle (%)	Time (sec)	Pressure (psig)	Creep Time (sec)	Pressure (psig)	Height (in)	Kerf (in)	Power (W)	Feedrate (ipm)
Marking all thicknesses									0.0	15	0.12	0	150	150
0.018	26 GA	1.5	021098	22	0.06	100	0.1	45	0.1	175	0.02	0.008	3000	700
0.036	20 GA	1.5	021098	22	0.06	100	0.1	45	0.1	175	0.02	0.008	3000	600
0.048	18 GA	1.5	021098	22	0.06	100	0.1	45	0.1	200	0.02	0.008	3000	500
0.060	16 GA	1.5	021098	22	0.06	100	0.2	45	0.1	200	0.02	0.008	3000	430
0.075	14 GA	1.5	021098	22	0.06	100	0.2	45	0.2	200	0.02	0.008	3000	360
0.105	12 GA	2.0	021099	20	0.08	100	0.5	45	0.3	200	0.02	0.008	3000	260
0.125	1/8 in	2.0	021099	20	0.08	100	0.5	45	0.3	225	0.02	0.008	3000	235
0.135	10 GA	2.0	021099	20	0.08	100	0.5	45	0.3	225	0.02	0.008	3000	210
0.164	8 GA	2.0	021099	20	0.12	100	0.5	45	0.5	225	0.02	0.008	3000	150
0.188	3/16 in	2.0	021099	20	0.12	100	0.5	45	1.0	225	0.04	0.008	3000	120
0.250	1/4 in	2.5	021100	19	0.12	100	1.0	45	1.0	225	0.04	0.008	3000	75
0.313	5/16 in	2.5	021100	18	0.12	100	1.5	45	1.5	250	0.04	0.008	3000	48
0.375	3/8 in	2.5	021100	18	0.12	100	2.0	45	2.0	250	0.04	0.008	3000	35
0.438	7/16 in	2.5	021100	17	0.20	100	2.5	45	2.0	275	0.04	0.008	3000	24
0.500	1/2 in	2.5	021100	17	0.20	100	3.0	45	2.0	275	0.04	0.008	3000	20

* Nitrogen assist gas

HFL030 (3.0 kW) Aluminum* cut chart - Metric

Thickness	Nozzle			Pierce Parameters				Cut Parameters					
mm	Size and Type (mm)	Part Number	Extension (mm)	Height (mm)	Duty Cycle (%)	Time (sec)	Pressure (bar)	Creep Time (sec)	Pressure (bar)	Height (mm)	Kerf (mm)	Power (W)	Feedrate (mmpm)
Marking all thicknesses								0.0	1	3.0	0	350	4000
0.5	1.5	021098	21	3.0	100	0.1	3	0.2	13.6	0.5	0.2	3000	25400
1.0	1.5	021098	21	3.0	100	0.1	3	0.2	13.6	0.5	0.2	3000	25400
1.5	1.5	021098	21	3.0	100	0.1	3	0.2	13.6	0.5	0.2	3000	14000
2.0	2.0	021099	21	3.0	100	0.1	3	0.2	13.6	0.5	0.2	3000	10800
2.5	2.0	021099	20	3.0	100	0.1	3	0.2	13.6	0.5	0.2	3000	9500
3.0	2.0	021099	20	3.0	100	0.1	3	0.2	13.6	0.5	0.2	3000	7500
3.5	2.0	021099	20	3.0	100	0.2	3	0.3	15.3	0.5	0.2	3000	6250
4.0	2.0	021099	20	3.0	100	0.2	3	0.5	17.0	0.5	0.2	3000	5250
5.0	2.0	021099	20	3.0	100	0.2	3	0.5	17.0	0.5	0.2	3000	3250
6.0	2.5	021100	19	3.0	100	1.0	3	2.0	17.0	1.0	0.2	3000	2000
8.0	2.5	021100	19	3.0	100	2.0	3	2.0	17.0	1.0	0.2	3000	1250
9.0	2.5	021100	19	3.0	100	2.0	3	2.0	17.0	1.0	0.2	3000	750
10.0	2.5	021100	19	3.0	100	3.0	3	2.0	17.0	1.0	0.2	3000	550

* Nitrogen assist gas

HFL030 (3.0 kW) Aluminum* cut chart - English

Thickness		Nozzle			Pierce Parameters				Cut Parameters					
Decimal (in)	Gauge and Fraction	Size and Type (mm)	Part Number	Extension (mm)	Height (in)	Duty Cycle (%)	Time (sec)	Pressure (psig)	Creep Time (sec)	Pressure (psig)	Height (in)	Kerf (in)	Power (W)	Feedrate (ipm)
Marking all thicknesses									0.0	15	0.12	0	350	160
0.018	26 GA	1.5	021098	21	0.12	100	0.1	45	0.2	200	0.02	0.008	3000	1000
0.036	20 GA	1.5	021098	21	0.12	100	0.1	45	0.2	200	0.02	0.008	3000	1000
0.048	18 GA	1.5	021098	21	0.12	100	0.1	45	0.2	200	0.02	0.008	3000	700
0.060	16 GA	1.5	021098	21	0.12	100	0.1	45	0.2	200	0.02	0.008	3000	550
0.075	14 GA	2.0	021099	21	0.12	100	0.1	45	0.2	200	0.02	0.008	3000	425
0.105	12 GA	2.0	021099	20	0.12	100	0.1	45	0.2	200	0.02	0.008	3000	350
0.125	1/8 in	2.0	021099	20	0.12	100	0.1	45	0.2	200	0.02	0.008	3000	275
0.135	10 GA	2.0	021099	20	0.12	100	0.2	45	0.3	225	0.02	0.008	3000	250
0.164	8 GA	2.0	021099	20	0.12	100	0.2	45	0.5	250	0.02	0.008	3000	200
0.188	3/16 in	2.0	021099	20	0.12	100	0.2	45	0.5	250	0.02	0.008	3000	130
0.250	1/4 in	2.5	021100	19	0.20	100	1.0	45	2.0	250	0.04	0.008	3000	75
0.313	5/16 in	2.5	021100	19	0.20	100	2.0	45	2.0	250	0.04	0.008	3000	50
0.375	3/8 in	2.5	021100	19	0.20	100	3.0	45	2.0	250	0.04	0.008	3000	25

* Nitrogen assist gas

HFL030 (3.0 kW) Brass* cut chart - Metric

Thickness	Nozzle			Pierce Parameters				Cut Parameters					
mm	Size and Type (mm)	Part Number	Extension (mm)	Height (mm)	Duty Cycle (%)	Time (sec)	Pressure (bar)	Creep Time (sec)	Pressure (bar)	Height (mm)	Kerf (mm)	Power (W)	Feedrate (mmpm)
0.5	1.5	021098	21	3	100	0.1	3.0	0.2	13.6	0.5	0.15	3000	17750
1.0	1.5	021098	21	3	100	0.1	3.0	0.2	13.6	0.5	0.15	3000	11000
1.5	1.5	021098	21	3	100	0.1	3.0	0.2	13.6	0.5	0.15	3000	7500
2.0	1.5	021098	21	3	100	0.2	3.0	0.2	13.6	0.5	0.15	3000	5700
2.5	2.0	021099	21	3	100	0.3	3.0	0.3	13.6	0.5	0.15	3000	3500
3.0	2.0	021099	21	3	100	0.5	3.0	0.5	13.6	0.5	0.15	3000	3000
3.5	2.0	021099	21	3	100	0.5	3.0	0.5	13.6	0.5	0.15	3000	2250
4.0	2.0	021099	21	3	100	0.5	3.0	1.0	13.6	0.5	0.15	3000	1800
5.0	2.0	021099	21	3	100	0.5	3.0	1.0	13.6	0.5	0.15	3000	1400
6.0	2.5	021100	21	3	100	0.5	3.0	1.0	13.6	0.5	0.15	3000	950

* Nitrogen assist gas

HFL030 (3.0 kW) Brass* cut chart - English

Thickness		Nozzle			Pierce Parameters				Cut Parameters					
Decimal (in)	Gauge and Fraction	Size and Type (mm)	Part Number	Extension (mm)	Height (in)	Duty Cycle (%)	Time (sec)	Pressure (psig)	Creep Time (sec)	Pressure (psig)	Height (in)	Kerf (in)	Power (W)	Feedrate (ipm)
0.018	26 GA	1.5	021098	21	0.12	100	0.1	45	0.2	200	0.02	0.008	3000	700
0.036	20 GA	1.5	021098	21	0.12	100	0.1	45	0.2	200	0.02	0.008	3000	450
0.048	18 GA	1.5	021098	21	0.12	100	0.1	45	0.2	200	0.02	0.008	3000	350
0.060	16 GA	1.5	021098	21	0.12	100	0.1	45	0.2	200	0.02	0.008	3000	300
0.075	14 GA	1.5	021098	21	0.12	100	0.2	45	0.2	200	0.02	0.008	3000	225
0.105	12 GA	2.0	021099	21	0.12	100	0.3	45	0.3	200	0.02	0.008	3000	150
0.125	1/8 in	2.0	021099	21	0.12	100	0.5	45	0.5	200	0.02	0.008	3000	110
0.135	10 GA	2.0	021099	21	0.12	100	0.5	45	0.5	200	0.02	0.008	3000	95
0.164	8 GA	2.0	021099	21	0.12	100	0.5	45	1.0	200	0.02	0.008	3000	70
0.188	3/16 in	2.0	021099	21	0.12	100	0.5	45	1.0	200	0.02	0.008	3000	55
0.250	1/4 in	2.5	021100	21	0.12	100	0.5	45	1	200	0.02	0.008	3000	35

* Nitrogen assist gas

HFL030 (3.0 kW) Copper* cut chart - Metric

Thickness	Nozzle			Pierce Parameters				Cut Parameters					
mm	Size and Type (mm)	Part Number	Extension (mm)	Height (mm)	Duty Cycle (%)	Time (sec)	Pressure (bar)	Creep Time (sec)	Pressure (bar)	Height (mm)	Kerf (mm)	Power (W)	Feedrate (mmpm)
0.5	1.5	021098	21	3	100	0.2	2.0	0.2	6.9	1	0.15	3000	25400
1.0	1.5	021098	21	3	100	0.2	2.0	0.2	6.9	1	0.15	3000	15000
1.5	1.5	021098	21	3	100	0.2	2.0	0.2	6.9	1	0.15	3000	8900
2.0	1.5	021098	21	3	100	0.2	2.0	0.2	6.9	1	0.15	3000	3750
2.5	2.0	021099	21	3	100	0.2	2.0	0.2	6.9	1	0.15	3000	3000
3.0	2.0	021099	21	3	100	0.2	2.0	0.2	6.9	1	0.15	3000	2500
3.5	2.0	021099	21	3	100	0.3	2.0	0.3	6.9	1	0.15	3000	2000
4.0	2.0	021099	20	3	100	0.5	2.0	0.5	6.9	1	0.15	3000	1500
5.0	2.0	021099	19	3	100	1.0	2.0	1.0	6.9	1	0.15	3000	1000
6.0	2.5	021100	19	3	100	2.0	2.0	2.0	6.9	1	0.15	3000	600

* Oxygen assist gas

HFL030 (3.0 kW) Copper* cut chart - English

Thickness		Nozzle			Pierce Parameters				Cut Parameters					
Decimal (in)	Gauge and Fraction	Size and Type (mm)	Part Number	Extension (mm)	Height (in)	Duty Cycle (%)	Time (sec)	Pressure (psig)	Creep Time (sec)	Pressure (psig)	Height (in)	Kerf (in)	Power (W)	Feedrate (ipm)
0.018	26 GA	1.5	021098	21	0.12	100	0.2	30	0.2	100	0.04	0.008	3000	1000
0.036	20 GA	1.5	021098	21	0.12	100	0.2	30	0.2	100	0.04	0.008	3000	600
0.048	18 GA	1.5	021098	21	0.12	100	0.2	30	0.2	100	0.04	0.008	3000	450
0.060	16 GA	1.5	021098	21	0.12	100	0.2	30	0.2	100	0.04	0.008	3000	350
0.075	14 GA	1.5	021098	21	0.12	100	0.2	30	0.2	100	0.04	0.008	3000	150
0.105	12 GA	2.0	021099	21	0.12	100	0.2	30	0.2	100	0.04	0.008	3000	115
0.125	1/8 in	2.0	021099	21	0.12	100	0.2	30	0.2	100	0.04	0.008	3000	90
0.135	10 GA	2.0	021099	21	0.12	100	0.3	30	0.3	100	0.04	0.008	3000	80
0.164	8 GA	2.0	021099	20	0.12	100	0.5	30	0.5	100	0.04	0.008	3000	55
0.188	3/16 in	2.0	021099	19	0.12	100	1.0	30	1.0	100	0.04	0.008	3000	40
0.250	1/4 in	2.5	021100	19	0.12	100	2.0	30	2.0	100	0.04	0.008	3000	20

* Oxygen assist gas

Firmware upgrade procedure

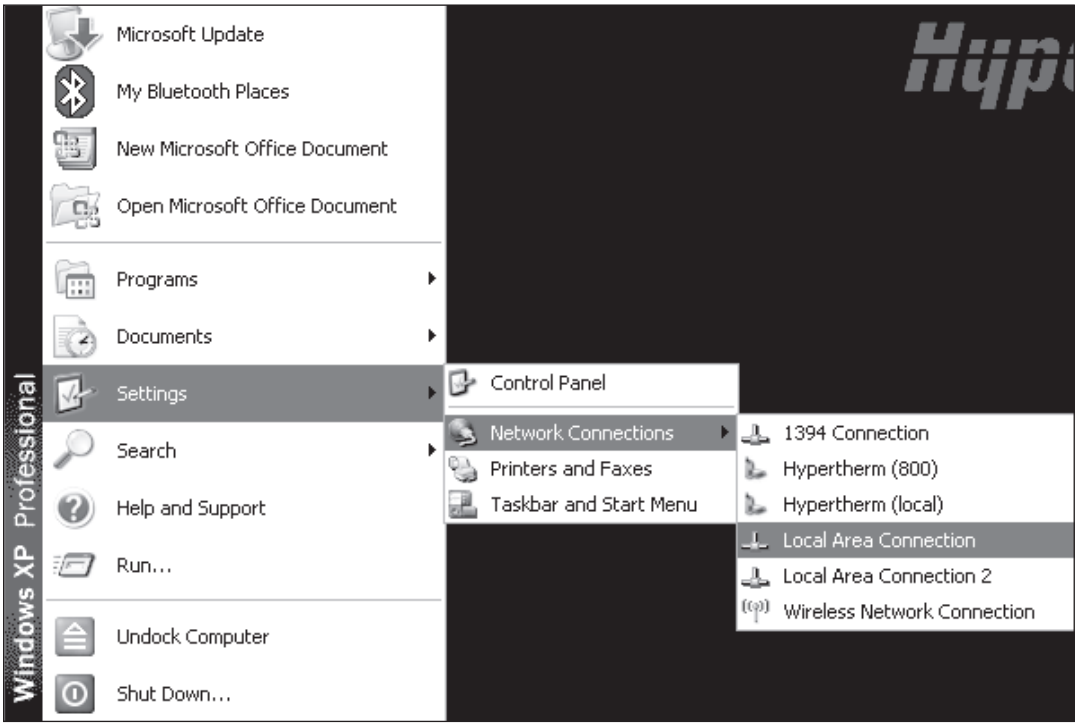
The fiber laser power supply and the laser head controller support field upgrades to their firmware using a standard ethernet connection. The equipment needed to perform a firmware upgrade is a host computer, standard ethernet cable, and Hypertherm flash upgrade programs and associated binary files.

The fiber laser uses a private network with a fixed addressing scheme. The fiber laser power supply should never be connected to other networks. Before the host computer can be used for the upgrade procedure it needs to have a properly configured Ethernet Connection set to an IP address of 10.217.2.1. The following instructions are for a typical Windows XP based computer, the instructions also assume that the user is familiar with configuring local area network settings. For details about setting an IP address on other operating systems please refer to your computer's operating system manual.

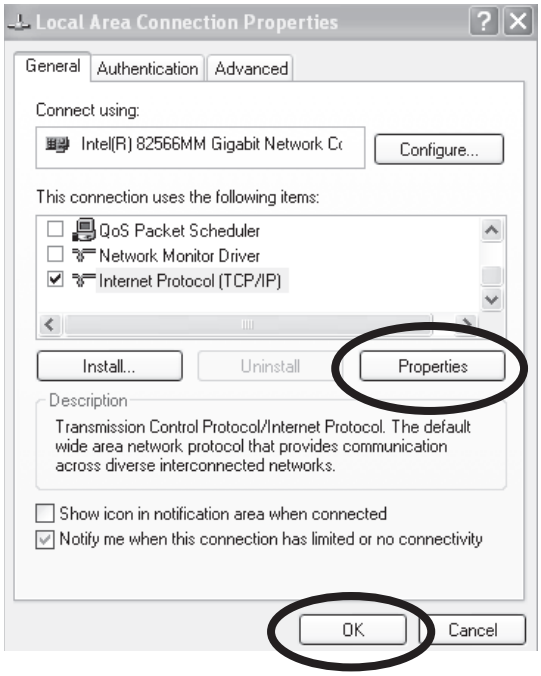
Note: Phoenix software version 9.72.1 and higher now includes the firmware for the laser system. If the firmware for the Laser Power Controller (LPC) or Laser Head Controller (LHC) is older than the version in Phoenix, they will be updated to the new version.

Setting the IP address

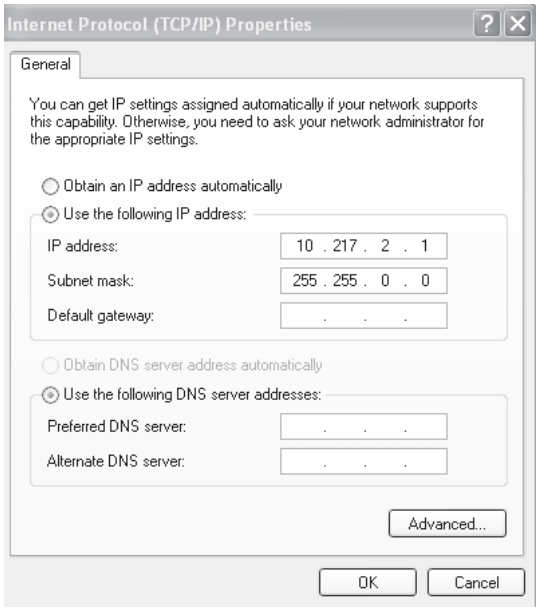
1. From the Start menu select the Settings tab.
2. From the Settings menu select Network Connections.
3. From the Network Connections menu select Local Area Connection.



4. The Local Area Connection window shown below should appear. Click on the Properties button and then the OK button.



5. Set the properties as shown in the window below.



Continue to the next page

Upgrading the firmware

If a Hypertherm CNC is used, the Hypernet cable must be disconnected from the Hypernet port on the fiber laser power supply before the host computer is connected to the fiber laser power supply. See page 2-42 for the location of the Hypernet/Ethernet ports on the fiber laser power supply.

Software settings on the laser head controller should be recorded before a firmware upgrade is performed because the parameters may be reset during the firmware upgrade process.

Note: Do not disconnect the ethernet cable once the update has begun. Do not turn off the laser power supply during a software update!

The current fiber laser power supply firmware is contained in a file named Laser.bin. The update program for the Laser power supply is named LaserUpdate.exe. The current fiber laser head controller firmware is contained in a file named Head.bin. The update program for the laser head controller is named HeadUpdate.exe. The binary files and programming files must be contained within the same folder. It is important to keep bin files organized in different directories based on software version since all the software versions use the same naming convention.

To program controllers use windows explorer to navigate to the desired directory and run the HeadUpdate.exe to update the laser head controller or run LaserUpdate.exe to update the laser power supply controller. When the flash update program is executed, a DOS window appears displaying the current status. The update status should progress from 0% to 100% before the window disappears. The controller will indicate flash update in progress.

If the DOS window pops up and quickly disappears there may be a problem with ethernet connectivity or configuration. Also check that the Hypertherm CNC cable was disconnected from the laser power supply during the update.

After the programming update is complete turn OFF power to the system and turn it back ON again. The laser head should be recalibrated and software setups should be verified.

Section 4

MAINTENANCE

Routine Maintenance

Dehumidifier

The Hypertherm fiber laser is equipped with a dehumidifier to maintain the humidity level of the HFL cabinet. The cabinet is a dust tight enclosure and periodic inspection of the gasket seals should be performed. The dehumidifier has a built-in evaporator to remove accumulated condensation from the unit.

Inspection and cleaning of the collimator

To inspect the collimator optics, you must remove the collimator from the system:

1. Remove power to the fiber laser to prevent accidental beam exposure from the infrared and pointing beams.
2. Remove power to the table to prevent accidental motion while near the gantry components.
3. Remove the cooling hoses from the beam delivery optical cable and collimator by unscrewing the retaining caps on the connectors, sliding them back on the hoses, and gently pulling on the hoses.
4. Wipe up any coolant before proceeding to prevent coolant contamination on the optics.
5. Clean the joint between the collimator and the beam delivery optical cable with clean, dry compressed air.
6. Remove the beam delivery optical cable from the collimator by rotating the locking nut on the top end of the collimator.
7. Gently pull the beam delivery optical cable out of the collimator and cover the end of the beam delivery optical cable with the protective cap to reduce contamination of the face of the quartz block.
8. Install the protective cap on the top end of the collimator to protect the collimator optics during removal.
9. Disconnect the proximity switch cable from the side of the cutting head (small connector) and feed the cable through the mounting bracket.
10. Remove the three M5 socket head cap screws that hold the collimator adapter flange to the mounting bracket and remove the collimator/flange assembly.

Inspect and clean the collimator:

1. Use a flashlight or other light source to illuminate the front surface of the collimator to check the surface condition of the optics.
2. Look through the collimator from the front and back with a diffuse light source behind the collimator to inspect internal surfaces.
3. If cleaning is necessary, contact technical support for instructions or to return the collimator for service.
4. After inspecting the collimator, place the protective cap over the collimator top surface to keep it clean while you reinstall it.

Reinstall the collimator:

See page 2-30 in the *Installation* section of this manual for instructions on how to properly install the collimator.

Caution: **If the instructions for collimator installation are not followed damage to the collimator or other optics in the laser head could occur.**

Cleaning the quartz block

The quartz block should always be cleaned before the beam delivery optical cable is installed.

The inspection and cleaning of the surface should be performed by a skilled operator.

Cleaning supply requirements:

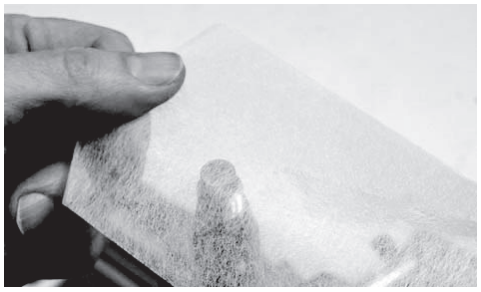
Canned, compressed air..... Designed for cleaning optics or electronics
Isopropyl alcohol, reagent grade..... 99% pure
Methanol ..... 99.8% pure
Denatured ethyl alcohol..... 99% pure
Acetone..... 99% pure

1. Remove the protective cap.

2. Carefully remove the protection tube.

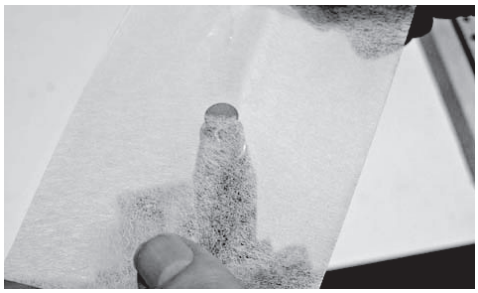
3. Use soft lens cleaning paper and isopropal alcohol for best results. Lens tissue is avaiable from Hypertherm (127306).

4. Put the lens paper on top of the quartz block.



5. Drip one drop of Isopropyl alcohol on the paper at the position of the quartz block.

6. Move the paper laterally until the quartz block is dry.
7. Verify visually that the quartz block is clean. Use a good light and look at the surface with a slight angle to improve visibility. There must be no dust, other particles, or traces of isopropal alcohol.8.



8. Carefully replace the protection tube.
9. Install the beam delivery optical cable.

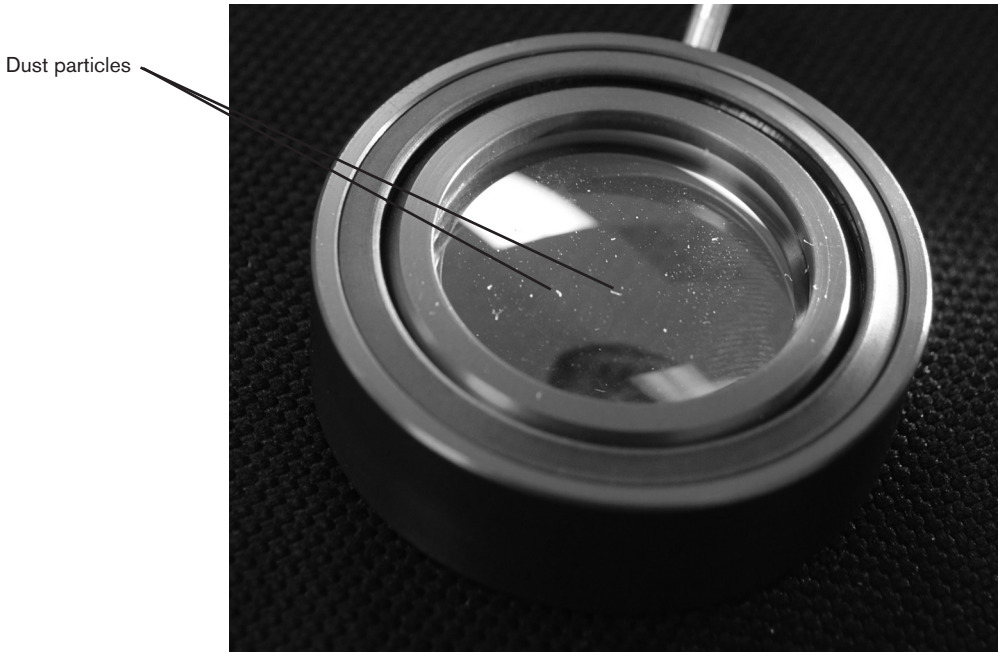
Nozzle inspection

- Inspect the nozzle orifice for damage.
- Inspect for spatter on the nozzle.
- Replace the nozzle if it is damaged.

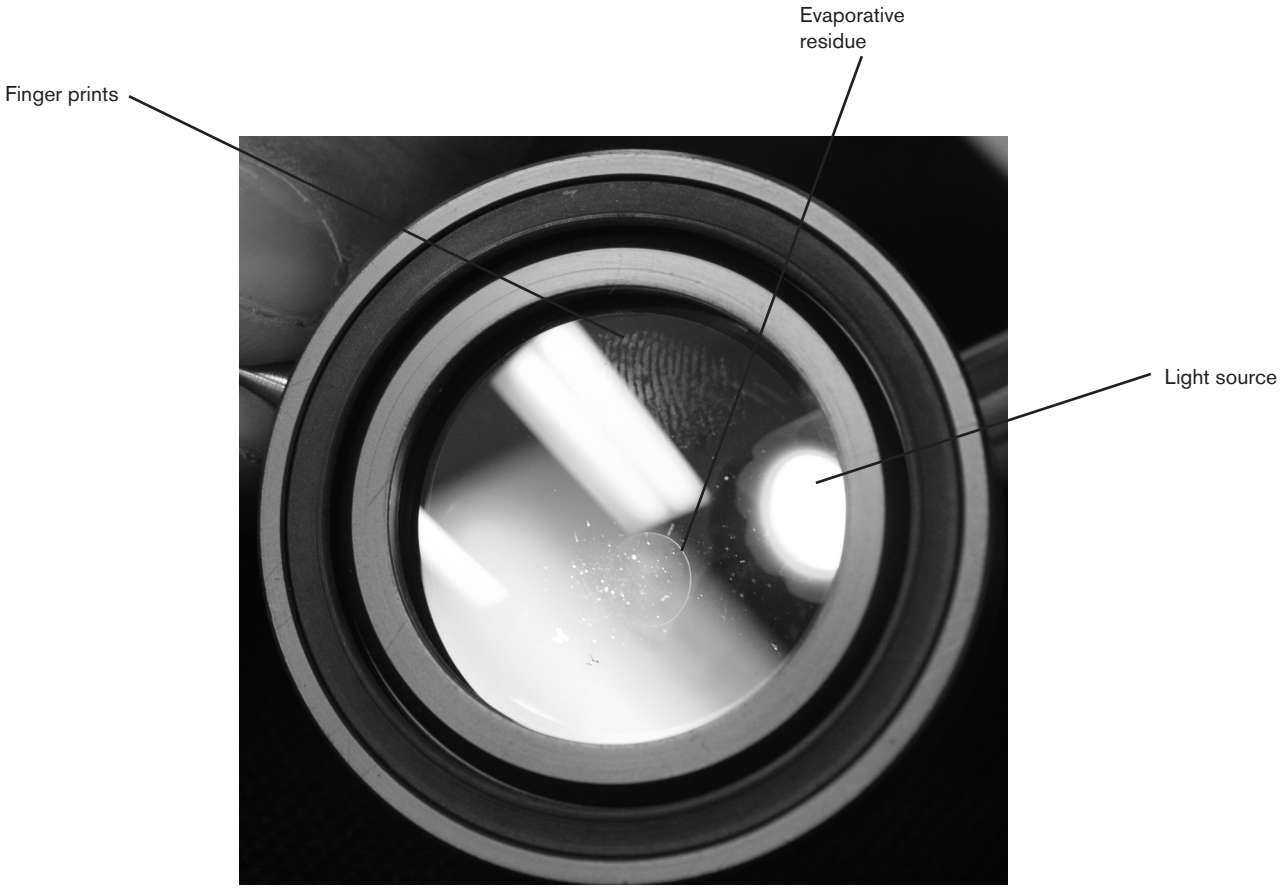
Lens inspection

Always use gloves (non-powdered) when handling a lens. Inspect the lens for scratches and foreign material before each use.

Caution: **Using a lens with ANY dust, debris, or spots can damage the lens.**

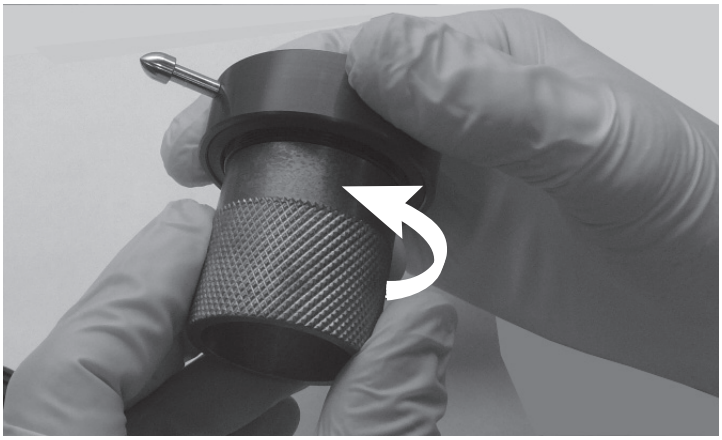


Shine a light source through the back side of the lens to reveal additional contamination. Vary the angle of the light source and the lens surface to look for other contaminants such as evaporative residue from the Isopropyl alcohol or finger prints from improper handling.

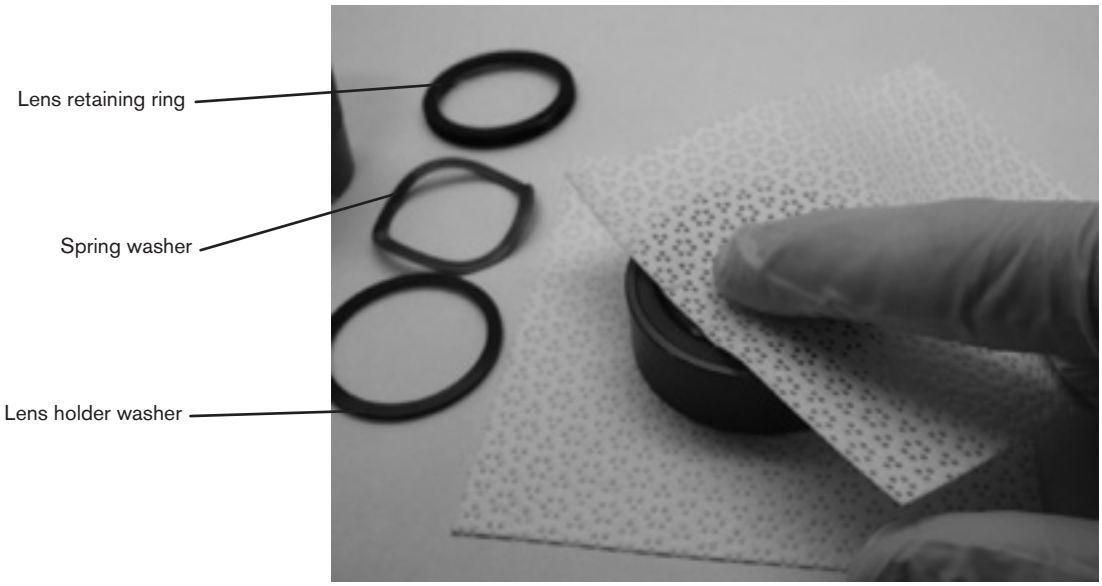


Lens removal

1. With gloves on, use the spanner wrench to unscrew the lens retaining ring.



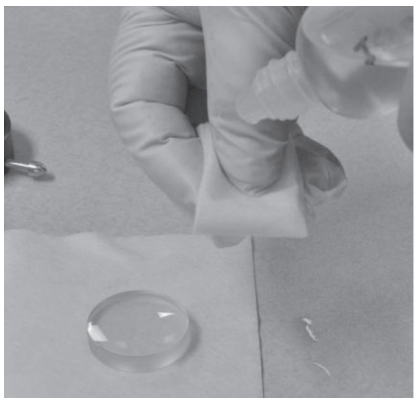
2. Remove the lens retaining ring, the spring washer, the lens window (not shown below), and the lens holder washer from the lens holder and gently push the lens out of the holder onto a clean lens wipe. Never touch the lens surface with bare skin.

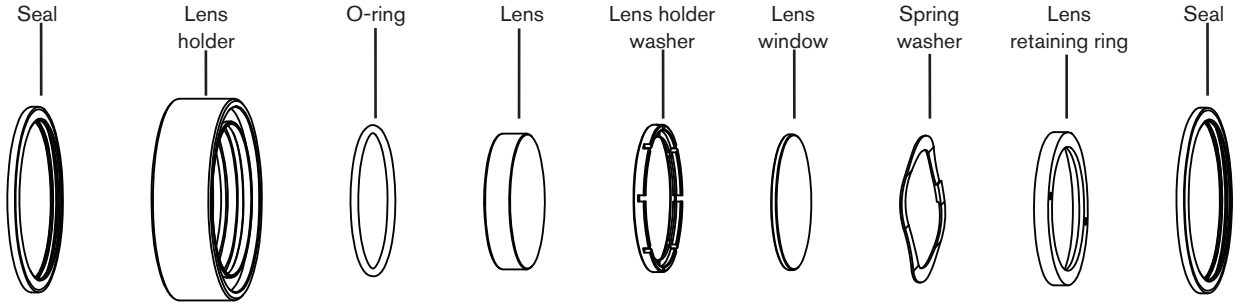


Lens cleaning

Notes: Always wear gloves and only handle the lens by the edges.
Isopropyl alcohol, REAGENT GRADE, is the only recommended cleaning solvent. Gently clean both sides of the lens with clean, canned air to remove loose dust and debris.

1. Clean both sides of the lens, using a new lens wipe for each pass. Apply a few drops of Isopropyl alcohol to the edge of the lens wipe and slowly pull it across the surface with gentle pressure. Discard the wipe after one use.

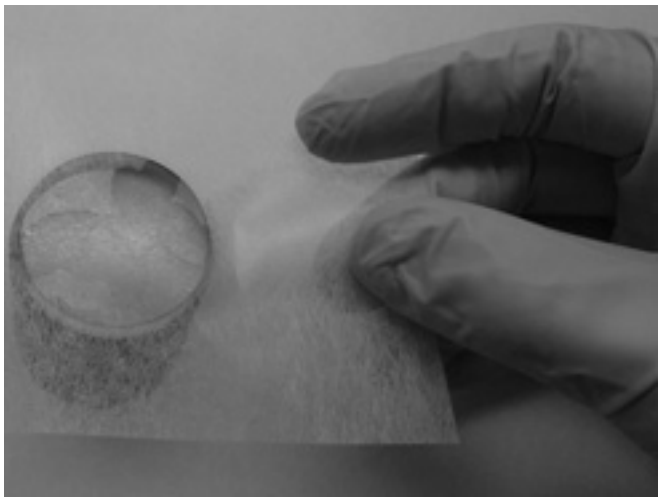




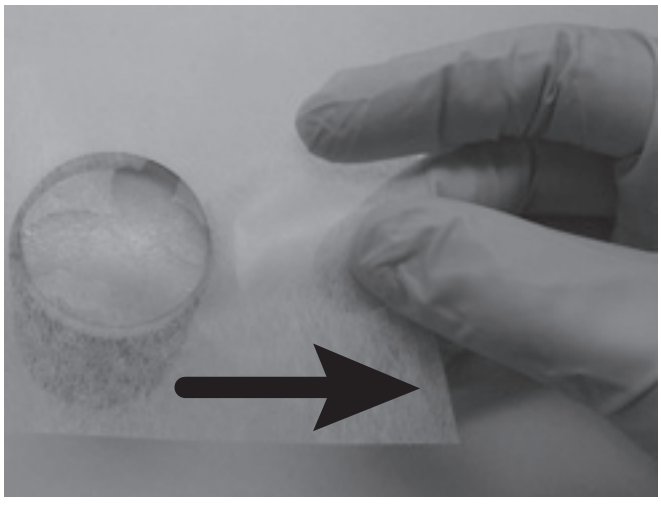
Drop and drag cleaning method

This method of cleaning prevents excessive pressure from being applied to the lens surface, which can cause foreign objects to scratch the lens. This cleaning method works best on the flat side of the lens.

2. Put a piece of lens tissue on the flat surface of the lens and put three or four drops of the Isopropyl alcohol on the lens tissue.

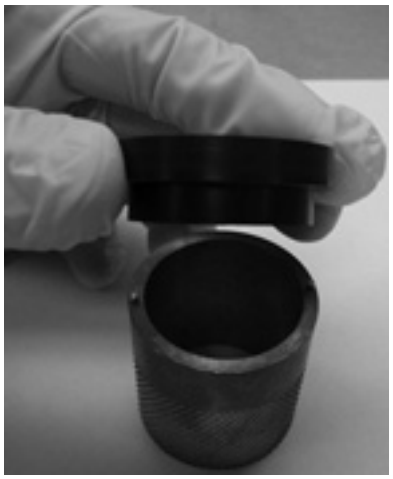


3. Slowly drag the tissue over the lens allowing the Isopropyl alcohol to evaporate as the tissue is pulled across the surface. Inspect the lens for contamination as described earlier and repeat this step if necessary.

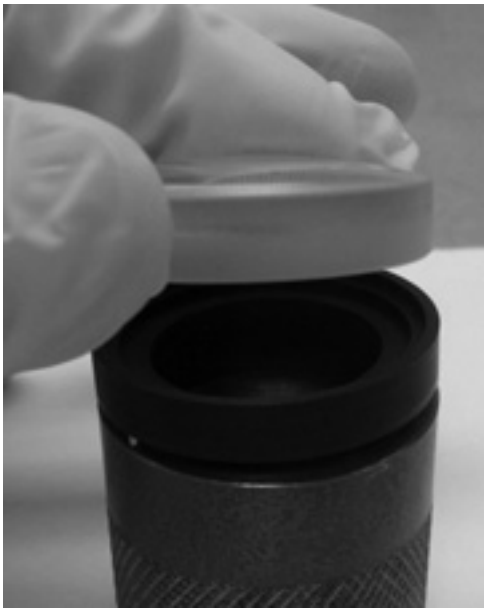


Lens installation

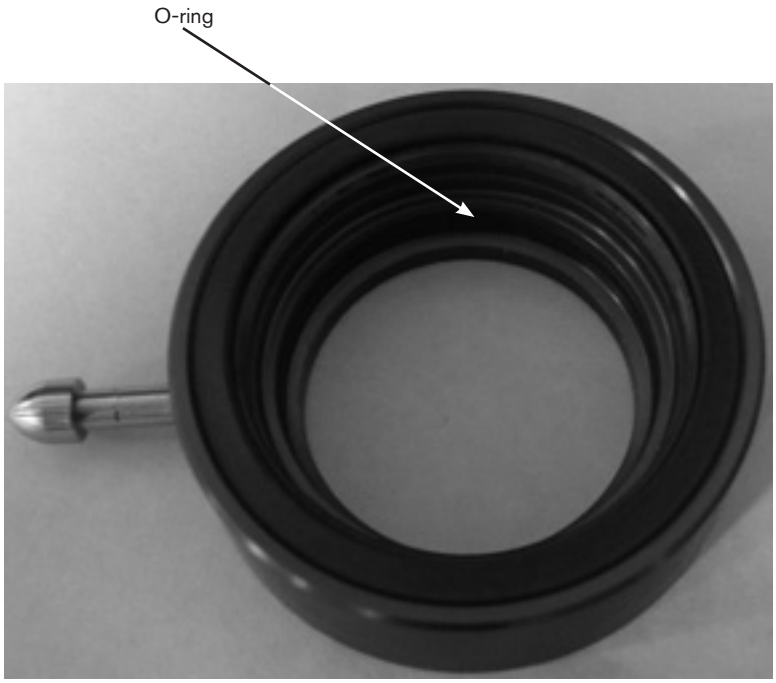
1. Put the lens-holder adaptor onto the top of the spanner wrench and align it over the pins.



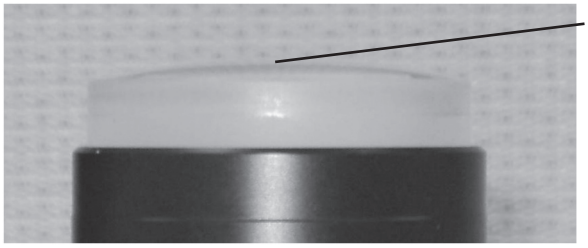
2. Inspect the lens for cleanliness again using the methods described earlier in this section. If the lens is clean, put it into the lens-holder adaptor.

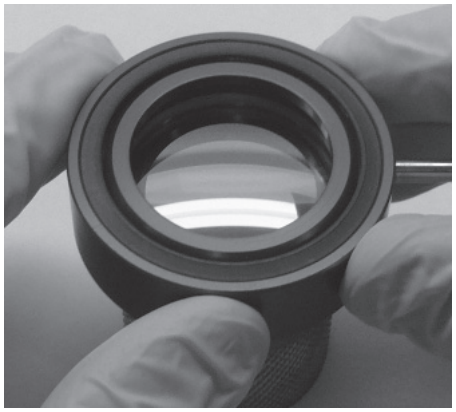


3. Verify that the o-ring is properly seated in the lens holder.

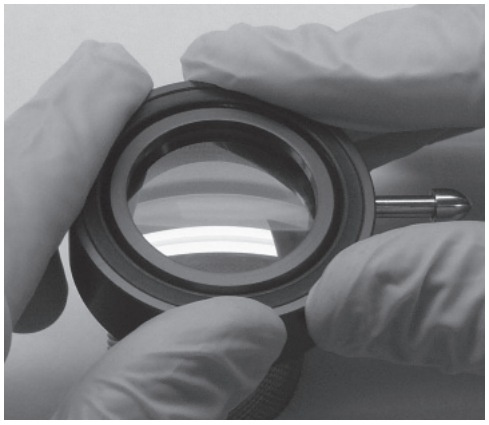


4. Verify that the curved surface of the lens is facing up.



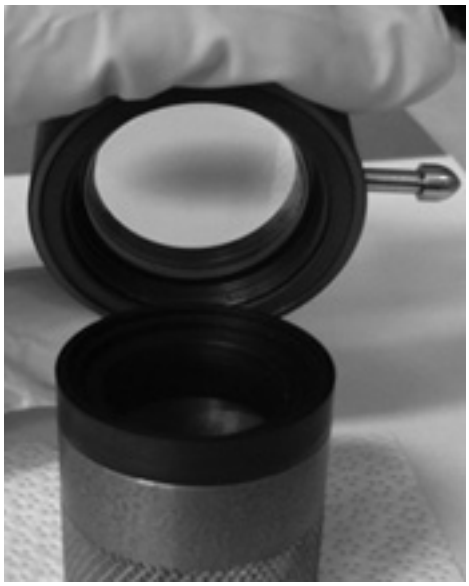


Place the lens holder over the lens

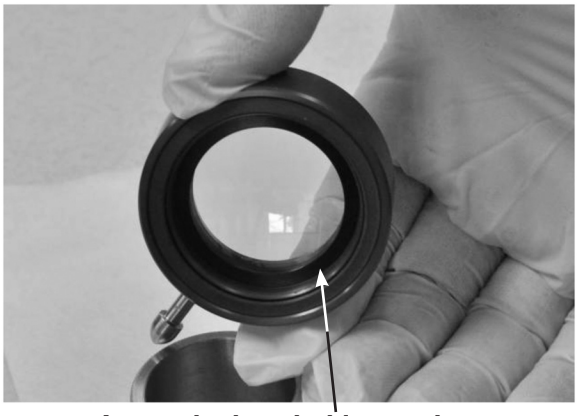


Gently press down to insert the lens into the lens holder

5. Remove the lens and the lens holder from the lens-holder adaptor, and insert the lens holder washer into the lens holder on the bottom (flat) surface of the lens. The side of the washer with the counter bore should be facing the lens surface.



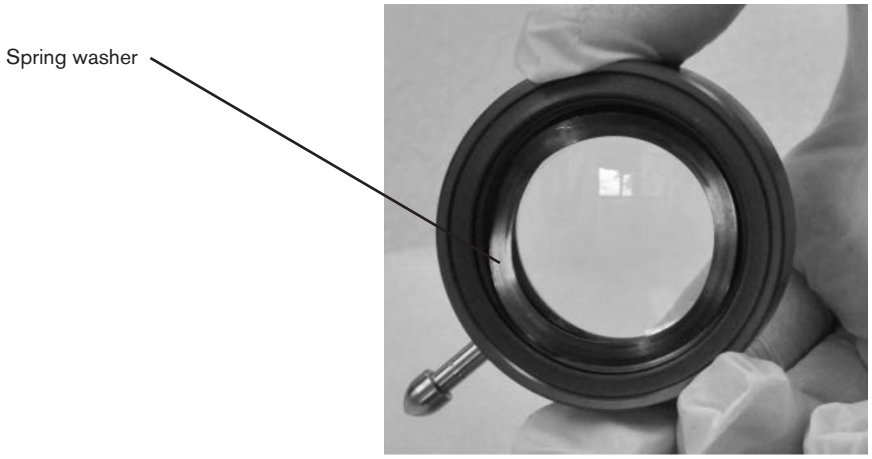
Remove the lens and the lens holder



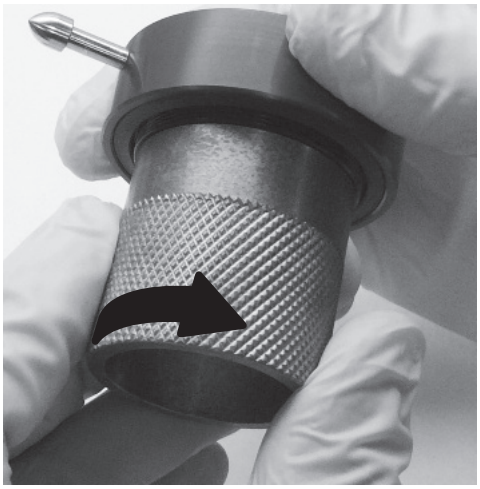
Insert the lens holder washer

6. Install the lens window, not shown, into the lens holder.

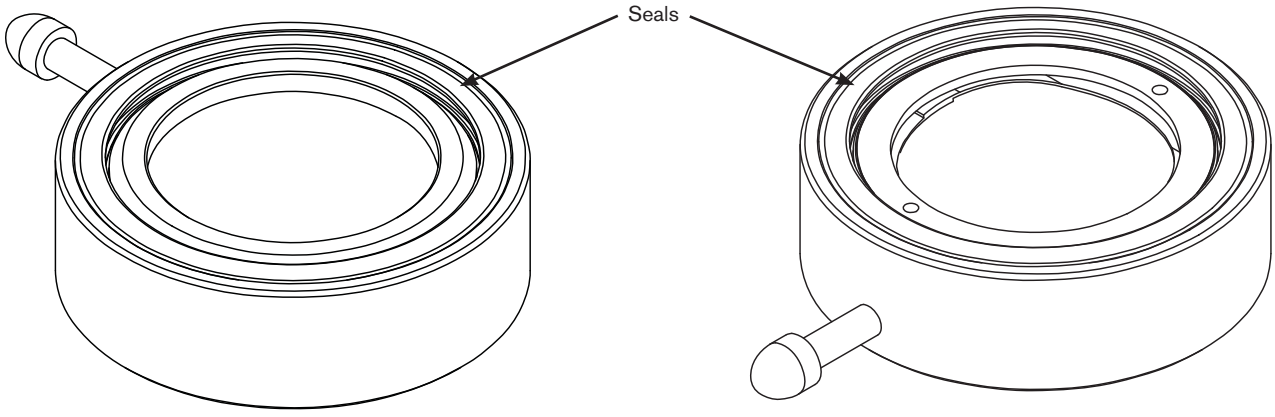
7. Install the spring washer into the lens holder.



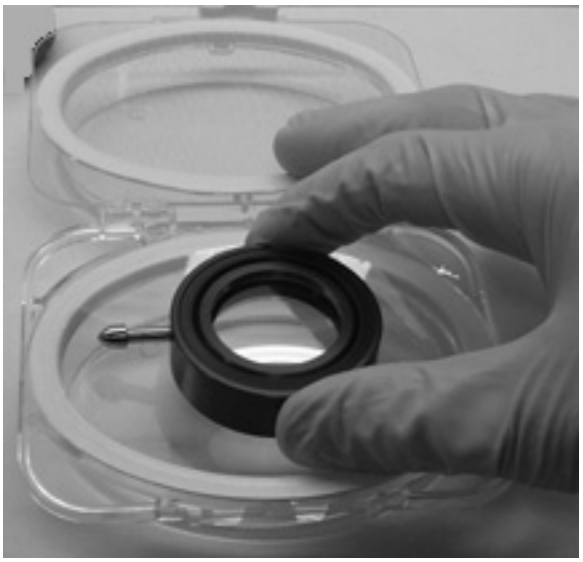
8. With the spring washer side of the lens holder facing upward, put the lens holder on a flat surface with a lens tissue beneath it.
9. Carefully start to screw the lens retaining ring into the lens holder using the spanner wrench. Be careful to avoid crossing the threads. DO NOT tighten the lens retaining ring at this time.
10. Once the lens retaining ring threads start to catch, turn the lens holder and spanner wrench over so the lens holder is on top of the spanner wrench (see figure below). This will prevent dust and debris from the threads from falling on the lens as the lens retaining ring is tightened. Tighten until snug.

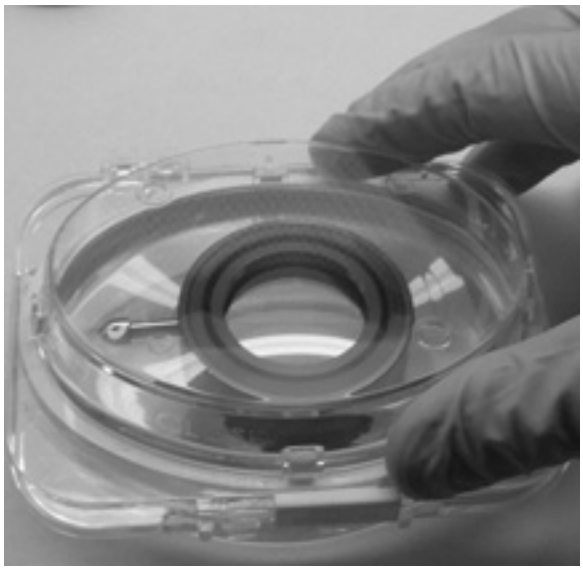


11. Inspect the completed assembly by using the methods described earlier in this section.
12. Verify that the top and bottom seals are properly installed in the lens holder.



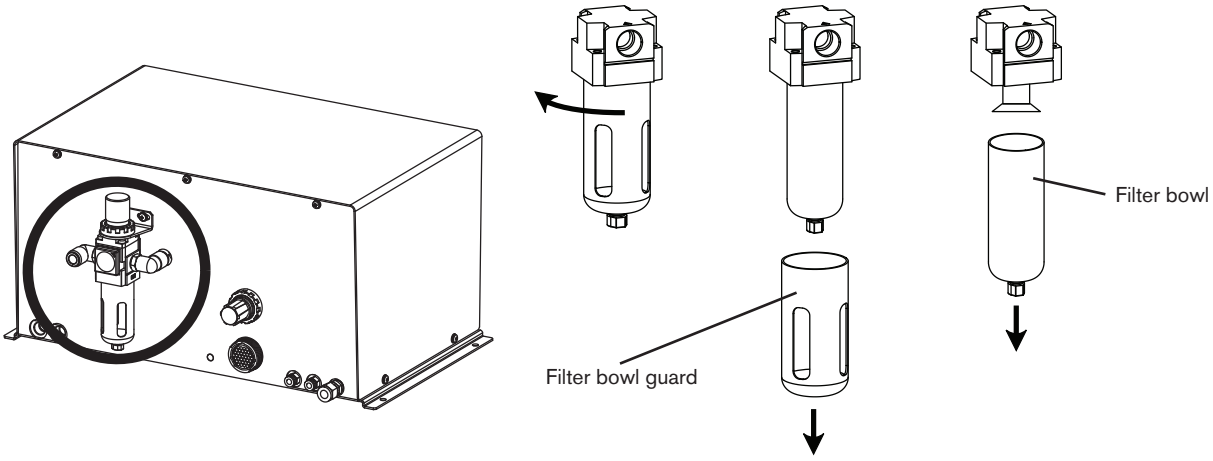
13. Immediately install the clean lens into the laser head, following the installation instructions in section 2, or place the lens assembly in a clean storage box.





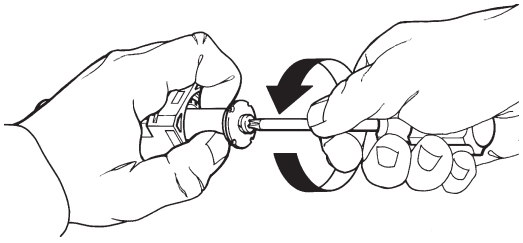
Air filter element replacement

1. Turn OFF all electrical power and disconnect the air hose from the filter.
2. Remove the filter bowl by turning it counter clockwise until it releases.
3. Pull the clear filter housing down firmly to remove it. The filter housing has an o-ring around the top. Apply a thin film of silicone lubricant on the o-ring to extend it's life. The o-ring should look shiny, but there should not be any excess or built-up grease.



4. Use a screwdriver to remove the filter element from the filter housing. Then install the new filter element (011110).

Note: Do not allow the filter element to turn when loosening the screw.



5. Reinstall the clear filter housing and the filter bowl.

LHC error messages

NOTE: module 5 and 6 errors are for the HFL030 only

Status Message	Description
System OK	No active faults
Module 1 ColdPlate Over Temp	Laser module 1 input cold plate exceeds 40° C
Module 1 Output Over Temp	Laser module 1 output cold plate exceeds 40° C
Module 1 Over Current	Laser module 1 over current fault (must cycle power to laser power cabinet to reset)
Module 1 Output Power Error	Laser module 1 power output exceeds 600 watts
Module 2 ColdPlate Over Temp	Laser module 2 input cold plate exceeds 40° C
Module 2 Output Over Temp	Laser module 2 output cold plate exceeds 40° C
Module 2 Over Current	Laser module 2 over current fault (must cycle power to laser power cabinet to reset)
Module 2 Output Power Error	Laser module 2 power output exceeds 600 watts
Module 3 ColdPlate Over Temp	Laser module 3 input cold plate exceeds 40° C
Module 3 Output Over Temp	Laser module 3 output cold plate exceeds 40° C
Module 3 Over Current	Laser module 3 over current fault (must cycle power to laser power cabinet to reset)
Module 3 Output Power Error	Laser module 3 power output exceeds 600 watts
Module 4 ColdPlate Over Temp	Laser module 4 input cold plate exceeds 40° C
Module 4 Output Over Temp	Laser module 4 output cold plate exceeds 40° C
Module 4 Over Current	Laser module 4 over current fault (must cycle power to laser power cabinet to reset)
Module 4 Output Power Error	Laser module 4 power output exceeds 600 watts
Module 5 ColdPlate Over Temp	Laser module 5 input cold plate exceeds 40° C
Module 5 Output Over Temp	Laser module 5 output cold plate exceeds 40° C
Module 5 Over Current	Laser module 5 over current fault (must cycle power to laser power cabinet to reset)
Module 5 Output Power Error	Laser module 5 power output exceeds 600 watts
Module 6 ColdPlate Over Temp	Laser module 6 input cold plate exceeds 40° C
Module 6 Output Over Temp	Laser module 6 output cold plate exceeds 40° C
Module 6 Over Current	Laser module 6 over current fault (must cycle power to laser power cabinet to reset)
Module 6 Output Power Error	Laser module 6 power output exceeds 600 watts
Primary Coolant Flow fault	Input water flow rate below minimum setpoint
Laser Supply Fault	DC power Supply fault due to Low line voltage
Bad Software Setup Parameter	Flash memory error defaults loaded
Process Fiber Coolant Fault	Process fiber flow rate below minimum setpoint
FCU Manifold Coolant Fault	Fiber to fiber coupling unit flow rate below minimum setpoint
Fiber-Fiber Leak Detected	Leak detected inside the fiber to fiber coupling unit
Cabinet Leak Detected	Water leak detected in the laser power controller unit

Status Message	Description
Safety Relay Interlock Fault	Safety relay is off (the safety circuit is in the open state)
Contactor 1 Fault	Safety contactor 1 malfunction
Contactor 2 Fault	Safety contactor 2 malfunction
Interlock Circuit 1 is Open	Front door of laser power control unit is open
Interlock Circuit 2 is Open	Rear door of laser power control unit is open
Delivery Fiber BDO-1 Fault	Fiber BDO interlock circuit malfunction
Delivery Fiber BDO-2 Fault	Fiber BDO interlock circuit malfunction
Fiber Combiner Fault	Combiner optical power sensor limit exceeded
Laser Supply Temperature Fault	Power supply temperature limit exceeded
Laser Supply Current Fault	Power supply current limit exceeded
24VDC Field Supply Fault	Laser controller field supply voltage out of range
Lens Door Open Fault	Laser head lens door is open
Head Collision Fault	Laser head collision
Laser Head Faulted	Laser Head is being calibrated or has an active fault
CNC Protocol Mismatch	Incompatible Pheonix version detected. Must upgrade pheonix to 9.72.2 or higher.
Ethernet Cable Disconnected	The ethernet cable is disconnected from Laser Power Controller inside the laser power supply, or the ethernet switch is not working.
CNC Communications Timeout	CNC communications error
LHC Communications Timeout	Laser head controller communications error
LPC Communications Timeout	Laser power controller communications error
Module 1 Low Power Error	Laser module 1 not producing expected output power. Latches after 3rd occurance. System should not be operated at full power until factory consultation. Permanent Laser damage could result
Module 2 Low Power Error	Laser module 2 not producing expected output power. Latches after 3rd occurance. System should not be operated at full power until factory consultation. Permanent Laser damage could result
Module 3 Low Power Error	Laser module 3 not producing expected output power. Latches after 3rd occurance. System should not be operated at full power until factory consultation. Permanent Laser damage could result
Module 4 Low Power Error	Laser module 4 not producing expected output power. Latches after 3rd occurance. System should not be operated at full power until factory consultation. Permanent Laser damage could result
Module 5 Low Power Error	Laser module 5 not producing expected output power. Latches after 3rd occurance. System should not be operated at full power until factory consultation. Permanent Laser damage could result
Module 6 Low Power Error	Laser module 6 not producing expected output power. Latches after 3rd occurance. System should not be operated at full power until factory consultation. Permanent Laser damage could result

Troubleshooting

Problem	Solution
The TIP TOUCH signal is constantly high	Look for an electrical short between the nozzle and earth ground or the nozzle and the retaining nut. 1. Verify that the insulating washer is installed between the nozzle adapter and the retaining nut. 2. Clean any debris from the nozzle and retaining nut area with a rag and compressed air.
The TIP TOUCH signal does not turn ON when the nozzle touches the workpiece or is touched by hand	Look for a bad connection between the nozzle, the nozzle adapter, and the contact ring. 1. Remove nozzle and nozzle adapter and verify that the tip touch signal is generated when the contact ring is touched. 2. Clean and replace parts as necessary. 3. Contact technical service for assistance.
Nozzle height is not at the correct level while cutting	1. Verify that the nozzle adapter nut is securely tightened. 2. Verify that the insulating washer is installed and is not damaged. 3. Use the diagnostic screen discussed in section 3 of this manual to verify that the analog output voltage on the laser head controller is approximately 1 VDC when the nozzle-to-workpiece distance is 1 mm. Repeat the calibration procedure in the Installation section if necessary.
The distance signal does not change as the distance between the nozzle and the workpiece changes	1. Verify proper connections of all wires and that the correct supply voltages are present. 2. Inspect the nozzle, the insulating washer, and the nozzle adapter, replace if necessary.
Poor cutting performance	1. Inspect and clean the lens. Replace if necessary. 2. Verify that the surface seals on the lens holder are installed and not damaged. Replace if necessary. 3. Verify that the manual focus position ring is set for the correct focal position. Verify the focal position by repeating the focus finding procedure, if necessary. 4. Verify that the o-rings in the pressure seal bushing, located between the nozzle adapter and the guard, are not damaged. 5. Verify that the insulating washer is not damaged. Replace as necessary. 6. Verify that the beam is centered in the nozzle orifice.

Troubleshooting the gas console

The compressed air supply must remain within specifications for proper operation of the gas console. If the compressed air supply is interrupted for any reason, it can result in several fault conditions with varying symptoms. If any gas supply problem is encountered, the first troubleshooting step should always be to check the compressed air supply to the gas console. For all the problems listed in the table below, it will be assumed that this and other obvious checks have been performed.

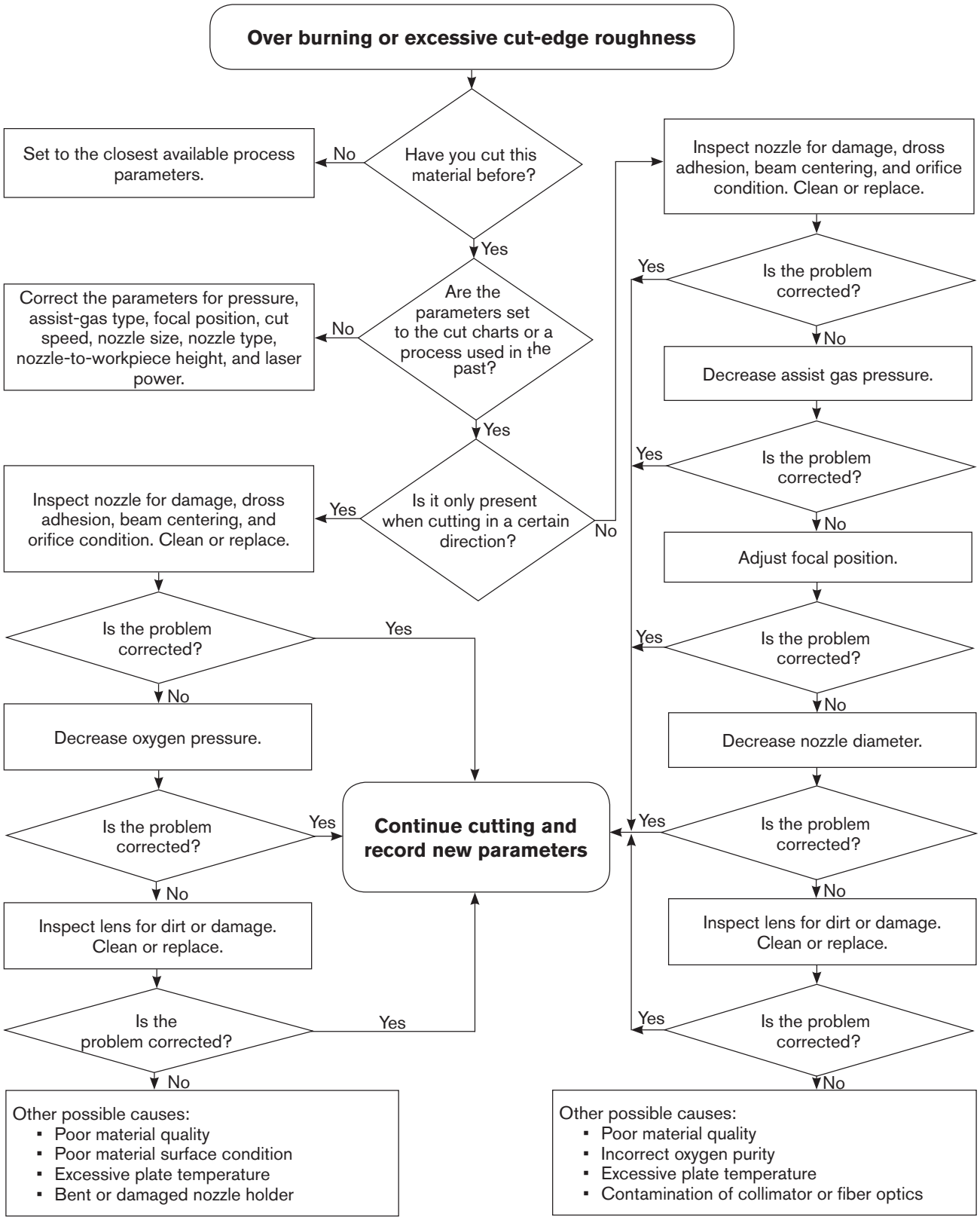
Common troubleshooting steps:

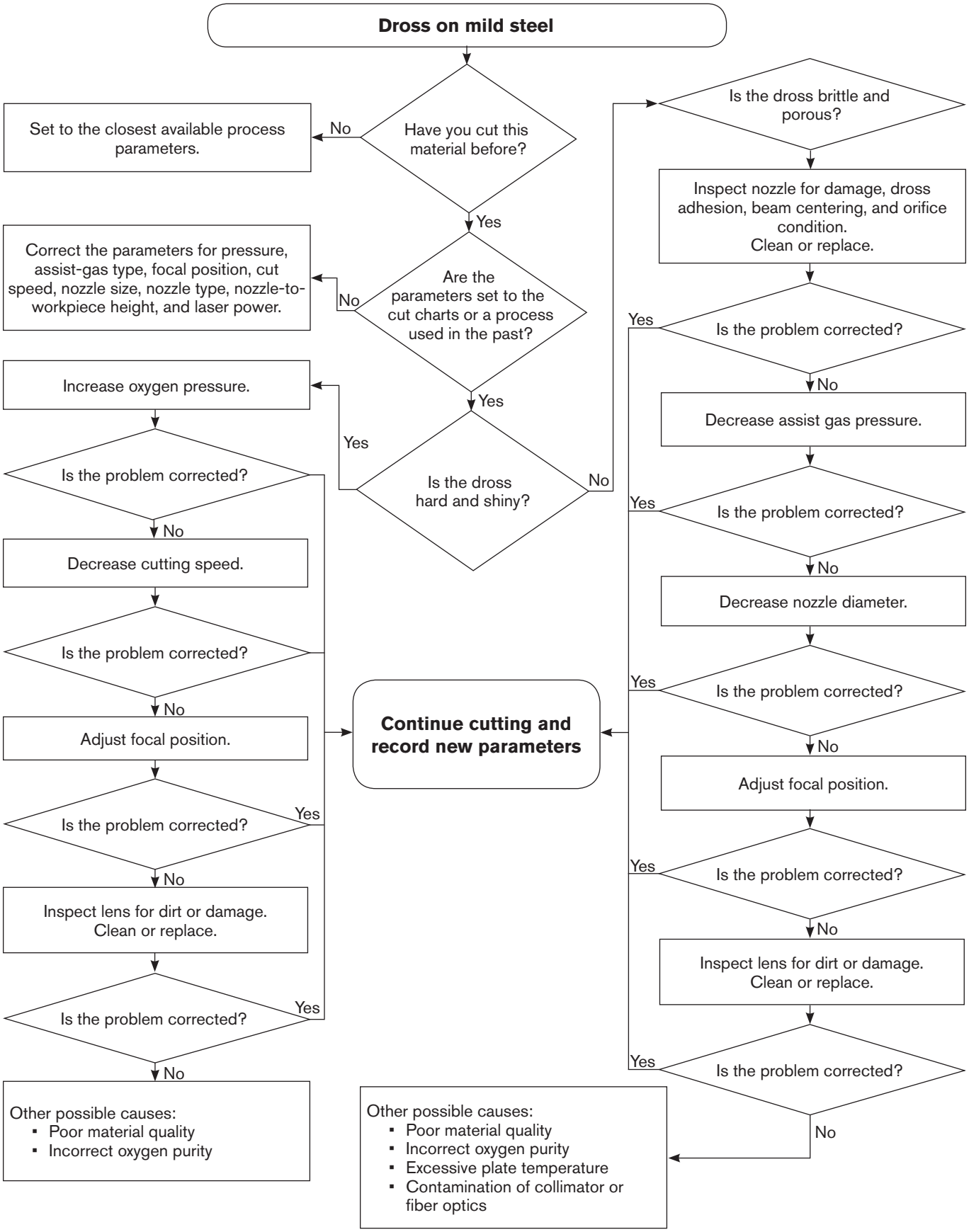
1. Check compressed air supply pressure
2. Ensure that the air input filter/regulator is set to outlet pressure of 0.5 MPa (75 psi)
3. Check cut gas supply pressure
4. Inspect gas hoses for kinks or other restrictions.

Problem	Solution
No side jet pressure during piercing	1. Verify that the side jet regulator is not in the “OFF” position (turned fully counter clockwise). 2. Verify that the “pierce time” is not set to 0 sec in the cut chart.
CNC reports Cut Gas Lost Error	Verify that the cut/pierce pressure in the cut chart is greater than 0.3 bar (4.5 psi/30 kPa).
Low cut gas pressure (especially for high-pressure nitrogen cutting)	1. Verify that the focusing lens is installed in the head and that the circular sealing ring is installed in the lens holder. 2. Verify the flow rate capability of the gas supply system; even though supply pressure is within specifications, this can drop dramatically if maximum flow rate capabilities are exceeded.
The screen on the laser head controller shows the correct pressure but there is no gas flow at the nozzle for nitrogen cutting.	Verify the compressed air supply as detailed above.
Gas pressure fluctuates periodically	This problem can occur with a small nozzle bore and gas pressure set at a low level. Example: A 1 mm nozzle and the cut pressure set at 0.5 bar (7.3 psi/50 kPa). Choose higher cut gas pressure, or use a larger nozzle if these factors do not affect cut quality/speed.

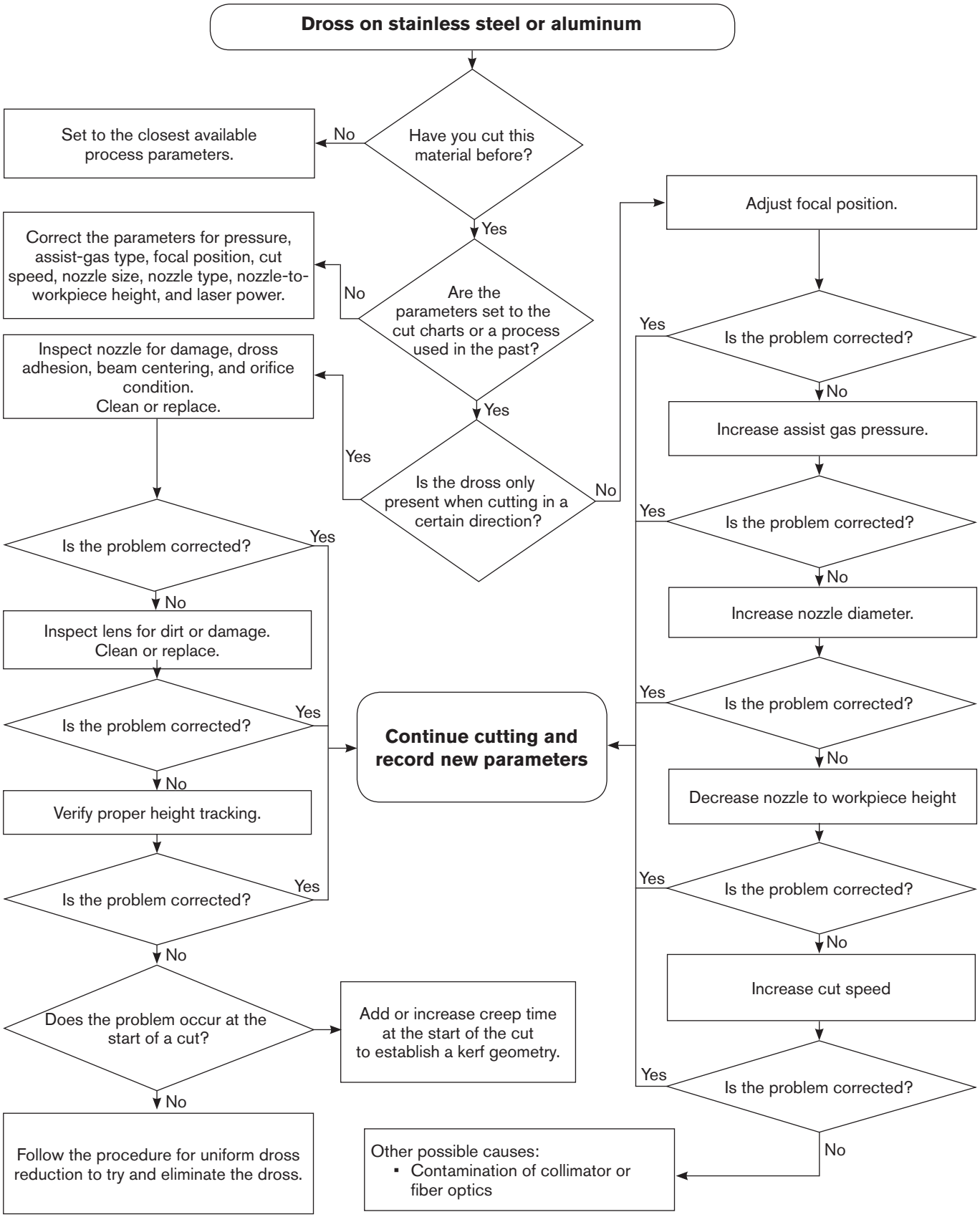
Troubleshooting routines

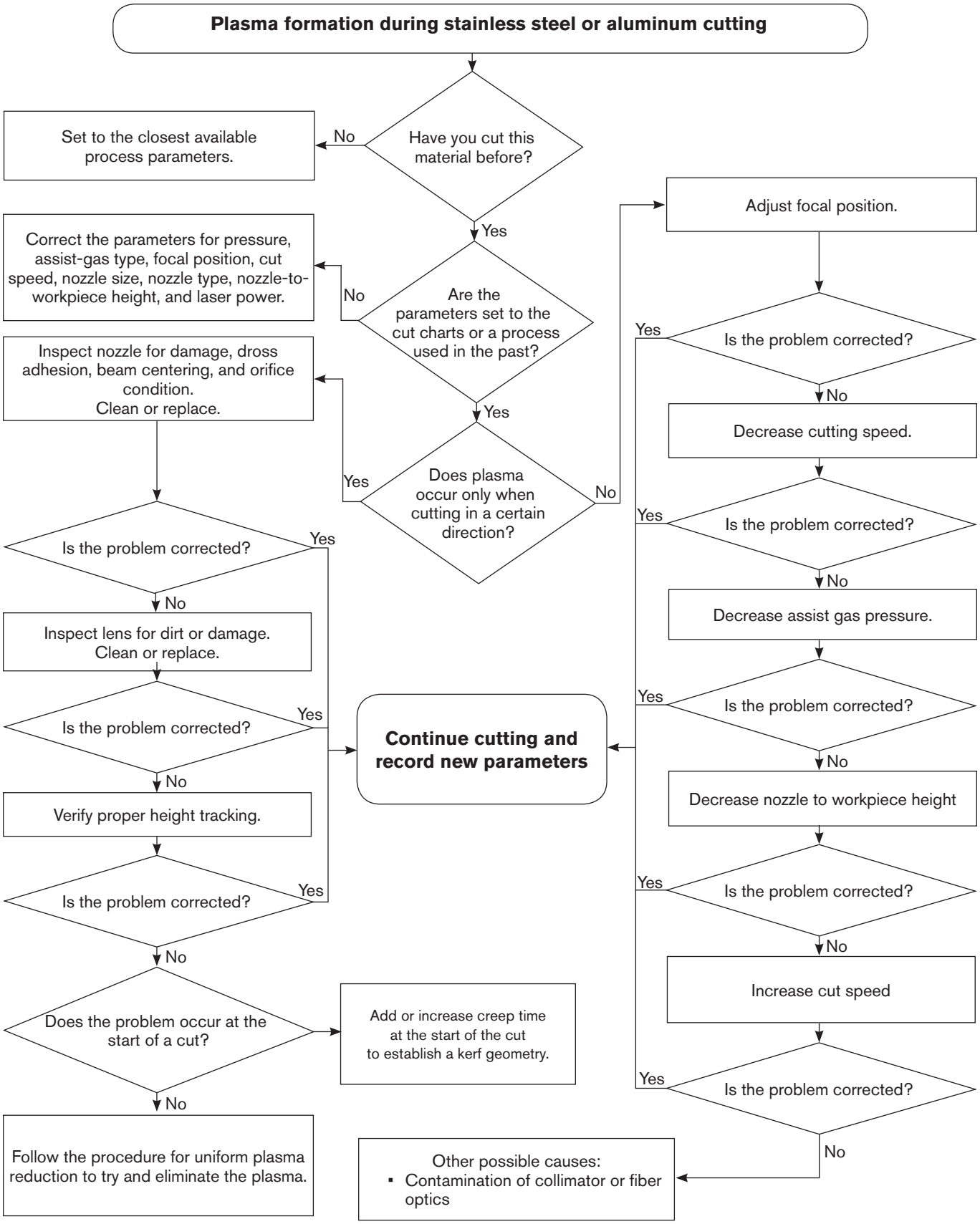
Mild steel O_2 cutting




Dross on mild steel
Have you cut this material before?
No
Set to the closest available process parameters.
Yes
Are the parameters set to the cut charts or a process used in the past?
No
Correct the parameters for pressure, assist-gas type, focal position, cut speed, nozzle size, nozzle type, nozzle-to-workpiece height, and laser power.
Yes
Is the dross hard and shiny?
Yes
Increase oxygen pressure.
Is the problem corrected?
Yes
No
Decrease cutting speed.
Is the problem corrected?
Yes
No
Adjust focal position.
Is the problem corrected?
Yes
No
Inspect lens for dirt or damage. Clean or replace.
Is the problem corrected?
Yes
No
Other possible causes:
▪ Poor material quality
▪ Incorrect oxygen purity
No
Is the dross brittle and porous?
Inspect nozzle for damage, dross adhesion, beam centering, and orifice condition. Clean or replace.
Is the problem corrected?
Yes
No
Decrease assist gas pressure.
Is the problem corrected?
Yes
No
Decrease nozzle diameter.
Is the problem corrected?
Yes
No
Adjust focal position.
Is the problem corrected?
Yes
No
Inspect lens for dirt or damage. Clean or replace.
Is the problem corrected?
Yes
No
Other possible causes:
▪ Poor material quality
▪ Incorrect oxygen purity
▪ Excessive plate temperature
▪ Contamination of collimator or fiber optics
Continue cutting and record new parameters

Stainless steel and aluminum N_2 cutting




Plasma formation during stainless steel or aluminum cutting
Have you cut this material before?
No
Set to the closest available process parameters.
Yes
Are the parameters set to the cut charts or a process used in the past?
No
Correct the parameters for pressure, assist-gas type, focal position, cut speed, nozzle size, nozzle type, nozzle-to-workpiece height, and laser power.
Yes
Does plasma occur only when cutting in a certain direction?
Yes
Inspect nozzle for damage, dross adhesion, beam centering, and orifice condition.
Clean or replace.
No
Adjust focal position.
Is the problem corrected?
Yes
No
Decrease cutting speed.
Is the problem corrected?
Yes
No
Decrease assist gas pressure.
Is the problem corrected?
Yes
No
Decrease nozzle to workpiece height
Is the problem corrected?
Yes
No
Increase cut speed
Is the problem corrected?
Yes
No
Is the problem corrected?
Yes
No
Inspect lens for dirt or damage.
Clean or replace.
Is the problem corrected?
Yes
No
Verify proper height tracking.
Is the problem corrected?
Yes
No
Continue cutting and record new parameters
Does the problem occur at the start of a cut?
No
Add or increase creep time at the start of the cut to establish a kerf geometry.
Follow the procedure for uniform plasma reduction to try and eliminate the plasma.
Other possible causes:
▪ Contamination of collimator or fiber optics

Troubleshoot the nozzle extension calibration

Nozzle extension calibration must detect at least two volts from 0 mm to 18 mm. This can be verified using LHC diagnostic display. The Noz Pos variable displays the nozzle position voltage. If there is < 2 volt change in the voltage during calibration:

1. Check the head for proper grounding.
2. Check, and if necessary, replace the cable or connector on the 12-pin cable (223169) between the LHC and the laser head.
3. Cycle power to the laser power supply and try calibration again.

If these steps do not correct the problem, the laser head requires factory service, or the system must be operated using manual nozzle positioning until factory service is possible.

Troubleshoot CHS calibration errors

The CHS calibration routine in the laser head controller must detect a change of at least 2.5 volts from 1 mm to 10 mm.

To verify that the CHS sensor is producing an accurate voltage:

1. Navigate to the LHC diagnostic screen for AIN. RAW CHS is displayed in counts and a change in position from 1 mm to 10 mm must be greater than a 820-count difference.
2. If this is not the case, check the head for proper grounding.
3. Check, and if necessary, replace the cable or connector on the 12-pin cable between the LHC and the laser head.

Cycle power to laser power supply and try calibration again. If these steps do not correct the problem, the laser head requires factory service, or the system must be operated using manual height control until factory service is possible.

LPC service mode parameters

Note: The following I/O points automatically change to “vrtual” I/O points when an EdgePro CNC is used in the cutting system: DIN19 through DIN23, DIN26, and DIN27. This allows users to validate values sent from the CNC over Hypernet.

DIN Status 0 – 19

DIN 0	PS Flt	On = Power supply faulted Off = Power supply OK
DIN 1	DR INT1	On = Front cabinet door open Off = Front cabinet door closed
DIN 2	DR INT2	On = Rear cabinet door open Off = Rear cabinet door closed
DIN 3	FCU Leak	Flt = Leak detected in fiber coupling unit
DIN 4	PF Flw	Flt = Flow rate out of range for the process fiber
DIN 5	Safe Rly	On = Safety circuit open Off = Safety circuit closed
DIN 6	Cont1	On = Power supply contactor 1 active Off = Power supply contactor 1 inactive
DIN 7	Cont2	On = Power supply contactor 2 active Off = Power supply contactor 2 inactive
DIN 8	Cur Lim1	On = Laser module 1 current limit fault Off = Laser module 1 current limit in range
DIN 9	Cur Lim2	On = Laser module 2 current limit fault Off = Laser module 2 current limit in range
DIN 10	Cur Lim3	On = Laser module 3 current limit fault Off = Laser module 3 current limit in range
DIN 11	Cur Lim4	On = Laser module 4 current limit fault Off = Laser module 4 current limit in range
DIN 12	DIN12	On = Input active Off = Input inactive
DIN 13	DIN13	On = Input active Off = Input inactive
DIN 14	DIN14	On = Input active Off = Input inactive
DIN 15	DIN15	On = Input active Off = Input inactive
DIN 16	DIN16	On = Input active Off = Input inactive
DIN 17	Leak	Flt = Cabinet leak detected
DIN 18	H20 Flw	Flt = Input water flow rate out of range
DIN 19	Beam On	Hypernet OFF = Digital beam enable input is displayed Hypernet ON = Virtual beam on state from CNC

DIN Status 20 – 31

DIN 20	PTL Enb	On = Pointing laser active Off = Pointing laser inactive Hypernet ON = CNC virtual value
DIN 21	Pulse Mode	On = Pulsing active Off = Pulsing Inactive Hypernet ON = CNC virtual value
DIN 22	SideJet	On = SideJet Active Off = SideJet inactive Hypernet ON = CNC virtual value
DIN 23	Flt Reset	On = Fault reset active Off = Fault reset inactive Hypernet ON = CNC virtual value
DIN 24	DIN24	On = Input active Off = Input inactive
DIN 25	Field Pwr	On = Laser system field 24VDC OK Off = Laser system field 24VDC low
DIN 26	AIR Sel	On = Air process gas Off = 0_2 process gas Hypernet ON = CNC virtual value
DIN 27	N_2 Sel	On = Nitogen process gas Off = ---0_2 or AIR process gas Hypernet ON = CNC virtual value
DIN 28	FCU Flw	Flt = Fiber Coupling Unit flow rate below minimum
DIN 29	DIN29	On = Input active Off = Input inactive
DIN 30	Fiber OK A	On = Delivery Fiber Interlock Circuit OPEN Off = Delivery Fiber Interlock Circuit CLOSED
DIN 31	Fiber OK B	On = Delivery Fiber Interlock Circuit OPEN Off = Delivery Fiber Interlock Circuit CLOSED

AIN Status 0 – 23

Note: these signals will show as SPARE when they are not active in a configuration

AIN 0	OUT5	HFL030 = Laser Module 5 output power in watts
	SPARE	HFL010, HFL015, and HFL020 = Unused input
AIN 1	OUT1	Laser module 1 output power in watts
AIN 2	CP5	HFL030 = Laser module 5 input temperature in degrees Celsius
	SPARE	HFL010, HFL015, and HFL020 = Unused input
AIN 3	OUT2	Laser Module 2 output power in watts
AIN 4	OTEMP5	HFL030 = Laser module 5 output temperature in degrees Celsius
	SPARE	HFL010, HFL015, and HFL020 = Unused input
AIN 5	OUT3	Laser module 3 output power in watts
AIN 6	OUT6	HFL030 = Laser Module 6 output power in watts
	SPARE	HFL010, HFL015, and HFL020 = Unused input
AIN 7	OUT4	Laser module 4 output power in watts
AIN 8	CP1	Laser module 1 Input temperature in degrees Celsius
AIN 9	OTEMP1	Laser module 1 output temperature in degrees Celsius
AIN 10	CP2	Laser module 2 input temperature in degrees Celsius
AIN 11	OTEMP2	Laser module 2 output temperature in degrees Celsius
AIN 12	CP3	Laser module 3 input temperature in degrees Celsius
AIN 13	OTEMP3	Laser module 3 output temperature in degrees Celsius
AIN 14	CP4	Laser module 4 input temperature in degrees Celsius
AIN 15	OTEMP4	Laser module 4 output temperature in degrees Celsius
AIN 16	PS TEMP	Power supply temperature sensor in volts (-20° C to 100° C)
AIN 17	PS	Power supply actual current in amps
AIN 18	CP6	HFL030 = Laser module 6 input temperature in degrees Celsius
	SPARE	HFL010, HFL015, and HFL020 = Unused input
AIN 19	OTEMP6	HFL030 = Laser module 6 output temperature in degrees Celsius
	SPARE	HFL010, HFL015, and HFL020 = Unused input
AIN 20	PSCMD	Process power command (0-maximum rated power in watts)
AIN 21	DUTY	Corner power (0-100%)
AIN 22	GASCMD	Assist gas pressure setpoint in PSI
AIN 23	AIN23	Combiner optical sensor voltage

DOUT Status 0 – 15

DOUT 0	GRN STK1	On = Cabinet green stack light ON Off = Cabinet green stack light OFF
DOUT 1	YEL STK1	On = Cabinet yellow stack light ON Off = Cabinet yellow stack light OFF
DOUT 2	RED STK1	On= Cabinet red stack light ON Off = Cabinet red stack light OFF
DOUT 3	GRN STK2	On = External green stack light output contact closed Off = External green stack light output contact open
DOUT 4	YEL STK2	On = External yellow stack light output contact closed Off = External yellow stack light output contact open
DOUT 5	RED STK2	On = External red stack light output contact closed Off = External red stack light output contact open
DOUT 6	PTL CMD	On = Internal pointing laser contact closed Off= Internal pointing laser contact open
DOUT 7	CNTRL OK	On = Laser power controller OK Off = Laser power contoller Flt
DOUT 8	LASER FLT	On = Laser fault active output contact closed Off = Laser fault inactive output contact open
DOUT 9	PLT STATUS	On = Pointing laser on output contact closed Off = Pointing laser off output contact open
DOUT 10	LH FLT	On = Laser head fault active output contact closed Off = Laser head fault inactive output contact open
DOUT 11	TIPTOUCH	On = Nozzle contact active output contact closed Off = Nozzle contact inactive output contact open
DOUT 12	LH OR	On = Overrange output active output contact closed Off = Overrange output inactive output contact open
DOUT 13	GAS FLT	On = Gas fault output active output contact closed Off = Gas fault output inactive output contact open
DOUT 14	PS ENB	On = Power supply interlock enabled Off = Power supply interlock disabled
DOUT 15	H20 VALVE	On = Input water valve open Off = Input water valve closed

AOUT Status

PS CMD	Power supply command (0 – 10 Volts = 0 to 100%)
CHS	Scaled capacitive height sensor voltage (0 – 10 Volts = 0 – 10 mm)

LHC diagnostics parameters

DIN Status 0 – 8

DIN 0	TipTouch	On = Tip touch active Off = Tip touch inactive
DIN 1	Collision	Opn = Collision active switch open Cls = Collision inactive switch closed
DIN 2	Lens Dr	Opn = Lens door open Cls = Lens door closed
DIN 3	Gas Flt	On = Gas fault active Off = Gas fault inactive
DIN 4	LHC DIN4	Spare
DIN 5	LHC DIN5	Spare
DIN 6	LHC DIN6	Spare
DIN 7	LHC DIN7	Spare
DIN 8	LHC DIN8	Spare

AIN Status 0 – 7

AIN 0	Raw CHS	Capacitive height sensor in DAC counts
AIN 1	Noz Pos	Nozzle position sensor in volts
AIN 2	Intensity	Future option
AIN 3	O2 Fdbk	Output oxygen pressure sensor in volts
AIN 4	N2 Fdbk	Output nitrogen sensor output in volts
AIN 5	LHCAIN5	Spare
AIN 6	LHCAIN6	Spare
AIN 7	LHCAIN7	Spare

DOUT Status 0 – 7

DOUT 0	N2	On = Nitrogen assist gas on Off = Nitrogen assist gas off
DOUT 1	AIR	On = Compressed air assist gas on Off = Compressed air assist gas off
DOUT 2	Side Jet	On = Side jet on Off = Side jet off
DOUT 3	Purge	On = Purge gas on Off = Purge gas off
DOUT 4	LHC DOUT4	Spare
DOUT 5	LHC DOUT5	Spare
DOUT 6	LHC DOUT6	Spare
DOUT 7	LHC DOUT7	Spare

AOUT Status

LHC Gas1	Oxygen/Air proportional valve command voltage
LHC Gas2	Nitrogen proportional valve command voltage

HyIntensity Fiber Laser Machine Interface

Note: Go to page 4-32 to see examples of typical interface circuits.

LPC 1

Pin	Signal
A-1	Process power (analog input)[1]
A-2	Analog common
A-3	Corner power (analog input)[1]
A-4	Analog common
A-5	Assist gas pressure setpoint (analog input)[1]
A-6	Analog common
A-7	Capacitive height sense (analog output - 1 volt/mm)
A-8	Analog common
A-9	Laser fault output_A[2]
B-2	Gas fault output_A[2]
B-3	Gas fault output_B[2]
B-4	Digital beam enable input[3]
B-5	Pointing laser enable input[3]
B-6	Corner power pulsing enable input[3]
B-7	Side jet enable input[3]
B-8	Laser fault reset input[3]
C-1	Over range output_B[2]
C-2	Pointing laser status output_A[2]
C-3	Pointing laser status output_B[2]
C-4	Laser head fault output_A[2]
C-5	Laser head fault output_B[2]
C-6	Nozzle contact output_A[2]
C-7	Nozzle contact output_B[2]
C-8	Over range output_A[2]
C-9	Laser fault output_B[2]

Part	Part number
Mating connector	108945
22-24 AWG sockets	108946
Connector housing	108941
Cable strain relief	108942
Crimp tool made by Phoenix Contact	1687419

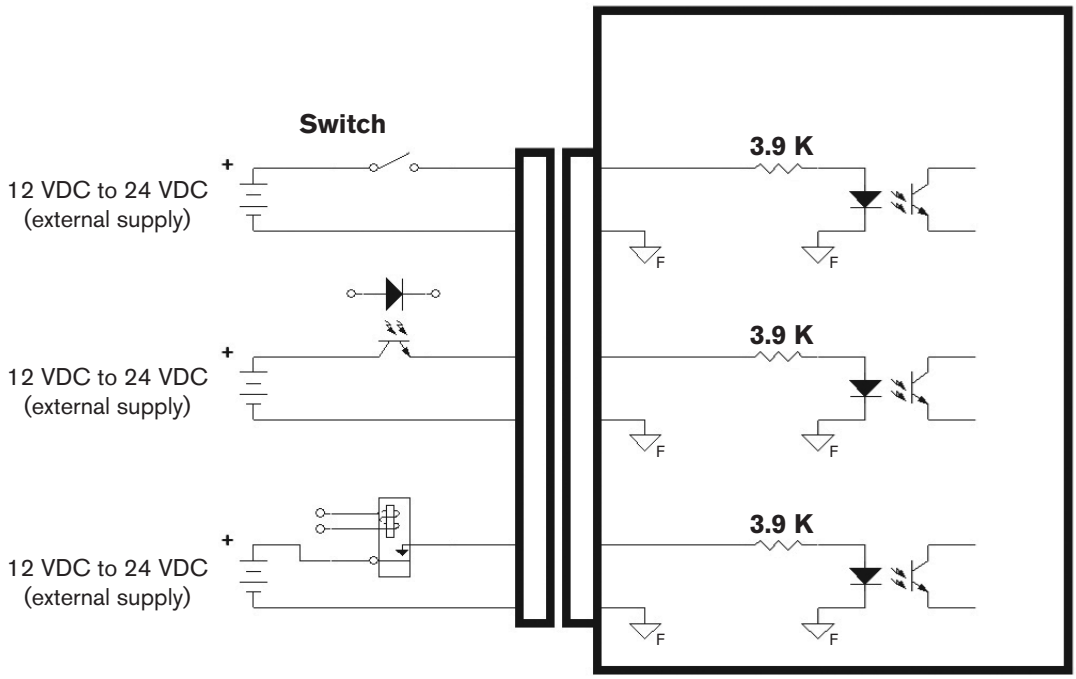
Notes: [1] These analog inputs are 0 – 10 VDC single ended inputs
[2] These discrete outputs are dry relay contacts (5 – 24 VDC @ 0.2 amps)
[3] These discrete inputs require a positive voltage (12 – 34 VDC) to activate the input

LPC 2

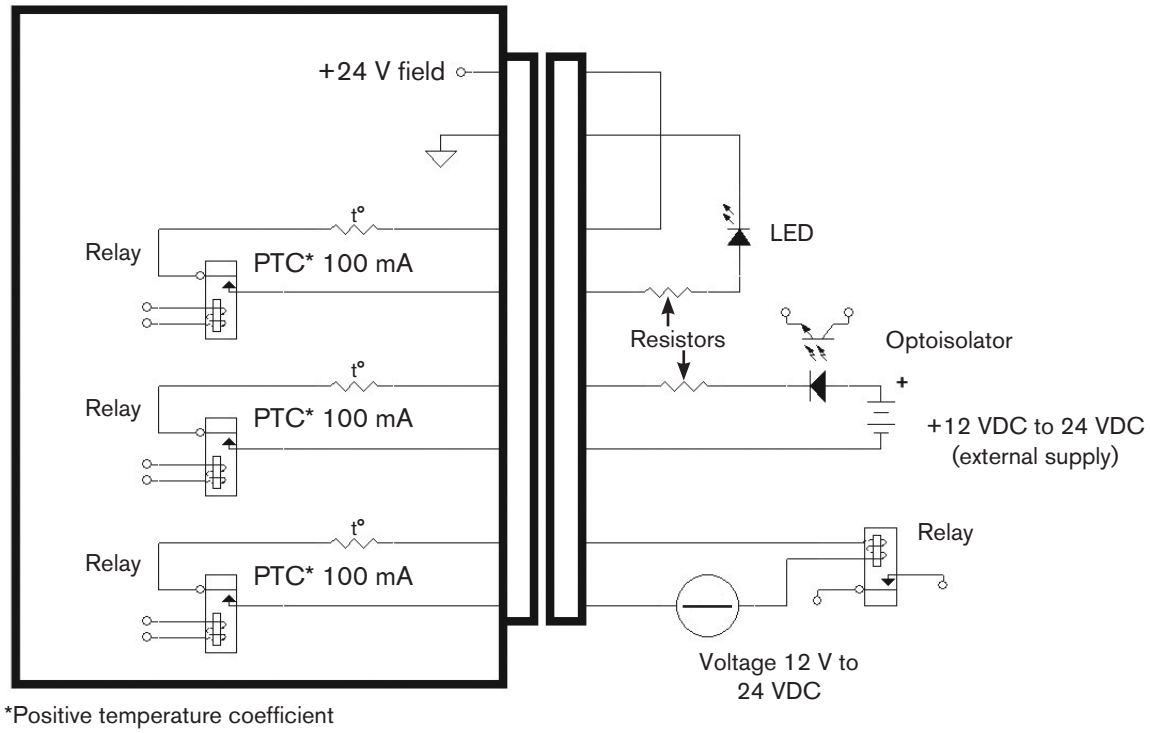
Pin	Signal
A-1	External door interlock NO Contact 1[3]
A-2	External door interlock NO Contact 2[3]
A-3	External start/reset switch indicator +[3]
A-4	Keyswitch contact[3]
A-5	External green stack light output_A[1]
A-6	External yellow stack light output_A[1]
A-7	External red stack light output_A[1]
A-8	Oxygen/air select input[3]
A-9	Laser head controller power (+24 VDC)
B-2	NC
B-3	NC
B-4	Field common
B-5	Field common
B-6	Chiller remote start
B-7	Chiller remote start
B-8	NC
C-1	External E-Stop switch NO contact 1[3]
C-2	External E-Stop switch NO contact 2[3]
C-3	External start/reset switch indicator[3]
C-4	Start/reset momentary switch[3]
C-5	External green stack light output_B[2]
C-6	External yellow stack light output_B[2]
C-7	External red stack light output_B[2]
C-8	Nitrogen select input[2]
C-9	Laser head controller power (common)

Part	Part number
Mating connector	108944
22-24 AWG pins	108948
18 AWG pins	108947
Connector housing	108941
Cable strain relief	108942
Crimp tool made by Phoenix Contact	1687419

Notes: [1] These discrete outputs are dry relay contacts (5 – 24 VDC @ 0.2 Amps)
[2] These discrete inputs require a positive voltage (12 – 34 VDC) to activate the input
[3] Reference the Electrical diagram for external safety switches in the Installation section of this manual



Example of voltage sourced inputs



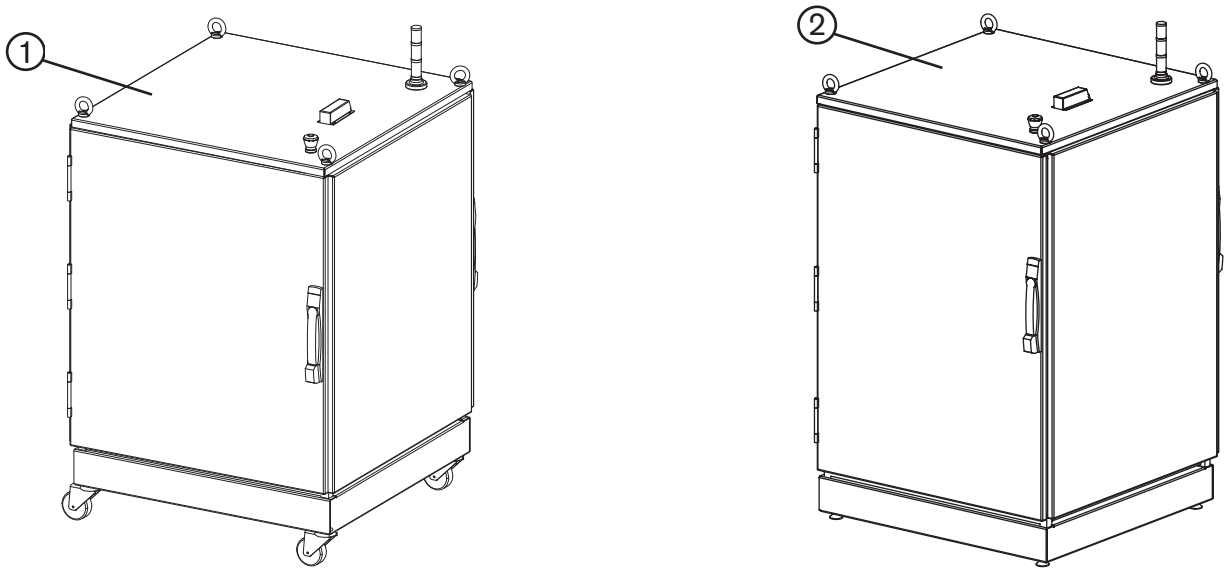
*Positive temperature coefficient

Example of relay outputs

Section 5

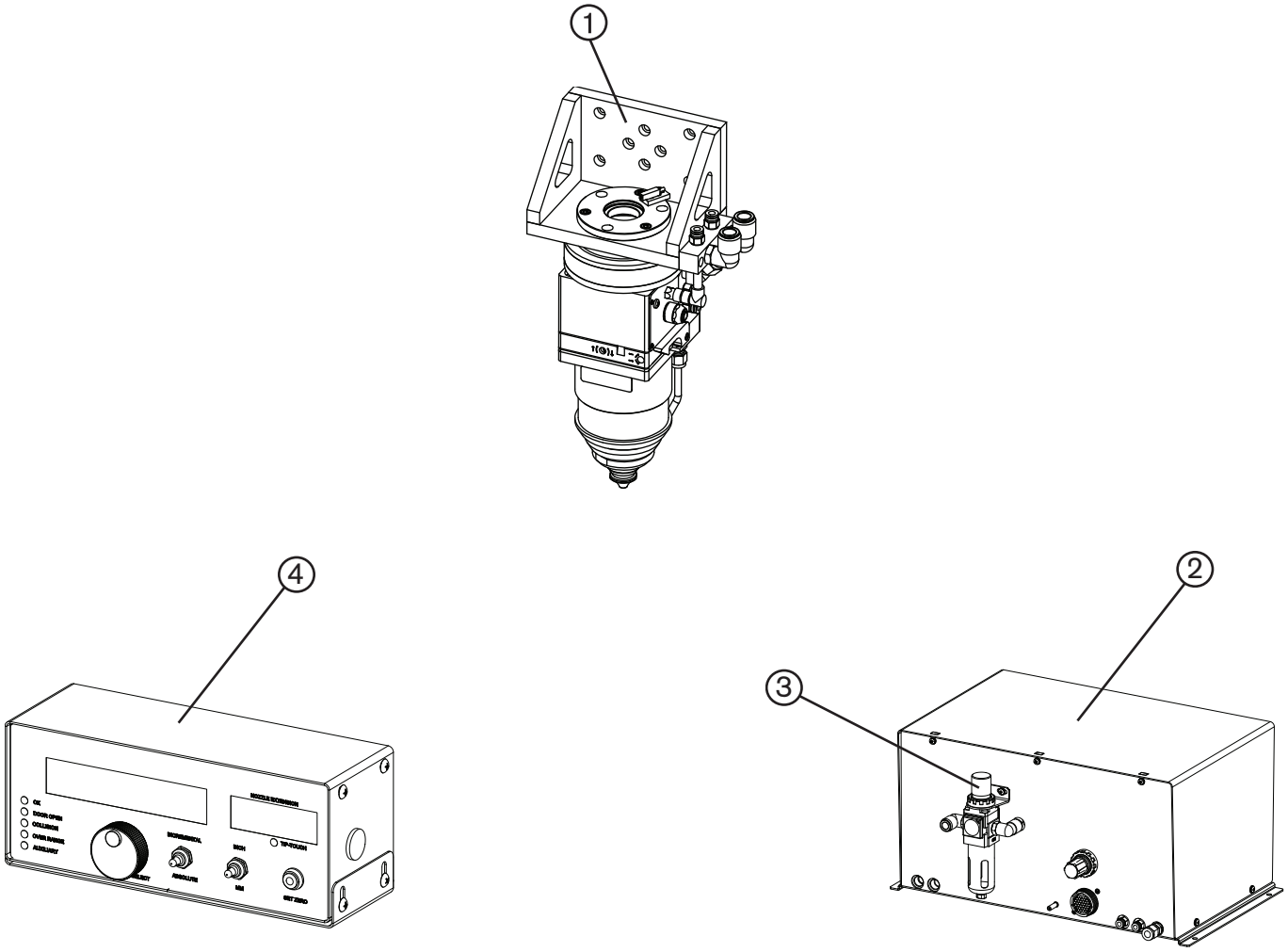
PARTS LIST

Fiber laser supply



Item	Part number	Description
1	051041	HFL010 — 1.0 kW fiber laser supply, with fiber coupling unit, 400-480 VAC, 50/60 Hz
	051042	HFL010 — 1.0 kW fiber laser supply, without fiber coupling unit, 400-480 VAC, 50/60 Hz
	051023	HFL015 — 1.5 kW fiber laser supply, with fiber coupling unit, 400-480 VAC, 50/60 Hz
	051043	HFL015 — 1.5 kW fiber laser supply, without fiber coupling unit, 400-480 VAC, 50/60 Hz
	051039	HFL020 — 2.0 kW fiber laser supply, with fiber coupling unit, 400-480 VAC, 50/60 Hz
	051044	HFL020 — 2.0 kW fiber laser supply, without fiber coupling unit, 400-480 VAC, 50/60 Hz
2	051048	HFL030 — 3.0 kW fiber laser supply, with fiber coupling unit, 440-480 VAC 50/60 Hz
	051053	HFL030 — 3.0 kW fiber laser supply, without fiber coupling unit, 440-480 VAC 50/60 Hz
	051049	HFL030 — 3.0 kW fiber laser supply, with fiber coupling unit, 380-400 VAC 50/60 Hz
	051052	HFL030 — 3.0 kW fiber laser supply, without fiber coupling unit, 380-400 VAC 50/60 Hz

Fiber laser components



Item	Part Number	Description	Quantity
1	051024	LF150 laser head: 150 mm EFL/35 mm optical	1
2	051025	Fiber laser auto gas selection console	1
3	011109	Filter assembly	1
	011110	Filter element	1
4	051026	Laser head controller	1

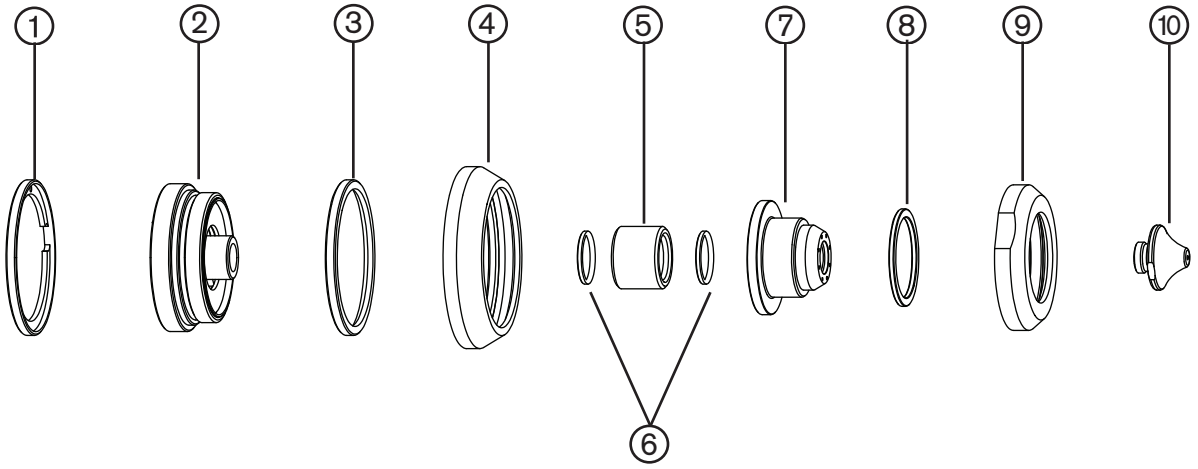
Starter kit

Part Number	Description	Quantity
228602	Kit: HyIntensity fiber laser starter kit	1
	Fiber laser standard nozzle: 1.0 mm	2
	Fiber laser standard nozzle: 1.5 mm	1
	Fiber laser standard nozzle: 2.0 mm	2
	Fiber laser standard nozzle: 2.5 mm	1
	Fiber laser dual nozzle: 1.2 mm	1
	Fiber laser dual nozzle: 1.5 mm	2
	Fiber laser dual nozzle: 2.0 mm	2
	Fiber laser dual nozzle: 2.5 mm	1
	Dropper: 30 mL	1
	Fiber laser safety glasses: wavelength = OD7+ @ 1040 – 1100 nm	2
	10 X Fixed-focus loupe	1
	Pen LED light: .60 diameter x 5.63	1
	Lens tissue: 2.75 x 4.75	1
	Lens cleaning fixture	1

Consumables

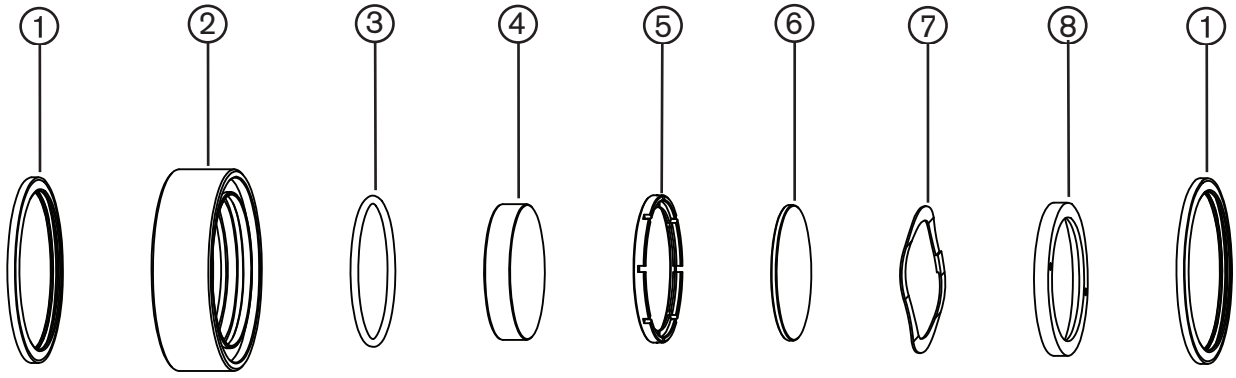
Part Number	Description	Quantity
228859	Fiber laser lens assembly	1
021105	Fiber laser lenses: 150 mm EFL / 35 mm OD	1
027991	Fiber laser lens cleaning wipes	1
104641	Lens cleaning fixture	1
127306	Lens tissue	1
026910	Fiber laser silicon O-ring: 35 mm x 2 mm	1
127275	Fiber laser seal: 1.875 in OD VARISEAL	1
228615	Fiber laser lens holder assembly: 150 mm EFL standard	1
127293	Fiber laser lens spring (use without the lens window)	1
104519	Fiber laser lens washer (use without the lens window)	1
021108	Lens window	1
127359	Fiber laser lens spring (use with the lens window)	1
104656	Fiber laser lens washer (use with the lens window)	1
021096	Fiber laser standard nozzle: 1.0 mm	1
021097	Fiber laser standard nozzle: 1.2 mm	1
021098	Fiber laser standard nozzle: 1.5 mm	1
021099	Fiber laser standard nozzle: 2.0 mm	1
021100	Fiber laser standard nozzle: 2.5 mm	1
021101	Fiber laser standard nozzle: 3.0 mm	1
021102	Fiber laser dual nozzle: 1.2 mm	1
021103	Fiber laser dual nozzle: 1.5 mm	1
021104	Fiber laser dual nozzle: 2.0 mm	1
021106	Fiber laser dual nozzle: 2.5 mm	1
104516	Fiber laser nozzle adapter	1
104517	Fiber laser nozzle adapter washer	1

LF150 cutting head - lower parts



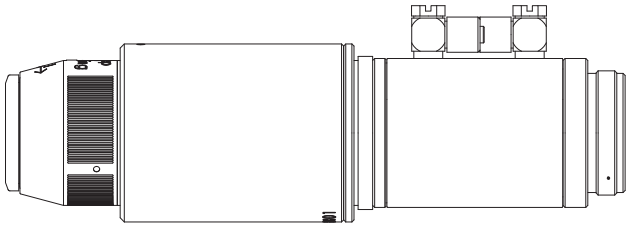
Item	Part Number	Description	Quantity
1	104558	Washer: upper guard	1
2	228802	Guard	1
3	104559	Washer: lower guard	1
4	104563	Retaining nut	1
5	104565	Bushing	1
6	026913	O-ring:	2
7	104516	Nozzle adapter	1
8	104517	Washer: nozzle adapter	1
9	104564	Nozzle adapter retaining nut	1
10	See previous page for part numbers	Nozzle	1

Lens assembly parts



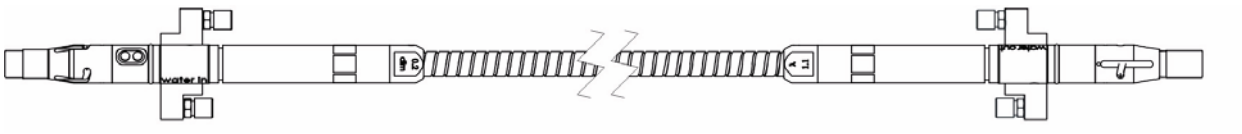
Item	Part Number	Description	Quantity
1	127275	Seal: 1.875 in. OD variseal	2
2	104540	Lens holder: LF150 150 mm EFL / 35 mm diameter/red	1
3	026910	O-ring: silicone 70 duro 35 mm x 2 mm	1
4	021105	Lens: 150 mm EFL / 35 mm OD fused silica plano-convex	1
5	104519	Washer: LF150 lens holder (for use without the window)	1
	104656	Washer: LF150 lens holder (for use with the window)	1
6	021108	Window: 35 mm OD x 1.5 mm (TA/R 1070 nm)	1
7	127293	Wave ring: 1.5 in. OD stainless steel (for use without the window)	1
	127359	Wave ring: 1.5 in. OD stainless steelr (for use with the window)	1
8	104542	Retaining ring: LF150	1

Collimator



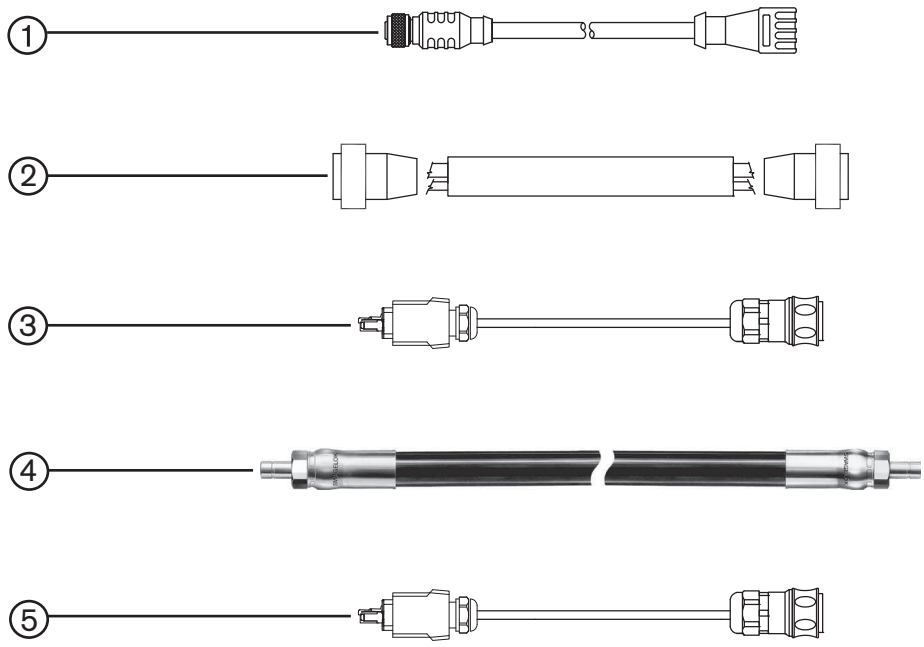
Item	Part Number	Description
1	051027	Fiber laser collimator: 60 mm
	051028	Fiber laser collimator: 100 mm

Beam delivery optical cable



Item	Part Number	Description
1	051029	Fiber laser beam delivery optical cable: 10 m (33 ft) 100 micron
	051030	Fiber laser beam delivery optical cable: 20 m (65.5 ft) 100 micron
	051045	Fiber laser beam delivery optical cable: 20 m (65.5 ft) 200 micron

Cables and hoses



Item	Part Number	Description	Quantity
1	223169	Cable: laser head controller to laser head – 10 m (33 ft)	1
2	223138	Cable: auto gas selection console – 10 m (33 ft)	1
3	223171*	Cable: hypernet to laser – 10 m (33 ft)	1 or 2
4	024874	Hose: gas – 10 m (33 ft)	1
5	223247*	Cable: hypernet to laser – 20 m (66 ft)	1 or 2

* Two of these cables are required in a configuration that includes a Hypertherm CNC.

HFL Instruction Manual revision 3 changes (807090)	
Changed Page	**Description of changes for revision 3 (date of revision - 10/2012)**
Cover	Added information about the HFL030 so this manual now covers all of the Hypertherm HyIntensity fiber lasers.
Universal change	Beam delivery cable (BDO) was changed to beam delivery optical cable but it is still referred to as the BDO.
S5 and S7	Added new wavelength output stickers for the HFL030 to the safety section.
PS-1 Through ES-2	Added product and environmental stewardship information after the safety information.
Universal change	The table of contents was removed from the first page of each section.
Specifications Section	Re-arranged the information to group it more effectively.
1-2	Added part numbers for the HFL030 laser supplies.
1-3	Added the rated power output for the HFL030 laser supply.
1-4	Added a page with the HFL030 graphic and weight for the HFL030 laser supply.
1-8	Moved Chiller requirements to it's own page (1-11).
1-10	Added caution about filtration requirements for oxygen and nitrogen supply gas lines.
1-11	Added caution saying that filtration for the cooling system must meet the chiller requirements.
2-11	Add information about the HFL030 and a note saying the graphic shows the HFL010, 015, 020 enclosure.
2-15	Add "(supplied by user and machine mounted)" next to "Red Stack Light."
2-19	Updated the graphic at th etop of th epage showing the LHC mounted and tilted. Removed the top brackets that ar enot availabl on the LHC.
2-30 and 2-31	Replaced photographs with line art for clarity.
2-32	Removed the last two steps and the photograph that went with them. The steps no longer apply.
2-36	Moved "2 Fiber laser supply to laser head" information to the next page (2-37). Reformated the push-to-connect information so it fits the page better (no surrounding box).
2-38	Updated the text in the caution box to reflect the missing labels (water in/water out) on the new collimators. Added a note about the new collimators above the caution box.
2-39	Replaced the photograph with line art and numbered the connections to correlate with the numbered list on the previous page.
2-52	Corrected the silkscreen shown on the back of the gas console, above the air filter.
2-54	Added a note about the HFL030's Phoenix software version requirement. The system needs version 9.72.3 or higher to function correctly.
2-55	Added HFL030 to step three.
3-18	Updated the information in the "Cause" column for the "Door open" fault.
3-27, 3-31 and 3-35	Updated with a new screenshot
3-34	Added HFL030 information to the Digital beam enable diagram
3-40 to 3-49	Added "Optimizing fiber laser cut quality"
3-51 to 3-81	Updated existing cut charts as needed. Added HFL030 cut charts. Added brass and copper cut charts for HFL020 and HFL030. Added

HFL Instruction Manual revision 3 changes (807090)	
3-82	Added a note about Laser firmware being included in Phoenix version 9.72.1 and higher.
4-13	Replace the two photographs at the bottom of the page with line art for clarity.
4-16 and 4-17	Added a note saying “module 5 and 6 errors are only for HFL030.” Added the information for the HFL030 and updated all status and descriptions for clarity.
4-25	Added a note about I/O points that automatically change to “virtual” when using HyperNet.
4-26	Added a new page with DIN status 20 - 31. This was left out by error in the last revision.
4-27	Added a note saying that signals are identified as “spare” when not used. Update the table with HFL030 information.
4-33	Removed “Use internal field + 24 VDC” from the right side of the graphic at the bottom of the page.
5-2	Updated the fiber laser supply part numbers and descriptions for HFL010, 015, and 020, and a added part numbers and descriptions for HFL030. Moved other part information to the next page.
5-3	Added a new page for the components that were moved from page 5-2.
5-6	Added a heading “ LF150 cutting head - lower parts” to the page.

HFL Instruction Manual revision 2 changes (807090)	
Changed Page	**Description of changes for revision 2 (date of revision - 1/2012)**
Cover	Added information about the HFL010 and HFL020 so this manual now covers all 3 of the Hypertherm HyIntensity lasers.
Universal change	HFL015 replaced by HyIntensity fiber laser where ever it appears.
S5 and S7	Added 2 new wavelength output stickers to the safety section.
1-2	Added part numbers for the HFL010 and the HFL020 laser supplies.
1-3	Added the rated power output for the HFL010 and the HFL020 laser supplies.
1-4	Added weights for the HFL010 and HFL020 laser supplies.
1-8	Added flow rate and cooling capacity information for the HFL010 and the HFL020 chiller requirements.
2-4 and 2-5	Rearranged the order of the system components to fit the reorganized order of component installation.
2-24	Added instruction about installing the laser head mounting bracket to the laser head, and using the protective cap.
2-25	Spread out the dimensional drawings of the laser head and the grounding of the laser head over 2 pages. It was previously crowded onto 1 page.
2-27 to 2-31	Added more detail and pictures to the collimator installation instructions.
2-34	Added the part number for the 20 m (65.5 ft), 200 micron beam delivery optical cable.
2-38 through 2-40 and 2-46	Removed part numbers for the beam delivery optical cable and collimator coolant hoses.
2-45	Changed the graphic of the cable to show the correct part.
2-52	Added the text “but they must meet the pressure requirements (see section 1, *specifications*).
2-59	Changed lens installation (installing a lens in a lens holder) to lens assembly installation (installing a lens assembly into the lens bay in the laser head).
3-4 and 3-5	Updated the flow charts.
3-6	Updated the diagram.
3-25	Removed the in-line graphic of the selection knob for clarity.
3-35	Added laser output in watts for the HFL010 and the HFL020.
3-41	Updated the consumables table.
3-42 through 3-44	Added cut charts for the HFL010.
3-48 through 3-50	Added cut charts for the HFL020.
3-51	Added the heading “Setting the IP address.”
3-53	Changed the heading from programming to Upgrading the firmware.
4-8	Removed the examples of cleaners that should NOT be used.
4-9	Updated the graphic of the exploded view to include the lens window and lens holder washer.
4-12	Added step 6 “installing the lens window”.
4-30	Corrected the mating connector part numbers.
5-2	Added the part numbers for the HFL010 and HFL020 fiber laser supplies.

HFL Instruction Manual revision 2 changes (807090)	
5-3	Updated the consumables in the starter kit (228602).
5-4	Updated the list of consumables.
5-6	Updated the graphic and the list of lens parts.
5-8	Added the part numbers for the 200 micron Beam delivery optical cable.
Appendix A	Removed the coolant appendix.