

DIAMOND J-1000 Series OEM Laser



Preinstallation Manual

*Preinstallation Manual
DIAMOND J-1000 Series
OEM Lasers*



COHERENT.

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Bloomfield, CT 06002

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1 INTRODUCTION

1.1 Signal Words and Symbols in This Manual

This documentation may contain sections in which particular hazards are defined or special attention is drawn to particular conditions. These sections are indicated with signal words in accordance with ANSI Z535.6 and safety symbols (pictorial hazard alerts) in accordance with ANSI Z535.3 and ISO 7010.

1.1.1 Signal Words

Four signal words are used in this documentation: **DANGER**, **WARNING**, **CAUTION**, and **NOTICE**.

The signal words **DANGER**, **WARNING**, and **CAUTION** designate the degree or level of hazard when there is the risk of injury:

DANGER!

Indicates a hazardous situation that, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.

WARNING!

Indicates a hazardous situation that, if not avoided, could result in death or serious injury.

CAUTION!

Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

The signal word “**NOTICE**” is used when there is the risk of property damage:

NOTICE

Indicates information considered important, but not hazard- related.

Messages relating to hazards that could result in both personal injury and property damage are considered safety messages and not property damage messages.

1.1.2

Symbols

The signal words **DANGER**, **WARNING**, and **CAUTION** are always emphasized with a safety symbol that indicates a special hazard, regardless of the hazard level:



This symbol is intended to alert the operator to the presence of additional information.



This symbol is intended to alert the operator to the presence of important operating and maintenance instructions.



This symbol is intended to alert the operator to the danger of exposure to hazardous visible and invisible laser radiation.



This symbol is intended to alert the operator to the presence of dangerous voltages within the product enclosure that may be of sufficient magnitude to constitute a risk of electric shock.



This symbol is intended to alert the operator to the danger of Electro-Static Discharge (ESD) susceptibility.



This symbol is intended to alert the operator to the danger of crushing injury.



This symbol is intended to alert the operator to the danger of a lifting hazard.

1.2

Preface

This is the preinstallation manual for the DIAMOND J-1000 Series OEM/ Industrial laser manufactured by Coherent. These lasers are OEM systems; they are designed as components which are to be inserted by the original equipment manufacturer (OEM) prior to delivery to the end user. Coherent requires that the user read "Laser Safety" (p. 9), before operating the laser.



NOTICE!

Read this manual carefully before operating the laser for the first time. Failure to follow the instructions and safety precautions in this manual can result in serious injury or death. Special attention must be given to the material in "Laser Safety" (p. 9), that describes the safety features built into the laser. Keep this manual with the product and in a safe location for future reference.



DANGER!

Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

1.3 Export Control Laws Compliance

It is the policy of Coherent to comply strictly with U.S. export control laws.

Export and re-export of lasers manufactured by Coherent are subject to U.S. Export Administration Regulations, which are administered by the Commerce Department. In addition, shipments of certain components are regulated by the State Department under the International Traffic in Arms Regulations.

The applicable restrictions vary depending on the specific product involved and its destination. In some cases, U.S. law requires that U.S. Government approval be obtained prior to resale, export or re-export of certain articles. When there is uncertainty about the obligations imposed by U.S. law, clarification must be obtained from Coherent or an appropriate U.S. Government agency.

Products manufactured in the European Union, Singapore, Malaysia, Thailand: These commodities, technology, or software are subject to local export regulations and local laws. Diversion contrary to local law is prohibited. The use, sale, re-export, or re-transfer directly or indirectly in any prohibited activities are strictly prohibited.

1.4 Notice Concerning Regulatory Status of DIAMOND Series Lasers

This laser component does not include all safety features that are required by the United States Food and Drug Administration (FDA), Center for Devices and Radiological Health (CDRH) in laser systems sold to end users. It is sold solely to qualified manufacturers who in their end product, supply interlocks, indicators, and other required safety features, in full compliance with 21 CFR 1040, Subchapter J and/or other applicable national and local regulations.

1.5 Notice Concerning Warranty

Operation or handling of this laser component, inconsistent with this manual, may void the warranty.

1.6 The Preinstallation Manual

This preinstallation manual is designed to familiarize the user with the J-1000 Series system and its designated use. It contains important information on how to install the laser system safely, properly, and most efficiently. Observing these instructions helps to avoid danger, reduce repair costs, and downtimes and increase the reliability and lifetime of the laser system.

This manual describes the physical hazards related to the laser system, the means of protection against these hazards, and the safety features incorporated in the design of the laser system.

1.6.1 Intended Audience

The preinstallation manual is intended for all persons that are to work on or with the laser system.

1.6.2 Numbering of Sections, Pages, and Instructions

The sections are numbered continuously. The name of the section appears in the upper outside corner of every odd page. Each section ends with an even page number. Consequently, certain even pages at the ends of sections will be intentionally left blank.

The pages of this manual are numbered continuously by section. The page number appears in the bottom center of every page.

Each step within a procedure is sequentially numbered. Each procedure starts with the step number one.

1.6.3 Cited Standards

Unless otherwise stated, all technical standards cited in this manual relate to the latest version of the standard that is applicable at the date of the publication of this manual.

This information is in compliance with the Performance Standards for Laser Products, ' *United States Code of Federal Regulations*, 21 CFR 1040.10(d). In many cases, the international standards (ISO and IEC standards) have been adopted wholly or in part by national or regional standards authorities and are known locally under the designation assigned by this authority. For instance, the IEC 60825-1 has been adopted by the European Committee for Standardization as the standard EN 60825-1 and, in turn, by various national standards authorities as standards such as DIN EN 60825 (Germany) and BS EN 60825 (United Kingdom). The exact content, number and revision date of the national standard may, however, vary from that of the corresponding international standard. For further information, contact the publisher of the respective national standard.

1.7 Units of Measurements

In this manual, units of measurement are used according to the metric system (international system of units (SI)), e.g. meter, millimeter, square meter, cubic meter, liter, kilogram, bar, pascal; and imperial system, e.g. tons, pounds, and ounces; gallons and quarts; miles, yards, feet, and inch.

Temperatures are primarily indicated in degrees Celsius (°C) and Fahrenheit (°F).

The water hardness is indicated in parts per million (ppm; American Hardness).

1.8 Feedback Regarding Documentation

If there are any comments regarding the documentation provided, contact the Coherent Documentation Department.

In any correspondence, provide the following:

- the document part number, revision, and date of issue,
- the section number, page number and, where applicable, the procedure step number,
- a description of any errors,
- a proposal for improvements.

1.8.1 Feedback Address

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5100 Patrick Henry Drive
Santa Clara, CA. 95054
USA

2 LASER SAFETY



This user information is in compliance with the following standards for Light-Emitting Products IEC 60825-1 / EN 60825-1 “*Safety of laser products - Part 1: Equipment classification and requirements*” and CDRH 21 CFR Title 21 Chapter 1, Subchapter J, Part 1040 “*Performance standards for light-emitting products*”.



WARNING!

LASER RADIATION - AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION CLASS 4 LASER PRODUCT!



WARNING!

Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

This laser safety section must be reviewed thoroughly prior to operating the J-1000 Series laser system. Safety instructions presented throughout this manual must be followed carefully.

2.1 Hazards

Hazards associated with lasers generally fall into the following categories:

- Biological hazards from exposure to laser radiation that may damage the eyes or skin
- Electrical hazards generated in the laser power supply or associated circuits
- Chemical hazards resulting from contact of the laser beam with volatile or flammable substances, or released as a result of laser material processing

The above list is not intended to be exhaustive. Anyone operating the laser must consider the interaction of the laser system with its specific working environment to identify potential hazards.

2.1.1 Optical Safety

Laser light, because of its optical qualities, poses safety hazards not associated with light from conventional light sources. The safe use of lasers requires all operators, and everyone near the laser system, to be aware of the dangers involved. Users must be familiar with the instrument and the properties of coherent, intense beams of light.

The safety precautions listed below are to be read and observed by anyone working with or near the laser. At all times, ensure that all personnel who operate, maintain or service the laser are protected from accidental or unnecessary exposure to laser radiation exceeding the accessible emission limits defined in the laser safety standards.



WARNING!

Direct eye contact with the output beam from the laser may cause serious eye injury and possible blindness.

The greatest concern when using a laser is eye safety. In addition to the main beam, there are often many smaller beams present at various angles near the laser system. These beams are formed by specular reflections of the main beam at polished surfaces such as lenses or beamsplitters. While weaker than the main beam, such beams may still be sufficiently intense to cause eye damage.

Laser beams are powerful enough to burn skin, clothing, or combustible materials, even at some distance. They can ignite volatile substances such as alcohol, gasoline, ether, and other solvents, and can damage light-sensitive elements in video cameras, photomultipliers, and photodiodes. The user is advised to follow the control measures below.

2.1.1.1 Recommended Precautions and Guidelines

1. Observe all safety precautions in the preinstallation and operator's manuals.
2. Always wear appropriate eyewear for protection against the specific wavelengths and laser energy being generated. See "Laser Safety Eyewear" (p. 11) for additional information.
3. Avoid wearing watches, jewelry, or other objects that may reflect or scatter the laser beam.

4. Stay aware of the laser beam path, particularly when external optics are used to steer the beam.
5. Provide enclosures for beam paths whenever possible.
6. Block the beam before applying tools such as Allen wrenches or ball drivers to external optics.
7. Limit access to the laser to trained and qualified users who are familiar with laser safety practices. When not in use, lasers should be shut down completely and made off-limits to unauthorized personnel.
8. Terminate the laser beam with a light-absorbing material. Laser light can remain collimated over long distances and therefore presents a potential hazard if not confined. It is good practice to operate the laser in an enclosed room.
9. Post laser warning signs in the area of the laser beam to alert those present.
10. Exercise extreme caution when using solvents in the area of the laser.
11. Never look directly into the laser light source or at scattered laser light from any reflective surface, even when wearing laser safety eyewear. Never sight down the beam.
12. Set up the laser so that the beam height is either well below or well above eye level.
13. Avoid direct exposure to the laser light. Laser beams can easily cause flesh burns or ignite clothing.
14. Advise all those working with or near the laser of these precautions.

2.1.1.2

Laser Safety Eyewear

Always wear appropriate laser safety eyewear for protection against the specific wavelengths and laser energy being generated. The appropriate eye protection can be calculated as defined in the “EN 207 Personal eye protection equipment - Filters and eye-protectors against laser radiation (laser eye-protectors)”, in other national or international standards (e.g. ANSI, ACGIH, or OSHA) or as defined in national safety requirements. Anyone working with or near the J-1000 Series laser must wear laser safety eyewear with an OD rating 5 eye protection.



CAUTION!

Laser safety eyewear protects the user from accidental exposure to laser radiation by blocking light at the laser wavelengths. However, laser safety eyewear may also prevent the operator from seeing the beam or the beam spot. Exercise extreme caution even while wearing safety glasses.

2.1.1.3 Viewing Distance

The J-1000 Series lasers produce optical power levels that are dangerous to the eyes and skin if exposed directly or indirectly. These products must be operated only with proper eye and skin protection at all times. Never view directly emitted or scattered radiation with unprotected eyes. When viewing the laser during operation, the operator must maintain the Nominal Ocular Hazard Distance (NOHD) between the laser or scattered radiation and the operator's eyes. Figure 2-1 summarizes the NOHD for the power range of the J-1000 Series for direct viewing of the collimated beam along with two other common configurations. The NOHD in this figure is based on the Maximum Permissible Exposure (MPE = 0.1 W/cm²) level for each power condition as specified in ANSI Z136.1 and IEC 60825-1.

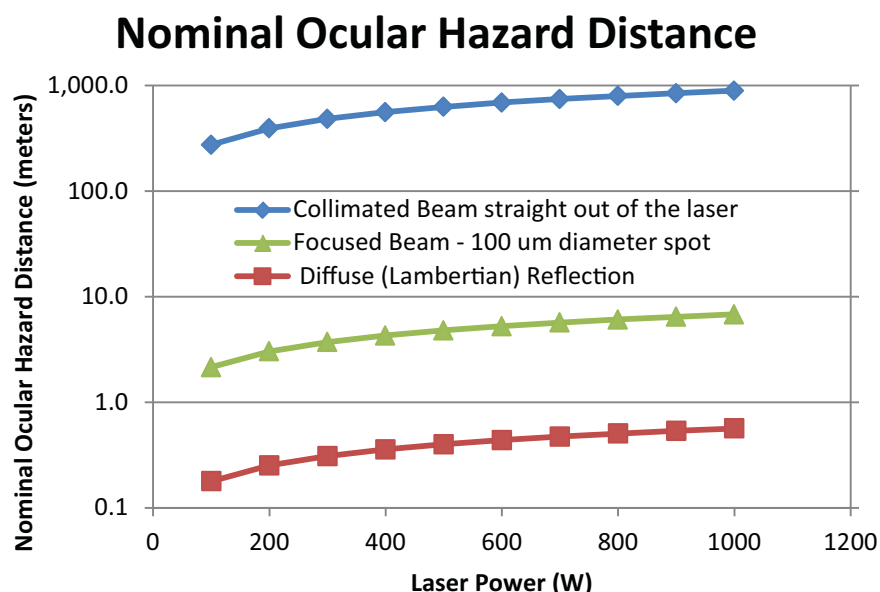


Figure 2-1. Nominal Ocular Hazard Distance (NOHD) for indicated conditions calculated per ANSI Z136.1-2007

2.1.2 Electrical Safety

All J-1000 Series laser systems, which consist of the laser head and the RF power module, require high current at + 48 VDC to operate. This voltage is sourced from commercially available power supplies from various manufacturers. The typical input voltage to these power supplies is 208 or 480 VAC. These voltages can be lethal. Every portion of the electrical system should be treated as if it is at a dangerous voltage level.

High RF power levels are present in the RF power module compartment and laser resonator compartment when the power is on. There is no RF radiation exposure hazard to personnel so long as all protective covers are not removed.



DANGER!

Normal operation of the J-1000 Series should not require access to the power supply circuitry. Removing the power supply cover will expose the user to potentially lethal electrical hazards. Contact an authorized service representative before attempting to correct any problem with the power supply.

2.1.2.1

Recommended Precautions and Guidelines

The following precautions must be observed by everyone when working with potentially hazardous electrical circuitry:



DANGER!

When working with electrical power systems, the rules for electrical safety must be strictly followed. Failure to do so could result in the exposure to lethal levels of electricity.

1. Disconnect main power lines before working on any electrical equipment when it is not necessary for the equipment to be operating.
2. Do not short or ground the power supply output. Protection against possible hazards requires proper connection of the ground terminal on the power cable, and an adequate external ground. Check these connections at the time of installation, and periodically thereafter.
3. Never work on electrical equipment unless there is another person nearby who is familiar with the operation and hazards of the equipment, and who is competent to administer first aid.
4. When possible, keep one hand away from the equipment to reduce the danger of current flowing through the body if a live circuit is touched accidentally.
5. Always use approved, insulated tools.

2.1.2.2 Laser Head and RF Power Module

High RF power levels are present in the RF power module and laser head when the power is on. Read the appropriate manual sections carefully before attempting any maintenance of components housed within the RF power module or laser head enclosures.

2.2 Safety Features and Compliance with Government Requirements

The following features are incorporated into the instrument to conform to several government requirements:

United States of America:

The applicable United States Government requirements are contained in 21 CFR, Subchapter J, Part 1040 administered by the Center for Devices and Radiological Health (CDRH).

Integrators who incorporate a J-1000 Series laser into other products that they introduce into United States commerce are defined in the law as manufacturers who are thus required to manufacture their products to conform to the Federal standard, certify them, and submit product reports to the CDRH.

For jurisdictions outside of the United States, it is the responsibility of the buyer of this laser device to ensure that it meets the local laser safety requirements.

Europe:

The European Community requirements for product safety are specified in the Low Voltage Directive (LVD) (published in 2014/35/EU). The Low Voltage Directive requires that lasers comply with the standard EN 61010-1/IEC 61010-1 "Safety Requirements For Electrical Equipment For Measurement, Control and Laboratory Use" and EN 60825-1/IEC 60825-1 "Safety of Laser Products". Compliance of this laser with the European requirements is certified by the CE mark.

2.2.1 Laser Classification

Governmental standards and requirements specify that the laser must be classified according to the output power or energy and the laser wavelength. The J-1000 Series is classified as Class 4 based on 21 CFR, Subchapter J, Part 1040, section 1040.10 (c) and/or IEC/EN 60825-1;2007, Clause 8 and IEC/EN 60825-1:2014, Clause 4. In this manual, the classification will be referred to as Class 4.

2.2.2 Protective Housing

The laser head is enclosed in a protective housing that prevents human access to radiation in excess of the limits of Class radiation as specified in the 21CFR, Part 1040 Section 1040.10 (f)(1) and EN 60825-1/ IEC 60825-1 Clause 6.2 except for the output beam, which is Class 4.

2.2.3 Protective Covers (Safety Interlocks)

The laser's protective covers are not interlocked and should only be removed by trained service technicians.



WARNING!

Use of controls or adjustments, or performance of procedures other than those specified herein, may result in hazardous radiation exposure.



DANGER!

To avoid potentially fatal electrical shock hazards from electrical equipment, follow all applicable electrical codes such as (in the U.S.) the National Electrical Code.

2.3 Compliance to Standards Relevant to CE Mark

J-1000 Series lasers are OEM products, and are sold as components for integration into complete laser systems by a system integrator. These products are tested and CE Marked as independent products. For specific details regarding what applicable compliance directives and standards the products have been tested to, refer to the Declaration of Conformity which is available upon request from Coherent, per contact information on p. ii of this manual.

Compliance to applicable standards for a particular laser tool incorporating J-1000 Series lasers must be demonstrated by the manufacturer of the complete system. The primary issue for the system integrator is to design covers, shielding, grounding, routing of electrical cable assemblies, and control elements with the proper safety features so that during subsequent testing the system meets the appropriate standards.

2.4 Environmental Compliance

This section describes compliance with various environmental regulatory directives to identify hazardous substances.

2.4.1 Electromagnetic Compatibility

Compliance of this laser with the Electromagnetic Compatibility (EMC) requirements is certified by the CE mark. For more information about the CE mark see “Compliance to Standards Relevant to CE Mark” (p. 16).

Each application and installation is unique, and in some cases, the user may experience Electromagnetic Interference (EMI) noise being emitted from various electronic components. This laser uses high-frequency RF (100 MHz). While adequate countermeasures have been taken to suppress this emission to meet the requirements stated on the Declaration of Conformity, the user may wish to employ additional measures to suppress the EMI to reduce the emissions further. Standard methods of reducing the EMI are:

1. Use of shielded control cables grounded on both ends
2. Addition of appropriate ferrite beads to cables connected to the beam source.

2.4.2 RoHS Compliance

The RoHS directive restricts the use of certain hazardous substances in electrical and electronic equipment. Coherent can provide RoHS certification upon request for products requiring adherence to the RoHS Directive.

2.4.3 China-RoHS Compliance

Coherent products supplied by Coherent are in conformity with applicable requirements of China's "Management Methods", commonly referred to as China-RoHS, and associated standards and applies to the production, sale, and import of products in the People's Republic of China.

The China RoHS Regulation requires that the Environment-Friendly Use Period (EFUP) symbol be displayed on any product. This symbol indicates an environmental-friendly use period with the number of years inside the circle (Figure 2-2).



Figure 2-2. Environmentally Use Period Symbol

This regulation also requires that the date of manufacture be identified (in Chinese characters) on the product label (Figure 2-3).

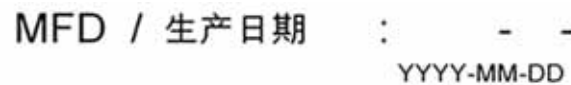


Figure 2-3. Manufacture Date

The China RoHS Hazardous Substance Marking Table is located in the shipping document packet shipped with the product (or laser system).

2.4.4 EU REACH

REACH (Registration, Evaluation, Authorization, and Restriction of Chemicals) is a European Union Commission (EUC) Regulation on chemicals and their safe use (EC 1907/2006) and entered into force on 01 June, 2007.

Coherent products are “articles” as defined in REACH Article 3(3) and do not release substances under their normal use. Suppliers of articles must provide recipients with information on Substances of Very High Concern (SVHC) if those are present above a concentration limit of 0.1% on an article level. As Coherent's duty to communicate information on substances in articles, the delivered product(s), based on Coherent's knowledge, may contain the listed chemical substance(s) included on the REACH Candidate List at this link:

https://edge.coherent.com/assets/pdf/reach_article_33_statement.pdf

The current Candidate List of SVHCs can be found on the ECHA website <https://echa.europa.eu/home>

Coherent will post information on SVHCs to the Coherent website as the information becomes available and assures its customers that Coherent products are in full compliance with the EU REACH requirement. For detailed information on SVHC and Coherent products, visit:

<https://www.coherent.com/company/environmental>.

2.4.5 Waste Electrical and Electronic Equipment (WEEE)

The European Waste Electrical and Electronic Equipment (WEEE) Directive (2012/19/EU) is represented by a crossed-out waste material container label. The purpose of this directive is to minimize the disposal of WEEE as unsorted municipal waste and to facilitate its separate collection.

The WEEE Directive applies to this product and any peripherals marked with this symbol. Do not dispose of these products as unsorted municipal waste. Contact the local distributor for procedures for recycling this equipment.

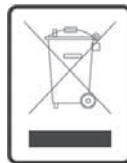


Figure 2-4. Waste Electrical and Electronic Equipment Label

2.5 Location of Safety Labels

Refer to Figure 2-5 and Figure 2-6, "Labels" (p. 20) for a location and description of all required safety labels. These include warning labels indicating removable or displaceable protective housings, apertures through which laser radiation is emitted, and labels of certification and identification [21 CFR § 1040.10(g), 21 CFR § 1010.2, and 21 CFR § 1010.3/ EN 60825-1/IEC 60825-1, Clause 7].

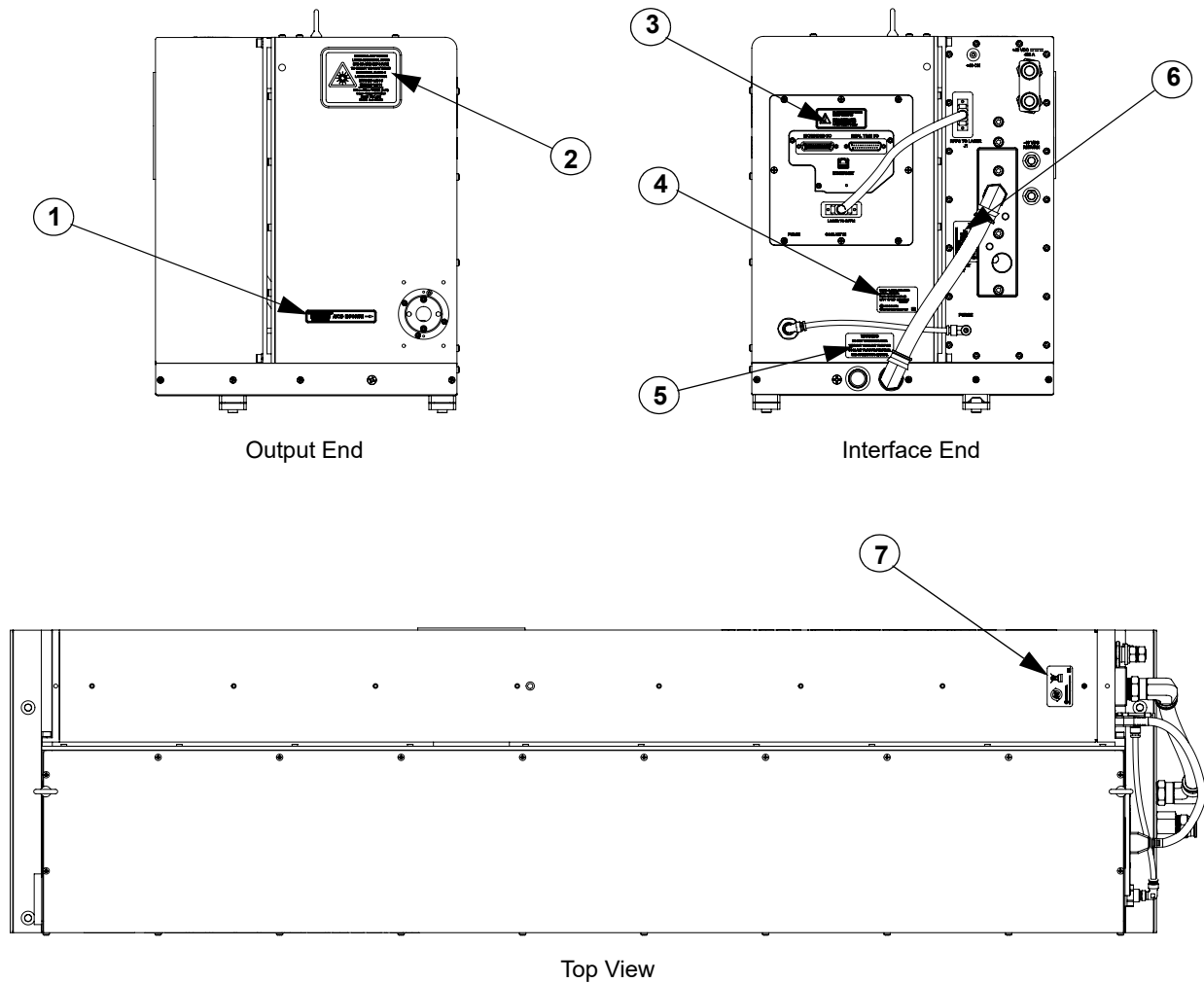
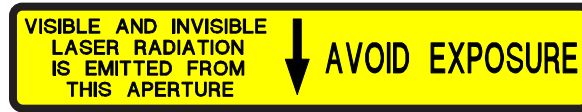


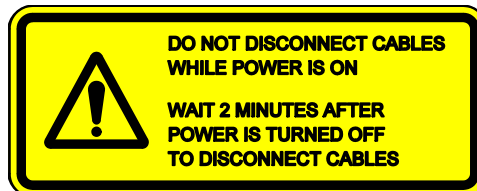
Figure 2-5. Label Placement



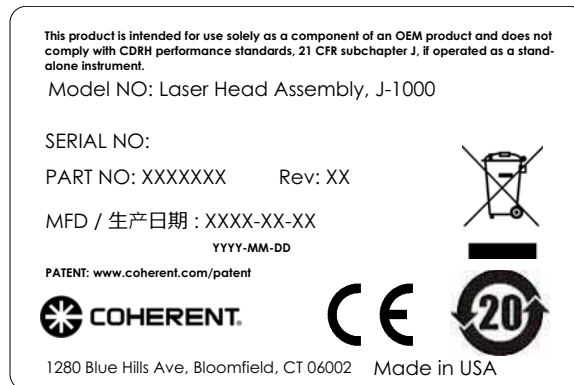
1 – Laser Aperture Label



2 – Laser Classification Label



3 – Cable Disconnect Cautionary Label

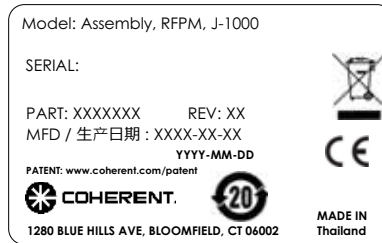


4 - Laser Head Product Nameplate Label (Example)

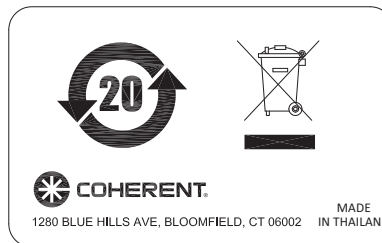
Figure 2-6. Labels



5 – Coolant Requirement Warning Label



6 – RF Power Module Product Nameplate Label (Example)



7 – Compliance Label on RF Power Module

Figure 2-6. Labels (Continued)

2.6 Sources of Additional Information

The following are sources for additional information on laser safety standards and safety equipment and training.

2.6.1 Laser Safety Standard

American National Standard for Safe Use of Lasers
ANSI Z136 Series
American National Standards Institute (ANSI)
www.ansi.org

Performance standards for light-emitting products
21 CFR Title 21 Chapter 1, Subchapter J, Part 1040
U.S. Food and Drug Administration
www.fda.gov

2.6.2 Publications and Guidelines

International Electrotechnical Commission (IEC)
www.iec.ch

A Guide for Control of Laser Hazards
American Conference of Governmental
and Industrial Hygienists (ACGIH)
www.acgih.org

Laser Safety Guide
Laser Institute of America
www.lia.org

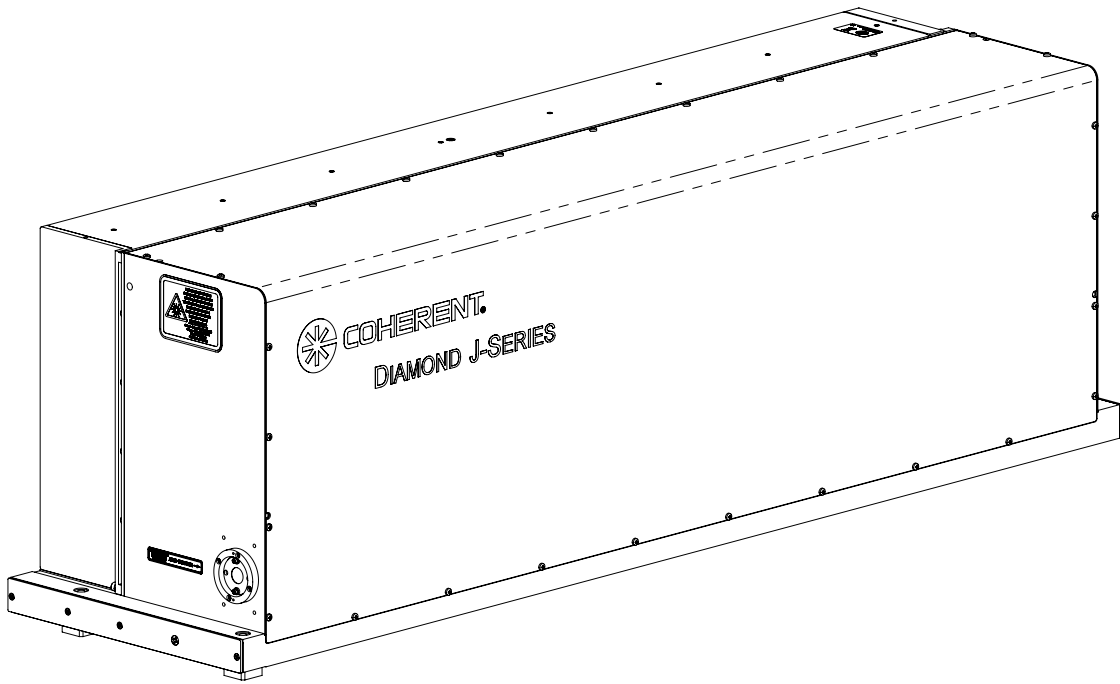
3 SYSTEM DESCRIPTION

3.1 Introduction

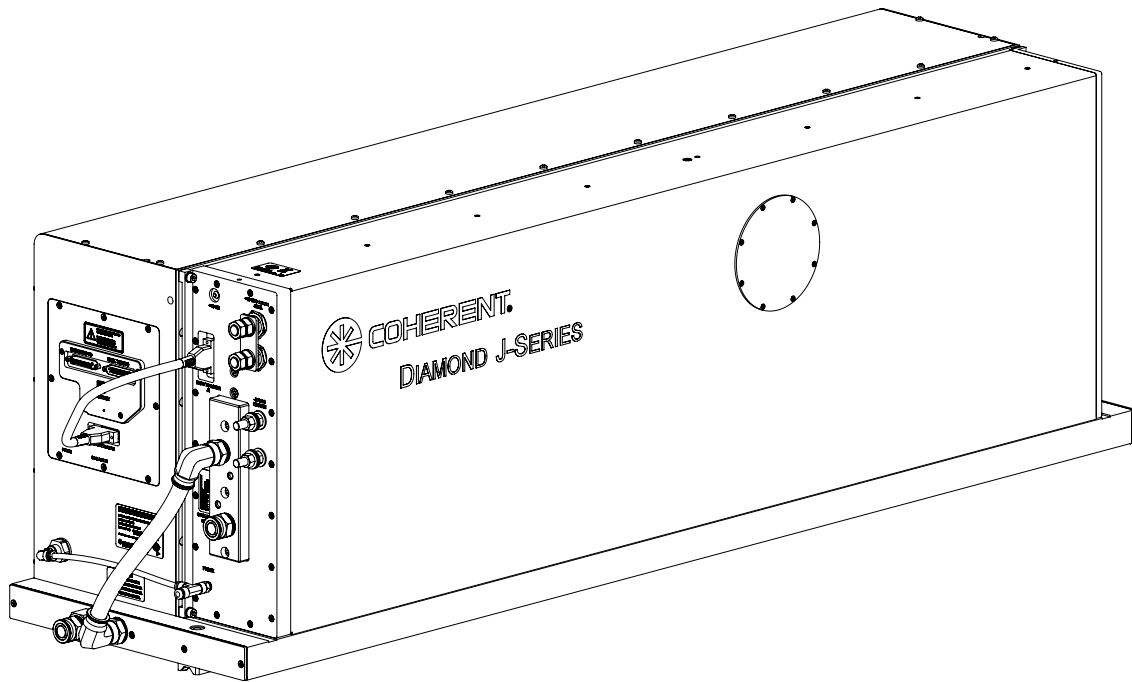
The J-1000 Series laser systems (Figure 3-1 and Figure 3-2) are integrated, RF excited, liquid-cooled, sealed-tube, pulsed industrial CO₂ lasers and consist of an integrated laser head and RF power module. These integrated systems operate on 48 VDC at high currents; therefore a DC power supply is required. To remove heat from the laser system (and from the liquid-cooled DC power supply, if used), external liquid cooling is essential. A continuous supply of purge gas to the laser system is needed to prevent condensation and reduce contamination on optical surfaces. Internal control electronics act on external signals to vary pulse frequency and duty cycle while monitoring laser performance and safety circuits. A simplified laser system block diagram is shown in Figure 3-3, "Simplified System Block Diagram" (p. 25).



Figure 3-1. J-1000 Series Laser Systems



a. Output End Isometric View



b. Interface End Isometric View

Figure 3-2. J-1000 Series Laser

3.2 Purpose of This Manual

This manual is designed to assist the Original Equipment Manufacturer (OEM) during the integration of any J-1000 Series laser. It contains information on the performance and operation of the laser as well as installation and control methods. This OEM manual is intended to be used by trained staff during the process of integration into a laser tool.

3.3 J-1000 Series Lasers

J-1000 Series lasers operate in either a pulsed or quasi-continuous wave modes, and can be operated via several control and communication methods to generate many pulse formats. This allows the user complete control of the output beam and power output.

All J-1000 Series lasers are equipped with a powerful embedded control system that is useful in providing onboard diagnostics (setup and troubleshooting) as well as fault isolation. Laser data are accessible using a standard LAN connection via HTML protocol. A detailed description of the embedded control is available in "Appendix A: Embedded Diagnostics and Fault Matrix" (p. 133). A simplified laser system block diagram is shown in Figure 3-3.

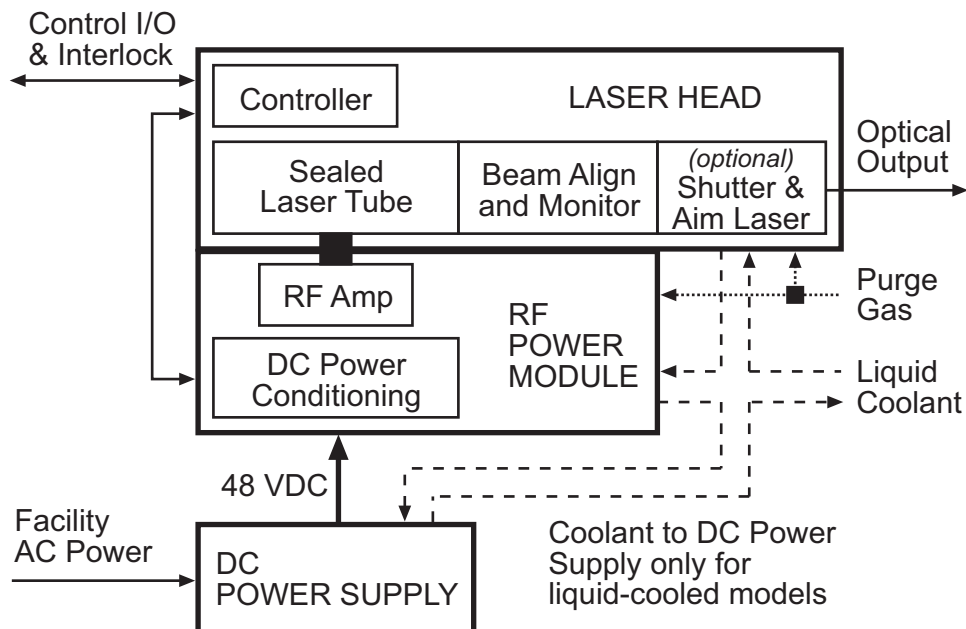


Figure 3-3. Simplified System Block Diagram

3.4 Laser System Components

J-1000 Series lasers contain the laser head (tube) with beam conditioning optics, (optional) shutter and RF matching network, simmer circuit, control electronics, coolant temperature and internal monitors, and the RF power module (Figure 3-4).

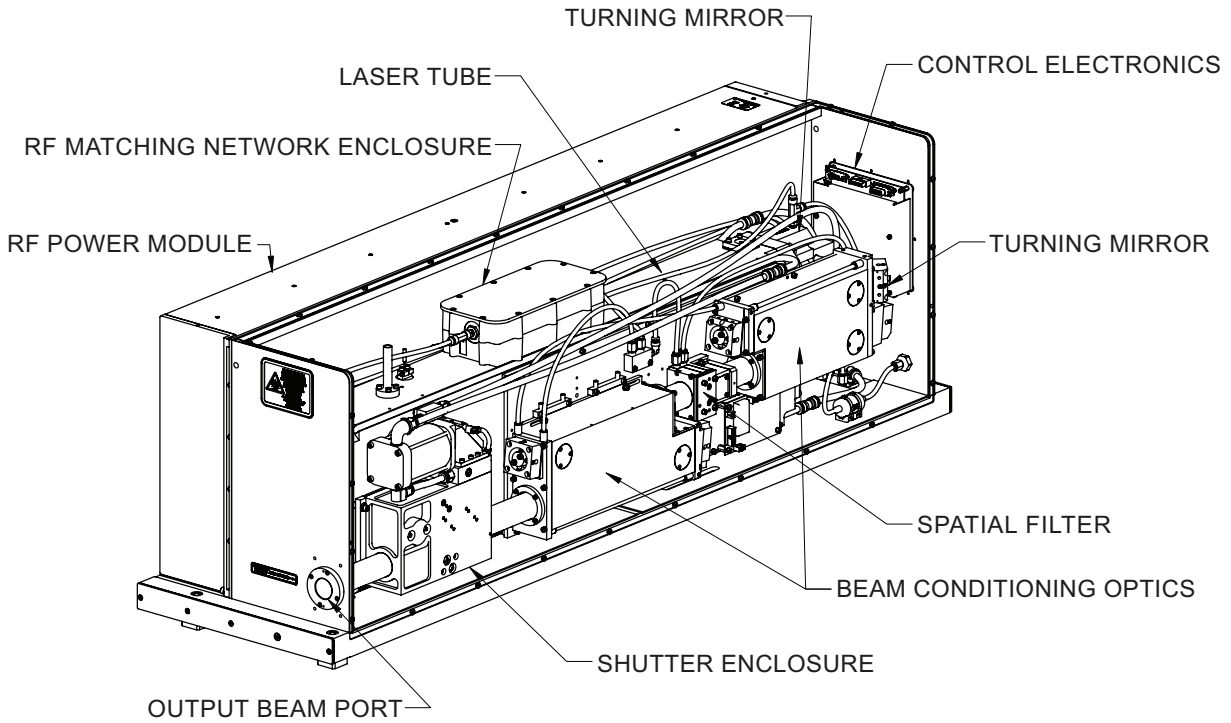


Figure 3-4. J-1000 Series Laser - Component Placement Diagram



NOTICE!

The laser system incorporates a sealed laser tube, which by design requires no laser gas exchange or periodic refill for operation.

The all metal construction of the laser head provides high thermal stability and resistance to damage due to shock and/or vibration.

3.4.1

Tube

The laser tube consists of a two mirror optical cavity with fluid-cooled rectangular shaped (slab design) electrodes extending the length of the tube. An RF matching network is mounted on top of the tube and coils within the tube are positioned to create a uniform distribution of RF energy across the electrodes (see Figure 3-5).

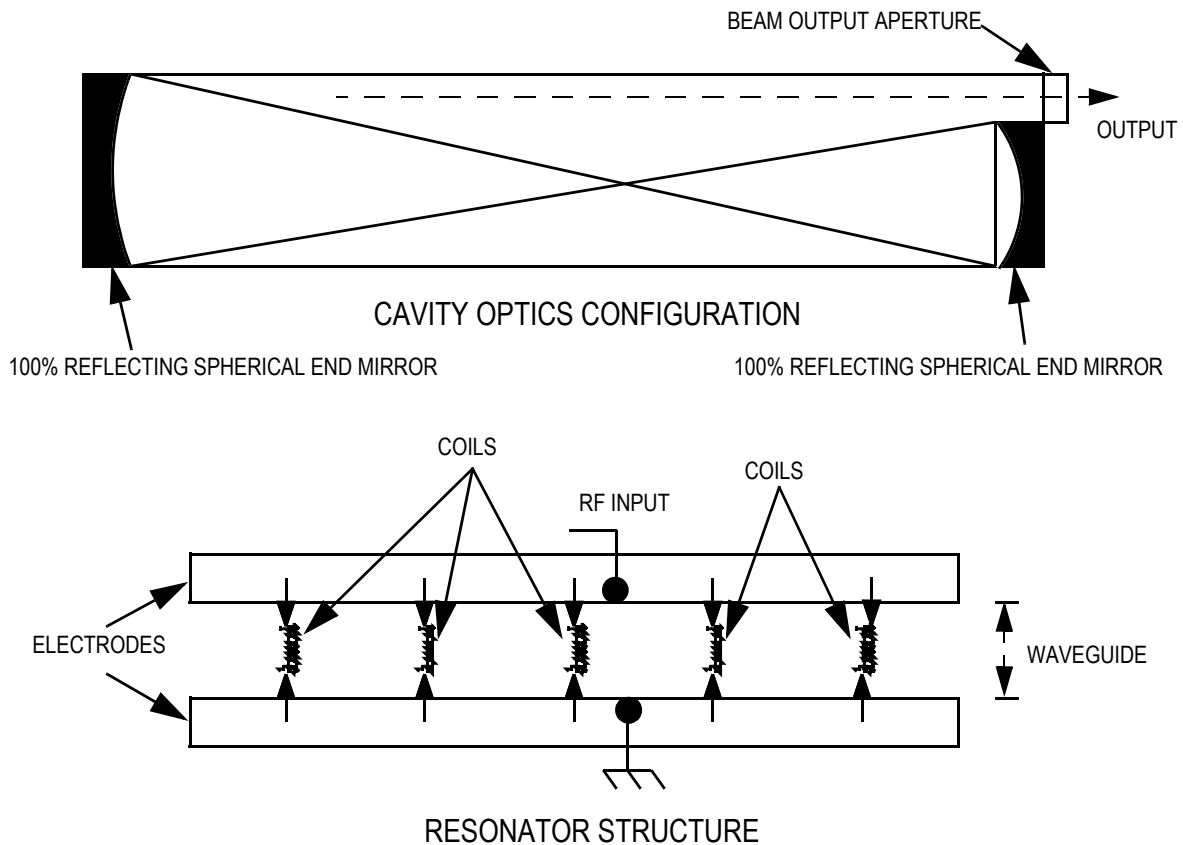


Figure 3-5. Laser Tube

One of the 100% reflecting end mirrors partially covers the electrode area. The gap at the end of the mirror forms the output path for the laser beam. The beam exiting in this gap passes through a zinc selenide sealing window at the output end of the tube.

3.4.2 Optics

The resonator optics are within the sealed head and require no maintenance or alignment. Upon exiting the laser cavity, the asymmetrical laser beam (wide in one transverse beam axis and narrow in the orthogonal beam axis) propagates through an output window and on through a series of precision aligned optical components. These components serve to create a circular symmetrical propagating optical beam. As the beam is corrected for symmetry, it is also focused through a narrow set of knife edges. These knife edges are set wide enough to allow the main lobe of radiation to pass, but also strip off unwanted side-lobe energy. Finally, the beam reflects off of a spherical mirror which nominally collimates the beam for minimum divergence, then to an (optional) internal shutter assembly before it exits the laser head aperture.

3.4.3 Simmer Circuit

The simmer circuit generates short duration RF pulses at 1,000 μ s intervals (1 kHz rate) to the tube gas in order to promote rapid starting after periods of being turned off. The simmer pulse is automatic to ensure instant-on operation, but is not powerful enough to cause laser action. When commanded to modulate, the simmer circuit is disabled.

3.4.4 Control Electronics

The J-1000 Series control electronics provide control, diagnostics, and fault management for the system. Primary control and diagnostics are provided through dedicated signal connections on the interface panel. The hardware interface circuitry is highly similar to the other DIAMOND OEM products. See "Control Interfaces" (p. 85) for a detailed interface description.

A secondary Ethernet interface is provided for remote control, diagnostics, and troubleshooting. See "Appendix A: Embedded Diagnostics and Fault Matrix" (p. 133) for more information.

All J-1000 Series lasers are equipped with a main controller as well as distributed microcontrollers located throughout the system. Fault management is accomplished by the main controller using data from the distributed microcontrollers. The main controller also polls the distributed microcontrollers for status information and system warnings.

3.4.5 Coolant Temperature Monitor

All J-1000 Series lasers require water with a corrosion inhibitor additive as the cooling medium to remove heat from the laser head and RF power module. Temperature probes and circuits within the laser head and RF power module continuously monitor the coolant temperature whenever the laser is on. If the internal coolant temperature falls outside pre-set limits, the laser will not operate and will indicate a temperature fault condition. To prevent temperature faults, the customer must maintain proper coolant temperature and flow as specified in the utility requirements.



NOTICE!

Failure to provide proper coolant temperature and flow to this laser will result in intermittent or halted operation of this laser.

3.4.6 Internal Power Monitor

J-1000 Series lasers are equipped with an internal power monitor. The final mirror allows a small percentage of the output beam to strike a thermopile sensor located behind it. This sensor generates an output voltage proportional to laser output power. An analog signal is available at the extended interface signal connector, with a conversion factor of 1.5 mV per watt. The internal power meter is calibrated against an external power meter calibrated and traceable to NIST calibration standards.

3.5 RF Power Module

The RF power module provides pulsed RF power to the laser head to energize the laser gas mixture in the tube. The laser output pulse (width and frequency) is based on an input modulation signal to the RF power module.

The RF power module should always be physically and electrically connected to the laser head (load). Although protection is built into the unit, operating the RF power module with no load could cause damage.

The RF power module control circuitry also has the following features:

- Provides protection from duty cycle exceeding 60%.
- Limits the pulse width to less than 1 msec.
- Monitors forward and reflected RF power to and from the laser head.
- Contains a factory set VSWR limit (a ratio between two monitored voltages, representing efficient coupling of RF Energy) that limits duty cycle in case the laser fails to start.
- The RF power module contains embedded control sensors which supports fault isolation. Further description of this capability is found in "Appendix A: Embedded Diagnostics and Fault Matrix" (p. 133).

3.6 DC Power Supply

A high current 48 VDC power supply is the required power source for the J-1000 Series laser systems.

Note that the laser presents a pulsed dynamic load to the DC power supply. Using an oscilloscope, laser modulation induced variation across the RF power module DC input terminals will be observed.

It is the responsibility of the system integrator to provide AC input power wiring (electrical disconnect, circuit breaker/fusing, power cord, receptacles, and mating plugs). Consult a qualified electrician to select and install the appropriate components that meet local electrical codes.

The DC power supply output cables are a critical part of the overall system. Coherent can provide the DC output cables required to handle the high current requirement.

3.7 Configuration & Facility Requirements

Table 3-1 provides configuration and facility requirements for the J-1000 Series laser system's. Laser performance specifications are provided in the J-1000 Series data sheet available on-line at www.coherent.com and in the test report provided with each laser system.

Table 3-1. Configuration & Utility Requirements

Parameter	Value
Laser Physical Characteristics	
Weight	173 kg (381 lbs.)
Dimensions (L x W x H)	1497 x 384 x 471 mm (58.9 x 15.1 x 18.5 in.)
Electrical Power Requirements	
DC Input Voltage (VDC)	48 ± 1.0%
Continuous DC Current (A)	≤ 425
Peak Current (A)	< 628 for up to 1 ms
Coolant	
Heat Load (kW)	< 22
Dynamic Coolant Flow Rate (l/pm)	> 25 lpm (6.5 gpm)
Coolant Temperature Stability (max.)	±1°C (±1.8°F)
Coolant Setpoint Temperature Range	21 to 25°C (69.8 to 77°F)
Coolant ¹	Anti-corrosion treated water
Coolant Differential Pressure ² (kPa)	344 kPa (50 psi) @ 25 lpm (6.5 gpm)
Coolant Maximum Static Pressure (kPa)	827 kPa (120 psi)
Environmental Conditions	
Ambient Temperature	5 to 45°C (41 to 113°F)
Relative Humidity ³ (%)	< 95 (non-condensing)
Altitude	< 2,000 m (<6,500 ft.)
Shock & Vibration	1 G static acceleration 0.2 G RMS vibration
<p>The above specifications subject to change without notice.</p> <p>¹ See "Coolant Composition" (p. 43)</p> <p>² This differential pressure is from system input to output and does not include the pressure drop from chiller fittings and the supply and return hose.</p> <p>³ Do not operate at or below dew point.</p>	

3.8 Laser Dimensional Drawings

The laser dimensions and required clearance are shown in Figure 3-6.



Note that the clearance dimensions given for interface connections and service access are minimums. Increasing the clearance dimensions will provide ease of installation, troubleshooting, and service.

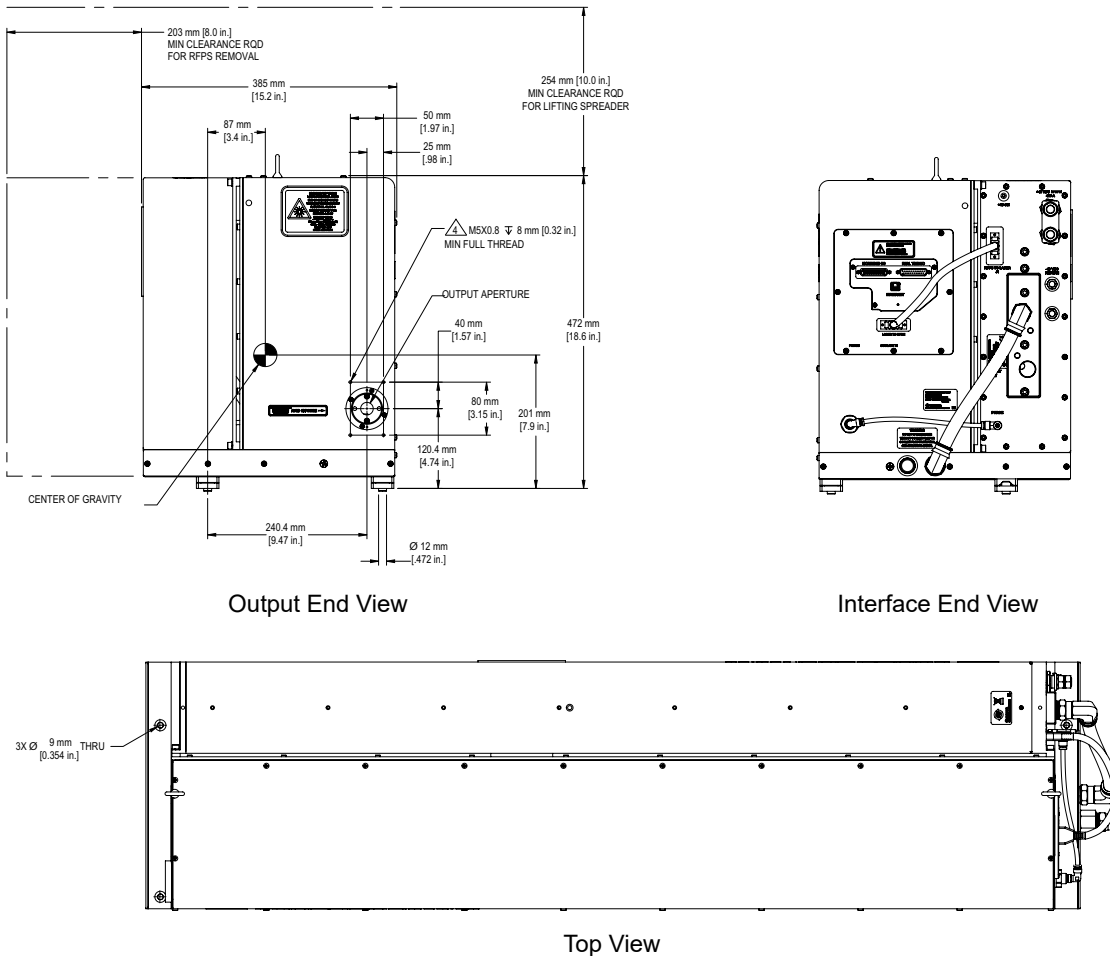
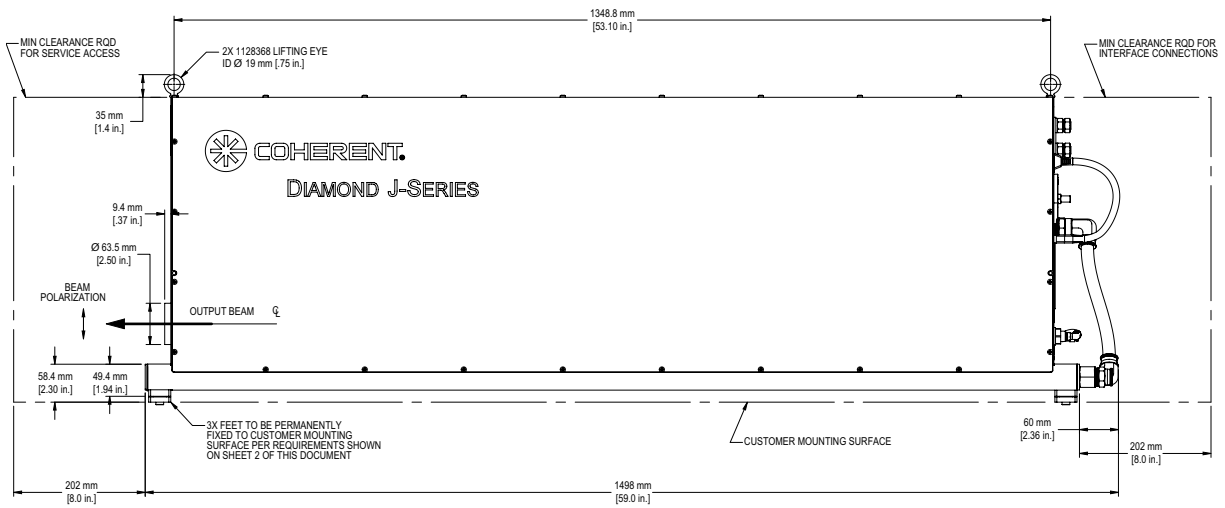
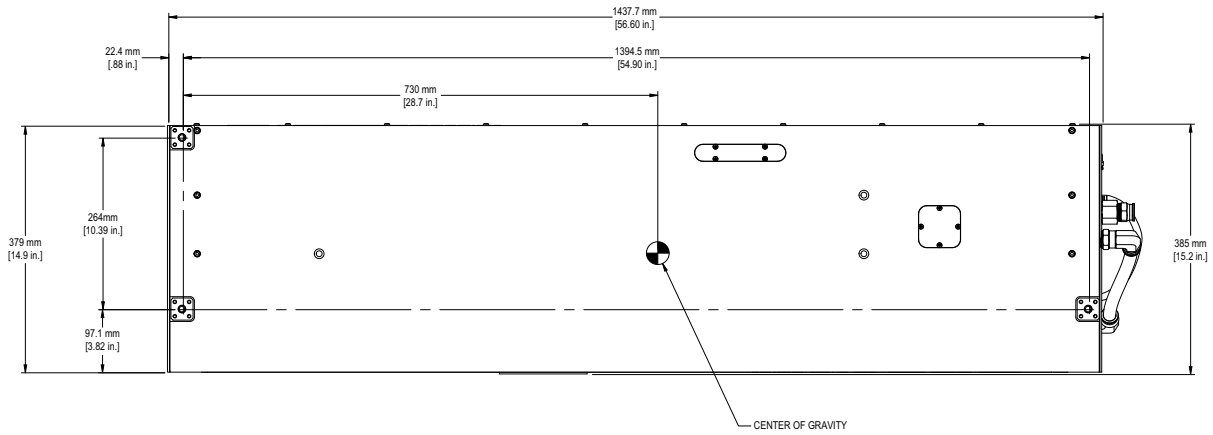


Figure 3-6. J-1000 Series Dimensions (including clearance)



Side View



Bottom View

Figure 3-6. J-1000 Series Dimensions (including clearance)

4

UTILITY REQUIREMENTS AND SYSTEM INSTALLATION



NOTICE!

Before installation, it is essential that the customer read this manual thoroughly. It is important that the user become familiar with all aspects of the installation and operation of the J-1000 Series laser system, including and specifically the information contained in "Laser Safety" (p. 9).

4.1

Preinstallation Checklist

In order to perform a smooth integration of the laser system into a tool or installation at a customer site, it is necessary to prepare in advance. A preinstallation checklist outlining the general requirements is provided in Table 4-1.

Table 4-1. Preinstallation Checklist

Activity	General Requirements	Reference(s)
Confirm Laser Environment	<ul style="list-style-type: none"> <input type="checkbox"/> Temperature and Humidity in specification <input type="checkbox"/> Cleanliness <input type="checkbox"/> Vibration <input type="checkbox"/> Ventilated space 	<p>“Confirm Laser Environment” (p. 38)</p> <p>“Operation in Humid Environments” (p. 38)</p>
Receive and Inspect	<ul style="list-style-type: none"> <input type="checkbox"/> Area is clean and sufficiently large enough to uncrate laser <input type="checkbox"/> Forklift or pallet jack capable of moving the fully loaded crate (320 kg/705 lbs.) <input type="checkbox"/> Forklift or hoist capable of lifting the 173 kg (381 lbs.) laser off shipping pallet <input type="checkbox"/> Cart capable of moving 173 kg (381 lbs.) laser to installation area 	<p>“Receive and Inspect” (p. 39)</p> <p>“Unpacking and Inspection” (p. 58)</p>
Laser Installation Area	<ul style="list-style-type: none"> <input type="checkbox"/> Clear path to installation site <input type="checkbox"/> Forklift or hoist capable of lifting the 173 kg (381 lbs.) laser plus lifting hardware into tool <input type="checkbox"/> Laser head mounting area prepared: lift access, mounting feet installed, able to support 173 kg (381 lbs.) laser system plus weight of cables, hoses, output aperture accessories, etc. <input type="checkbox"/> Service access provided <input type="checkbox"/> All connections reach the laser head 	<p>“Laser Installation Area” (p. 40)</p> <p>“Mounting the Laser System Components” (p. 68)</p>
Laser System Cooling	<ul style="list-style-type: none"> <input type="checkbox"/> Chiller installed and operational (loop test OK) <input type="checkbox"/> Coolant is a mixture of water and corrosion inhibitor <input type="checkbox"/> 30 µm particle filter installed at laser head inlet <input type="checkbox"/> Shut-off valves installed (optional, recommended) <input type="checkbox"/> 5/8” ID or greater hose between the laser and chiller <input type="checkbox"/> Required flow rate, temperature set point and temperature stability capability verified 	<p>“Laser System Cooling” (p. 41)</p> <p>“Coolant Composition” (p. 43)</p> <p>Table 3-1, “Configuration & Utility Requirements,” (p. 31)</p>

Table 4-1. Preinstallation Checklist (Continued)

Activity	General Requirements	Reference(s)
Laser System Purge Gas	<ul style="list-style-type: none"> <input type="checkbox"/> N₂ or filters installed to provide clean, dry air <input type="checkbox"/> Shut-off valve installed (optional, recommended) <input type="checkbox"/> Output fitting installed to accept 1/4" OD tubing <input type="checkbox"/> Clean, flexible 1/4" OD tubing to connect purge gas supply to the laser head 	<p>"Laser System Purge Gas" (p. 47)</p> <p>"Accessories and Options" (p. 165)</p>
DC Power Supply	<ul style="list-style-type: none"> <input type="checkbox"/> Rack w/shelf, bench or frame (mounting) prepared <input type="checkbox"/> Electrical circuit with circuit breaker/fuse and electrical disconnect ready <input type="checkbox"/> Mains input (electrical disconnect to power supply) power cable ready <input type="checkbox"/> Cooling water system, supply and return lines and fittings ready (for liquid-cooled DC power supplies only) 	<p>OEM Product Literature (external document(s))</p> <p>"DC Power Supply Electrical Service" (p. 51)</p>
Beam Delivery System	<ul style="list-style-type: none"> <input type="checkbox"/> Beam delivery system purge gas ready <input type="checkbox"/> Optical Isolator installed (if cutting/marketing reflective material) <input type="checkbox"/> External optical beam delivery system meets optical specifications 	<p>"Beam Delivery System" (p. 52)</p>
Laser Control, Measurement and Diagnostic	<ul style="list-style-type: none"> <input type="checkbox"/> If using a Coherent DIAMOND Remote Control, a controller is available <input type="checkbox"/> If monitoring laser diagnostics with a personal computer via network cable, a computer Ethernet cross-over cable is required <input type="checkbox"/> For 3rd party controller, see OEM documentation <input type="checkbox"/> Interlocks installed <input type="checkbox"/> Suitable Power Meter and Detector Head available 	<p>"Laser Control, Measurement & Diagnostic" (p. 53) and "Control Interfaces" (p. 85)</p> <p>DIAMOND Remote Control Operator's Manual, part number 1235412 (external document)</p> <p>"Power Meters and Sensors" (p. 165)</p>
Laser Safety	<ul style="list-style-type: none"> <input type="checkbox"/> Laser Safety Officer (LSO) identified (recommended) <input type="checkbox"/> Laser Safety Training completed <input type="checkbox"/> Laser Controlled Area established <input type="checkbox"/> Personal Protective Equipment (laser safety eyewear) available 	<p>"Laser Safety" (p. 54)</p> <p>"Laser Safety" (p. 9)</p>

4.1.1 Confirm Laser Environment

The laser must be installed and operated in a temperature and humidity-controlled environment. The operating temperature must be 5 – 45°C (41 – 113°F). The humidity must be 5 – 95%, non-condensing, for the laser system coolant inlet temperature. Operating altitude must be <2,000 m (6,600 ft.).

Additionally, the laser environment should be clean and free of air-borne particles, and mounted such that vibrations are within specification. If possible, create a “clean” area for the laser and initial beam delivery optics and a “dirty” area for the final beam delivery system and work piece.

Since the laser and/or associated beam delivery systems may be nitrogen purged and the cutting/marking processes generally create noxious fumes, make sure to provide adequate ventilation for all operators in the area.

4.1.1.1 Operation in Humid Environments

The cooling fluid of the J-1000 Series lasers can condense moisture from the air when the temperature of the cooling fluid is at or below the dew point of the air.



NOTICE!

The system must not operate in a condensing environment since this condition will lead to catastrophic failure in both the laser head and the RF power module. Doing so will void the warranty. It is the responsibility of the customer to ensure an J-1000 Series laser system is never operated in a condensing environment. Failed laser heads and RF power supplies must be returned to the factory for repair.

Condensation may form on any component surface when the surface temperature is at or below the dew point of the air. The typical condition that leads to condensation is warm, humid weather combined with fluid that is cooler than the surroundings.

High risk conditions which are likely to lead to condensation are:

- Operating the laser in a room that is not air conditioned in high humidity environments
- Using cooling fluid that is not temperature controlled
- Leaving the cooling fluid system on when the laser is not operating for extended time periods

Risk of Condensation: The information required to determine if the cooling fluid temperature will lead to condensation is:

- Room temperature
- Relative humidity

Since weather conditions change, these factors need to be periodically checked especially in spring, summer, or wet seasons. In environments that are air conditioned, Coherent recommends setting the cooling fluid temperature to 23°C (73.4°F). For environments that are not air conditioned, Coherent recommends that the cooling fluid temperature be increased to the air temperature to avoid condensation in humid climates, but no higher than 26°C (78.8°F) and not less than 20°C (68°F).

4.1.2

Receive and Inspect

The J-1000 Series laser system packaging has been designed for robust shipment. Upon receiving the system, inspect the outside of all containers immediately to ensure no damage occurred during transit. If there appears to be visible damage (holes in the containers, fluid damage, crushing, etc.), immediately notify Coherent and a representative of the carrier. Request that a representative of the freight company be present when unpacking the contents.



NOTICE!

To avoid damage to the system, keep the original shipping containers and packing materials for transporting the J-1000 Series laser system from one location to another. If the system is to be returned to Coherent for repair, it must be transported in the original shipping container.

The containers may appear to be in good condition, but the contents may be damaged. Inspect all major components as they are unpacked. Unpacking procedure instructions are found in “Installation” (p. 54).

To unpack the laser system, at least two people and the following tools will be required:

- Scissors or a package cutting knife
- 8" adjustable wrench
- Large Pliers (may be required to loosen 2 wing-nuts)
- Forklift or pallet jack able to lift and move at least 320 kg (705 lbs.) - total weight of a fully loaded shipping crate
- Forklift or hoist capable of lifting the 173 kg (381 lbs.) laser system out of the crate
- Cart capable of supporting and transporting the 173 kg (381 lbs.) laser system to the installation area



NOTICE!

While in transit, the shipping container and its contents may be exposed to cold temperatures. To prevent condensation from developing on and within the laser system and causing damage, move the crate to a location near the installation area and allow it to acclimate before unpacking the laser.

4.1.3 Laser Installation Area

It is assumed that the laser will be integrated into a laser cutting or marking tool designed and manufactured by a third party. Because each system installation is unique, only general guidelines will be discussed.

4.1.3.1 Service Access

It is highly recommended that the system integrator follow the Coherent recommendation for laser orientation with respect to service access within the customer's equipment (see Figure 4-19a Laser Head Mounting Dimensions on page 69).

If placing the laser inside a cabinet or enclosure, make sure to design sufficient access to all lifting and mounting points. Additionally, make sure to provide adequate service clearance at the rear (interface connectors), the front (coupling to beam delivery system), top and sides (to remove covers for service access), and above and around the RF power module, as the RF power module is field replaceable.

- Mount the laser system with the RF power module readily accessible through service access panels.
- Provide easy access to all electrical and signal connections.
- Provide easy access to cooling and purge connections.



NOTICE!

Providing the recommended service access will provide ease and speed of service and repair of the J-1000 Series laser system.

Also, consider the interface/connection point locations at the rear end of the laser system and the length of cables, hoses and tubing, including service loops, when placing the DC power supply, chiller and control system.

4.1.3.2

Mounting Feet

Since all J-1000 Series laser beams are precisely aligned with reference to three kinematic mounting feet, it is recommended that laser integrators utilize this mounting feature. Refer to the mechanical drawing in Figure 4-19d “Mounting Foot Detail” on page 69.

Because beam pointing is virtually identical for all lasers referenced to these feet, re-alignment of delivery system optics, in the event of a laser replacement, will greatly be minimized if aligned to the reference position. Since the laser is precisely aligned to these mounting features, a laser can be replaced with minimal or potentially no delivery system re-alignment.

4.1.4

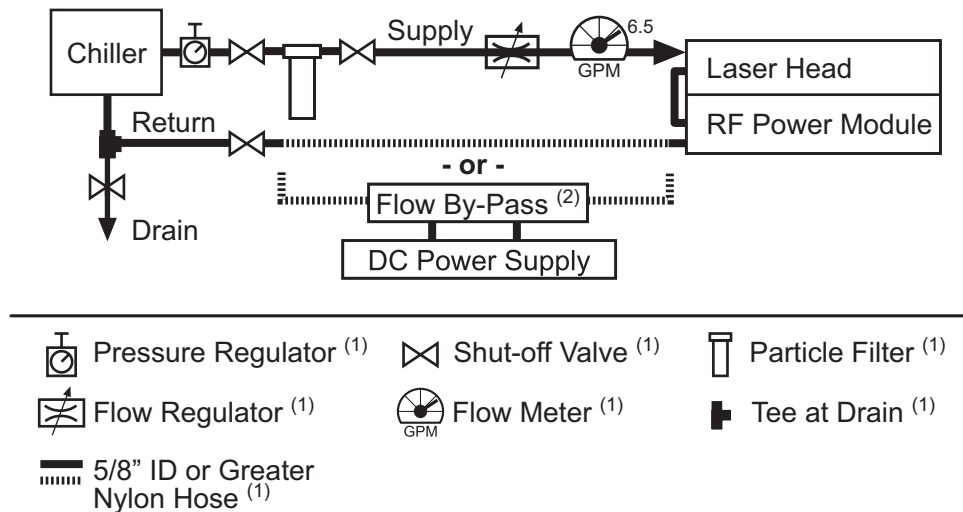
Laser System Cooling

The J-1000 Series laser head and the RF power module require a continuous flow of constant temperature cooling fluid. Because the properties of the cooling fluid are important for laser performance, ensure that the conditions remain within the tolerance limits listed in Table 3-1, “Configuration & Utility Requirements,” on page 31 at all times.

A closed-loop cooling system (chiller) should be used to obtain consistent and stable laser performance. The chiller must be able to remove up to 20 kW of heat, plus an additional 2 kW if the liquid-cooled DC power supply option is used. The coolant composition for the closed-loop chiller is described in the following section.

A typical flow diagram is shown in Figure 4-1. The delivery system and/or laser power detector may be connected in parallel auxiliary loops as long as they do not reduce the required flow to the laser, or they may be cooled by a separate chiller.

If using the optional liquid-cooled power supply, it is to be connected in series *after* the laser system. The liquid-cooled power supply must be installed with the provided bypass loop to maintain the high flow required by the laser (as the power supply alone will restrict the flow).



Notes:

1. Recommended - customer supplied parts
2. Included with optional Liquid-cooled DC Power Supply

Figure 4-1. Coolant Flow Diagram

4.1.4.1 Coolant Temperature

At the laser head, the inlet temperature of the cooling fluid should always be above the dew point to prevent condensation from developing inside the laser head or RF power module.

4.1.4.2 Coolant Filtering

To prevent accumulation of debris in the cooling system, the coolant should be filtered at the inlet to the laser system. Coherent recommends the use of a particle filter that traps particles larger than 30 µm in diameter. However, if the chiller manufacturer recommends a finer filter, follow their recommendation.

A coolant kit is provided with each laser system, which contains 3/4" NPT to Male GHT (Garden Hose Thread) and 3/4" NPT to Female GHT fittings. This permits the use of off-the-shelf garden hose to connect the laser system to the chiller system. In general, Coherent recommends the use of hose with an ID of 5/8" (16mm) or greater to minimize the pressure drop from the chiller to the laser system. Hose fittings and clamps to connect hoses to the chiller are not included. Do not exceed the maximum hose length specified by the chiller manufacturer.

Shut-off valves on the supply and return lines are recommended to facilitate maintenance to the cooling system filters and laser system.

4.1.4.3 Coolant Composition

The recommended coolant composition is a mixture of clean distilled water containing a low toxicity, corrosion inhibitor. **THE USE OF A CORROSION INHIBITOR IS MANDATORY IN THE J-1000 Series LASER!** Coherent has tested two different solutions that will prevent corrosion within the laser coolant circuit.

These are described in Table 4-2:

Table 4-2. Recommended Coolant for J-1000 Series Lasers

Product Name	Manufacturers Name and Contact	Heat Transfer Fluid Type	Required Heat Transfer Fluid Content	Freezing Burst Protection	Other Precautions
OptiShield	OptiTemp. Inc. www.optitempt.com US/Canada 231-946-2931	Corrosion Inhibited Water	10% solution in water	Does not reduce the water freezing point	Use may be restricted in geographical locations outside the US
DOWFROST™	Dow Chemical Inc. www.dow.com 989-636-1000	Inhibited Propylene Glycol and Water	30% in water	At 30% mix will provide burst protection to --25°C (13°F)	See Note below

Note on the use of Dowfrost:



Using Dowfrost at 30% in distilled water changes the heat transfer capacity of the water and also its viscosity. This means that the laser will be efficiently cooled as long as the specified flowrate of 1 gpm is maintained.



NOTICE!

Failure to provide adequate cooling to the laser will result in unstable operation and potential failure.



NOTICE!

To prevent damage to the laser head and RF power module, never operate the J-1000 Series liquid-cooled laser using untreated tap, distilled, or de-ionized water as a coolant. The laser contains materials which will suffer corrosion damage when exposed to water without corrosion inhibitors. Corrosion caused by improperly treated coolant voids the warranty.

It is important to add the right amount of corrosion inhibitor in the coolant mix. Too much may result in poor cooling performance and too little will result in reduced protection against corrosion. Levels lower than the recommended amount may also encourage microbial growth, which can result in fouling and blockage of the cooling system. Also, only use fresh, clean coolant mix (OptiTemp recommends that the coolant be drained and replaced annually).

Figure 4-2 shows system components from water circuits treated with inhibitor and a water circuit without inhibitor.



Untreated Water Circuit



Treated Water Circuit

Figure 4-2. Water Circuits - Untreated and Treated

4.1.4.4

Freeze/Burst Protection

The recommended coolant mixture does not provide freeze protection; therefore the coolant temperature must be maintained above the freezing point of water. Since lower temperatures may occur during shipment and storage, the J-1000 Series laser system (or separate laser head or RF power module components) should never be stored or transported unless the coolant has been completely removed by using a compressed air supply to blow out all coolant passages.



NOTICE!

Never store or ship a complete J-1000 Series laser system or laser head or RF power module (or liquid-cooled DC power supply, optional) with coolant installed, as the coolant may freeze and cause permanent internal damage. Always remove the coolant prior to storage or shipment by using a compressed air supply to blow out all coolant passages. Plug or cap coolant inlet and outlet fittings after draining to prevent residual coolant leaks during storage or shipment. Damage to the laser during storage or shipment, as a result of failure to remove coolant and plug the inlet and outlet fittings after coolant removal, is specifically excluded from the product warranty.

4.1.4.5 Flow Direction

At the laser system, the flow direction must be as follows: coolant is to flow to the laser head first, then out to the RF power module before being returned. Do not reverse flow direction or split the flow into two separate parallel circuits at the laser system. Refer to Figure 4-3.

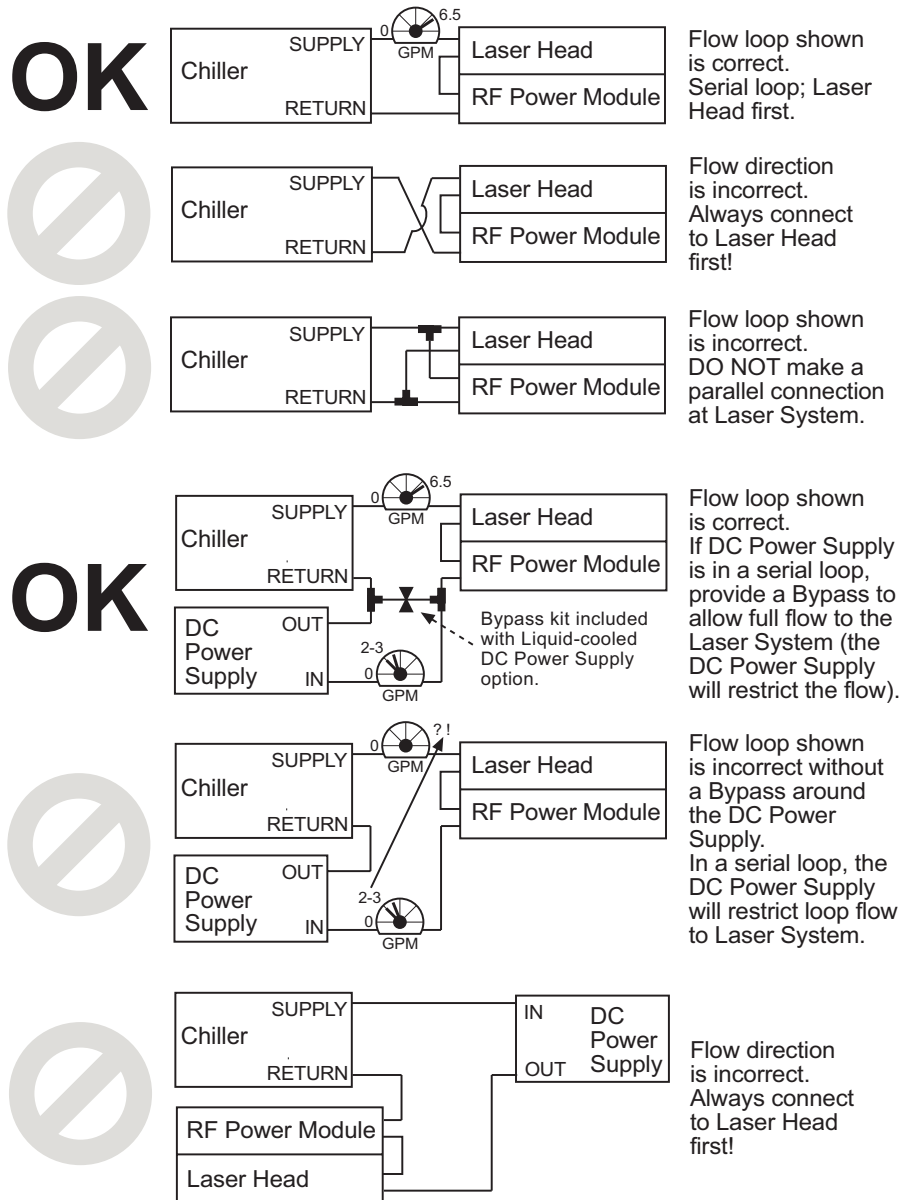


Figure 4-3. Coolant Flow to Laser System

If any other components are included in the cooling loop (e.g. DC power supply, as shown in Figure 4-1, "Coolant Flow Diagram," on page 42), they must not reduce the coolant flow to the laser head, and any heat absorbing/generating components must come after the laser system.

4.1.4.6 Chiller Electrical Supply

A large industrial chiller normally requires a 230 or 480 VAC, 3-phase electrical supply with its own circuit breaker or fuse protection and an electrical disconnect. Refer to the chiller manufacturer's installation guide for electrical requirements and installation instructions.

4.1.4.7 Electrical Disconnect

It is recommended that the chiller have a main power disconnect to electrically isolate it from mains power for maintenance and service. Consult a qualified electrician to select and install this hardware. A typical disconnect switch with fuse protection is shown in Figure 4-4.

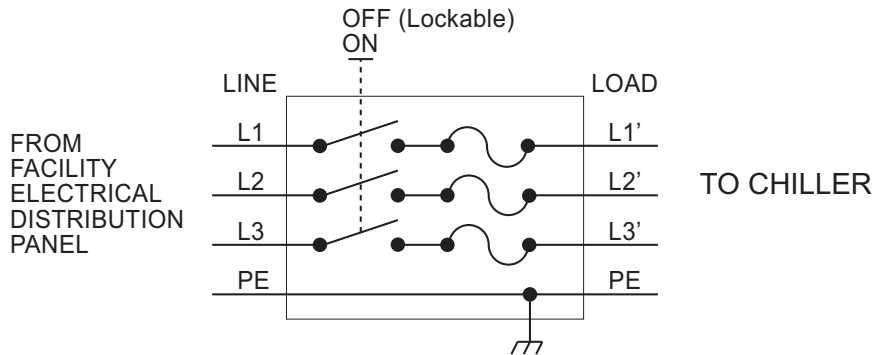


Figure 4-4. Electrical Disconnect Switch (with Fuse Protection)

4.1.5 Laser System Purge Gas



NOTICE!

The use of specified purge gas will extend the life and reduce cost of ownership of the J-1000 Series laser systems.

The quality of the purge gas is extremely important factor for trouble free operation of the laser. While the preferred purge gas is nitrogen with a purity of 99.95%, clean, dry air (CDA) is also acceptable.

J-1000 Series lasers are used in a wide range of material processing which often has by-products of dust, smoke, fumes, oil, and various gases. These by-products can cause contamination of the laser head optics as well as the beam delivery optics and electronic components. Contamination will severely degrade the system performance and can lead to damage or failure of sensitive components.

Passing a purge gas through the laser head and RF power module can prevent component damage by creating an internal positive pressure. Also, under some conditions of high humidity, the laser beam can be distorted by optical absorption of the laser beam by fluid vapor. This effect can be totally eliminated by use of a proper gas purge.

Adequate flow rates for purge gas can be achieved with an incoming pressure of 3 to 5 psi (0.2 to 0.35 bar).

4.1.5.1 Delivery System Purge Gas

Purge gas is brought to the laser system and split by a Tee into two paths, one to the laser head and the other to the RF power module.

The purge gas fills the RF power module and slowly leaks out of small gaps between enclosure covers. The gas purge to the laser head exits primarily via the beam output aperture. While this is the primary exit path for the purge gas, small gaps in the interfaces between the components comprising the protective housing result in additional purge exit paths. Therefore, the user should not rely on purge gas exiting the beam output aperture to provide purge gas to the user's beam delivery optics. A separate purge should be used for external beam delivery optics.

Threaded holes in the output end plate provide a convenient means to connect the user's beam delivery optics while maintaining a gas seal at this interface.



NOTICE

Do not rely on purge gas exiting the beam output aperture to purge the external beam delivery optics. A separate purge line should be used to purge the external beam delivery optics.

If a shared purge gas supply is directed to both the laser system and the beam delivery system, make certain the supply and supply line is properly sized to provide an adequate flow rate to the laser system.



NOTICE!

Other inert gases such as argon (Ar) must not be used. Use of inert gases will result in damage to the RF laser head. Only nitrogen as described above or compressed air as described below should be used as a purge gas.

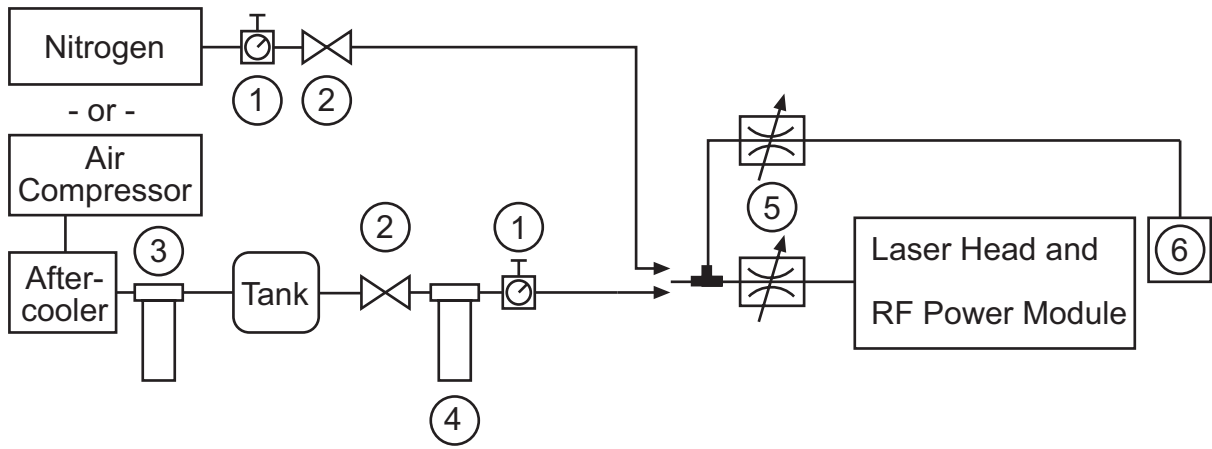
4.1.5.2

Guidelines for Use of Compressed Air for Purge

If nitrogen is not available, the alternative is clean, dry, oil-free compressed air. Compressed air is available in many facilities but typically is contaminated with water and oil vapors. The purity requirements for the compressed air are:

1. Filtered to remove particles larger than 1 micron.
2. Dried so that dew point is 10°C (18°F) lower than the inlet cooling fluid temperature to the J-1000 Series laser.
3. Oil free to better than 99.995%.

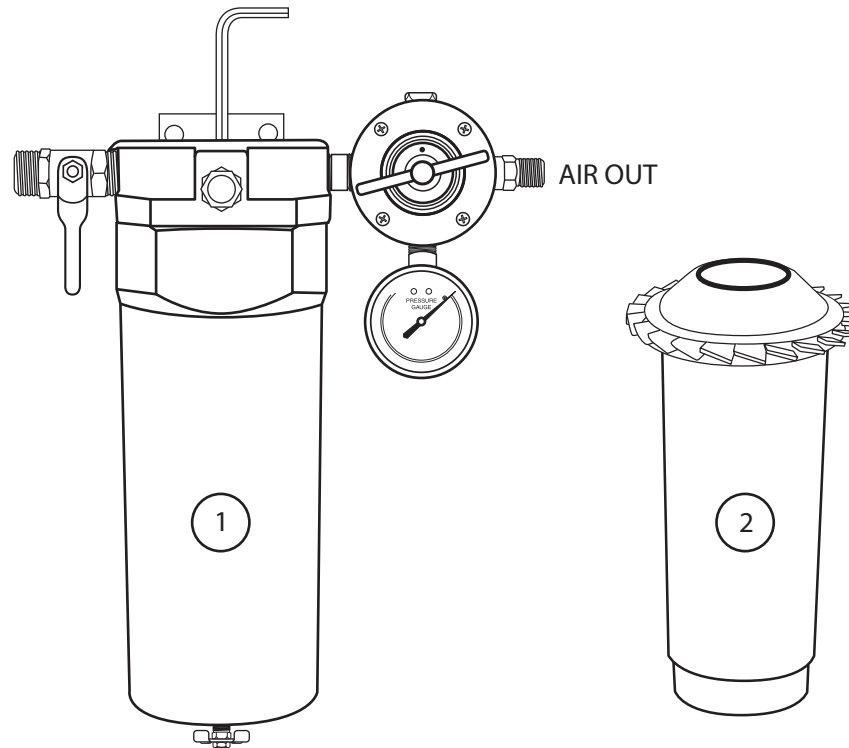
Recommended purge gas configurations are shown in Figure 4-5.



- | | |
|------------------------|-------------------|
| ① Pressure Regulator | ④ Filter Dryer |
| ② Shut-off Valve | ⑤ Flow Regulator |
| ③ Condensate Separator | ⑥ Delivery System |

Figure 4-5. Purge Gas Diagram

Coherent has identified a suitable dry air purge filter which filters to 0.1 microns and dries the air to a dew point of - 40°C (- 40°F). The filter is shown in Figure 4-6 and is widely available.



1. Air Purge Filter Assembly; Part Number: 1232642
2. Replacement Desiccant Filter Cartridge; Part Number: 1236040

Figure 4-6. Air Filter Dryer Unit

For additional information on the Purge Filter/Dryer Assembly, refer to “Air Filter Dryer Unit” (p. 169).



NOTICE!

It is the responsibility of the customer to provide purge gas of either nitrogen or compressed air that meets the specifications stated above, and clean flexible tubing to carry the purge gas. Failure to comply with these specifications will void the warranty and the customer is responsible for all cost of repair or damage to the laser.

See “Preventive Maintenance” (p. 115) in "Maintenance and Troubleshooting" (p. 115) for the routine maintenance required for the purge gas filters.

4.1.5.3 DC Power Supply Electrical Service

Consult the instruction manual provided by the DC power supply manufacturer for electrical service requirements. Also, consult local electrical codes to determine the current rating for fuses or circuit breakers for the electrical service to the power supply.

4.1.5.4 Electrical Disconnect

Both supplies require an electrical disconnect to reset faults and to provide a disconnect for service. Coherent recommends that a main power disconnect (to the DC power supply) be located in the same room as the laser system. Consult a qualified electrician to select and install this hardware. Refer to Figure 4-7.

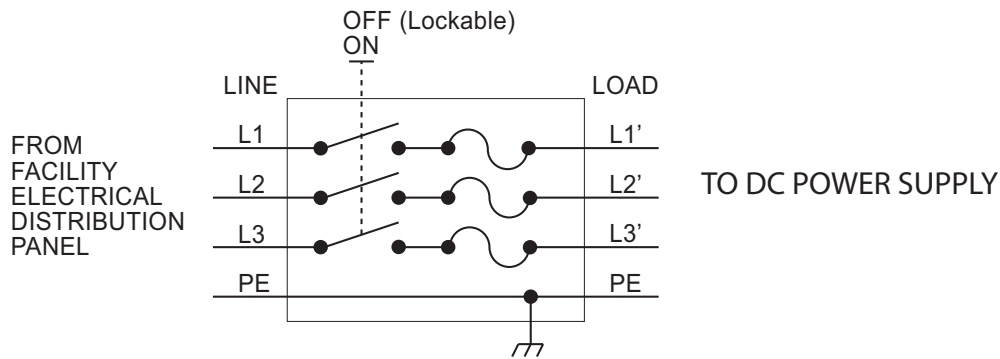


Figure 4-7. Electrical Disconnect Switch (with Fuse Protection)

4.1.5.5 Mains Power Cord

The integrator must provide the AC mains cable of suitable size (gauge) for the chosen length and current carrying requirement. Depending upon local electrical code, the power cord may need to be hard-wired into a junction box or electrical disconnect switch, or may be connected to mating plug and receptacle. Consult a qualified electrician and wire to local electrical code.

4.1.6 Beam Delivery System

The beam delivery system is typically designed and built by the system integrator.

Verify that the beam delivery system is designed for the J-1000 Series laser's beam specifications: wavelength, beam diameter, power density, divergence, output beam height (with respect to base-plate or mounting ball), mirror cooling, etc.

4.1.6.1 Shutter

If the laser is equipped with the optional internal shutter assembly, a red (visible) aiming laser is provided whenever 48 VDC is on and the shutter is closed. This aiming beam serves as a visual indicator of the process beam path, and can be used to align the beam delivery system. This optional internal shutter is intended to be a safety device - it is not to be used as a process shutter.

If the optional internal shutter assembly is not installed, it is recommended to provide an external safety shutter or beam block near the laser aperture to prevent laser exposure when servicing the delivery system. Make sure the beam block is made of suitable material to safely trap and dissipate the laser power.

4.1.6.2 Accessory Coupler

The laser head output aperture provides accommodation for a 50 mm (2") OD beam tube to couple to the laser head. Enclosing the beam within gas-purged metallic tubes is a safe and recommended method of transmitting the beam from the laser head to the work piece.

4.1.6.3 Purge

Providing a constant flow of purge gas to the delivery optics is recommended to keep optical surfaces clean and moisture free. If sharing a purge gas supply between the laser and deliver system, make certain that the laser system purge gas flow rate is maintained at the specified volume. See "Laser System Purge Gas" (p. 47).



NOTICE!

If cutting or marking reflective materials, an optical isolator must be installed between the laser and the process material to prevent work piece reflections from returning to the laser head and causing damage.

4.1.6.4

Optical Isolation

An optical isolator must be installed between the laser and the process material if cutting or marking reflective materials. This must be done to prevent work piece surface reflections from returning to the laser head.

Coherent has qualified the optical isolators listed in "Accessories and Options" (p. 165) for use with the J-1000 Series laser systems.

4.1.7

Laser Control, Measurement & Diagnostic

There are several methods of controlling and monitoring the laser. Some offer limited control, while others allow total control. Depending upon the end-user application, one or a combination of methods may be employed.

- Built-in Applet running on a PC
- Coherent DIAMOND Remote Control (optional)
- Applet + Coherent DIAMOND Remote Control
- TCP/IP via LAN/Internet Connection and TCP Client Software
- 3rd Party/Customer Designed Controller (Real Time Control Interface)

Laser control methods are discussed in "Control Interfaces" (p. 85). Consult with the Coherent Applications Department to determine which control method is best suited to requirements, schedule, and budget.

4.1.7.1

External Interlock Circuit

Regardless of which control method is used, the laser requires that an external interlock (user supplied) be satisfied (closed) for operation. It is highly recommended to incorporate a serial interlock loop consisting of switch contacts on all service access doors and panels, and interlock switches or light curtains on all material access gates and doors.

4.1.7.2 Laser Power Measurement

To accurately measure delivered laser power, a calibrated optical power meter (detector head plus display console) is necessary. Liquid (water) cooling is generally required for the detector head at J-1000 Series power levels. Make sure to provide adequate cooling for the detector head.

Coherent manufactures a wide range of power meters (display consoles and sensor heads). Refer to "Accessories and Options" (p. 165) for recommended measurement tools.

4.1.8 Laser Safety

Safety First! Read and understand the contents of "Laser Safety" (p. 9). Accidents can generally be reduced or eliminated by following all recommended safety guidelines.

Coherent recommends that each facility appoint and train a Laser Safety Officer (LSO) responsible for overseeing all aspects of laser safety.

Design systems with safety in mind. Use engineering controls such as: enclosed beam paths, interlocked covers, and safety shutters.

Designate a laser controlled area and keep all untrained and non-essential personnel out. Provide beam blocks, light shields, and/or curtains, as required, to establish a controlled area.

Insist that all operators and maintenance personnel receive proper training (and re-training) in laser and electrical safety. Require all personnel to have appropriate Personal Protective Equipment (PPE), especially laser safety eyewear suited to the laser in use and the job at hand.

4.2 Installation

The installation procedure consists of performing the following steps:

1. Prepare facility and ensure that all items on the "Preinstallation Checklist" (p. 35) are satisfied.
2. Receive and unpack the shipment.
 - Allow the laser system temperature to equilibrate.
 - Remove laser, DC power supply, loose parts, and accessories from shipping crates.
 - Inspect system components.

3. Mount the laser system and the DC power supply.
4. Connect optics purge gas line and perform a laser system purge (mandatory).



NOTICE

Damage to internal optical components may occur if the laser is not purged prior to use, and this damage is NOT covered by the laser warranty.

5. Connect the coolant lines and perform a leak check.
6. Connect the electrical cables.
7. Remove the output aperture cover and mount output accessories (couple beam delivery system to laser head).
8. Connect a laser controller.

4.2.1

Required Tools

To following tools will be required to unpack and install the laser system:

- Scissors or a package cutting knife
- Forklift or pallet jack to lift 320 kg (705 lbs.) - the weight of a fully loaded shipping crate
- A hoist capable of lifting at least 173 kg (381 lbs.) - the weight of the laser system
- A cart capable of supporting and transporting at least 173 kg (381 lbs.) - the weight of the laser system
- Metric hex wrench set (Allen keys)
- 1/4" flat-blade (–) screw driver
- #1 Phillips (+) screw driver
- Roll of 1/2" wide Teflon tape (included in coolant filter kit)
- 9/16" open end wrench (or 8" adjustable wrench)
- 3/4" open end wrench (or 8" adjustable wrench)
- Common hand tools

4.2.2 Required Parts and Equipment

Table 4-3 lists parts and equipment required to perform the installation. Note that some items are supplied with the laser system while others must be obtained locally.

Table 4-3. Parts and Equipment Required for Installation

Item	Quantity	Purpose	Included w/ Laser System
+48 VDC power supply	1	Provides +48 VDC power to the RF power module and the laser head.	No
AC power cord for DC power supply	1	Connects AC electrical supply to DC power supply input	No
Electrical disconnect for DC power supply	1	Disconnects power cord (to DC power supply) from AC electrical supply; can be mating plug/receptacle (if allowed by local code), or panel mounted disconnect	No
DC power supply cables	4 each 3 m (10 ft.) in length	48 VDC cables Qty. 4, 3/0 AWG cables (2 red & 2 black - each color to be connected in parallel) Transmits 48 volts to RF power module.	No
Mounting bolts/feet	3 feet, 3 bolts and 3 washers	Coherent supplied mounting feet & bolts used to secure the J-1000 Series. <ul style="list-style-type: none"> • Mounting Kit (P/N 1182966) • Bolts: M8 X 75 mm length (high strength steel) torque to 23.7 N·m (210 lb-in) Customer must prepare the mounting surface and supply hardware to mount the feet to the mounting surface (refer Figure 4-19c "Interface Mounting Dimensions" on page 69)	Yes
Liquid-cooling System/ Chiller	1	Provides temperature regulated liquid coolant to laser system (and to optional liquid-cooled DC power supply)	No
Coolant filter	1	Filters particles from coolant - 30 micron or better	Yes
Hose fittings	1	3/4" male NPT to male GHT (garden hose thread)	Yes
Hose fittings	1	3/4" male NPT to female GHT (garden hose thread)	Yes

Table 4-3. Parts and Equipment Required for Installation (Continued)

Item	Quantity	Purpose	Included w/ Laser System
Coolant kit	1	Coolant kit (if supplied) contains particle filter, fittings and coolant hose required to provide coolant to the laser system from the liquid-cooling system	Model Specific
Coolant hoses	as required	Provides coolant to the laser head and RF power module (and to optional liquid-cooled DC power supply) 5/8" ID or greater hose is recommended	No
Coolant	Amount varies	The heat transfer medium used to remove heat from the laser system; consists of a mixture of distilled (or de-ionized) water and corrosion inhibitor	No
Corrosion inhibitor	Amount varies	Prevents corrosion of metal parts in contact with the coolant	No
Purge Gas (Regulated Supply)	1	Used to displace atmosphere of air within the laser head and the RF power module; typically N ₂ or clean, dry air (CDA)	No
Purge Gas Filter	N/A if using N ₂ ; required if using CDA	Removes water vapor, oil, and particulates from compressed air; see "Accessories and Options" (p. 165)	No
Purge Gas tubing (between laser head and RF power module)	1 piece	A short length of 1/4 inch (6 mm) OD Teflon, polyethylene or polypropylene tubing to connect the purge gas line between the laser head and RF power module	Yes
Tee	1	1/4 inch (6 mm) OD Tee for splitting the purge gas tubing at the laser head and RF power module	Yes
Purge Gas tubing (between purge gas supply and laser system)	as required	1/4 inch (6 mm) OD Teflon, polyethylene or polypropylene tubing to connect the purge gas supply to the laser head	No

4.2.3 Facility Preparation

Prepare the facility (installation site) as described in Table 4-1, "Preinstallation Checklist," (p. 36).

4.2.4 Unpacking and Inspection

The J-1000 Series laser system packaging has been designed for robust shipment. Upon receiving the system, inspect the outside of all containers immediately for damage that may have occurred during transit. If there appears to be any visible damage (holes in containers, fluid damage, crushing, etc.), immediately notify Coherent and a representative of the carrier. Request that a representative of the freight company be present when unpacking the contents.



NOTICE!

To avoid damaging the laser system during transport, keep the original shipping crates, lifting hardware and packing materials for shipping the J-1000 Series laser system from one location to another. If the system is to be returned to Coherent for repair, it must be in the original shipping container.

Carefully unpack the crate in a clean, dry area. Inspect all major components as they are unpacked.



WARNING!

The J-1000 Series laser system is not designed to be lifted or carried by hand. To avoid personal injury or damage to the system, always lift, move, and place the laser using equipment approved for lifting and properly rated for the weights listed.



WARNING!

To avoid personal injury, never place any body parts below a lifted or suspended laser.

4.2.4.1

Unpacking Instructions

1. Unlock all six (6) clasps of the top cover (Figure 4-8).

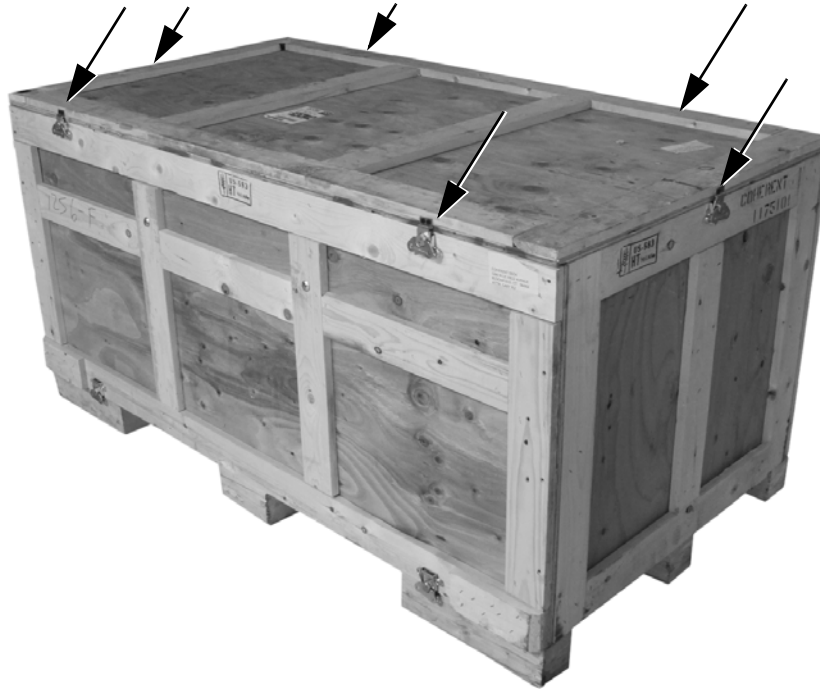


Figure 4-8. Removing Crate Cover

2. Lift up and pull off to remove top the top cover (Figure 4-9).



Figure 4-9. Top Cover Removed

3. Un-strap the system by releasing both (2) ratchet strap tie-downs (Figure 4-10).



Figure 4-10. Unstrapping the System

4. Locate the two eye-bolts (lifting eye-bolt, M6, 20 mm ID X 36 mm OD, zinc plated steel) included in the user documents bag (not shown).



STOP! Before proceeding, allow enough time for the laser to reach room temperature, especially when transported during the winter months, before cutting the moisture seal bag.

5. At the center of each end, carefully cut through the moisture seal bag as shown in Figure 4-11. Peel away the moisture seal bag and the bubble wrap underneath to expose the eye-bolt holes.



Figure 4-11. Exposing the Eye-bolt Holes

6. Fully turn all threads of the eye-bolts into the holes at the top of each end of the laser system (Figure 4-12).



Figure 4-12. Installation of Eye-bolts

Utility Requirements and System Installation

7. Loosen and remove the wing nuts (2 places) that secure the spreader bar to the inside of the crate, then pull the spreader bar off of the bolts and lift it up (Figure 4-13).



Figure 4-13. Removing Spreader from Crate



When originally shipped, the wooden spreader bar and associated lifting hardware were inspected to be in good condition. Always inspect the lifting components before use. Do not use any component that is rusted, rotted or broken.

8. Place the spreader bar on top of the laser system with the shackles toward the eye-bolts. Shackle the eye-bolts to the spreader bar as shown in Figure 4-14. Fully thread the shackle pin and tighten the pin with a pliers or wrench.



Figure 4-14. Attaching Eye-bolts to Spreader Bar

Utility Requirements and System Installation

9. Cut the moisture seal bag along the groove between the laser head and RF power module from eye-bolt to eye-bolt, then cut across the bag top at both ends (Figure 4-15).



Figure 4-15. Cutting Top of Moisture Seal Bag



Steps 10 through 15 involve lifting and suspending a heavy object (the laser system). Only use approved lifting equipment rated for the load. Wear appropriate safety shoes or protective shoe covers. Always keep hands and body parts out from under a suspended load.

10. Secure the spreader bar to a hoist capable of lifting 173 kg (381 lbs.). Carefully lift the laser system straight up, remove the moisture seal bag (Figure 4-16).



Figure 4-16. Lifting the J-1000 Series

11. Place the laser system on a cart capable of supporting and transporting 173 kg (381 lbs.). See Figure 4-17.



Figure 4-17. Place Laser System on Cart

12. Locate and remove the sealed plastic bag containing the RF power module system cable (Figure 4-18).

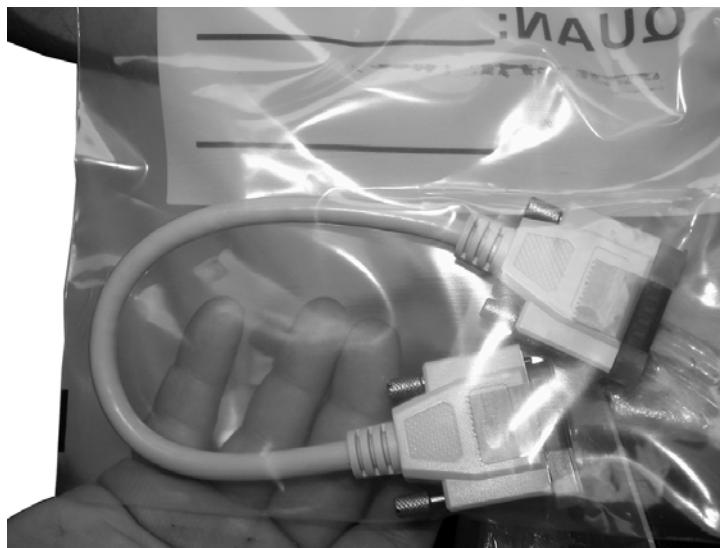


Figure 4-18. RF Power Module System Cable

13. Using the necessary lifting equipment, carefully set the laser system on a clean and flat surface, such as an optical table.
14. Remove the spreader bar and return it to the shipping crate.
15. Remove the eye-bolts from the top holes and store for future use.

4.2.5 Mounting the Laser System Components

The integrated laser system has provisions for stress free kinematic mounting. This mounting includes mounting features (supplied with the laser) that facilitate laser replacement. Since the laser is precisely aligned to these mounting features, a laser can be replaced with minimal or potentially no system re-alignment.

A protective cover is mounted to protect the beam output aperture of the laser during shipment. This must be removed before mounting the laser as it blocks access to one of the mounting holes.

Mount the laser using mounting feet as shown in Figure 4-19d. The M8 x 75 mounting bolts must be torqued to 23.7 N·m (210 lb.-in.). Do not over torque these mounting bolts. Doing so will distort the mounting feet.



NOTICE!

Torque specification for the M8 X 75 mounting bolts is 23.7 N·m (210 lb.-in.). Do not over torque. Over torquing will damage mounting feet.

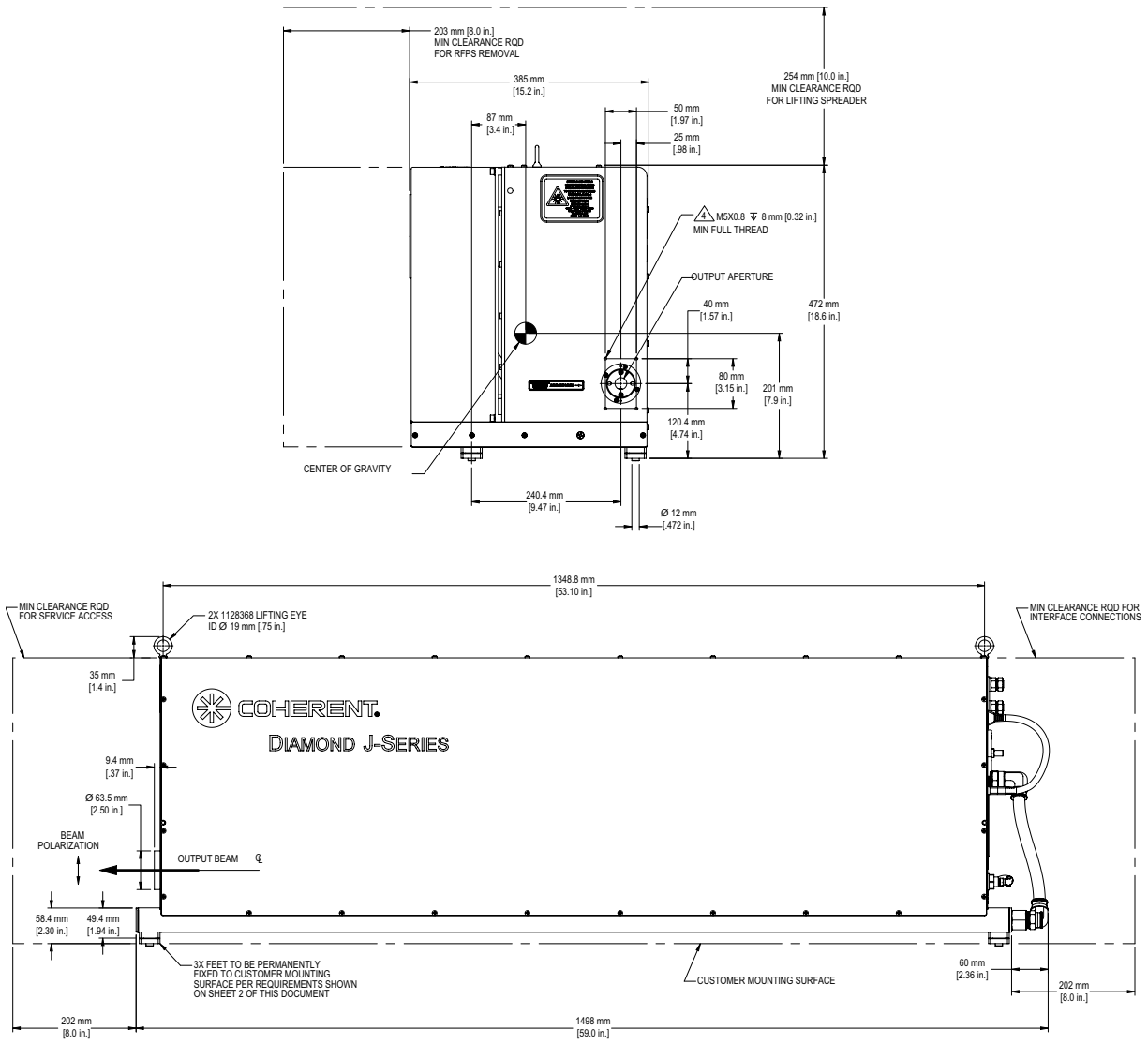
See Figure 4-19a, b, c & d.

The laser head can be mounted in any orientation. If mounted vertically with the beam tube up, ensure no dust or other particulates fall into the output aperture during installation.

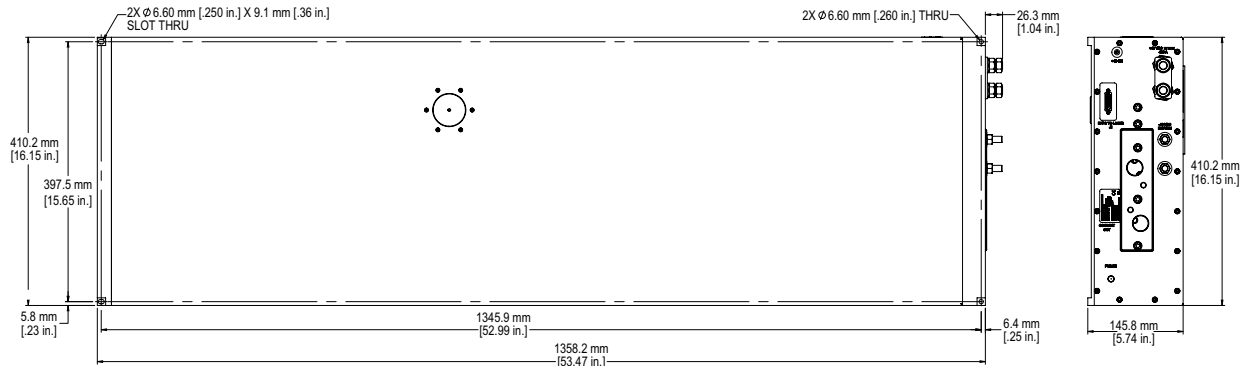


NOTICE!

Customers mounting the laser in a 'non-horizontal' feet down configuration are responsible for properly supporting the laser during installation (and de-installation). Great care must be taken that the laser (173 kg/381 lbs.) plus weight of hoses, cables, and externally mounted accessories is supported without damage to the laser structure. The top eye-bolts cannot be used for vertical installation.

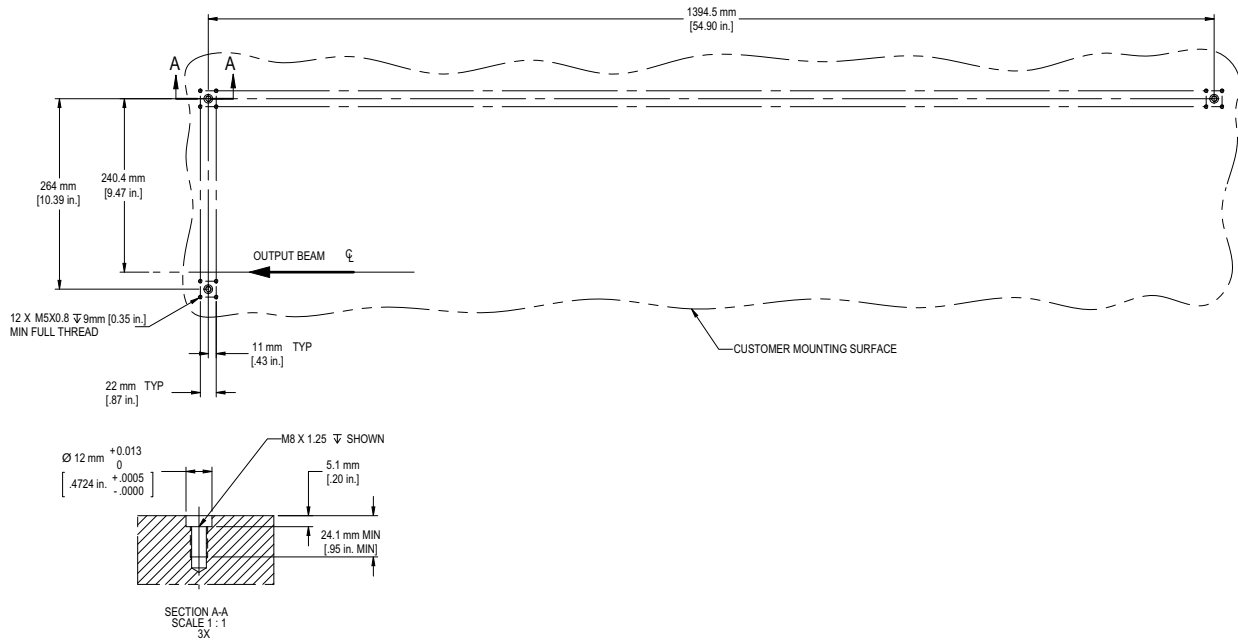


a. Laser Head



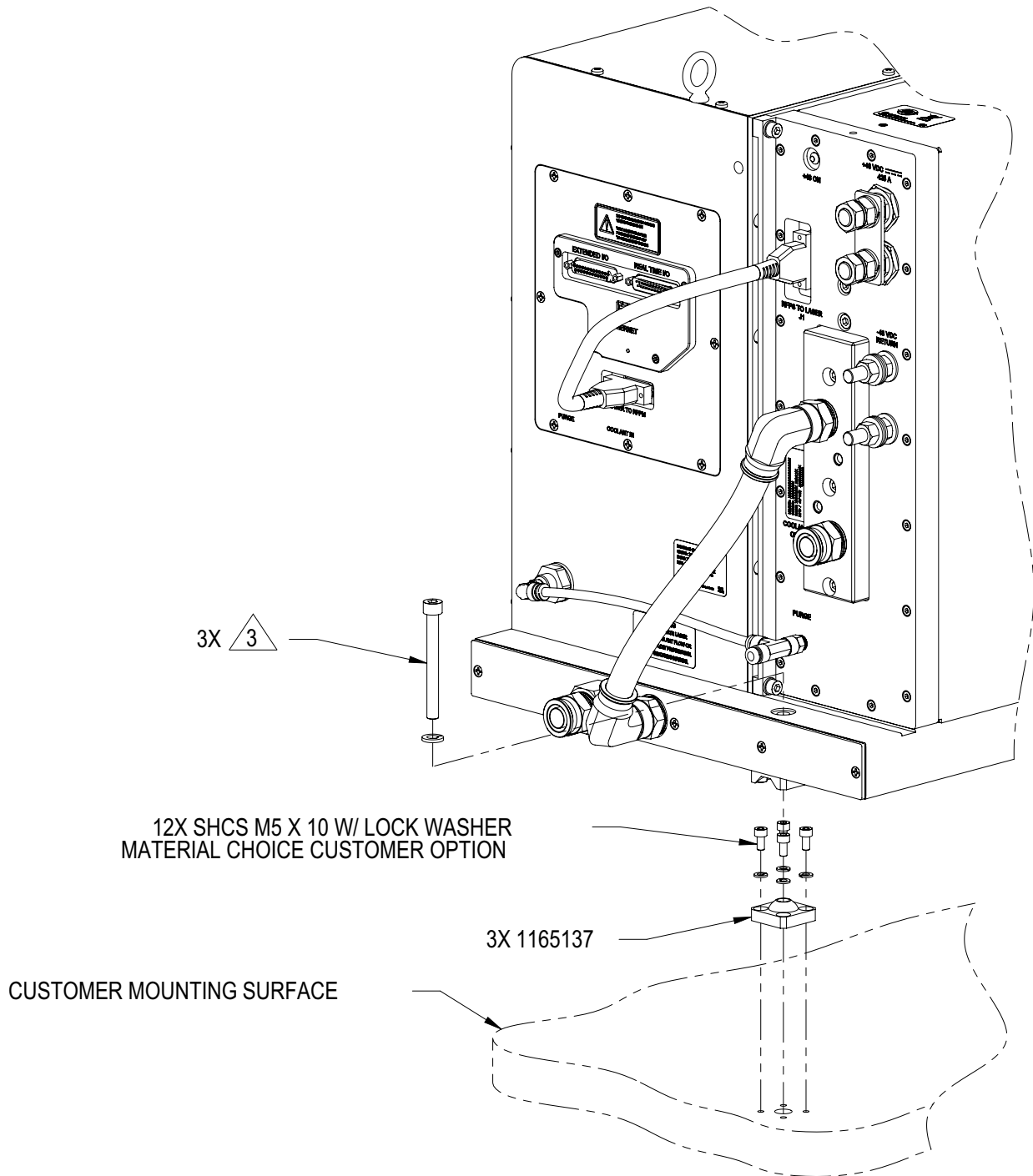
b. RF Power Module

Figure 4-19. J-1000 Series System Installation in OEM Equipment - Required Clearances



c. Interface Mounting Dimensions

Figure 4-19. J-1000 Series System Installation in OEM Equipment - Required Clearances



d. Mounting Foot Detail

Figure 4-19. J-1000 Series System Installation in OEM Equipment - Required Clearances

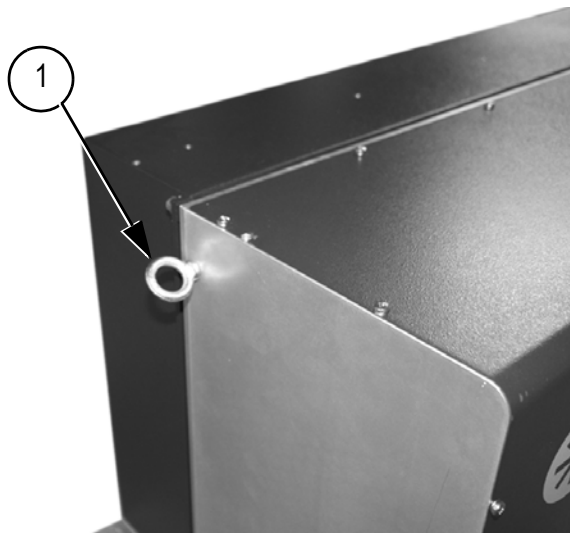
4.2.6 Vertical Mounting

For “beam up” vertical mounting, refer to Figure 4-20. For “beam down” vertical mounting, refer to Figure 4-21.



Do not use the top eye-bolt locations (previously used for lifting the laser system out of the crate) for a vertical lift!

1. Fully install the eye-bolts into the screw holes.



- 1 Install eye-bolt in upper hole
- 2 Remove Phillips head (+) screw from base
- 3 Install eye-bolt in lower hole

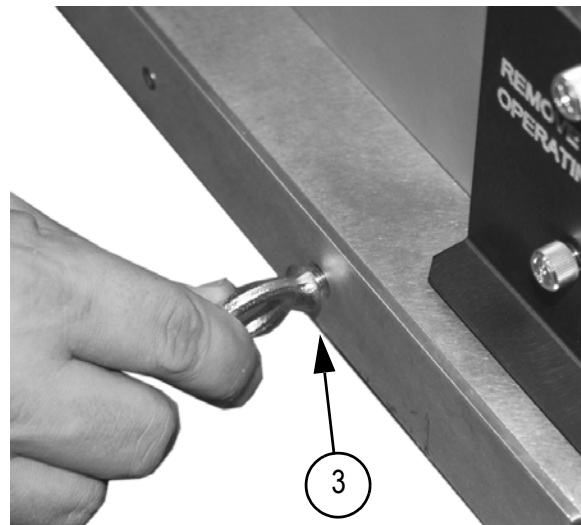
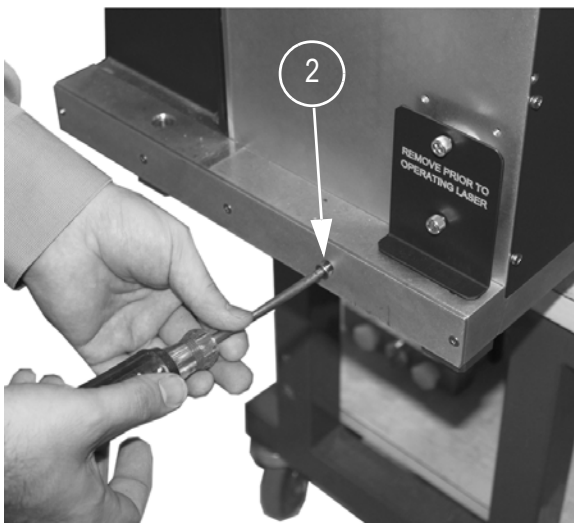
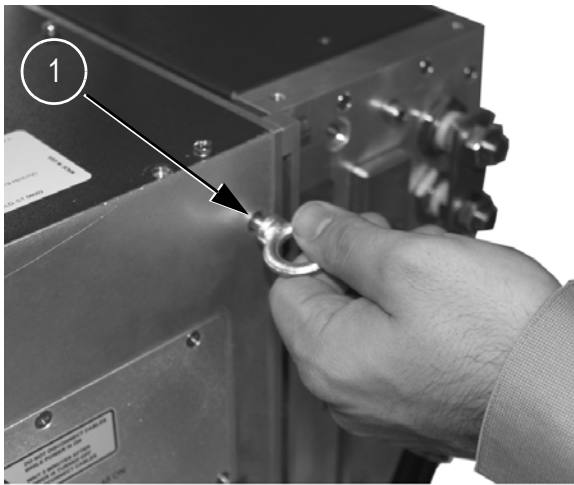


Figure 4-20. Vertical Mounting Eye-bolt Positions (Beam Up)



- ① Install eye-bolt in upper hole
- ② Remove Phillips head (+) screw from base
- ③ Install eye-bolt in lower hole

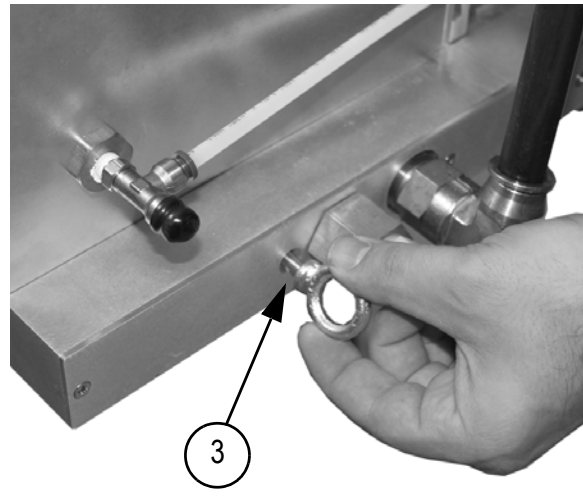
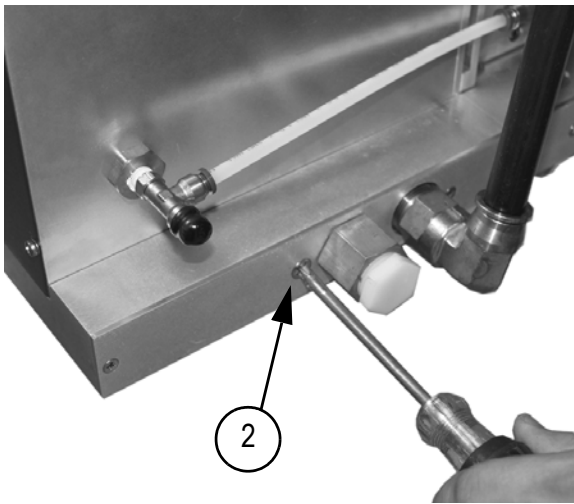


Figure 4-21. Vertical Mounting Eye-bolt Positions (Beam Down)

- Securely connect appropriate slings or chains to the eye-bolts and spreader bar. Chains/slings must be vertical when under load. See Figure 4-22.

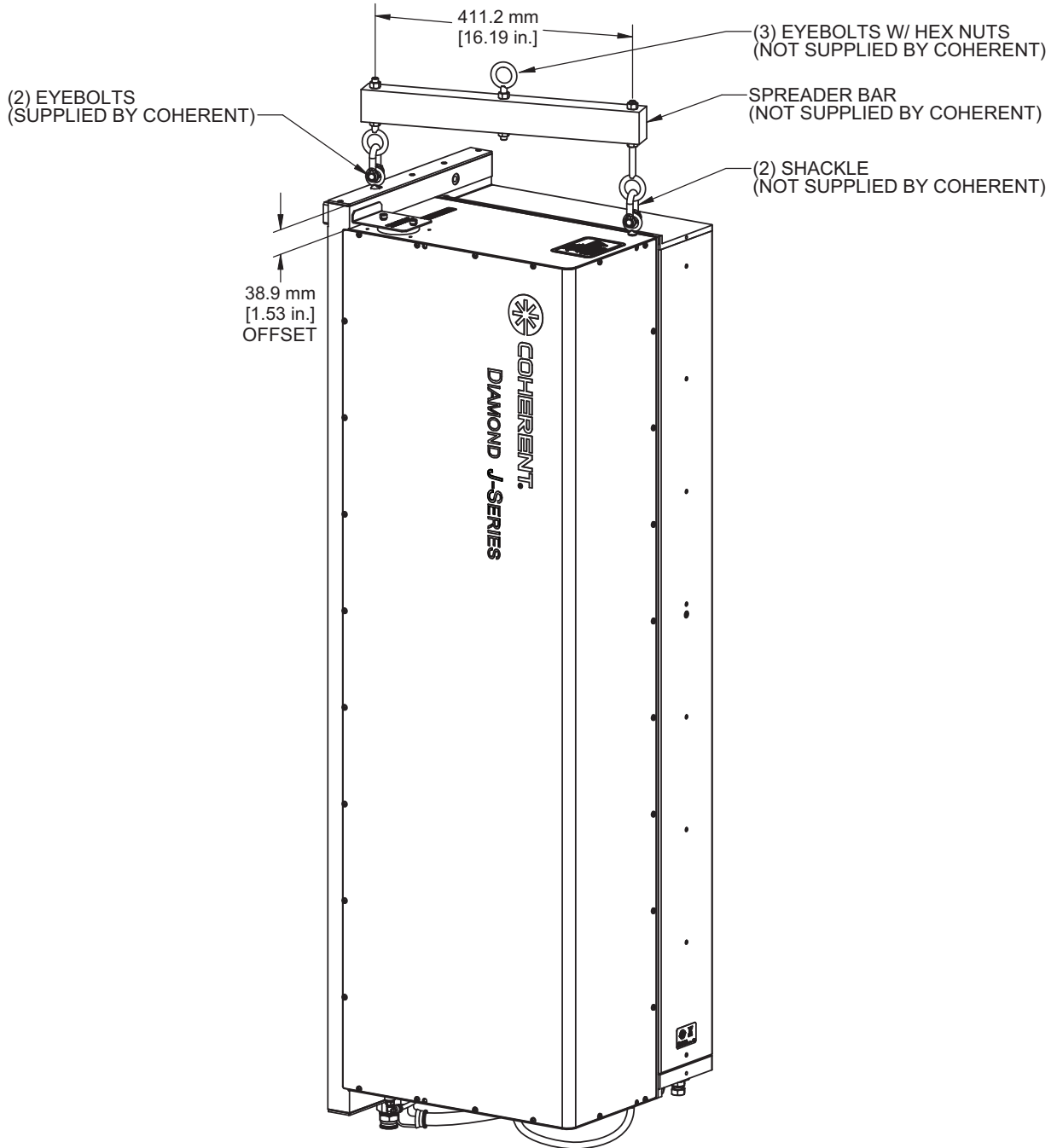


Figure 4-22. Vertical Mounting Illustration



The eye-bolts with hex nuts and shackle can be removed from the provided spreader bar and installed on the user supplied vertical lifting spreader bar.



If lifting laser in the Beam Up position, take extreme care to protect the interface connections from damage as the laser is tilted from horizontal!

3. Carefully lift the laser system while preventing the free end from moving around.

4.2.7

Mount the DC Power Supply

Refer to the information provided in "Accessories and Options" (p. 165) for mounting information.

Since the DC power cables (available from Coherent) are 3 m (10 ft.) in length, position the power supply output terminals within reach of the RF power module input terminals. Refer to Figure 4-25, "RF Power Module DC Input Terminal Fasteners," on page 80 for RF power module connection points.

4.2.8 Laser Head Indicators and Connections

Refer to Figure 4-23 and Table 4-4 for the location and description of the laser head indicators and connections.

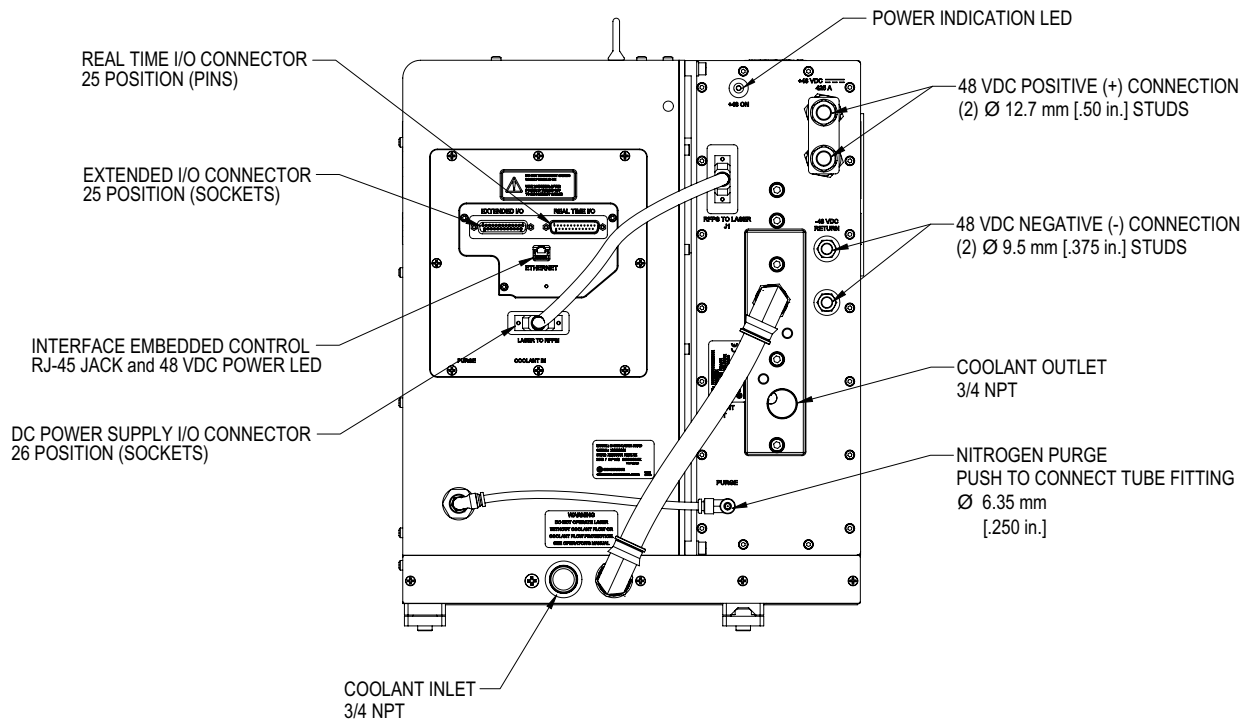


Figure 4-23. J-1000 Series Interface Connectors

Table 4-4. J-1000 Series Head Indicators and Connectors

Control	Function
Coolant (inlet)	Connection for the cooling fluid hose that supplies coolant from the coolant source.
Laser to RFPM connector cable	Connector cable provides internal laser head to RFPM signals.
Embedded Control/Diagnostic (interface connector)	LAN connector for control, diagnostics and troubleshooting.
Extended I/O (connector)	DB25 connector that provides extended capability (including shutter control and additional fault signals).
Real Time I/O (control connector)	DB25 connector that supplies control and input modulation signals from the user to the RF power module and supplies status information from the laser system.

Table 4-4. J-1000 Series Head Indicators and Connectors (Continued)

Control	Function
Power Indicator LED	LED illuminates when 48 VDC is applied to the RFPM terminals. One LED is near the top of the RFPA, and the other is next to the RJ-45 connector on the Controller panel.
48 VDC (+) (terminal)	Connects +48 VDC from the DC power supply to the RF power module. Use a 3/4" wrench. Apply 190 lb.-in. (21.4 N·m) torque to nut supplied.
48 VDC Return (-) (terminal)	Connects the RF power module ground to the DC power supply. Use a 9/16" wrench. Apply 190 lb.-in. (21.4 N·m) torque to nut supplied.
Coolant (outlet)	Connection for the cooling fluid hose. Cooling fluid travels from the laser head through the RF power module and out to the drain.
Nitrogen Purge (inlet)	<p>Provides for gas purge of the laser head and RF power module. Requires 1/4 inch (6.3 mm) OD Teflon, polyethylene or polypropylene tubing. Nitrogen is the preferred purge gas. Refer to "Installation" (p. 54) for additional information on purging the laser head.</p> <p>Note that the purge line on the laser head has a small filter (internal). This filter protects the laser optics from any particles that are generated as a result of connecting the purge gas tubing to the laser head. If customer supplied purge meets required specifications, this internal filter should last a lifetime.</p>

4.2.9 Optics Purge Connection

Locate the 1/4 inch Tee provided with the laser system at the purge input on the laser head. The Tee splits the purge line directing some purge gas to the RF power module.

Use 1/4 in. (6 mm) OD clean polyethylene, polypropylene or Teflon tubing and insert it into the Tee. Fully insert the tubing (until it bottoms out), then give it a slight pull and verify that the tube is held in place.

The purge gas at this input must meet the requirements discussed earlier in this chapter.

4.2.10 Set-up Purge

Set-up purge is required in order to eliminate moisture from the system prior to use. This is required even though the system packaging is designed to ship the laser in a 'dry condition'. Note that system purge is required whenever the system has been off for an extended period of time without purge.

1. Connect the tubing to the Tee as described in "Optics Purge Connection" (p. 77). Refer to Figure 4-23, "J-1000 Series Interface Connectors" (p. 76) for the purge gas line connection point.
2. Purge the laser system with nitrogen or clean, dry air for a minimum of two hours.



NOTICE!

Failure to purge the system leaves the system at substantial risk of optics failure. Guidelines for system purge gas are found in "Delivery System Purge Gas" (p. 48).

4.2.11 Connect Coolant Lines

Connect the fittings and coolant lines to the laser system, with the particle filter connected to the inlet coolant line near the laser head. Connection points are shown in Figure 4-23, "J-1000 Series Interface Connectors" (p. 76). Use Teflon tape on fittings. Observe the coolant flow direction shown in Figure 4-3, "Coolant Flow to Laser System" (p. 46).

The recommended coolant source is a closed-loop cooling system. Coolant composition must meet the requirements stated in "Coolant Composition" (p. 43). Refer to "Laser System Cooling" (p. 41) and "Installation" (p. 54) for additional information.

The recommended hose for coolant consists of a 5/8 inch (16 mm) minimum ID hoses up to 15 m (50 ft.).

After connecting the water hoses, verify that there are no water leaks as follows:

- Close supply and return valves, then turn the chiller on.
- Open the valve in the water return (drain) line.
- Slowly open the valve in the water supply line.
- With the water supply pressure and water line differential pressure in accordance with Table 3-1, "Configuration & Utility Requirements," (p. 31), check all connections for leaks.

4.2.12

Grounding of J-1000 Series Laser RF Module

The J-Series RF module DC Return is internally grounded directly to the chassis ground of the laser system. DC power supply cables from the DC power supply are to be connected directly to the marked connectors on the rear panels, see Figure 4-23, "J-1000 Series Interface Connectors" (p. 76).

These connections ensure correct grounding for the system. As an added precaution, an additional safety ground may be configured using a direct connection to the DC Return terminal. Refer to Figure 4-24.

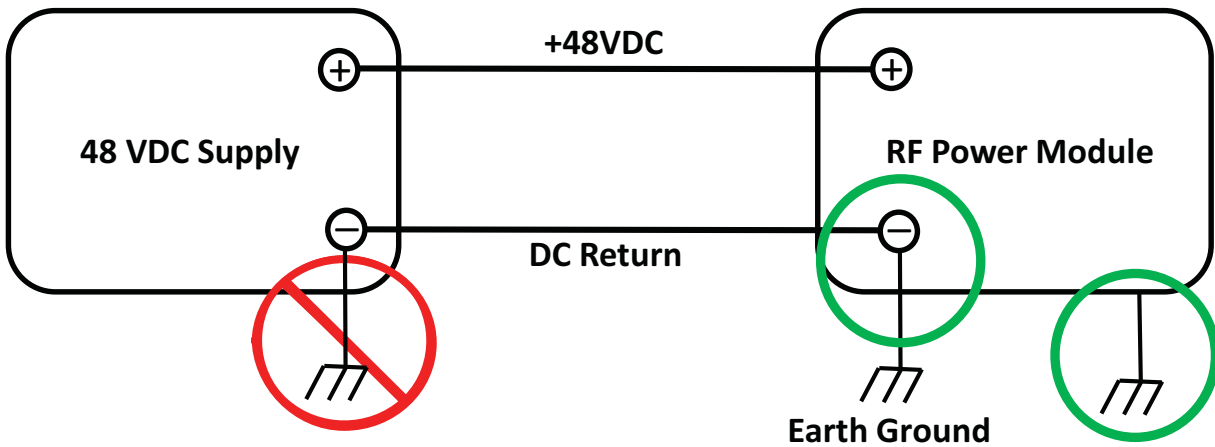


Figure 4-24. Grounding of J-1000 Series Laser RF Module



WARNING!

Never connect a safety (earth) ground to the DC Return terminal of the DC power supply. This terminal's potential will rise above safety (earth) ground potential due to current flow through the return cable. The DC Return terminal of the DC power supply is electrically isolated and must always be allowed to float above safety (earth) ground potential.

4.2.13 Connect Electrical Cables

1. Connect the short interface cable between the laser head (J14 - Laser to RFPM) and the RF power module (J1 - RFPM to Laser). Tighten the jack screws.



NOTICE!

Never connect or disconnect the laser to the RFPM connector cable when the laser is powered on. Wait at least 2 minutes after power is turned off before connecting or disconnecting the cable. Disconnecting or connecting this cable while the laser is powered could cause a fuse to blow and possibly damage the laser.

2. Connect all four DC power cables between the DC power supply and the RF power module.

Refer to the DC power supply manufacturer's instructions for terminal identification, recommended fasteners and torque specifications for connections at the DC power supply.

On the RF power module, fasten the cables as shown in Figure 4-25.

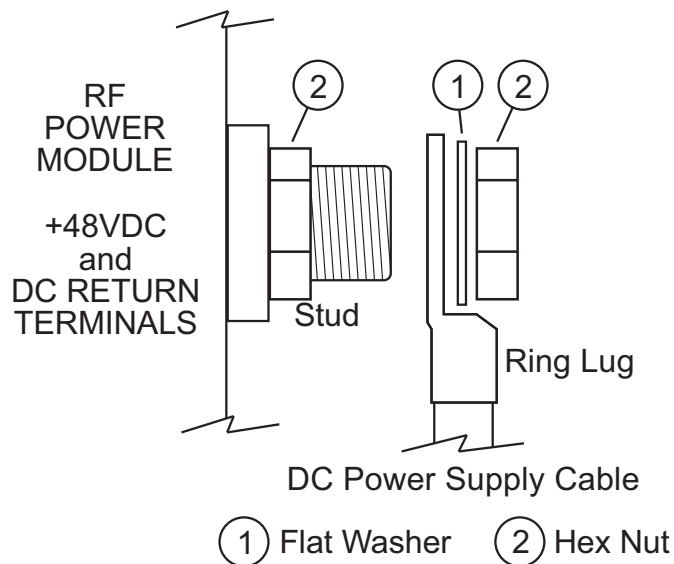


Figure 4-25. RF Power Module DC Input Terminal Fasteners

At the RF power module, place the protective terminal boots over the red cable ends before fastening the cables.

Use the RED cables for the “+48 VDC” positive (+) connections, and the BLACK cables for the “DC Return” negative (–) connections.

Apply 190 lb.-in. (21.4 N·m) torque to both supplied hex nuts.



WARNING!

Shut off the electrical power source before connecting the mains power cord. Consult a qualified electrician to make the main power connection.

3. Connect the AC power cord to the DC power supply. Refer to the power supply manufacturer’s instructions for terminal identification, recommended fasteners and torque specifications.

4.2.14

Remove Output Aperture Cover

Before attaching an optical isolator or other beam delivery components and before operating the laser, remove the output aperture cover. To remove the aperture cover, loosen the two thumbscrews. Set the cover aside for re-installation at future shipments. See Figure 4-26.

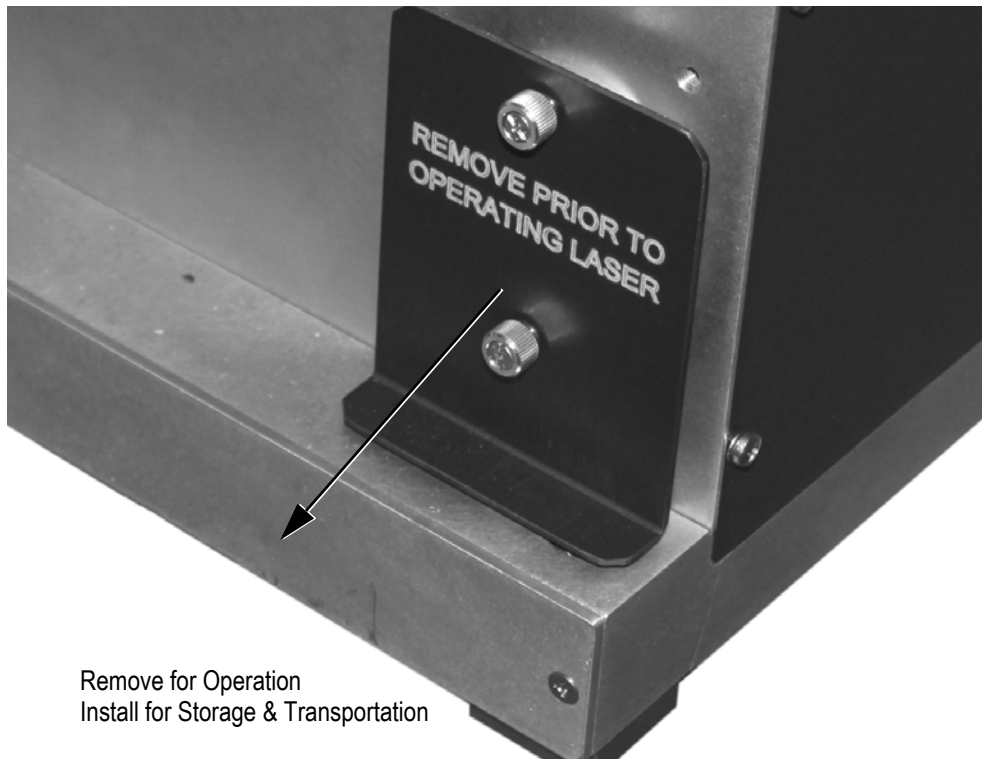


Figure 4-26. Output Aperture Cover



NOTICE!

Failure to remove the output aperture cover before operation (and lasing on the cover) will cause permanent damage to optical surfaces inside the laser head.

4.2.15

Mounting Accessories to Laser Aperture

The J-1000 Series lasers have provisions for the customer to mount optics/accessories via the laser front plate. The following provisions must be followed:

- Accessory mount maximum load: 2.3 kg (5 lbs.) at 254 mm (10 in.) or equivalent.
- The customer must provide a continuation of optical purge through the added components using a separate purge line (see Figure 4-27).

4.2.16

Controller Connection

Install and connect the controller cable(s) to the laser.

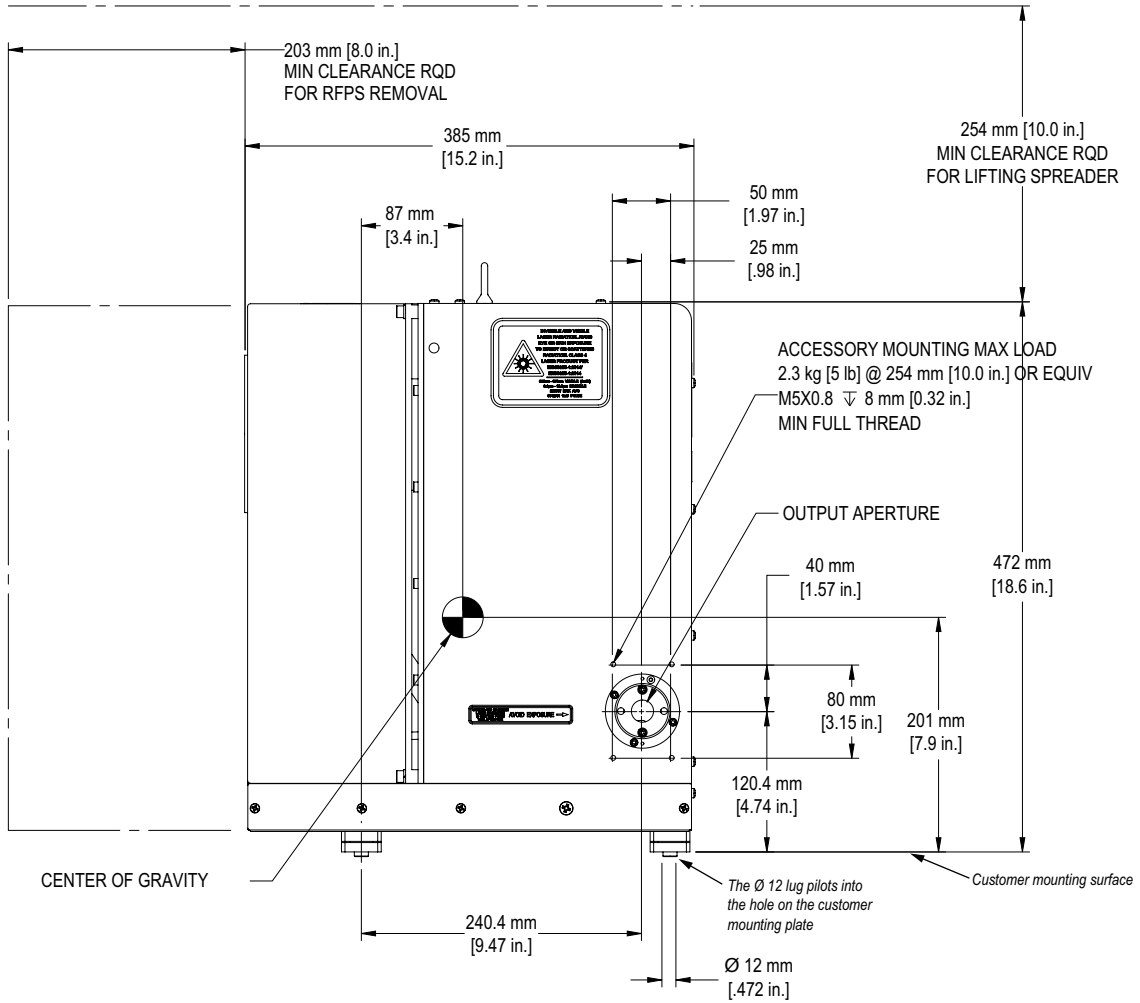


Figure 4-27. J-1000 Series Output End View

5 CONTROL INTERFACES

5.1 Introduction

This section describes the electrical interfaces required to operate J-1000 Series lasers. As shown in Figure 5-1, there are four control interfaces for the J-1000 Series consisting of:

1. Real time I/O
2. Extended I/O
3. Embedded control/diagnostic interface

Figure 5-1 and Table 5-1 provide a brief description of these interfaces and manual locations providing complete information. Also, Table 5-1 provides a description of LED indicators. Critical signals, which control laser power, are the pulse width and pulse period. Typical laser output power for various operating pulse widths and periods is shown in "Operation" (p. 105).

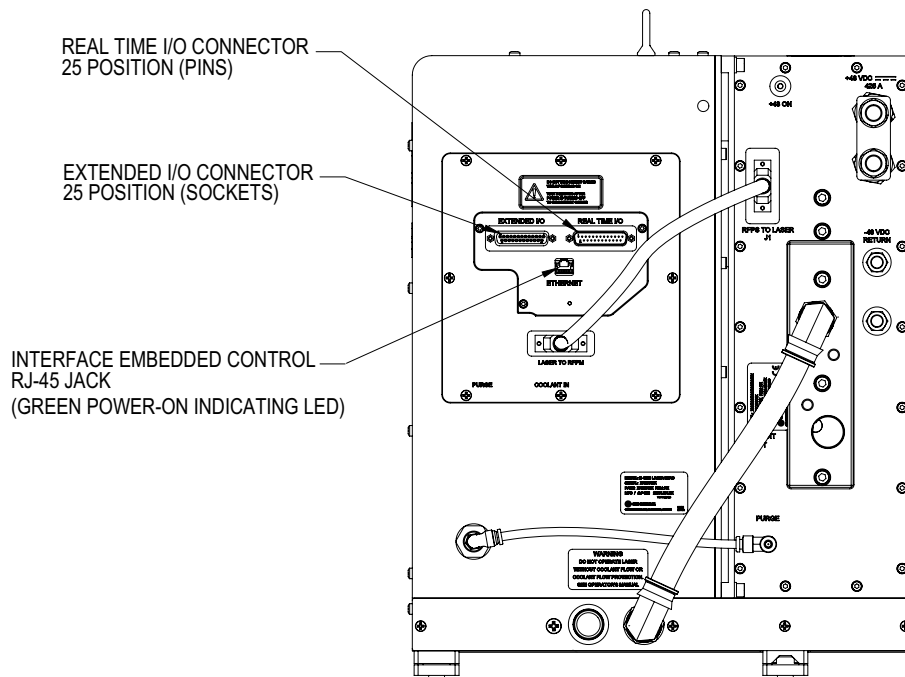


Figure 5-1. J-1000 Series Laser Electrical Interfaces

Table 5-1. J-1000 Series Laser Electrical Interfaces

Interface or Indicator	Description	Operator's Manual Section
Real Time Control and Status I/O	DB-25 connector (male)	Table 5-3, "Real Time Control and Status Interface," (p. 88) and Table 5-4, "Real Time Control and Status I/O Pinouts," (p. 88)
Extended I/O	DB-25 connector (female). Contains shutter interface signals and status, interlocks, low speed faults, and system warning.	Table 5-7, "Extended Interface Signal Descriptions," (p. 102) and Table 5-8, "Extended Interface Pin Descriptions," (p. 103)
Embedded Diagnostics	RJ-45 LAN connector Remote diagnostics and status information	"Appendix A: Embedded Diagnostics and Fault Matrix" (p. 133)
Power Indication LEDs	Located on Ethernet connector. Green emission indicates DC power is on (48 VDC). Amber (flashing) indicates network traffic or an Internet connection.	Figure 5-1, "J-1000 Series Laser Electrical Interfaces" (above)

5.2 Real Time Control and Status Interface

J-1000 Series lasers share many similar characteristics with earlier laser model as regards Real Time Control and Fault status reporting. Table 5-2 defines the details for the J-1000 Series.

Table 5-2. J-1000 Series Status and Control Details

Status or Control	J-1000 Series
Faults	A J-1000 Series latching fault requires system reset in order to resume operation.
Enable/Fault Reset Signal (Pin #3 and #16)	Enable: Required for operation. Enable must be asserted <i>after</i> system 48 VDC power-up. Fault Reset: Required for system reset in the case of fault condition.
System Fault (Pins #4 and #17)	This (added) signal indicates a latching system fault. Signal is high speed and the system fault asserts within microseconds of the laser being shut off.

5.2.1 Fault Types

Provided is a detailed definition and description of the J-1000 Series faults as illustrated in Figure 5-2.

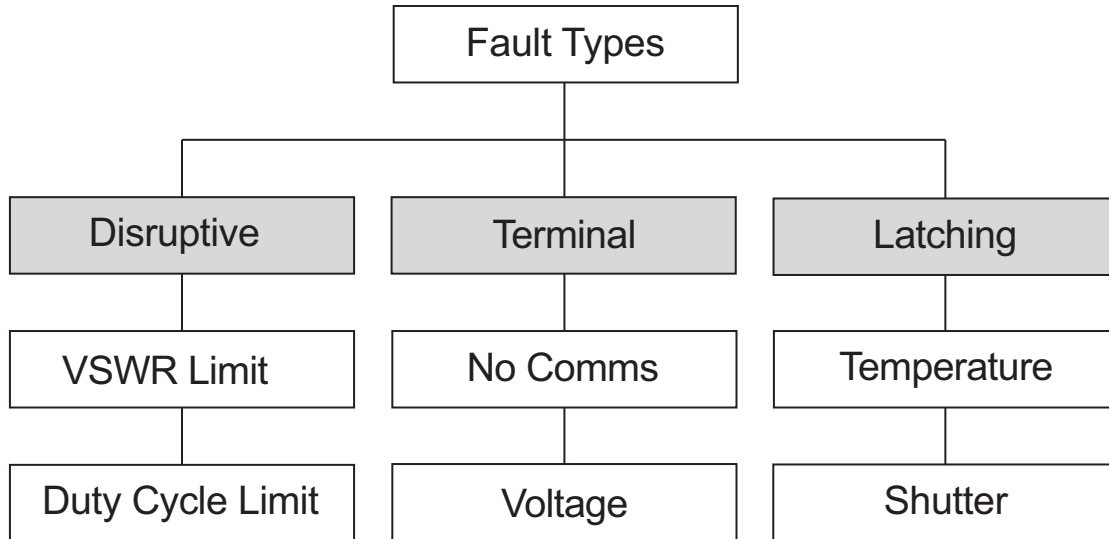


Figure 5-2. Types of J-1000 Series Faults

- **Disruptive (VSWR and Duty Cycle Limit)** - These faults indicate that a fault condition occurred during operation. These are high speed fault types. They indicate that the J-1000 Series control circuitry detected a fault condition and corrected it automatically. The user should check the output of the equipment to ensure that the end product was properly produced in the case of a disruptive fault. These faults are indicated on dedicated pin assignments.
- **Terminal** - These faults are detected on system power-up. Detection of a terminal fault condition will prevent system operation. Terminal faults are signaled by asserting the SYSTEM_FAULT line. Use the Ethernet interface to determine which condition caused the fault.
- **Latching (Temperature, Shutter)** - These faults indicate a serious J-1000 Series problem and cause immediate system shutdown. These faults are latched and system operation can only be restored by correcting the fault condition and toggling the enable/fault reset signal. These faults are indicated on dedicated pin assignments.

The latching faults and both disruptive faults have dedicated pins on the Real Time Input Output connector. The other two types of faults require an Ethernet connection to diagnose fully.

5.2.2 Real Time Control and Status I/O Description

The control and status signals are summarized in Table 5-3 and are accessed through the Real Time I/O DB25 connector on the control panel. To operate the laser, two input signals are required, as indicated in Table 5-3. In order to monitor the condition of the system, five output signals are provided and recommended for use in the user's control system. Detailed descriptions and pinouts of the control connector interface are provided in Table 5-4.

Table 5-3. Real Time Control and Status Interface

Identification	Brief Description	Connection
Input Signals		
MODULATION	Controls laser average output power through input of pulse width and pulse period.	Required
ENABLE/FAULT RESET	Enables laser operation. System reset after fault condition.	Required
Output Signals		
DUTY CYCLE LIMIT	Warning indicating that the system has exceeded the maximum duty cycle.	Recommended
VSWR LIMIT	Warning indicating an abnormally high amount of reflected RF power has occurred.	Recommended
ANALOG FORWARD	Signal proportional to the forward RF voltage.	Recommended
ANALOG REFLECTED	Signal proportional to the reflected RF voltage.	Recommended
SYSTEM FAULT	Indicates a system fault or warning	Recommended

Table 5-4. Real Time Control and Status I/O Pinouts

Pin	Function	Description
1	ANALOG FORWARD —Output signal	Analog output signal representing forward RF power from the RF amplifier to the laser head.
2	ANALOG REFLECTED —Output signal	Analog output signal representing reflected RF power from the laser head.
3	ENABLE/FAULT-RESET —Input signal	Enable is required in order to operate system. Enable must be asserted after 48 DC power is applied. This is accomplished by connecting pin # 3 to a RETURN. Fault reset is required in order to re-establish operation after a system fault occurs. This is accomplished by opening then reconnecting pin # 3 to a RETURN. This pin should not be used for safety interlock.

Table 5-4. Real Time Control and Status I/O Pinouts (Continued)

Pin	Function	Description
4 (+) and 17 (-)	SYSTEM FAULT —Output signal	Active high, differential, digital, output signal indicating that a system fault is present.
7 (+) and 20 (-)	MODULATION —Input signal	Differential input signal that controls the laser output. Laser output power will be present for the duration of this pulse only. See the model specific specifications for allowed pulse durations.
10 (+) and 23 (-)	DUTY CYCLE LIMIT —Output signal	Differential digital signal that is only valid when laser output is commanded (MODULATION input high). A logic high on this signal when laser output is commanded indicates that the commanded modulation exceeds the model-specific duty cycle or pulse width limit. This signal only goes high for that portion of the modulation command which is in violation of the model-specific duty cycle or pulse width limit. Therefore, this signal indicates which portion of the commanded modulation input is being inhibited due to the fault condition. A logic low on this signal when laser output is commanded indicates that the input modulation command is within acceptable limits. This signal is at logic low when laser output is not commanded (MODULATION input low).
11 (+) and 24 (-)	VSWR LIMIT —Output signal	Differential digital signal that is only valid when laser output is commanded (MODULATION input high). A logic high on this signal when laser output is commanded indicates that the reflected RF power exceeds the safe operating limit and that the protection circuit is active. This signal goes high only for that portion of the input modulation command when the VSWR protection circuit is active. Therefore, this signal indicates which portion of the commanded modulation input is being inhibited due to the fault condition. A logic low on this signal when laser output is commanded indicates that the input modulation command is within acceptable limits. This signal is at logic low when laser output is not commanded (MODULATION input low).
14, 15, 16	RETURN	Reference for pin 1, 2, and 3
5, 6, 8, 9, 12, 13, 18, 19, 22, 25	RESERVED	Do Not Connect

5.2.3 Input Signal Requirements

The two inputs required to operate the laser are the ENABLE and MODULATION signals. Figure 5-3 shows the schematic of the input circuit for these two signals.

After the application of DC power, connecting the ENABLE to RETURN enables laser system operation. The ENABLE/RETURN connection must be opened and then closed to clear a latching fault.

The second function required to operate the laser is the MODULATION signal. This signal will determine the laser “on” interval typically called the pulse width. The time interval between the start of one “on” period and the next “on” period is called the pulse period. The pulse width must be in the specified range for the specific model type. MODULATION pulse widths longer than allowed will automatically be limited to the maximum allowed pulse width by the protection circuit in the RF power module. The duty cycle must be no greater than the maximum allowed. The duty cycle is the ratio of the pulse width divided by the pulse period and then multiplied by 100. If either the duty cycle or the pulse width exceeds these limits, a warning will occur on the DUTY CYCLE LIMIT output. A more complete description of this signal and typical waveforms follow later in this section.

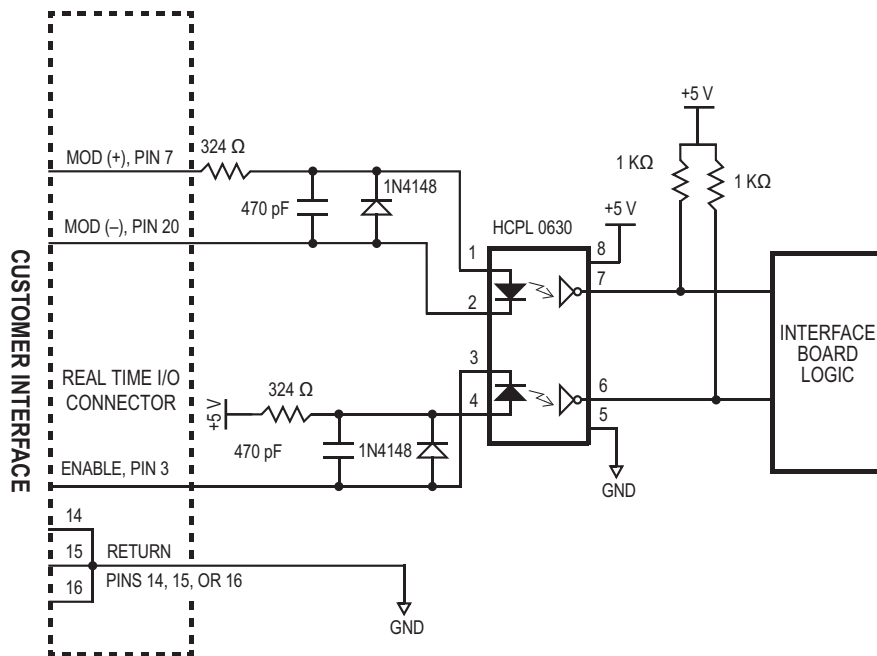


Figure 5-3. Real Time I/O Input Circuit for Laser Operation

5.2.4 Drive Circuit for RF Power Module

An example of a drive circuit to interface to the ENABLE and MODULATION inputs is shown in Figure 5-4.

The MODULATION input interface shown in Figure 5-4 is designed to be driven by a differential line driver meeting the requirements of EIA Standard RS-422A. Common mode voltage on the driver signals should be kept as low as possible and cannot exceed $\pm 15V$ relative to the laser system ground. Examples of suitable line drivers are indicated in Table 5-5.

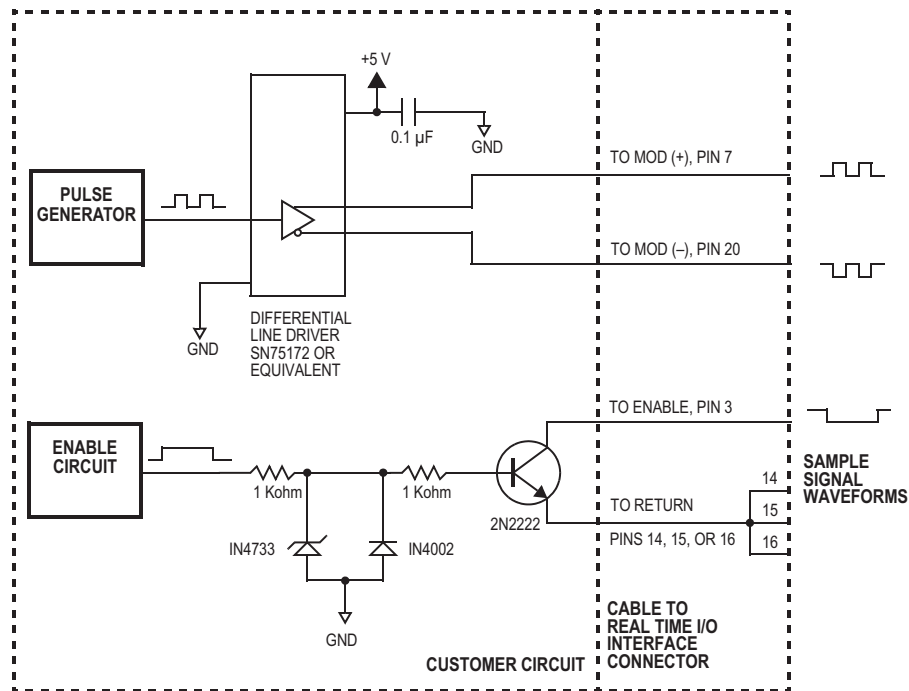
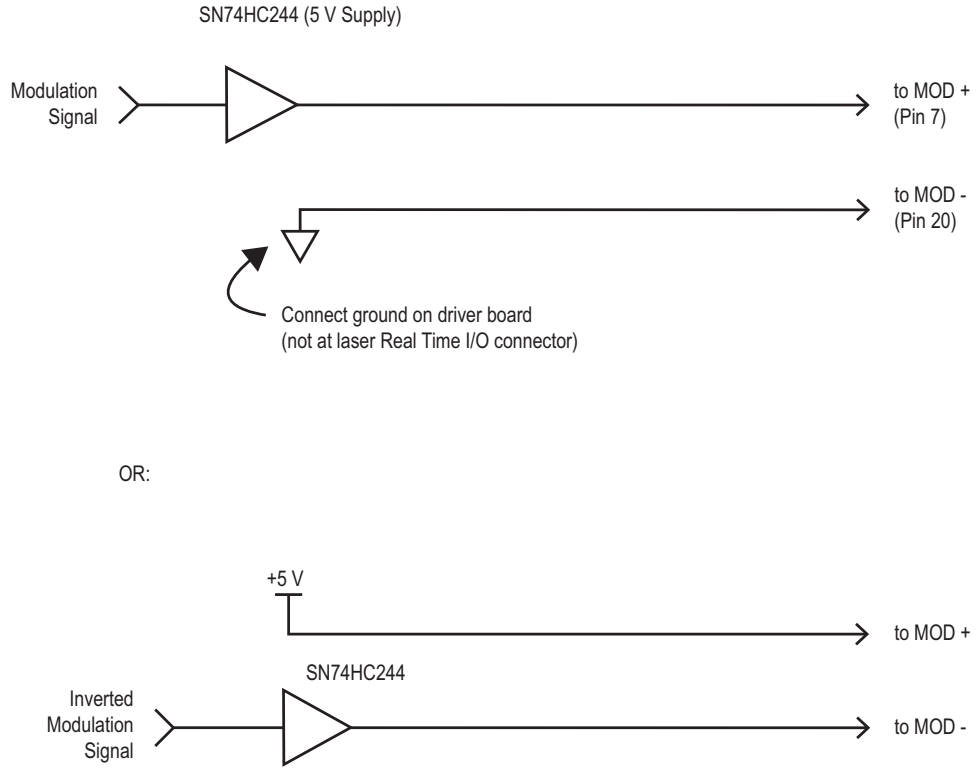


Figure 5-4. Typical Drive Circuit for Real Time Control

Table 5-5. Examples of Line Drivers Meeting RS-422A

Device Part Number	Description	Manufacturer	Mfg Web Site
SN75172	Quad Driver	Texas Instruments	www.ti.com
AM26LS31C			
AM26C31			
SN75ALS191	Dual Driver		
DS26LS31C	Quad Driver		
MC75172			

Alternatively, the MODULATION and ENABLE inputs may be driven by a single-ended circuit. Examples of single-ended driver circuits are shown in Figure 5-5.



Or, use SN74HC240 (inverting version of 74HC244) with inverted modulation for the top configuration, and non-inverted modulation for the bottom configuration.

Figure 5-5. Single-Ended Driver Circuit

5.2.5 Output Signal Recommendation

There are five output signals from the Real Time I/O Interface Connector. Four of these indicate the status of the laser system. These four outputs (duty cycle limit, VSWR limit, analog forward, and analog reflected) provide useful information to the user on the function of the laser system. Figure 5-6 shows a schematic of the output circuits located in the RF power module interface circuit. Although monitoring of these four outputs is not required, it is strongly recommended for the overall ease of use of the complete system.

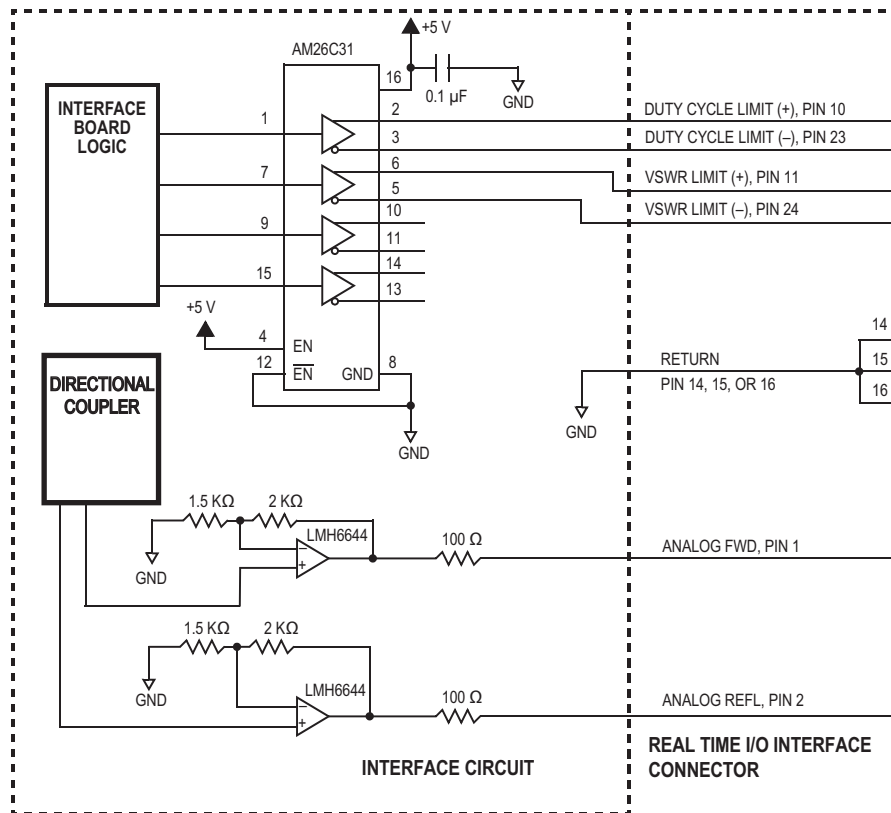


Figure 5-6. Real Time Control and Status Interface Schematic

The purpose of these signals is to warn the user of potential faults and can assist in the diagnosis of several types of operating problems. A common situation when these warnings are useful is when incorrect pulse widths and pulse periods have been selected. An example would be selecting a duty cycle of 70% (max. duty cycle = 60%) and the user observing unstable laser performance. The warning indicator DUTY CYCLE LIMIT will show the error and make it possible to rapidly correct this problem.

5.2.6 Output Signal Description

Coherent recommends using both VSWR LIMIT and DUTY CYCLE LIMIT to directly monitor disruptive faults. This class of faults allows operation but is disruptive and can lead to unwanted results.

The DUTY CYCLE LIMIT and the VSWR LIMIT disruptive faults indicate when the control circuitry in the RF power module is activated and limiting the operation of the RF power module. When these functions are activated, the output power of the laser can be unstable or much lower than expected. If there is a DUTY CYCLE LIMIT warning, then check the MODULATION pulse width and pulse period to ensure that they are not exceeding the model specific maximum duty cycle limit or maximum pulse width.

The VSWR LIMIT indicates that the ratio of the reflected RF voltage to the forward RF voltage has exceeded a preset limit. In some transient starting situations, the VSWR LIMIT disruptive fault will be activated. Coherent recommends checking the status of this indicator about 100 ms after starting the MODULATION signal. If the disruptive fault signal persists during stable operation, additional diagnostics can be performed using techniques presented in "Maintenance and Troubleshooting" (p. 115) and in "Appendix A: Embedded Diagnostics and Fault Matrix" (p. 133) in the operator's manual to determine if the problem resides in the laser head or the RF power module.

5.2.7 Monitoring Circuit Example

An example of a monitoring circuit that can be connected to the output of the Real Time I/O interface circuit is indicated in Figure 5-7.

The J-1000 Series output circuits shown in Figure 5-6, "Real Time Control and Status Interface Schematic," (p. 93) are designed to use line receivers meeting the requirements of EIA Standard RS-422A. Common mode voltages on the drive signals should be kept as low as possible and cannot exceed ± 15 Volts relative to the laser system ground. Examples of suitable line receivers are shown in Table 5-6.

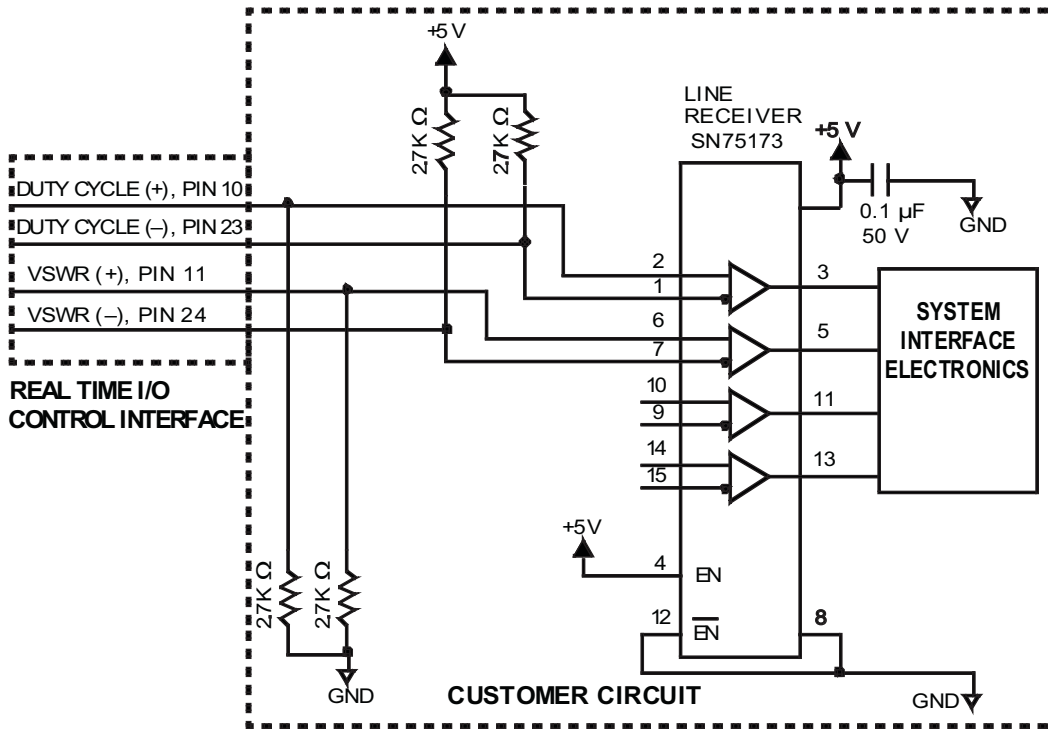


Figure 5-7. Typical Monitoring Circuit
Example Status Monitor (Real Time I/O Control and Status Interface)

Table 5-6. Examples of Line Receivers Meeting RS-422

Device Part Number	Description	Manufacturer	Mfg Web Site
SN75173	Quad Receiver	Texas Instruments	www.ti.com
AM26LS32A			
MC3486			
AM26C32			
SN75157			
DS26LS32C	Quad Receiver		

5.3 Control Using DIAMOND Remote Control

A remote controller is available for use with the J-1000 Series laser, see Figure 5-8 below. This remote may be purchased under part number 1228720. Contact Coherent for additional information. For specifications and operating instructions, refer to the DIAMOND Remote Control Operator's Manual, part number 1235412.



Figure 5-8. DIAMOND Remote Control

5.4 Simmer

The simmer is enabled as soon as DC power is applied to the system, as long as the system interlock is closed. (At any time, opening the system interlock will disable both modulation and simmer.) If the simmer pulses are unable to cause breakdown of the gas after a model specific time period, their duration will be limited by the control electronics to an unconditionally safe state.

Whenever the user applies modulation, the simmer is turned off. No new simmer pulses will be generated until no modulation has been applied for an entire simmer period (typically 1000 μ s for most models). If a repetitive modulation signal with an off time of less than the simmer period (for example, the inverse of the simmer period at 10% duty cycle, with an off time of 900 μ s) is applied, no simmer pulses will be generated. Any repetitive modulation signal with a frequency greater than 1 kHz will inhibit all simmer pulses, but a repetitive modulation signal with a frequency less than 1 kHz also inhibit all simmer pulses if the off time is less than 1000 μ s.

5.4.1 Simmer Faults

There are two fault conditions that are monitored and reported by the simmer logic: Simmer Discharge Loss and Simmer Feedback Loss which are described in greater detail below. These faults are reported to the user in the log file and web page activity window as described in “Appendix A: Embedded Diagnostics and Fault Matrix” (p. 133). These faults are also reported on the VSWR LIMIT output signal on pins 11 and 24 of the Real Time Control and Status I/O connector. Since simmer is only active when modulation is not applied the presence of a VSWR LIMIT fault in the absence of a modulation signal indicates that a simmer fault has been detected. The specific simmer fault can be determined by referring to the log file or activity window. Once modulation is applied the function of the VSWR LIMIT signal reverts to that described elsewhere in this manual.

5.4.2 Simmer Discharge Loss Fault

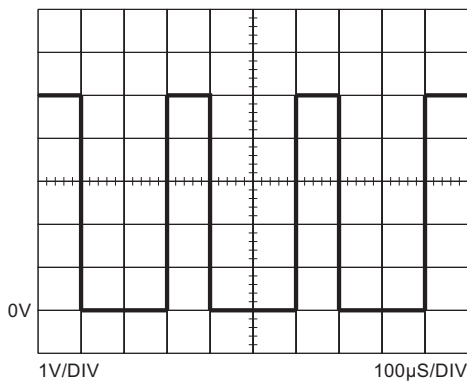
The Simmer Discharge Loss fault indicates that the simmer logic did not detect a valid plasma ignition event in the maximum time allowed for a simmer pulse. The presence of this fault indicates that laser ignition has degraded and that an effective simmer discharge is no longer being generated. This fault may appear on a transient basis, particularly if the laser has been off for an extended period. However, if the fault persists, the laser may require service to remedy this condition.

5.4.3 Simmer Feedback Loss Fault

The Simmer Feedback Loss fault indicates that the feedback signals expected from the RF Power Module (RFPM) are either missing or inadequate for proper operation of the simmer logic. If this condition is detected the simmer logic limits the simmer pulses to an inherently safe minimum value. Since the RFPM feedback signals are also used by the VSWR protection logic the presence of this fault indicates that VSWR protection is compromised and the unit should be promptly serviced to prevent damage to the RFPM.

5.5 Output Signal Waveforms

Figure 5-9, Figure 5-10 on page 99 and Figure 5-11 on page 100 provide representative input and resulting output signals under normal operation, a VSWR fault condition and a duty cycle fault condition respectively. Each figure provides a detailed description of the input signals and the resulting output signals.



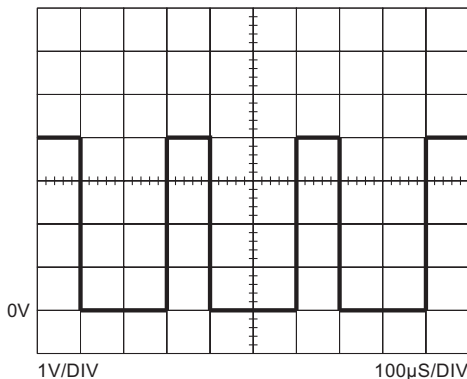
Modulation (+): Input
pin 7 (reference pin 14)

Pulse Width = 100μs

Pulse Period = 300μs

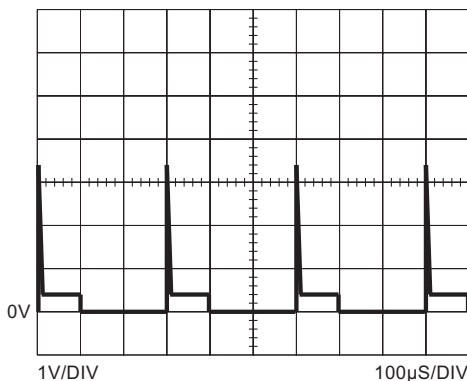
Duty Cycle = 33%

Laser is ON when modulation signal is high



Analog Forward: Output
pin 1 (reference pin 14)

Analog Forward signal is high anytime the modulation signal is active (high) and within specification.



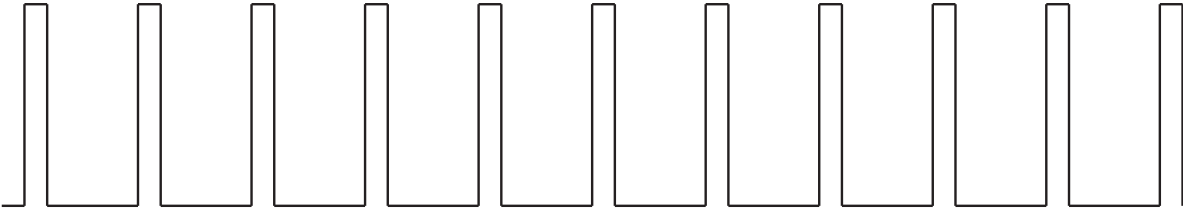
Analog Reflected (+): Output
pin 2 (reference Pin 14)

Analog Reflected signal remains low when the modulation signal is high, except for a short spike at the leading edge of the pulse.

Figure 5-9. RF Amplifier Output Signals - Normal Operating Conditions

Modulation

(pin 7 referenced to pin 14)



1. If VSWR fault is detected on the first pulse,

Analog Forward

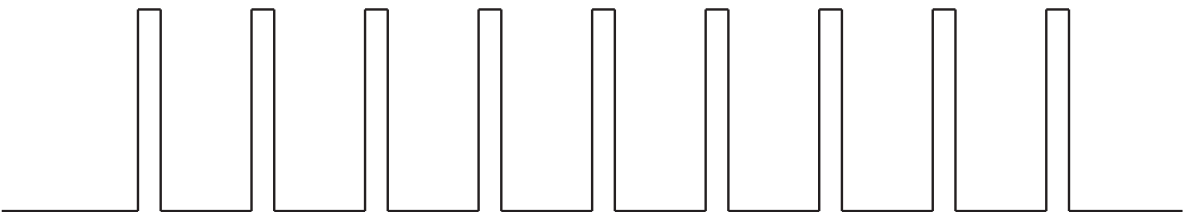
(pin 1 referenced to pin 14) RF is applied to the laser during a HI condition.



2. Subsequent pulses are suppressed until the VSWR controller algorithm determines it is safe to resume delivery of forward power.

VSWR Limit

(pin 11 referenced to pin 14)

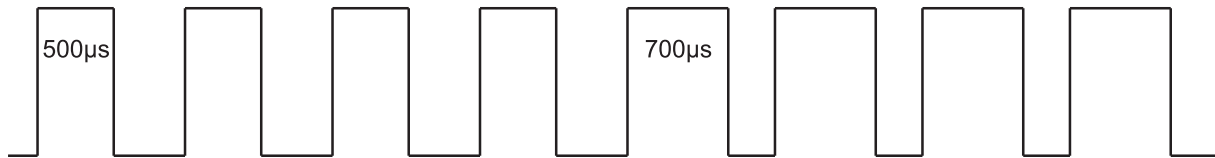


3. Pulses suppressed due to a VSWR Fault appear as HI pulses on VSWR Limit.

Figure 5-10. RF Amplifier Output Signals - VSWR Fault for a 60% Duty Cycle Limit Example

Modulation

(pin 7 referenced to pin 14)

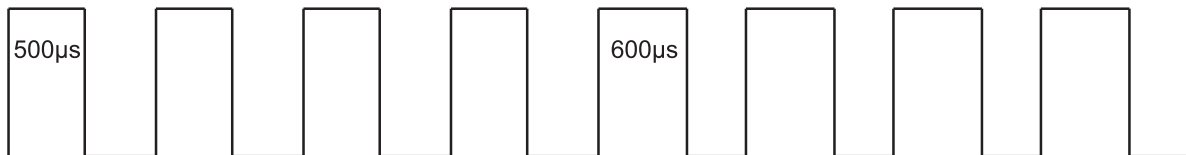


Normal (Legal)
PP = 1000 µs
PW = 500 µs
Duty Cycle = 50%

Changed to:
PP = 1000 µs
PW = 700 µs
Duty Cycle = 70% (ILLEGAL)

Analog Forward

(pin 1 referenced to pin 14) RF is applied to the laser during a HI condition.



PW limited to 600us or
Duty Cycle limited to 60%
(portion of pulse exceeding
either is suppressed)

Duty Cycle Limit

(pin 10 referenced to pin 14)



Duty Cycle Limit signal HI
for portion of suppressed pulses

Figure 5-11. RF Amplifier Output Signals - Duty Cycle Fault

5.6 Extended Interface Connector and Signal Descriptions

The Extended Interface connector gives the user access to more monitoring and control features of J-1000 Series laser systems. There are 3 inputs and 4 outputs on this connector that are described in Table 5-7, "Extended Interface Signal Descriptions," (p. 102). Pin assignments and signal specifications are described in Table 5-8, "Extended Interface Pin Descriptions," (p. 103). Pin assignments and signal specifications are described in Table 5-8, "Extended Interface Pin Descriptions," (p. 103).

5.6.1 System Interlock

A System Interlock input signal is required to enable modulation to the laser. This input can also be used to disable modulation when put in series with a safety circuit. See Table 5-7, "Extended Interface Signal Descriptions," (p. 102) and Table 5-8, "Extended Interface Pin Descriptions," (p. 103).

In normal operation, this pin is either connected directly to ground with a short wire jumper, or drives an external interlock loop which can be opened with electromechanical switches.

5.6.2 Shutter Control and Status

The Shutter Interlock (the shutter is an optional component on some model types) is used to enable the shutter. It is a contact closure on the Extended I/O connector and is described in Table 5-8, "Extended Interface Pin Descriptions," (p. 103). Once enabled the shutter is commanded to the open or closed state by sending the appropriate signal to the shutter command input. Signals are also available to monitor the shutter's position, one for the Shutter Closed Status and one for the Shutter Open Status. Finally, there is a shutter latching fault signal that indicates if the shutter is in a fault condition or is stuck between opening and closing.

In normal operation, this pin is either connected directly to ground with a short wire jumper, or drives an external interlock loop which can be opened with electromechanical switches.

5.6.3 Over Temperature Fault

This output signal indicates that the operating temperature is above a safe operating condition. The presence of this latching fault will shut down the system.

5.7 Extended Interface Signal Descriptions

Table 5-7. Extended Interface Signal Descriptions

Identification	Brief Description	Connection
Input Signals		
Shutter Command	Opens and closes shutter (if shutter option is installed)	Required*
System Interlock	Enables modulation	Required
Shutter Interlock	Enables shutter operation	Required*
Output Signals		
Shutter Closed Status	Signals that shutter is closed	Recommended*
Shutter Open Status	Signals that shutter is open	Recommended*
Shutter Latching Fault	Indicates a shutter fault	Recommended*
Over Temperature Latching Fault	Indicates an unsafe temperature condition	Recommended
*Note: Shutter signals apply if shutter option is installed		



NOTICE!

The optional shutter is provided for beam blocking purpose only. This shutter is not to be used for beam modulation (as a 'process shutter')

5.8 Extended Interface Pin Descriptions

Table 5-8. Extended Interface Pin Descriptions

Pins	Function	Description
1, 2, 7, 11, 14, 19	Reserved	Do not connect.
9 (+) and 22 (-)	Shutter Closed Status	Active high, differential, digital, output signal indicating the shutter is closed. This output signal will be asserted when the shutter is present and closed. During latching faults, this signal will not be present since the shutter is disabled.
10 (+) and 23 (-)	Reserved	Do not connect.
12, 13	Return	Reference for pins 24, 25
15 (+) and 3 (-)	Shutter Command	Active high, digital, input signal that commands the shutter to open. This input signal is used to command the operation of the shutter.
16 (+) and 4 (-)	Reserved	Do not connect.
17 (+) and 5 (-)	Shutter Open Status	Active high, differential, digital, output signal indicating the shutter is open. This output signal will be asserted when the shutter is present and open. During system faults, this signal will not be present since the shutter is disabled.
18 (+) and 6 (-)	Shutter Latching Fault	Active high, differential, digital, output signal indicating that there is a shutter fault. This output signal will be asserted when a shutter fault has been detected. There are two conditions which can cause a shutter fault. First, if the shutter takes too long to swing from open to closed and vice versa. Second, a fault will be generated if the customer is commanding the shutter to be closed and the shutter closed status signal is not detected. For the purposes of fault detection, shutter open, shutter moving, or neither open nor closed are tested for determining a fault condition. A Shutter Latching Fault causes system shutdown.
20 (+) and 8 (-)	Over Temperature Fault	Active high, differential, digital, output signal indicating an operating temperature outside an allowed range has occurred. This output signal will be asserted when any peripheral microcontroller detects a temperature that is outside the allowed temperature range. Refer to "Appendix B: Data Reader Software Guide" (p. 153) for ranges. Over temperature latching fault is a system fault that causes shutdown.
21	Analog Laser Power Monitor	Analog output signal that is proportional to the laser power (1.5 mV/W \geq 1.5 V at 1,000 W).
24	System Interlock	This pin must be connected to pin 12 (return) for laser to operate. It has priority over all other interlocks. (Note: open-circuit voltage is 48 V with an impedance of 7680 Ω .)
25	Shutter Interlock	This pin must be connected to pin 13 (return) for the shutter to operate. This signal does not inhibit system operation. If the system does not have a shutter, the Shutter Interlock must be left open. (Note: open-circuit voltage is 24 V with an impedance of 2880 Ω .)

5.8.1 System Interlock Circuit

Figure 5-12 shows the interlock schematic for the System Interlock Circuit. INTERLOCK+ goes to pin 24 of Extended I/O. INTERLOCK_FLAG is an internal signal used to enable and disable laser operation. Note that the INTERLOCK+ has an open-circuit voltage of 48 V, and the relay coil resistance is 7680 Ω . The Shutter Interlock circuit is similar, but the open-circuit voltage is 24 V, and the coil resistance is 2880 Ω .

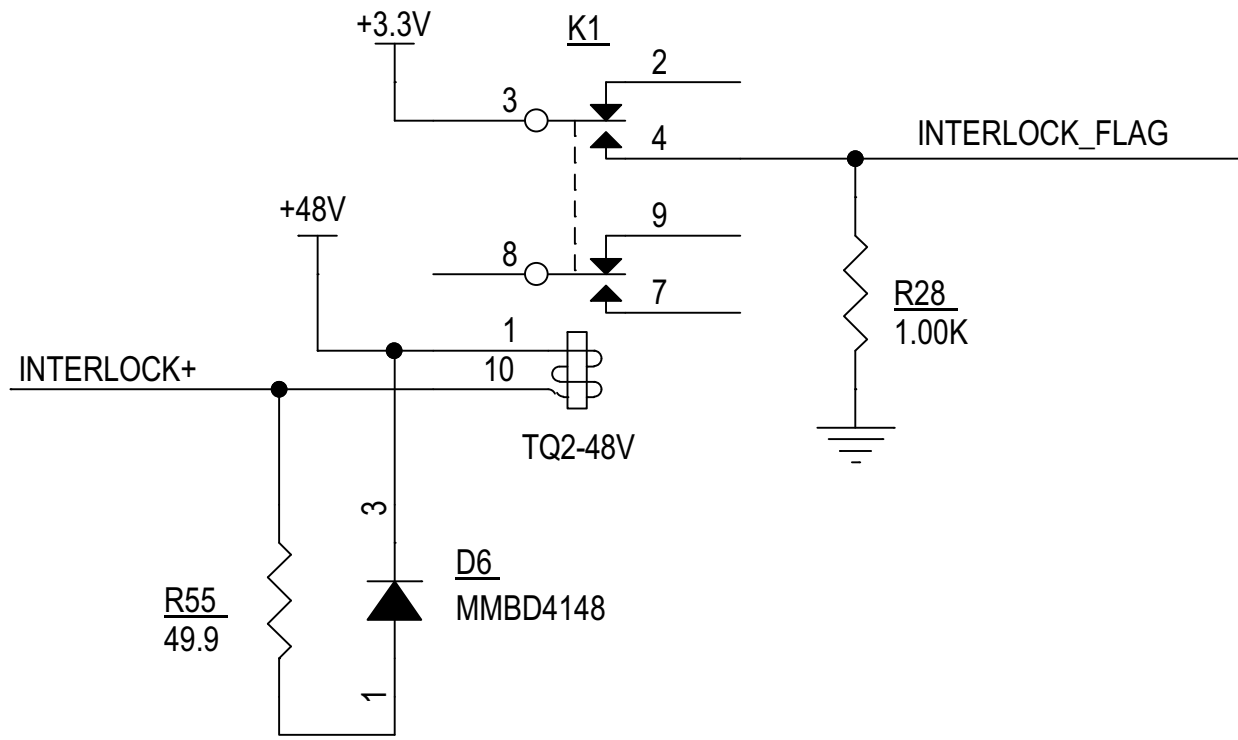


Figure 5-12. System Interlock Circuit



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