YLS Laser series

User manual


Paris, France
London, England
Burbach, Germany
Moscow, Russia
Daejon, South Korea
Tokyo, Japan
Milan, Italy
Oxford, USA
Beijing China
Hong Kong China
Bangalore, India
In progress
Manufacturing, Sales and R&D
Manufacturing and Sales
Sales Only

Contents

1. GENERAL INFORMATION

Thank you for choosing IPG Photonics for your laser needs. Years of experience has made IPG lasers the highest quality, most efficient and highest powered fiber lasers in the world today. Contact us and we will work with you to meet all your laser needs, both new systems and retrofitting existing laser systems. Please contact our IPG Photonics Customer Service Department with any questions or concerns you may have.

The IPG Photonics YLS-Series lasers have been developed to meet industrial market demands as an efficient, reliable, and maintenance-free product. The YLS laser product line is a series of diode-pumped ytterbium fiber lasers with output power ranging from 1kW to 100kW in multi-mode configurations and 100W to 10kW in single-mode configurations. The YLS laser operates in the wavelength region of 900 - 1200nm.

Depending on power level, the laser can be Air-Cooled (AC) or Water-Cooled (WC). The YLS laser series have typical wall-plug efficiencies that exceed 35%.

Test results for your laser system including output power, power consumption, optical characteristics and more are available on the included media.

IPG Photonics fiber lasers are designed and tested to comply with functional safety requirements. By following this guide and applying sound laser safety practices, the laser will be a safe and reliable device.

Because of its special characteristics, laser light poses safety hazards different than light from other sources and requires the use of personal and equipment safety devices. All laser users and persons near the laser must be aware of the hazards involved in operating a laser. All use and integration of any laser systems should be monitored by a qualified laser safety representative.

In order to ensure the safe operation and optimal performance of the product, please follow these warnings and cautions in addition to the other information contained elsewhere in this document. These safety precautions must be observed during all phases of operation, maintenance and repair of this instrument.

Operators are urged to adhere to these recommendations and to apply sound laser safety practices at all times.

1.1. USER MANUAL

This operating manual illustrates the safe and efficient operation of the high power laser (hereafter referred to as the **Laser**). This document is part of the laser and should be kept in close proximity to the laser and operating personnel.

This operating manual contains important information regarding assembly, commissioning, operation, and maintenance of the laser.

Operating and maintenance personnel should carefully review and understand this document before installing or operating the laser.

1.2. MANUFACTURER

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	Internet:	www.ipgphotonics.com	
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Service	Telephone:	(508) 373 - 1157	
	E-mail:	support@ipgphotonics.com	
	Fax:	(508) 373 - 1242	

1.3. TARGET AUDIENCE

This operating manual was created by IPG Photonics Corporation for operating and maintenance personnel.

The laser owner must ensure that the operator and maintenance personnel have been provided with proper laser operation and safety training.

Maintenance personnel are responsible for the assembly/installation, maintenance and repair. These personnel must have been trained in the maintenance of the product by IPG Photonics or another competent IPG branch office. Successful participation in the training is confirmed with a certificate.

1.4. MANUAL INFORMATION

IPG Photonics grants no usage rights, either directly or indirectly, under a patent or other industrial property rights or copyright on the basis of the use of information provided in this document.

Trademarks: Designations that serve as trademarks retain their legal status with or without labeling as trademarks.

Changes: Technical changes that are required for further development of the product series are reserved.

Service: In the event of faults that cannot be rectified using this operating manual, please contact the IPG service department.

IPG Photonics believes that the information provided is correct and reliable. IPG Photonics provides no warranty of any kind, except with regard to the information in this document, including the assurance of suitability for general or specific use. Furthermore, IPG Photonics accepts no responsibility for the use of information in this document, for patent violations or rights of third parties that result from the use of this information.

Documents: In addition to this operating manual, the complete user documentation includes the following:

- Commissioning report
- Circuit diagram
- Accessories list
- Technical data
- Additional system documents in accordance with contractual agreements.

1.5. MANUAL CONVENTIONS

Various symbols and numbering styles are used in this manual in order to designate actions, lists, status, descriptions… etc. The most important layout conventions are listed below.

Content	Example
Instructions to be followed in a specific order	1. Action 1 2. Action 2
Individual instruction, instruction with a specific order and indication of result.	⇒ Action Condition/result after performing the action or additional explanation
List without specific order	• List item
List with specific order	(1) First list item (2) Second list item
Soft key button(s) or keyboard	Soft key button
Menu Title	***Menu Title***
Menu path	***\Menu 1\Menu 2\Command***
System messages, signal names	*Message text*
Operating modes	ON REMOTE

Table 1-1 Manual conventions

1.6. ABBREVIATIONS

The following table lists abbreviated syntax used throughout this manual.

Abbreviation	Definition
CW laser	Continuous wave laser
CAN	Controller Area Network (Industrial protocol)
CW	Continuous Wave
DI-water	De-ionized water
Δp_{max}	Maximum pressure difference
DI water	Partially deionized water
FBUS	Fieldbus
FFBD	Fast Fiber Break Detection
FC	Fiber coupler
FSE	Field Service Engineer
IP address	Internet protocol address
L1,L2,L3	Phase conductor
LAN	Local area network
LCA	Laser connector automotive (Fiber connector type)
LC	Laser chiller
LED	Light-emitting diode
LSB	Least significant bit
MPI	Multi-port interface
MSB	Most significant bit
PE	Physical earth conductor
PF	Process fiber
PLC	Programmable Logic Controller
HLC-8	Fiber connector type
HLC-16	Fiber connector type
LCA	Fiber connector type
QD	Fiber connector type
QCW laser	Quasi-Continuous Wave
RMA	Return material authorization
TCP/IP	Transmission control protocol / Internet protocol
VAC	Volts alternating current
VDC	Volts direct current
YLS	Ytterbium laser system

Table 1-2 Abbreviations

1.7. TERMS AND DEFINITIONS

The following terms and definitions are used throughout this manual:

Dry Contact:	A dry contact is a voltage free contact.
Feeding Fiber:	An optical fiber originating at the splice box.
Process Fiber:	An optical fiber originating at output of a fiber to fiber coupler or a Beam switch.
Maximum output power:	Maximum output power is typically 105% of the lasers stated output power.
Nominal output power:	Nominal output power is the lasers stated output power.

2. SAFETY

The product was designed, manufactured and tested for safety according to the currently applicable safety rules and laws and current engineering practices. The product is in a technically fault- free condition.

However, the product can pose dangers when it is:

- Operated by personnel without proper training.
- Used improperly or contrary to the intended use.
- Used in a fault condition, from a safety perspective.

2.1. SAFETY CONVENTIONS

The following safety conventions are used throughout this manual.

➢ **Warnings:**

- Protection against possible injuries and property damage.
- Indication of the magnitude of danger by means of a key word.
- Indicate the risk of personal injury with the danger symbol.
- Describe the type and source of the danger.
- State the risk and possible consequences.
- Present measures for avoiding dangers and prohibit specific actions.

➢ **Warning tables:**

Here are some examples of warning tables used through this manual. Following this example you will find details regarding the elements that make up the warning tables.

WARNING (key word)	
	Warning symbol ⇒ Danger source
	Prohibited symbol ⇒ Measures to prevent danger
	Mandatory symbol ⇒ Results of taken measures

- **Safety Symbols:** Safety symbols are displayed in the left column of the warning:
  - The **Warning symbol** designates warnings against personal injury.
  - The **Prohibited symbol** indicates an action that should not be performed.
  - The **Mandatory symbol** indicates a required action that must be performed to prevent dangerous condition.

- **Key word:** The *key word* indicates the magnitude of a potential danger and the probability of its occurrence.

- **Source of danger:** The type and cause of the dangers are specified here.

- **Possible consequences of failure to heed warning:**

  The possible consequences of failure to heed the warning are, for example, crushing injuries, burns or other severe injuries. Additional explanations can also be given here.

- **Measures/Prohibitions:**

  Actions that must be taken to avoid a danger or that are prohibited in order to avoid a danger are listed under measures / prohibitions.

- **Key words:**

DANGER
 The danger key word indicates an immediate danger. If this danger is not avoided, this will lead to death or severe injuries.

WARNING
 The warning key word indicates a possible danger. If this danger is not avoided, this could lead to death or severe injuries.

CAUTION

The caution key word indicates a possible dangerous situation. If this dangerous situation is not avoided, this could lead to an injury.

NOTICE

If this notice is not observed, there is a risk of damage to the product or other property damage.

- **Additional instructions:**

Important notice: Should be observed for safe and error-free work.

Additional information regarding the product, method of operation, or general information.

2.2. SAFETY INSTRUCTIONS

Normal Operation: Operation of the product is only permitted if all safety equipment is in operation.

Access to the work zones must be secured with isolating protection equipment with safety interlock function (laser cell) such that the area outside the work zones satisfies the requirements of laser class 1.

The laser cabinet must always be closed and locked during operation. Keys for maintenance and repair work may only be issued to authorized personnel.

Maintenance: Maintenance work may only be performed by trained experts.

The product may not be operated with electrical connections that are faulty or not ready for operation.

Always perform cleaning and maintenance work on the product while it is shut down. Always follow the procedure for decommissioning of the product described in this operating manual. Immediately following completion of the work, all safety features and protection equipment must be reattached or put into operation.

Only permit authorized and appropriately trained personnel who have received safety training to access the product. Always close the product housing after maintenance work.

In the event of faults in the energy supply, switch off the product immediately.

2.3. INTENDED USE

The product is primarily intended for materials processing, IPG YLS series lasers have been used in the following processes:

- Cutting
- Metal Welding
- Drilling
- Brazing & Soldering
- Cladding
- Additive Manufacturing
- Surface Cleaning and Structuring
- Heat Treating

2.4. UNINTENDED USE

The operational safety of the supplied product is only guaranteed if the intended use is complied with. The limit values specified in the technical data may not be exceeded under any circumstances. The use of optics (e.g. fiber coupler, process fiber, process optics) that are not authorized by IPG will not be covered by the warranty. Further any damage to the IPG laser, materials being processed and/or the laser work area which result from the use of non-authorized optics will be the responsibility of the system owner.

2.5. OWNER OBLIGATIONS

The system owner must ensure that the safety and health of the operating personnel are always protected during use of the product.

The system owner must in particular ensure that:

- The product is used only as intended (see Intended Use).
- The product is used only in a flawless, properly functional condition.
- All safety and warning labels are affixed to the product and remain readable.
- Appropriate fire protection is present at the setup location.
- The safety equipment is always kept freely accessible and is regularly inspected.
- Only properly trained or educated personnel operate, maintain or repair the product.
- The responsibilities of the assigned personnel are defined and complied with.
- The operating personnel have completely read and understood the operating manual and know all the safety instructions and residual dangers described in the operating manual.
- First aid is made possible for the operating personnel (e.g. through first aid training and appropriate first aid equipment).
- The personal protective gear is available to the operating and maintenance personnel and used in accordance with the applicable regulations.
- The operating personnel are not under the influence of drugs, alcohol or medications that reduce reaction speed.
- The safety- and risk-conscious work of the personnel is regularly inspected.
- The specified maintenance and inspection work is performed on time.
- In addition to the instructions in this manual, the rules and regulations for accident prevention as well as the environmental and occupational safety regulations of public authorities and industry associations applicable at the usage site are complied with.
- Electrical work is only performed by qualified electricians.
- The operating manual is available for consultation at the usage site of the product at all times and is in a readable condition.

2.6. RESPONSIBILITY OF OPERATING PERSONNEL

Every operator:

- Must follow the fundamental rules with regards to safety-conscious work, accident prevention and the operation of the product.
- Must know the current applicable status for provisions on laser safety.

2.7. PERSONNEL QUALIFICATIONS

Personnel assigned to assemble, maintain, operate and inspect the product must have the corresponding qualifications for performing this work.

The areas of responsibility, competency and supervision of the personnel must be precisely regulated by the laser owner.

Any lack of knowledge on the part of the personnel must be corrected through training and instruction.

Operating Personnel

The operating personnel must have corresponding vocational training in metalworking and be trained in operation of the product. During operation on an industrial robot, the operating personnel must be capable of operating the robot used (training generally provided by the robot manufacturer).

The operating personnel may **only**:

- Operate the laser
- Carry out cleaning work (except for cleaning of the fiber connectors)

Maintenance personnel

The maintenance personnel are responsible for the assembly/installation, maintenance and repair. The personnel must have been trained in maintenance of the product by IPG Photonics or another competent IPG branch office, unless this work is performed by employees of IPG.

The maintenance personnel consists of experts who have the corresponding qualifications for performing the work listed below.

After corresponding training by IPG, the maintenance personnel may:

Assembly and installation

- Set up or assemble the product
- Run lines and fibers to the product
- Connect the product (the voltage supply must be connected by an electrician)
- Install the software

Maintenance

- Preventive maintenance work to maintain operational readiness
- Independent troubleshooting according to the information on troubleshooting in the section on status messages, warnings and alarms

All other work may only be performed by employees of IPG service department itself or by appropriately qualified specialist personnel after consultation with this service department.

Qualified Specialist

A Qualified specialist is person/persons, who have been trained, assigned and instructed by the owner of the end product in which the described product has been incorporated.

These persons are familiar with the pertinent standards, provisions, accident prevention regulations and operating conditions on the basis of their education, experience and training.

They are authorized to perform the respectively necessary activities and to recognize and avoid any dangers that may arise in this process.

2.8. SAFETY-CONSCIOUS WORK

Existing national regulations for accident prevention as well as any internal work, operating and safety regulations of the system owner must be complied with. Any contact protection present for moving parts may not be removed from products that are in operation. Dangers from electrical energy must be prevented.

The product may only be operated in accordance with the intended use and in a fault-free condition.

2.9. PERSONNEL PROTECTIVE GEAR

The system owner must provide the following personal protective gear.

- Laser safety glasses (900…1200nm)
- Safety shoes
- Safety gloves

2.10. SPECIFIC DANGERS

Some specific dangers that can arise during operation of the laser:

- Dangers from laser radiation
- Dangers from electrical energy
- Dangers from gas and particle emissions

2.10.1. Laser radiation

The product emits energy-intensive radiation with a power level in the kW range and a wavelength of 1070 nm. The precise specifications of the laser power can be found in the supplied technical data.

Dangers from laser radiation arise from:

- Direct laser radiation
- Reflected laser radiation
- Scattered laser radiation

Information on important safety measures for working with laser radiation can be found in your regional accident prevention regulations. These regulations make reference to the harmonized standard EN 60825-1, which exists internationally as the standard IEC 60825-1. United States regulations for laser performance standards is covered by 21 CFR 1040.10 and 21 CFR 1040.11.

Laser classes Lasers are classified into various classes based on their danger potential. The meaning of the laser classes is described briefly below. A precise definition with specification of the limit values is contained in the standard EN 60825–1 and/or 21 CFR 1040.10.

Class 1 Laser systems that are safe in normal operation even with prolonged direct observation of the laser beam and even if the exposure occurs in connection with optical instruments (magnifying glasses or telescopes).

Class 2M Laser systems that emit visible radiation that is safe for the naked eye only in event of brief exposure. An eye injury can be caused by exposure through focusing optical instruments (magnifying glasses, telescopes, microscope, etc.).

Class 4 Laser systems for which direct viewing of the beam and skin exposure are dangers and for which even the viewing of the diffuse reflections can be dangerous. These lasers can also pose a fire risk.

Product classification

With suitable protective housing and protective covers, the product satisfies the requirements of laser class 1. With opened protective housing and bypassed safety switches (if present) as well as directly at the point of beam exit from the process fiber, the product falls under laser class 4.

The guide laser of the product in the visible spectral range from 600 nm to 700 nm satisfies the requirements of laser class 2M as long as the cross-section is not reduced by optical instruments (magnifying glass, lens, or telescope).

2.10.2. Electrical energy

The product is operated with a 400 or 480 VAC supply voltage. The system owner must ensure that the supply voltage is free of voltage fluctuations and noise (such as noise induced by electrical motors or actuators).

The isolations and connections of all electrical supply lines must be undamaged.

In particular, the protective earth conductor (PE) may not be interrupted at any point.

Work on electrical components may only be performed by qualified electricians. For all work on electrical components, the following safety rules must be followed:

- Lockout-tagout
- Verify power is disconnected
- Ground and short-circuit
- Restrict access to parts still powered

2.10.3. Gas and particle emission

During the welding and cutting of some materials, toxic gases can be produced by the interactions between the laser beam and the material. This must be taken into account by the system owner. The product itself does not emit any hazardous substances. The system owner should consult with their safety officer to determine if any hazardous emissions are possible based on the process and materials used. IPG Photonics does not accept any responsibility for any hazardous byproducts.

2.11. SAFETY DEVICES

The laser is equipped with the following safety devices:

- E-Stop button
- External E-Stop (Remote Interlock)
- Fiber break monitor
- Door interlock
- Water leak detectors
- Beam switch (if equipped)
- Fiber coupler (if equipped)

The figures below indicate the locations of the laser safety devices found on a laser built with integrated beam switch.

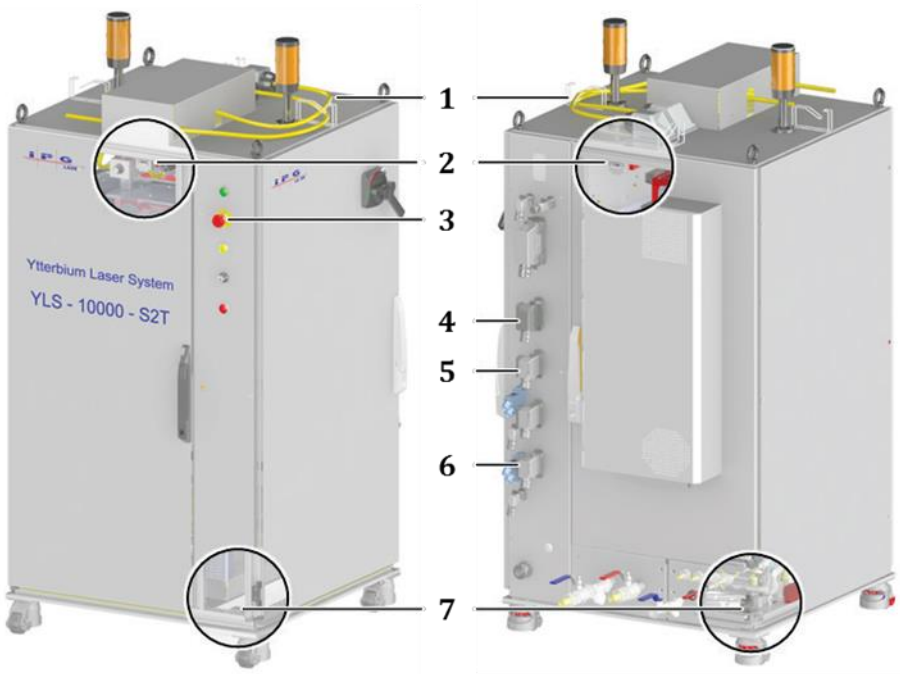


Figure 2-1 Safety equipment (Laser with integrated beam switch)

Item	Designation
1	Fiber break monitoring
2	Door interlock
3	E-Stop button
4	Safety interface (external E-Stop)
5	Safety interface of the beam switch, channel 1
6	Safety interface of the beam switch, channel 2
7	Water Leak detectors

The status of the individual safety devices is indicated in the LaserNet software in the tabs ***Status,*** ***Alarms,*** and ***Warnings.***

The triggering of a safety device has the following effect:

1) The corresponding safety circuit is opened
2) The laser modules power supply is shut down
3) Laser emission is terminated

Switching on the laser power supply:

In order to switch on the laser power supply, all safety circuits must be closed and the safety control of the product must be reset.

⇨ Close all safety circuits

The yellow light of the Interlock illuminated pushbutton on the front side of the product goes out once all safety circuits are closed.

If all safety circuits are closed, the safety control of the product can be reset manually.

The following options are available to you for performing a manual reset:

- Laser ON illuminated pushbutton
- Ethernet interface for the LaserNet software
- Safety interface
- Hardwiring interface (optional)

Another option consists of the bus system (see supplied fieldbus protocols).

⇨ Use one of the options to reset the safety control and switch on the laser power supply.

The green light of the Start illuminated pushbutton on the front side of the product lights up as soon as the safety control of the product has been reset and the laser power supply has been switched on.

Inspection of the illuminated pushbutton

- For inspection of the illuminated pushbutton press the respective button

⇨ The button lights up when pressed

Monitoring the status:

The status of the product can be monitored via the safety interface.
When the laser power supply is switched on, the contacts are closed.
They can be used, among other uses, to control external warning lamps.
The signal for the status of the E-Stop button is connected to the safety interface (status of E-Stop button, 2-channel safety output) and can be integrated into the safety circuit of the system owner.

2.11.1. E-Stop button

An E-Stop button is located on the front side of the laser. Pressing of the E-Stop button leads to an immediate shutdown of the laser modules power supply and thereby the laser emission. After triggering of the E-Stop button, laser emission is no longer possible.

To switch the main power supply back on, the E-Stop button must be manually reset.

2.11.2. External safety interface

Two-channel safety signal external E-Stop. If this input is not connected properly, the ability to turn on the main power supply will be inhibited.

- Safety requirements according to EN 13849-1
- Performance level d, category 3
- A safe emergency stop shutdown of the laser emission can be achieved with a secure two-channel signal removal at this interface. The system integrator should use this interface for a safety subsystem within its overall safety chain (sensor systems – logic – actuator system).

2.11.3. Fast Fiber break detection (FFBD)

The feeding fiber and the process fiber of the laser are continuously monitored (electrical contact). In the event of a fault, the power to the laser modules and laser emission will be switched off.

2.11.4. Beam switch

The beam switch (if equipped) is located inside the laser cabinet.

Each channel of a beam switch provides a two channel external E-Stop, these external "channel" external E-stops are intended to be wired into the work cell's safety circuit associated with the beam switch channel. If the work cell door is opened when that channel of the beam switch is activated (mirror not in home position) and the module power supply is on. The mirror will be returned to the home position, module power supply switched off and emission stopped. The beam switch monitors the process fibers for excessive FFBD and fiber interlock and will also shut down emission under these conditions.

2.11.5. Fiber coupler

The fiber coupler (if equipped) is located inside the laser cabinet.

The fiber coupler monitors the process fiber for excessive FFBD and fiber interlock and will shut down emission under these conditions.

2.11.6. Door interlocks

Safety switches are located on the cabinet doors of the laser. If any door is opened, there will be an immediate shut down of the module power supply and thereby the laser emission.

For lasers that require a tool to remove a side panel, no interlocks are provided and laser emission is possible with panels removed.

2.11.7. Water leak detectors

Water leakage detectors are located in the bottom of the laser cabinet (inside). If water is detected there will be an immediate shut down of the module power supply and thereby the laser emission.

2.12. WARNING LABELS

General description of the warning labels located on the laser (Additional documentation provides more detailed information).

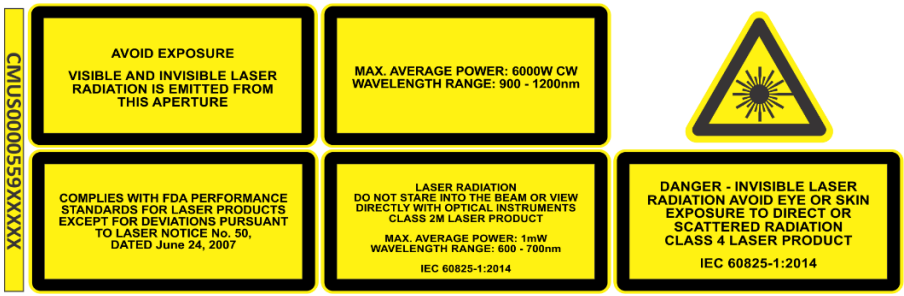
Warning Labels	
Label	**Description**
	**Dangerous laser radiation warning label** Typically located on laser cabinet doors, fiber and laser beam exiting points.
	**Hazardous electrical voltage warning label** Located on all potential electrical voltage danger points
	**Lock out Tag out** This label is located near the electrical panel for use in lock out tag out for service

Table 2-1 Warning Labels

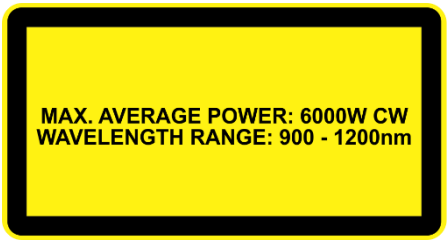
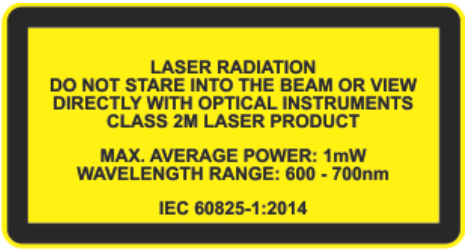
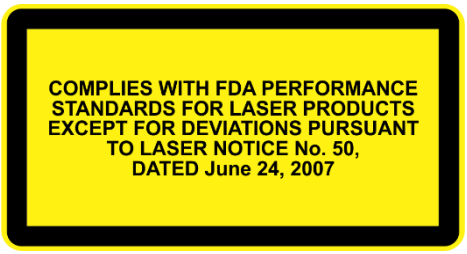
2.13. INFORMATION LABELS

The table below provides a general description of the information labels located on the laser (Additional documentation accompanying the laser provides detailed information as pertaining to the lasers power level and options). IPG has chosen to illustrate labels associated with a YLS-3000 for this section. Please see Appendix B for a full listing of labels used for the YLS laser family of products.

The following label will be displayed on the front of the laser.



Information label	Description
	**Laser radiation information** Located at the end of a feed fiber. Located at both ends of a process fiber.
	**Class 4 laser information** Located on the laser

	
	**Class 4 laser information** When panel is removed from laser
	**Class 4 laser information** When interlocks are defeated
	**Guide laser information** Located on the laser
	**FDA Compliance information**

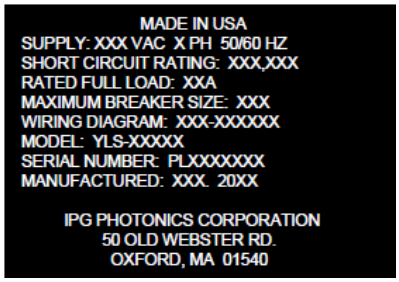
	This label is present near the laser output, or output fiber location.
	IPG Photonics data tag provides model, SN, date of manufacture and electrical information. See Electrical Requirements section for appropriate power requirements.

Table 2-2 Information labels

2.14. LASER MODIFICATIONS AND REPLACEMENT PARTS

Alteration or modifications to the laser are only permitted with written approval from IPG Photonics. Original spare parts and accessories authorized by IPG Photonics serve to ensure safety. Failure to heed these instructions results in exclusion of all liability.

2.15. LASER SAFETY REFERENCES

For additional information regarding laser safety please refer to the references below.

Laser Institute of America (LIA)
13501 Ingenuity Drive, Suite 128
Orlando, Florida 32826
Phone: 407-380-1553 Fax: 407-380-5588 Toll Free: 800-34-LASER
Email: lia@laserinstitute.org

American National Standards
ANSIZ136.1, American National Standard for the Safe Use of Lasers
(Available through LIA)

International Electro-technical Commission
IEC 60825-1
International Standard
Safety of laser products
Part 1: Equipment classification, requirements and user's guide
(Available through LIA)

Center for Devices and Radiological Health
21 CFR 1040.10 – Performance Standards for Light-Emitting Products
https://www.fda.gov/Radiation-EmittingProducts/default.htm

US Department of Labor – OSHA
Publication 8-1.7 – Guidelines for Laser Safety and Hazard Assessment
http://www.osha.gov/

Laser Safety Equipment
Laurin Publishing
Laser safety equipment and Buyer's Guides
https://www.photonics.com/Publications.aspx

IPG Photonics recommends that the owner of the laser investigate any local, state, or federal requirements as well as facility or building requirements that may apply to the installing or using a laser or laser system.

3. LASER DESCRIPTION

The YLS series of high power fiber lasers with optional integrated optics (beam switch or fiber coupler) described in this manual, were developed for material processing. The primary applications consist of welding and cutting of metal and metal alloys. Depending on the configuration, the dimensions of the cabinet and the emission power of the laser can vary (1kW to 100 kW). For lasers less than 10 kW, generally a single cabinet design is used; for lasers above 10kW, multiple cabinets are used. Independent of the laser enclosure, the location of most controls and interfaces remain the same.

3.1. OVERVIEW

The following figure provides an overview of the common elements of the laser. Figure 3-1 uses a YLS-10000-S2T laser as an example (10kW with 2 channel, top located beam switch).

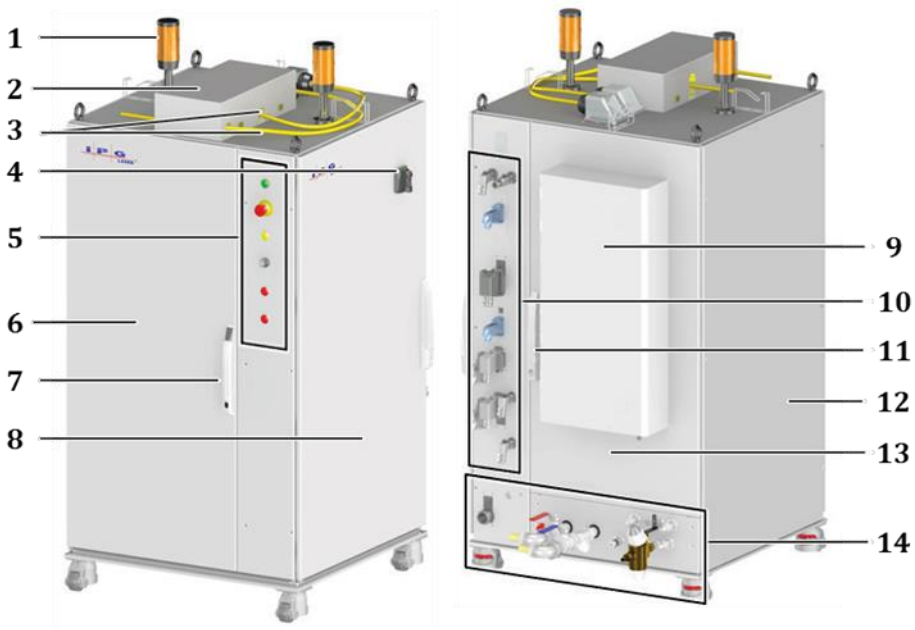
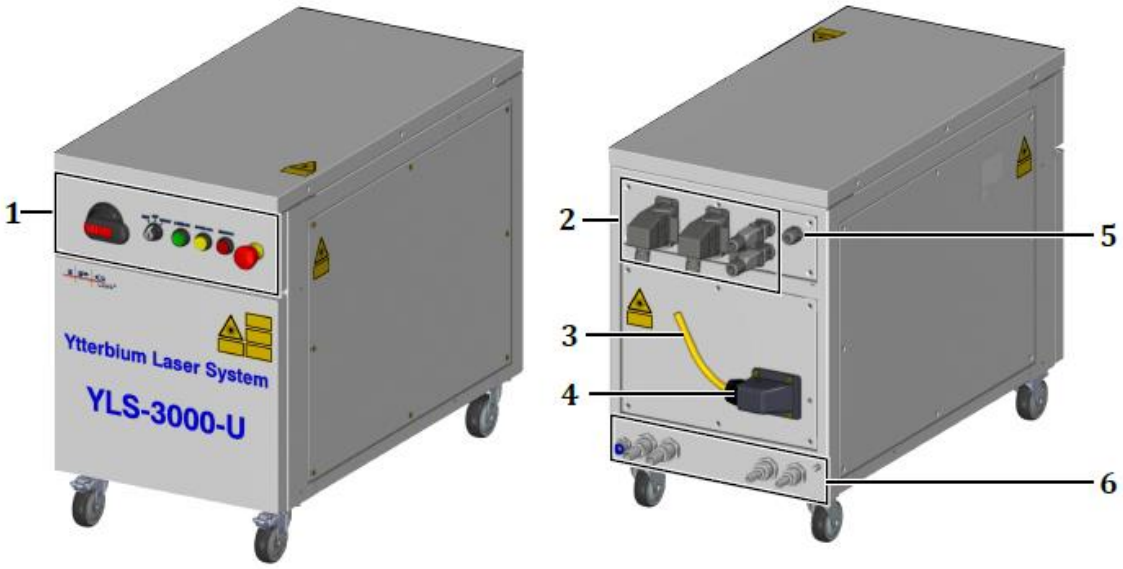


Figure 3-1 Laser Overview

Ref.	Designation	Description
1	Stack lights	The stack lights consist of two segments. The lower light is steady when the laser module power supply is on. The upper light flashes when the laser emission is enabled.
2	Fiber strain relief enclosure	Enclosure to protect process fiber strain relief.
3	Process fiber	Laser emission fiber
4	Main power switch	Electrical disconnect from main power source.
5	Controls/Indicators	Laser controls and indicators
6	Front door	Provides access to the optical modules, power supplies, and integrated optics.
7	Door handle with lock	Lockable handle to limit access to laser components.
8	Side door	Provides access to control electronics and electrical panel.
9	Air conditioner (optional)	The air conditioner cools the laser and reduces humidity.
10	Interfaces	The interface connectors provide laser control and status.
11	Door handle with lock	Lockable handle to limit access to laser components.
12	Side panel	On single-cabinet models, the splice box and the flow switches for the cooling loops are located behind the side panel.
13	Rear door	Provides access to the integrated optics, optical module circuit breakers, and cooling plumbing.
14	Water connections	Water cooling connections (supply and return)

Table 3-1 Laser Overview

Ultra-Compact Laser



Ref.	Designation	Description
1	Operating elements	Controls and indicators for operating and monitoring the laser
2	Interfaces	Communication and safety interfaces
3	Feeding fiber	Optical fiber for emission delivery
4	Feeding fiber output	Optical fiber exit port
5	Power entry	Entry port for AC power connection
6	Connections	Water cooling connections

Table 3-2 Ultra Compact overview

3.1.1. **Stack Lights**

For the YLS laser series, there are two types of stack lights used depending on the size of the laser. The following table (Table 3-3) illustrates the two types of stack lights and there operation.

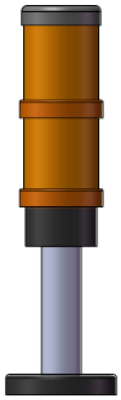
Compact laser stack lights			
Stack Light	**Status**		**Description**
	Off		Laser module power supply output is off
	On		Laser module power supply output is on*
	Flashing		Emission Enabled*
Standard laser stack lights			
Stack Light	**Status**		**Description**
	Top	Off	Emission Disabled
	Top	Flash	Emission Enabled*
	Bottom	Off	Laser module power supply output is off
	Bottom	On	Laser module power supply output is on*

Table 3-3 Stack Light Operation

* When the indicator is On, the internal power supply is active and the laser is capable of producing laser emission.

3.1.2. Controls and Indicators

The figure below illustrates the various laser controls and indicators located on the front panel of the laser. These controls and indicators may vary depending on the options installed in the laser. The illustration is typical for a YLS-10000-S2T laser.

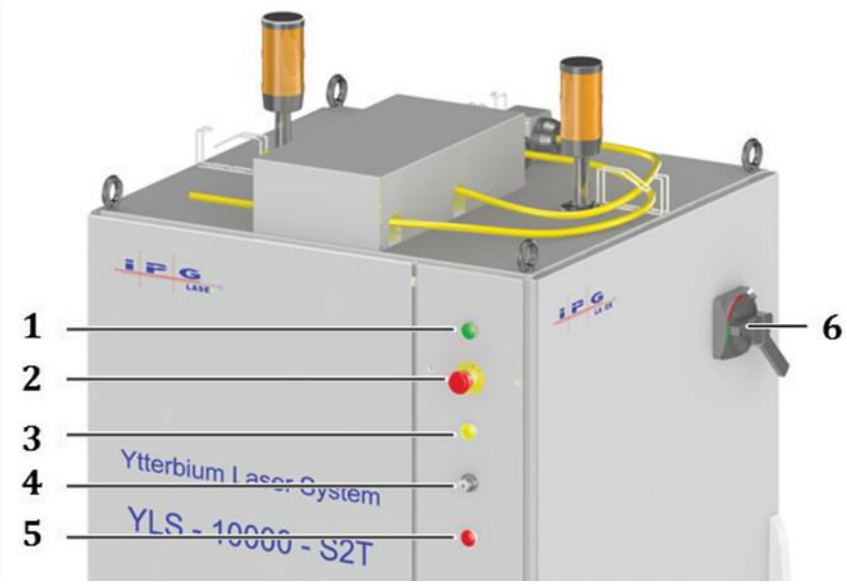
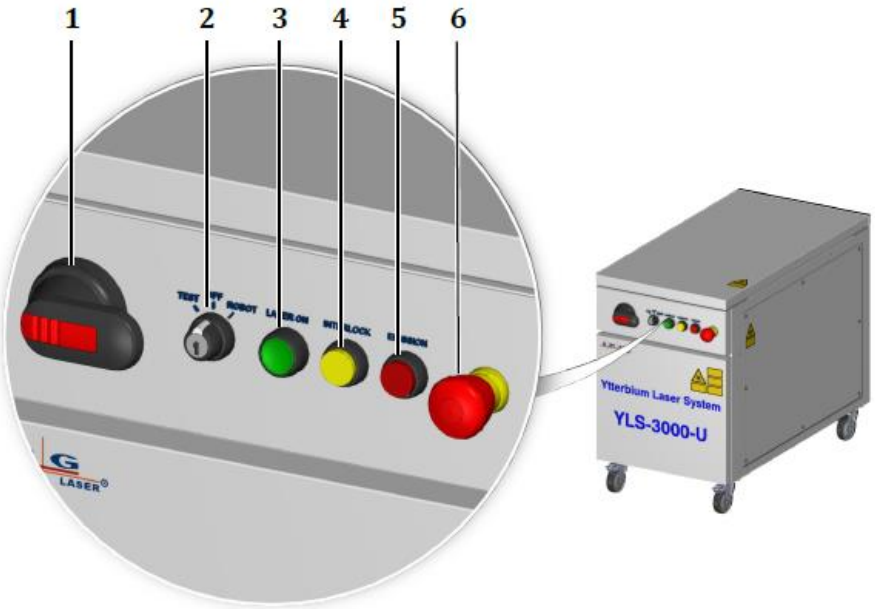


Figure 3-2 Controls and indicators

Ref.	Designation	Description
1	Start button	Pressing the start button switches on the laser modules power supplies. The start button will be illuminated when the main power supplies are on. When the indicator is On, the internal power supply is active and the laser is capable of producing laser radiation.
2	E-Stop button	Pressing the E-Stop button in an emergency situation switches off the main power supply and the laser emission.
3	Interlock button	The interlock indicator is an illuminated pushbutton. If it is on, there is something wrong with the interlock circuit. You can press the button to make sure the bulb is in good working condition.
4	Key switch	Selects the operating mode of the laser. “ON” to control the laser from the LaserNet software, “Remote” to control the laser via the hardwiring interface or the field bus interfaces.
5	Service mode switch (optional)	Service mode indicator is an illuminated pushbutton. When it is on the service mode switch is in the on position. You can press the button to make sure the light is in working condition.
6	Main power switch	Disconnects the laser from the AC source.

Table 3-4 Controls and indicators

Ultra-Compact Laser:



Ref.	Designation	Description
1	Main switch	Turning the main switch connects/disconnects the laser from the voltage supply.
2	Key switch	Selects the operating mode of the laser. “ON” to control the laser from the LaserNet software, “Remote” to control the laser via the hardwiring interface or the field bus interfaces.
3	Laser On push button	Pressing the illuminated pushbutton switches the laser power supply on. The illuminated pushbutton lights up green as soon as the laser power supply is switched on. When the indicator is On, the internal power supply is active and the laser is capable of producing laser radiation.
4	Interlock push button	The illuminated pushbutton lights up yellow as soon as the safety circuit is opened. You can check this lighting function by pressing the illuminated pushbutton.
5	Emission push button	The illuminated pushbutton lights up red as soon as the laser power supply is switched on and laser emission is possible. You can check this lighting function by pressing the illuminated pushbutton.
6	E-stop button	Pressing the E-Stop button in an emergency situation switches off the laser power supply and the laser emission.

Table 3-5 Ultra Compact Laser Controls

3.1.3. **Interface connections**

Located on the left rear panel of the laser are multiple connectors for control and status of the laser (see Figure 3-1 Laser Overview).

The number and arrangement of the connectors may vary depending on the options installed.

3.1.4. **Laser components**

The following figure indicates the main components in the laser. Depending on laser model and installed options, component placement may differ from what is indicated. Some components such as the beam switch are optional.

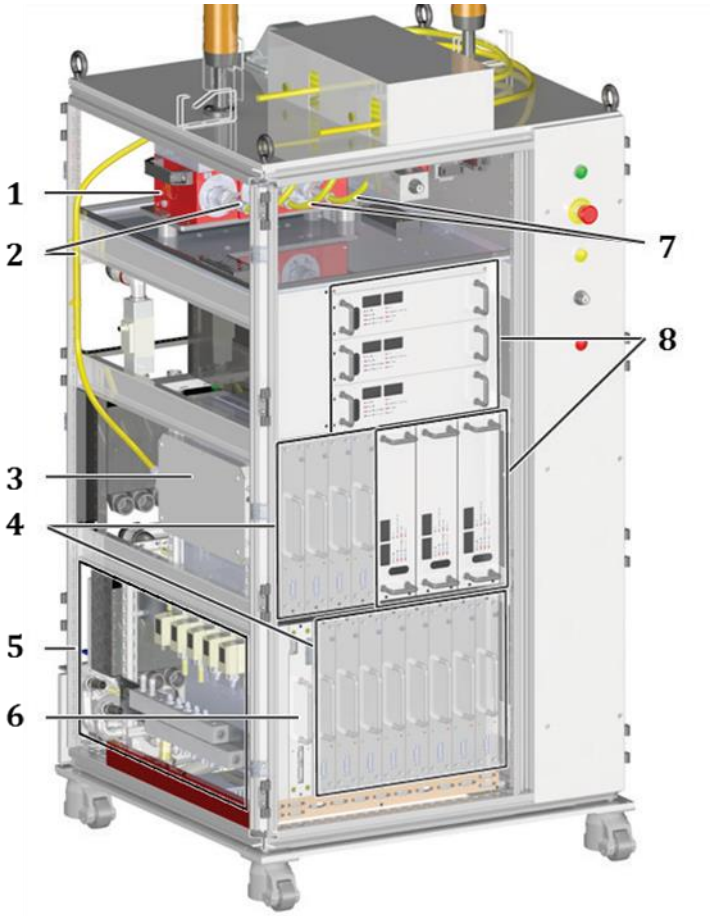


Figure 3-3 Laser components

Note: Depending on laser options and emission level cabinet layout as shown in Figure 3-3 will vary.

Ref.	Designation	Description
1	Beam switch	Directs the emission from the feeding fiber to the selected process fiber.
2	Feeding fiber	Transmits the laser emission from the splice box to the integrated optics.
3	Splice box	Connects the output of the splice box into the feeding fiber.
4	Laser modules	Generates laser emission.
5	Water manifold and flow meters	Distributes the cooling water to the laser modules and power supplies. Flow meters monitor and indicate flow rates.
6	Optical combiner	Connects the optical fibers from all of the optical modules to the splice box.
7	Process fibers	Transmits the laser emission from the integrated optics to the work piece.
8	Laser module power supplies	Provides DC power to laser modules

Table 3-6 Laser components

3.1.5. **Electrical panel**

The electrical panel is divided into two areas: one area with control electronics for the laser and one area with electrical distribution components.

The electrical panel of a YLS-10000-S2T laser is shown as an example in the following figure. The components and their arrangement on the electrical panel can vary based on the configuration of the laser.

The exact layout of the electrical panel of your laser as well as the information about the components used can be found in the supplied circuit and layout diagram.

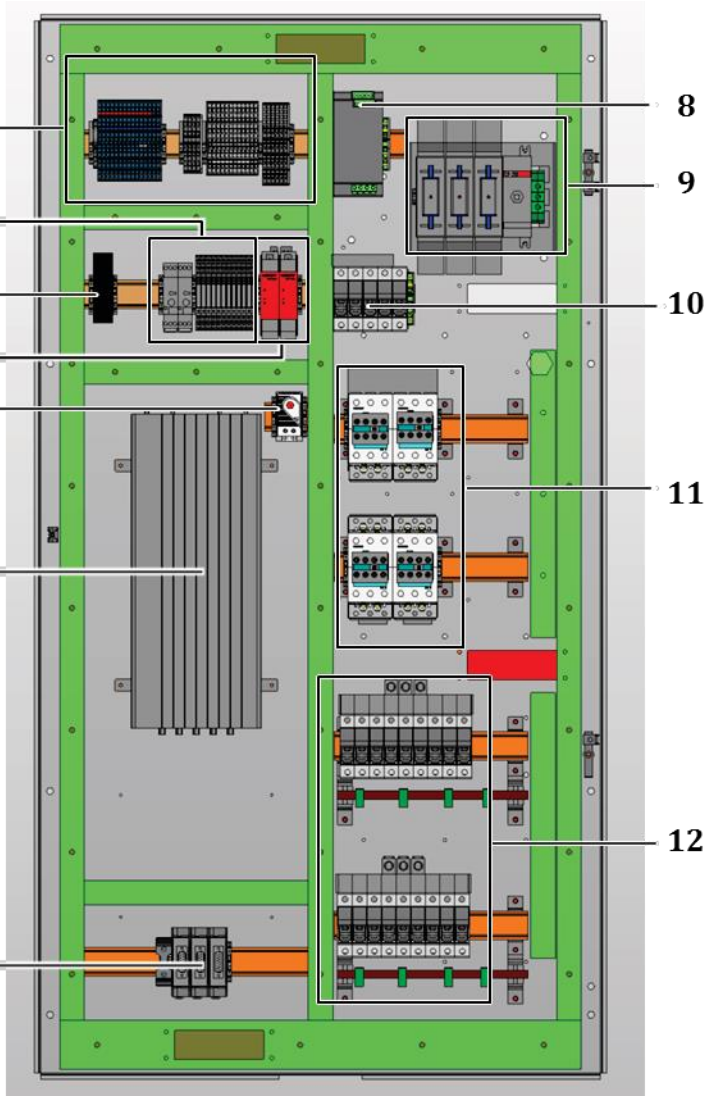


Figure 3-4 Electrical panel

Ref.	Designation	Ref.	Designation
1	Terminal blocks	7	Beam switch interface modules
2	Relay controls	8	24VDC power supply
3	Fuses	9	Main disconnect and fuses
4	Safety relays	10	Safety fuses
5	Temperature sensor	11	Power contactors
6	Control electronics	12	Power supply fuses

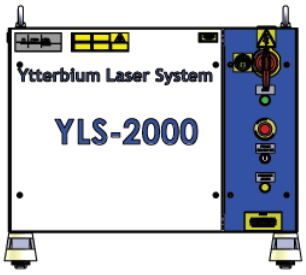
Table 3-7 Electrical panel components

3.1.6. **Laser Cabinet Dimensions**

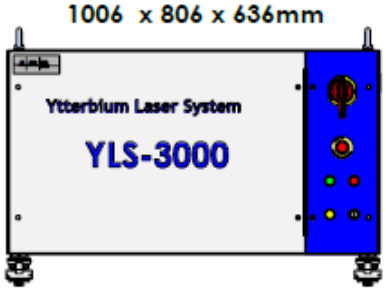
The following information is based on standard cabinet dimensions.

W X D X H
427 x 808 x 662

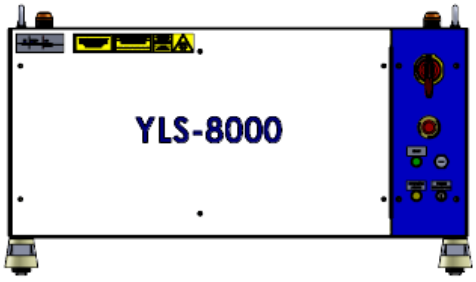
W X D X H
775 x 806 x 636mm



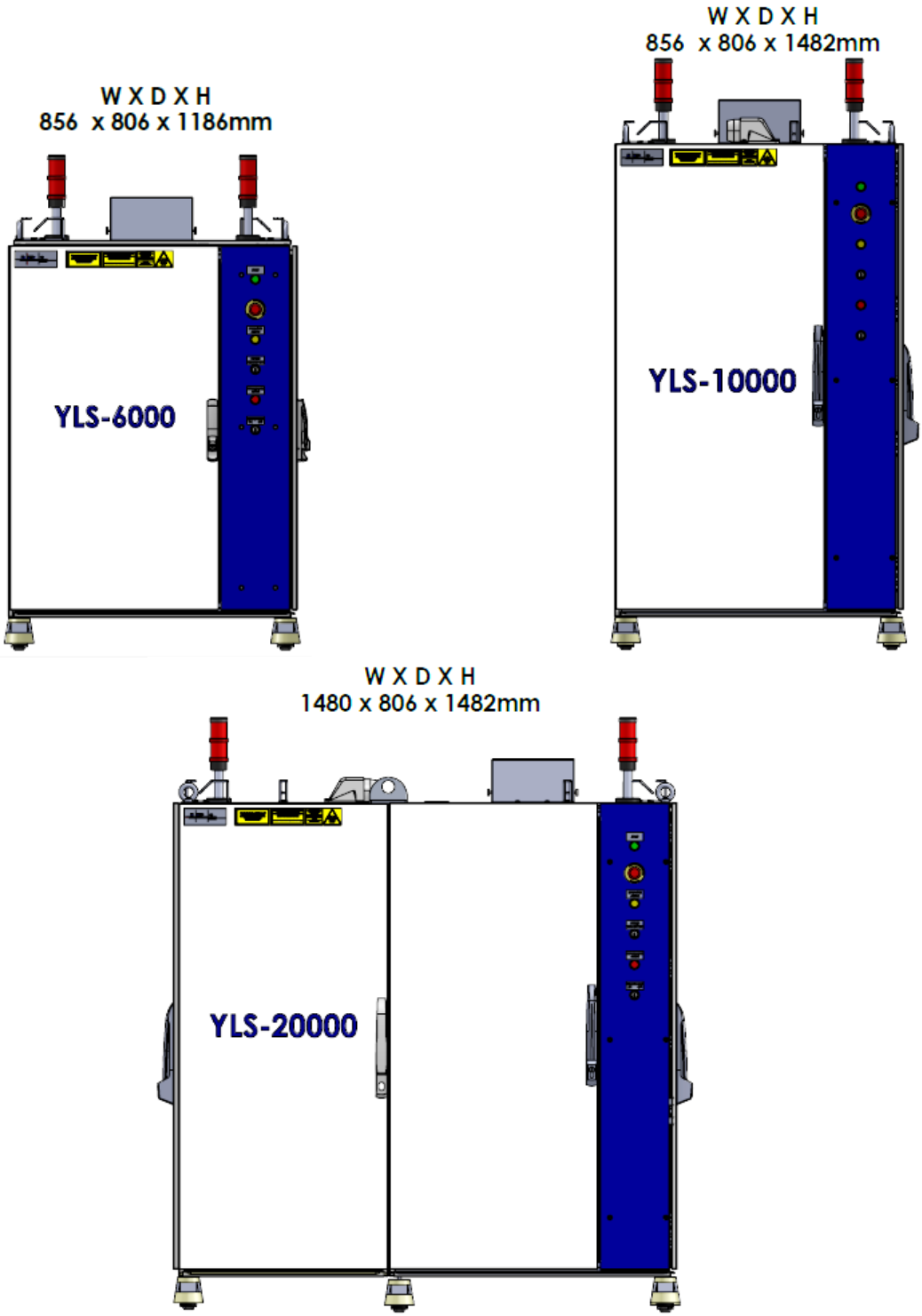
W X D X H
1006 x 806 x 636mm



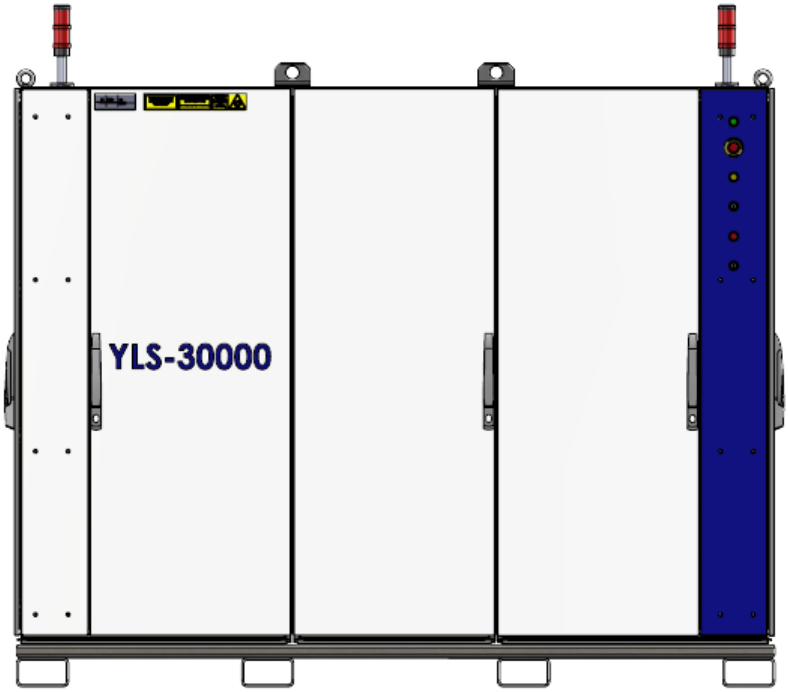
W X D X H
1206 x 806 x 636mm



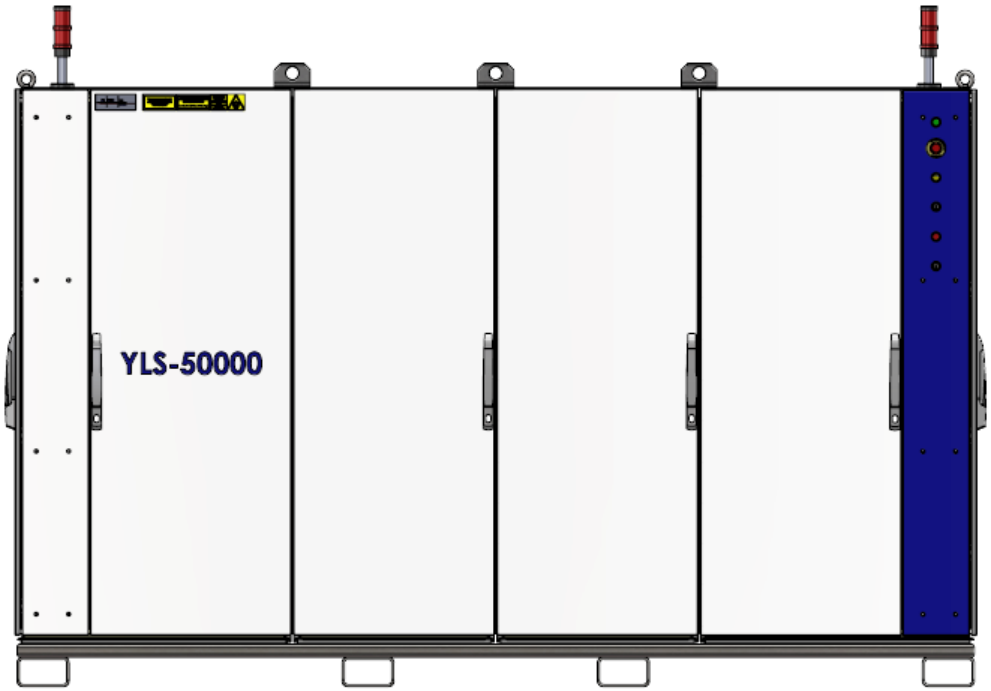
W X DX H
1007 X 808 X 903


W X D X H
856 x 806 x 1186mm
YLS-6000
W X D X H
856 x 806 x 1482mm
YLS-10000
W X D X H
1480 x 806 x 1482mm
YLS-20000

W X D X H
2728 X 806 X 1482mm



W X D X H
2728 X 806 X 1482mm



3.2. FUNCTIONAL OVERVIEW

Laser emission is produced in the laser modules by multiple laser diodes. Each laser module can be viewed as an independent laser. Depending on the module type, the module can have an output power of between 700 and 2000 W. The number of modules is determined by the nominal output power of the laser.

The laser modules require DC power to generate laser emission. The DC power is provided by 1 or more laser diode power supplies. The number of power supplies is determined by the laser power.

The emission generated in the laser modules is transmitted by the associated fibers into the combiner module, where the output fibers of all the laser modules are combined into a single fiber. The output fiber from the combiner module is spliced to the feeding fiber in the splice box.

Depending on the laser configuration, the feeding fiber may exit the laser at this point. Some lasers are configured with integrated optics such as a beam switch or fiber coupler. In these configurations the feeding fiber is connected to the input of either the beam switch or the fiber coupler. For lasers built with beam switches, it is possible to have 1 to 6 process fibers exiting the laser.

Process fibers can differ in their core diameter and length as required and can be replaced accordingly.

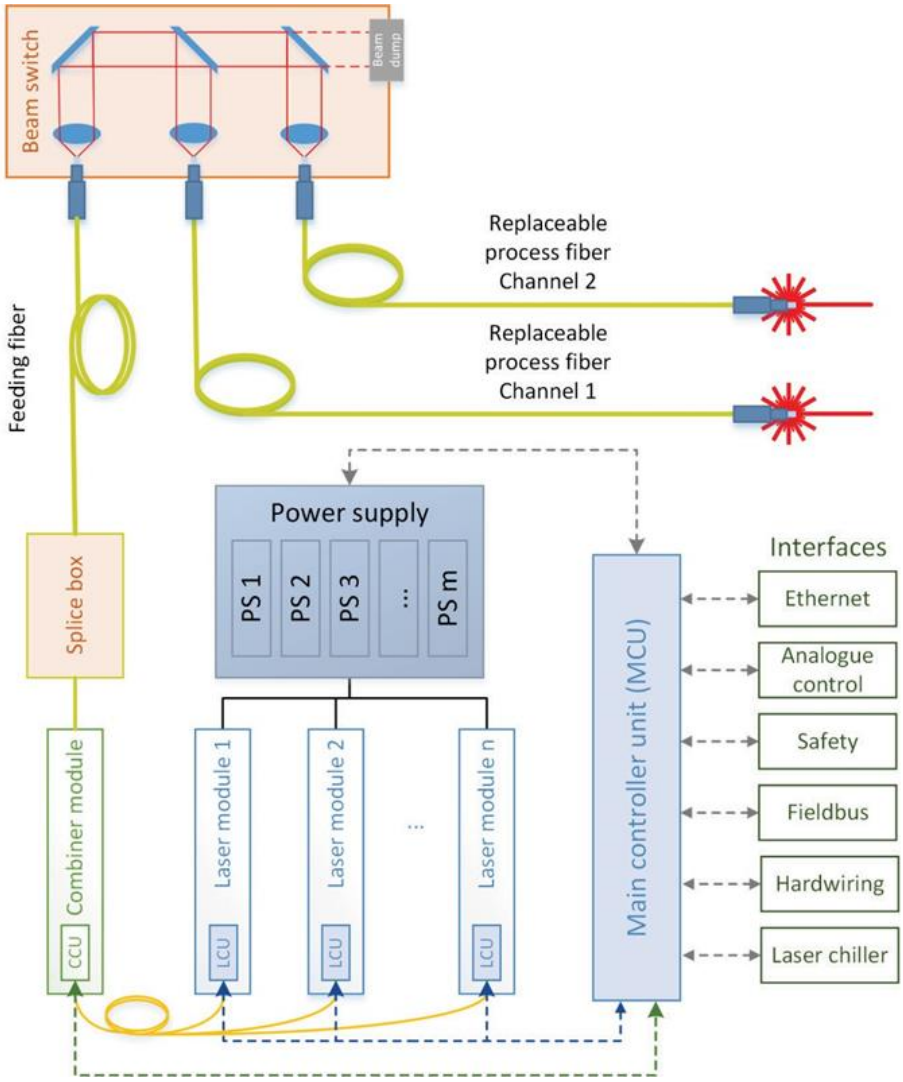


Figure 3-5 Functional overview (with beam switch)

3.2.1. **Beam switch**

A beam switch provides a convenient way to time share laser emission. Beam switches can be integrated with optical outputs for 1, 2, 3, 4, or 6 process fibers. Additionally switches can be factory configured for the following optical configurations:

- Single process fiber selection
- Dual process fiber selection (energy sharing option)

Switches configured for single process fiber selection pass all laser emission from the feeding fiber to the selected process fiber.

Switches configured for dual fiber selection pass laser emission to two process fibers simultaneously, depending on the optical mirrors installed 50% of the energy can go to the first process fiber and 50% of the energy will go to the second process fiber. The energy sharing option was developed for processes that require two simultaneous emission sources.

Note: For energy sharing configurations other emission sharing ratios may be available.

Emission into a process fiber is only possible when a mirror is placed in the optical path within the beam switch. Moving a mirror into an optical path can be achieved by several methods:

- LaserNet
- Laser program
- Hardwiring interface
- Fieldbus interface

In the event of a fault condition, the beam dump absorbs the laser emission and contains it within the beam switch, and the built-in thermal circuit breaker switches off the main power supply.

In addition to the previously described functions, the beam switch represents a safety device and is integrated into the lasers safety system.

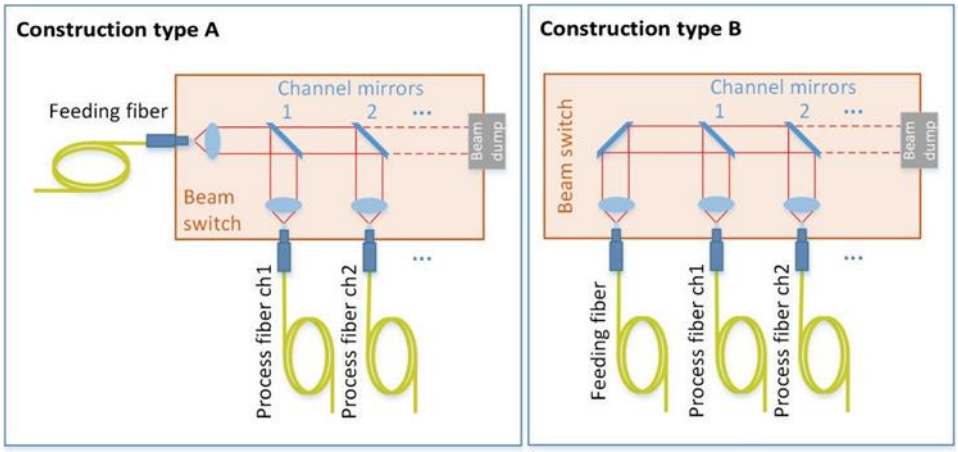


Figure 3-6 Beam switch configurations

The following table illustrates the flow meter mapping for up to a 6 channel beam switch.

Flow Switch	Monitors
FS1	Laser flow rate, displayed in status page of LaserNet
FS2	Feeding fiber connector
FS3	Channel 1 process fiber input attached to beam switch
FS4	Channel 1 process fiber output attached to work station
FS5	Channel 2 process fiber input attached to beam switch
FS6	Channel 2 process fiber output attached to work station
FS7	Channel 3 process fiber input attached to beam switch
FS8	Channel 3 process fiber output attached to work station
FS9	Channel 4 process fiber input attached to beam switch
FS10	Channel 4 process fiber output attached to work station
FS11	Channel 5 process fiber input attached to beam switch
FS12	Channel 5 process fiber output attached to work station
FS13	Channel 6 process fiber input attached to beam switch
FS14	Channel 6 process fiber output attached to work station

Table 3-8 Beam switch flow switches

3.2.2. **Fiber coupler**

Benefits of a fiber coupler:

1) The fiber coupler prevents back reflected laser emission from entering the lasers optical components and damaging the laser.
2) The fiber coupler provides a convenient location for changing the process fiber.

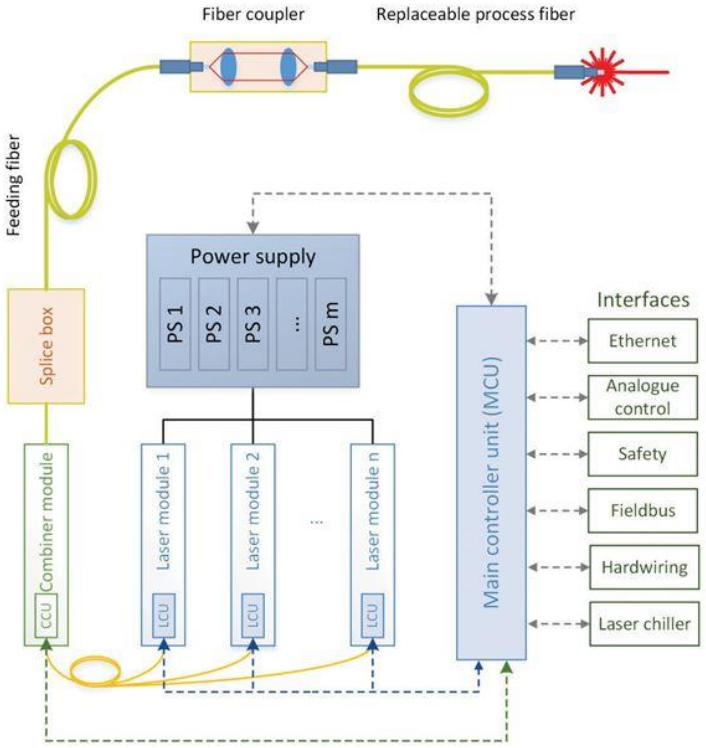


Figure 3-7 Fiber coupler

The following table illustrates the flow meter mapping for a fiber coupler.

Flow Switch	Monitors
FS1	Laser flow rate, displayed in status page of LaserNet
FS2	Feeding fiber connector
FS3	Coupler process fiber input attached to fiber coupler
FS4	Coupler process fiber output attached to work station

Table 3-9 Fiber coupler flow switches

4. TRANSPORT AND DELIVERY

In the event of improper handling during transport, damage to the product can occur that may affect the safety of the laser.

⇒ Wear the required personal protective gear during loading and unloading of the laser.

4.1. SCOPE OF DELIVERY

The delivery consists of:

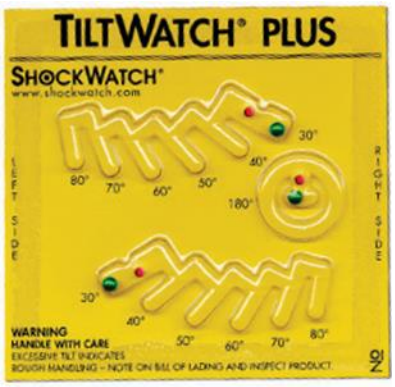
- High power fiber laser
- A documentation package including A CD or other media device.
- LaserNet (control application, located on media device)
- Accessories (see supplied accessories list)

4.2. PRODUCT DELIVERY

The product is delivered in packaging that offers maximum protection. The packaging is equipped with a shock and tip watch that warns in event of improper handling. If the packaging shows signs of external damage or the shock and tip monitoring were activated, immediately inform the transport company and your representative at IPG Photonics.

Not tipped

Tipped



Tipping Angle

Figure 4-1 Transportation monitoring

Transportation without shock Transportation with shock

Red indicators are a sign of possible damage

⇒ Check laser for damage immediately after delivery
⇒ In the event of damage, inform both IPG photonics and the shipping company in writing.
⇒ Always specify the serial number of the shock and or tip and tell monitoring device.

4.2.1. **Unloading**

The product is typically delivered in a wooden transportation crate along with the accessories. The system owner is responsible for the unloading of the product and accessories and locating them at the final installation location.

WARNING

Danger of severe injury from tipping

In the event of improper handling, there is a risk of serious injuries (i.e. crushing injuries) from tipping of the product.

⇒ Only use a forklift for unloading the product.

NOTICE
Avoid damage during transport • Always transport the laser in the upright position.

4.2.2. **Unpacking**

- Remove the laser and the supplied accessories from the packaging.
- Save packaging material in the event that future transportation or storage may be needed.
- Review packaging list and verify all parts, pieces are present and complete. If an item is missing or damaged, immediately notify IPG Photonics.

NOTICE
Further damage to the laser If the laser is operated in a damaged state, this may result in further damage to the laser and potentially create an unsafe environment. • If there is obvious or suspected laser damage do not operate the product.

NOTICE
Damage to optical components The optical fibers, in particular the fiber connectors, are sensitive optical components. There is a risk of damage in the event of improper handling. • Observe industry standards with regards to handling optical components to prevent damage during transportation and unpacking.

4.2.3. **Accessories**

The following accessories are supplied and shipped with each new YLS series laser.

Note: Items listed below may vary depending on the laser configuration and options.

- 2 control keys
- 2 cabinet keys
- 1 breaker box key (depending on system)
- Basic plumbing and hardware connections
- Optical connector covers and caps
- Electrical interface connectors and pins
- Electronic media; containing software, electrical schematic, user guide, and laser configuration files
- Printed copy of the laser schematic
- Stack lights (depending on model, may have been removed for shipping)
- Microscope kit (optional equipment Part # P30-001465)

4.2.4. **Forklift transportation**

Use a forklift whenever possible for moving the laser to the installation location.

Depending on the laser configuration, the laser may be equipped with reinforced steel frame or with casters.

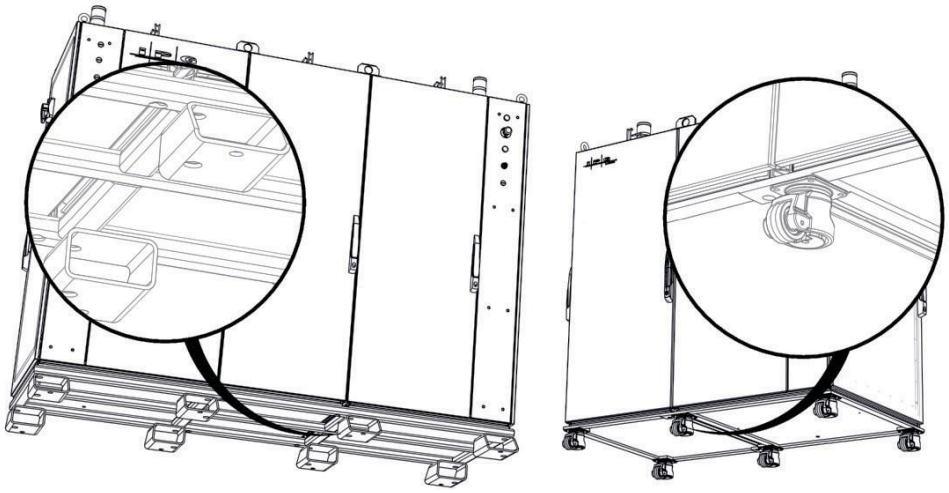


Figure 4-2 Laser with steel frame (left) casters (right)

- Always use a shipping pallet when transporting a laser that does not have a reinforced steel frame.

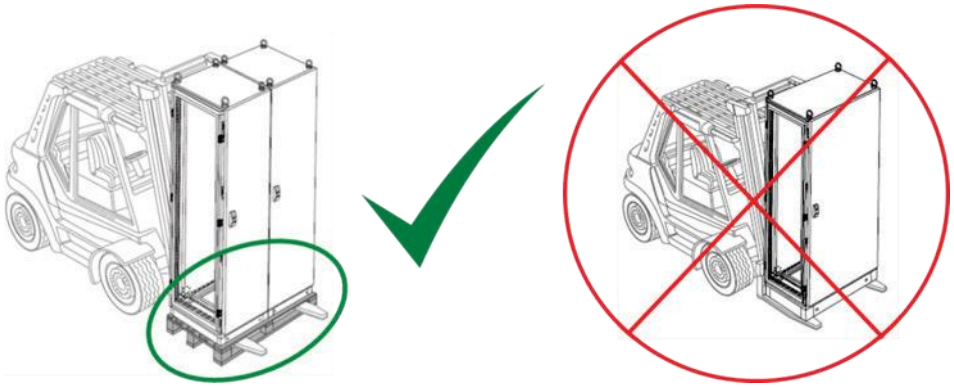


Figure 4-3 Pallet transportation

- Ensure that the laser is properly secured during transport.

4.2.5. **Transporting with crane**

Eye bolts are located on the top of the laser cabinet; these can be used to lift the product out of the transport packaging and to transport it to the installation site using a suitable lifting device.

WARNING

Risk of injury from falling product

Incorrect use of the eye bolts can result in the load shifting or falling during transportation.

Ensure the following:

- The hoist angle must be at least 60 during lifting with a crane (Figure 4-5).
- The eye bolt must be completely screwed in, level, and in full contact with the laser cabinet.
- The eye bolt is loaded in the ring plan and not side loaded (Figure 4-6).

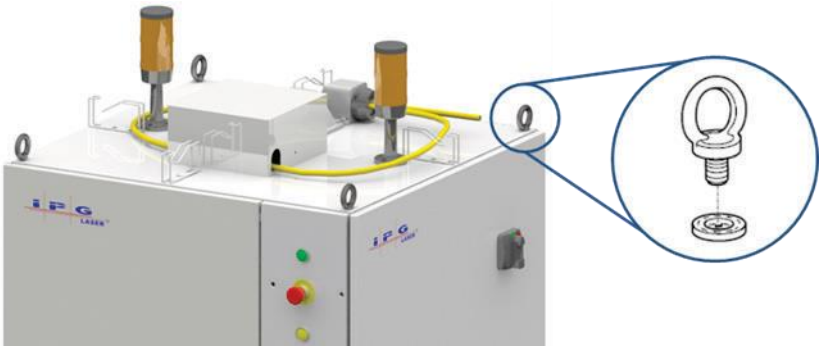


Figure 4-4 Eye bolt lifting points

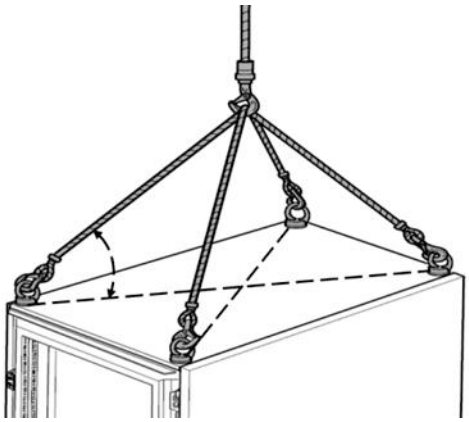


Figure 4-5 Hoist cable angle

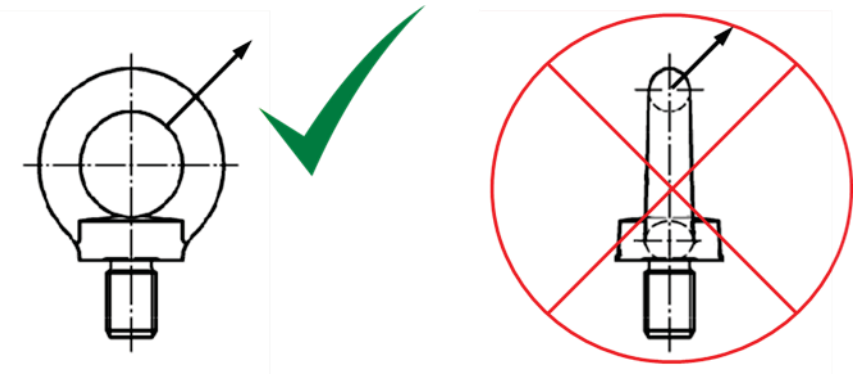


Figure 4-6 Tensile load on the eye bolt

Ultra-Compact Laser:

The product is equipped with threaded plates for fastening the eye bolts. These are located underneath the upper cover.

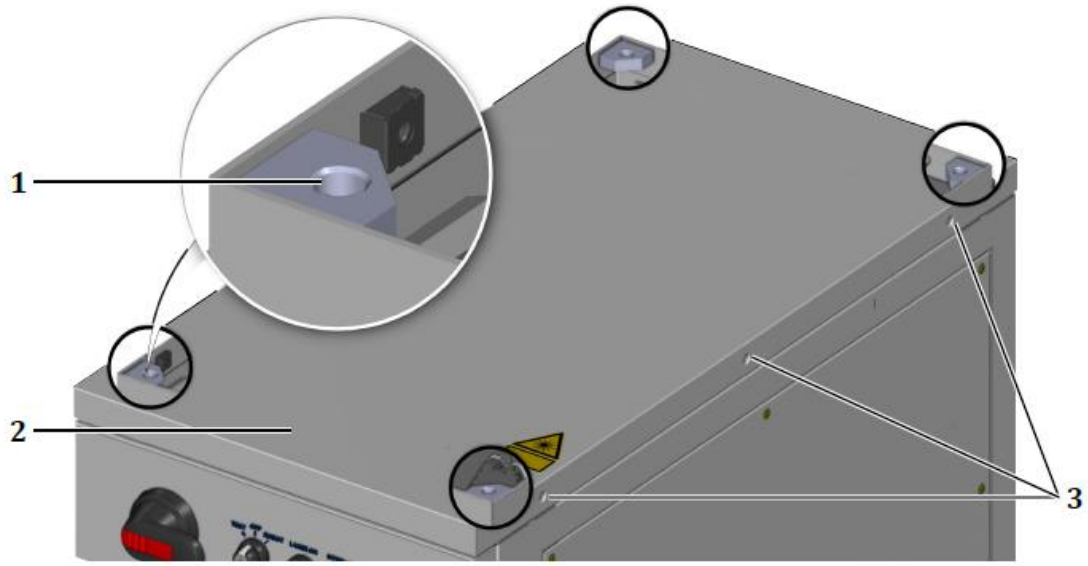


Figure 4-7 Ultra-Compact eye bolt locations

Ref.	Designation
1	M12 threads for fastening eye bolts
2	Top cover
3	Screws

Installing eye bolts:

1. Remove M5 screws on the left and right sides of the lasers top panel.
2. Carefully lift the top panel
   Note: The upper cover is connected to the frame of the laser cabinet by a grounding wire. The grounding wire is fastened to the grounding connector (star point) with a flat connector.
3. Disconnect the flat connector for the grounding wire from grounding connector on the frame.
4. Remove top panel
5. Screw the four eye bolts into the provided thread plates (M12 threads)

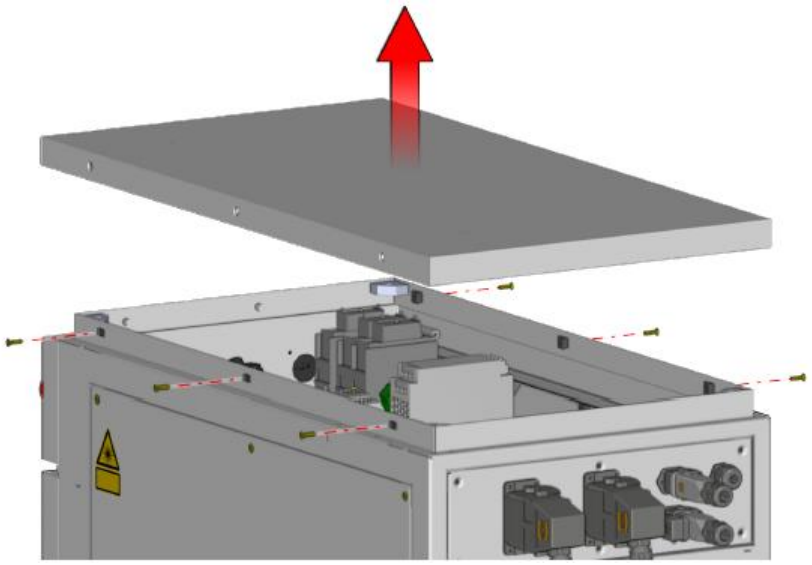


Figure 4-8 Ultra-Compact top panel removal

NOTICE

Damage to the electronics due to falling objects

The upper cover of the laser cabinet protects the electronics underneath. The removal of the upper cover reduces the protection class of the cabinet to IP00 (no protection). The electronics of the laser can be damaged by falling objects or penetrating water. This type of damage is not covered by the IPG warranty.

⇒ Take care not to allow any objects to fall into the laser.

⇒ Take care not to allow any liquids to enter the laser.

⇒ Restore the upper cover immediately after transport

4.2.6. **Transportation on casters**

Lasers equipped with casters can be moved to their final installation location over short distances without additional aids.

WARNING

Risk of death or severe injury due to tipping

Due to the high center of gravity on some laser configurations, there is a danger of tipping during transport.

⇒ Do not push the laser on/over uneven surfaces, openings in the floor, or gaps in the floor.

⇒ Rotate caster locking mechanism in order to move laser.

⇒ Move the laser on its casters over short distances and only on smooth and level floors.

⇒ Install the laser on a level surface.

⇒ Secure the laser against rolling by turning the caster lock (1) counter clockwise (Figure 4-9).

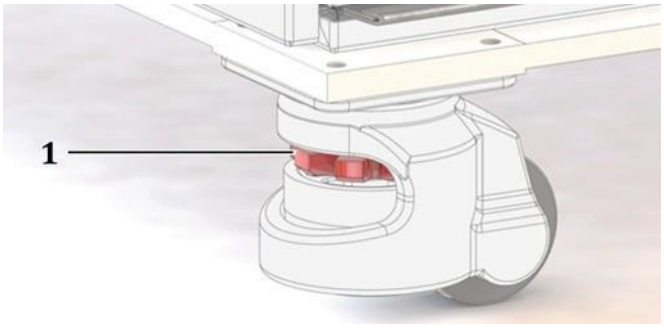


Figure 4-9 Caster lock

5. ASSEMBLY AND INSTALLATION

NOTICE

Danger of laser damage

Product parts can be damaged in the event of improper assembly/installation.

- Ensure only qualified specialists carry out the work described in the installation section.

The laser was developed to be integrated into a larger system. All fiber outlets of the laser are of class 4. It is the responsibility of the laser owner/integrator to ensure that the fibers receive proper enclosures to achieve laser class 1 in accordance to EN 60825-1:2014. The laser cabinet along with the laser feeding and process fibers adheres to class 1 requirements.

The personnel installing the laser must wear appropriate personal protective equipment.

WARNING

Upon reception of the laser it is possible the laser may have been exposed to a high humidity environment during transportation. It is recommended to turn on power to the laser without supplying cooling and checking the dew point level before operating the laser.

Section 9.1 will provide additional details.

Once the laser has been received, uncrated, and inspected for any damage that may have occurred in shipping, the customer is responsible for placing the laser in the location for which it can be commissioned. Prior to scheduling the commissioning, read the Pre-Installation guide and ensure all requirements are met or are available. Contact IPG photonics to schedule a service engineer to perform the laser commissioning and acceptance testing.

The customer must provide an authorized representative to be present during the acceptance testing. Acceptance testing will be performed in accordance to the commissioning report. Upon completion of the testing the authorized representative will be asked to review and sign off on the commissioning report. The customer will receive a copy of the report and a copy will be retained at IPG Photonics.

- See appendix C for a copy of the Installation request form.

5.1. SPACE REQUIREMENTS

NOTICE

Danger of damage due to freezing

If laser is located in an environment where temperatures can drop below freezing, damage can occur to the laser.

- Do not install laser in a location at risk of freezing temperatures.
- The laser is not intended to be used when the ambient temperature is below 5°c
- If the laser is installed in a location that the ambient temperature may drop below 5°c for less than 1 hour, the laser's chiller or house water must remain on to ensure the cooling system within the laser does not freeze.
- If the laser must be installed in a location that may see temperatures below 5°c for greater that 1 hour, a glycol antifreeze must be added to prevent freezing.

Laser dimensions along with weight and climate information can be found in the accompanying documentation.

5.2. INSTALLATION

The following items must be addressed before installing the laser:

- Select an installation location that provides adequate access to the laser from all sides.
  - A minimum distance of 1 meter on all sides is recommended.
- Note the weight of the laser along with temperature and humidity limits when selecting a suitable installation location.

5.3. CONNECTIONS

The laser requires a supply voltage as well as water cooling connections.

- Ensure that all required power and water connections are available and suitable.

Note: Some YLS lasers are air cooled and require no water connections.

5.3.1. Electrical requirements

The laser requires 400VAC 3 phase or 480VAC 3 phase. The precise information regarding power requirements can be found in the supplied technical data as well as on the lasers data tag.

The power connection consists of 4 poles (L1, L2, L3, and PE)

Laser	Requirement	Unit	Max. Deviation
Operating voltage (AC)	400 / 3P + PE	VAC	+/- 10%
	480 / 3P + PE		
Frequency	50 (400 VAC)	Hz	+/- 1%
	60 (480 VAC)		

The electrical connection takes place inside the laser at the electrical panel.

5.3.2. **Cooling requirements**

Tap Water

The tap water serves to cool the laser modules as well as the power supplies. The following requirements must be met:

- Water hardness should not exceed 0.25 dH.
- Electrical conductivity should not exceed 50 µS/cm.

DI Water

DI water serves to cool the optical components. Depending on the product configuration, it can also be used for cooling of the laser modules and power supplies. The DI water should meet the following requirements:

- Water hardness should not exceed 0.25 dH.
- If possible, the electrical conductivity of the water should be 35 to 45 µS/cm. In the event of higher conductivity, a DI cartridge built into a IPG Photonics chiller deionizes the water until the required level is reached. However this may take some time.

5.4. CABLES AND FIBERS

NOTICE

Damage to cables

Improperly run/installed cables can impair signal integrity and potentially damage the cable.

⇒ When running interface cables, fibers, water lines, and power cables, ensure that they are protected with a suitable conduit.
⇒ Do not run electronic cables adjacent to power cables.
⇒ Avoid creating a trip hazard.

NOTICE

Damage to optical fibers

The fiber optic cables can be damaged by mechanical stress.

The minimum bend radius of an unloaded fiber is 100mm. In areas were motion is present, the minimum bend radius is 200mm.

⇒ Avoid mechanical loads (shock, impacts, twisting… etc.)
⇒ When installing the fiber, ensure the minimum bend radius is adhered to.

The laser owner / system integrator is responsible for running the connection lines and the fiber cables to the laser.

A strain relief protects the fiber within the fiber cable from tensile loads (Figure 5-1).

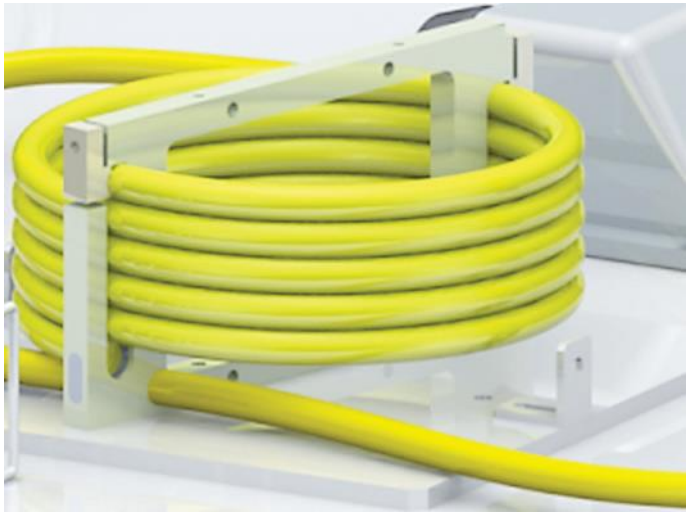


Figure 5-1 Process fiber strain relief

Warranty on the process fiber will be voided if the strain relief is removed.

Unpacking a process fiber

1. Remove packaging at end of fiber.
2. Remove any cable ties or tape that secures the fiber to the laser or transportation packaging.

Running the process fiber

3. While holding the fiber connector, unroll the fiber ensuring twisting does not occur.
4. Run the fiber from the laser to the work area in a suitable cable raceway.

5.5. LASER CONNECTIONS

NOTICE
Damage to electronic modules Mechanical modifications to the cabinet, plug connectors or pass-through openings can reduce the IP protection class 55 NEMA Class 12. If the protection class is lowered, dirt or moisture could enter the cabinet and cause damage.

⇒ Use only provided electrical connectors.

⇒ Close all unused interfaces connections with provided protective caps.

⇒ Consult with IPG Photonics before altering any interface connections.

⇒ Do not add any additional openings to the laser cabinet.

5.5.1. Connecting the water supply

NOTICE
Damage to electronic modules There is a potential to damage the laser, fiber connectors or optics due to incorrect connection of the cooling system connections. ⇒ Observe the following instructions before commissioning of the laser and while conducting laser maintenance.

Do not use the following materials for water piping:

- Mild steel
- Galvanized steel

It is recommended to use the following materials:

- Cooling circuit laser: Copper or stainless steel
- Cooling circuit Optics: Stainless steel (1.4301)

Water pipes should be designed as follows:

- Cooling circuit laser: 4 m³/h @ Δp_{max} = 0,5 bar
- Cooling circuit Optics: 2 m³/h @ Δp_{max} = 0,5 bar

- Work on the laser's internal cooling and water distribution system may only be performed by IPG service personnel or a trained expert.
- Insufficient supply of cooling water can lead to damage of the laser and optical components.
- Modifications to the lasers cooling system are not permitted, as proper cooling to individual components cannot be guaranteed.

For lasers without an integrated cooling system; the cooling of the laser and optics are provided by means of an external cooling system (chiller, house water). Within the laser there is a coolant distribution system that provides water to all of the necessary components (i.e. laser modules, power supplies, optical components). The water cooling connections (tap water for the laser, DI water for the optics) are located on the rear panel of the laser. As an example, connections to a YLS-10000-S2T is shown below (Figure 5-3). The number and arrangement of the connections will vary depending on the laser configuration. On most YLS laser models there is a cooling distribution label located inside the rear door above the cooling connections (Figure 5-2). Some compact laser models have the cooling diagram located externally above the cooling connections.
See Table 5-1 and Table 5-2 for cooling requirements based on laser output power.

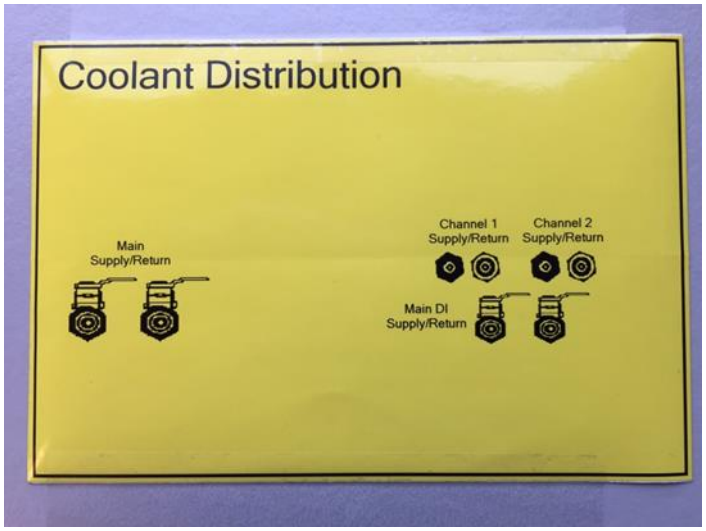


Figure 5-2 Cooling distribution label example

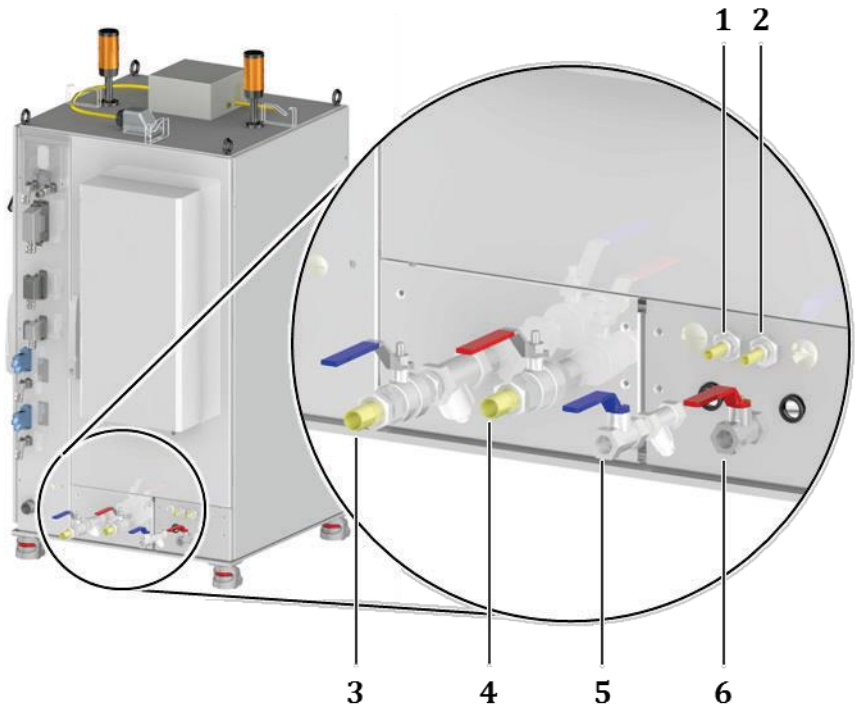


Figure 5-3 Cooling distribution connections

Reference	Description
1	Process fiber (external optics) supply
2	Process fiber (external optics) return
3	Main laser cooling supply
4	Main laser cooling return
5	DI water supply
6	DI water return

Note: Depending on installed options, water distribution connections may vary.

Connect the cooling supply and return lines to the appropriate water source.

NOTICE
Potential damage to fiber connectors and optics Incorrect connections of the water cooling lines can lead to overheating and damage to the process optics. ⇒ Connect the cooling water lines in series to guarantee proper cooling of the fiber connector.

After the cooling water has been connected to the fiber connector, the individual components can be connected in series or parallel (see Figure 5-4).

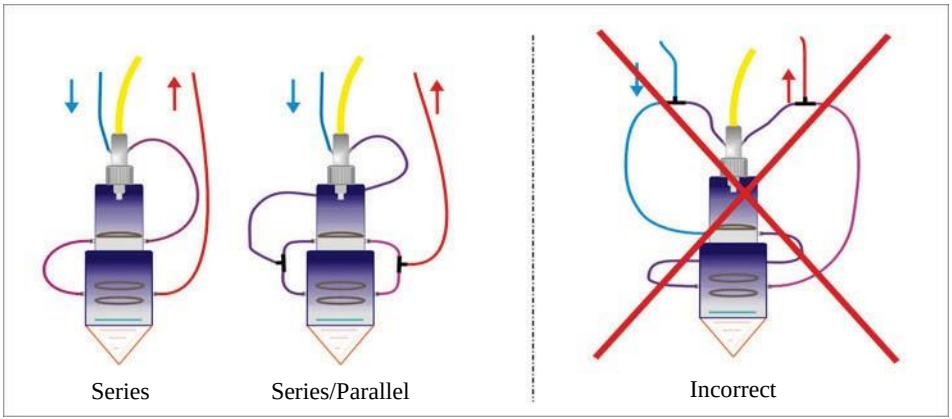


Figure 5-4 Process head water connections

Laser cooling chart				
Nominal laser output (kW)	Minimum laser cooling water flow (L/min)	Optical laser cooling water flow (L/min)	Minimum water temperature (C)	Maximum water temperature (C)
Laser Model: YLS Compact and water cooled QCW lasers				
1	6	10	18	25
2	9	15	18	25
3	12	20	18	25
4	15	25	18	25
5	18	30	18	25
6	21	35	18	25
Laser Model: YLS Standard				
1	6	10	18	25
2	9	15	18	25
3	12	20	18	25
4	15	25	18	25
5	18	30	18	25
6	21	35	18	25
8	27	40	18	25
10	33	50	18	25
15	39	60	18	25
20	48	80	18	25

Table 5-1 Laser cooling requirements

DI water optical cooling				
Nominal laser output (kW)	Minimum DI water flow (L/min)	Maximum DI water flow (L/min)	Maximum Pressure (bar)/(psi)	Temperature range (C)
<1.5	0.3	4	3/43.5	25-35
1.5 - 4	0.7	4	3/43.5	25-35
4 - 7	1.2	4	3/43.5	25-35
7 - 10	2.0	4	3/43.5	25-35
10 - 20	2.5	4	3/43.5	25-35
20 - 30	3.0	4	3/43.5	25-35
>30	5.0	10	3/43.5	25-35

Table 5-2 DI water requirements

Important: If laser does not fall in one of the above categories, use the next larger output power to determine cooling requirement. Contact IPG Customer Service department with any questions or concerns.

5.6. ELECTRICAL CONNECTIONS

DANGER

Risk of death from supply voltage

Coming into contact with the power connection and components can lead to death.

⇒ Ensure all work to be performed on energized components be done by a trained expert.

⇒ Ensure the main power cable is not live when connecting to laser.

⇒ Ensure the laser is properly connected to earth ground.

Any interruption of the ground connection can result in personal injury or death.

Connecting the AC power can vary depending on laser configuration. For lasers that have a 30amp main disconnect IPG Photonics provides a power cable. For all other lasers the customer is responsible for providing the power cable. Please refer to the IPG data tag and the Electrical Requirements in 5.3.1 for correct power requirements.

1. Open the right side door of the laser to access the electrical panel.
2. Run the AC power cable through the strain relief (Figure 5-5 items 2&3) located at the rear of the laser.
3. Earth ground should be connected **before** any of the power conductors.
4. Connect the three power conductors to main switch (Figure 5-5 item 1).
5. Secure the power cable using the provided strain relief.

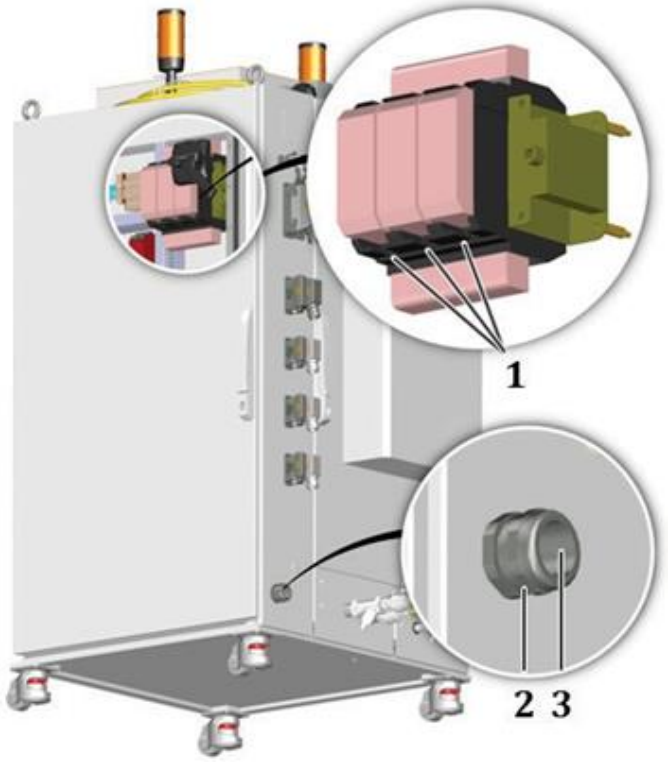


Figure 5-5 Power connections

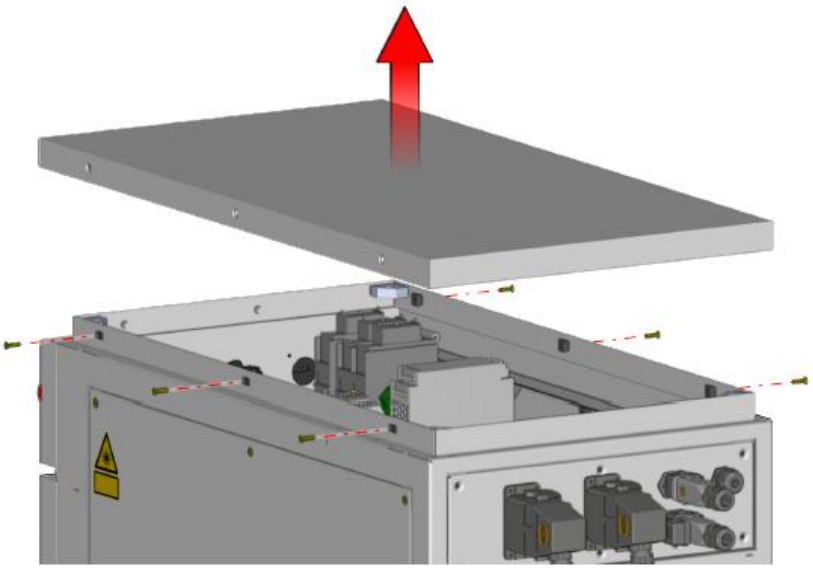
6. Add additional earth ground to the external earth ground lug (Thread lug M8 x 16mm) for leakage current. The minimum wire should be 8 gauge.

Figure 5-6 Earth Grounding lug

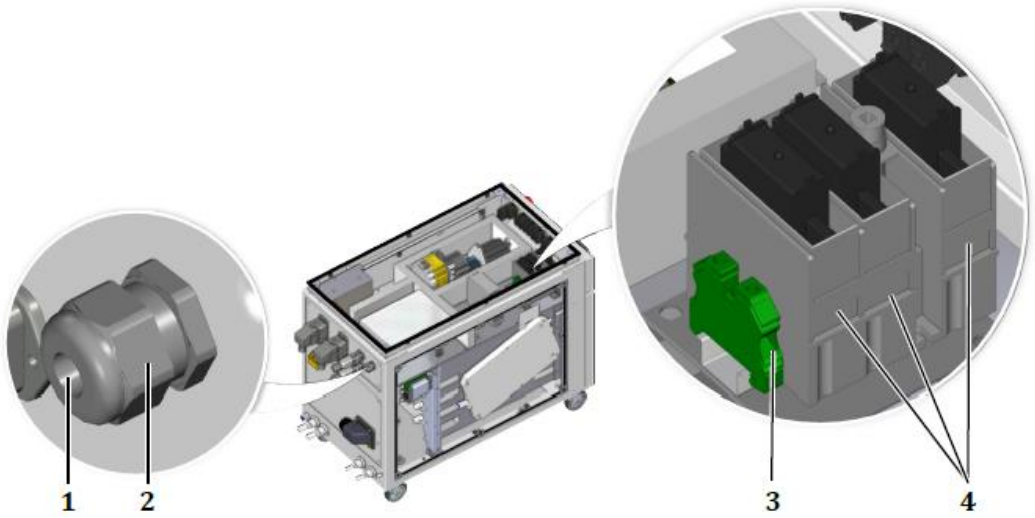
Ultra-Compact laser power connections:

Follow the steps below to connect the power supply:

1. Remove the M5 countersunk screws on the left and right side of the lasers top panel.
2. Carefully lift the top panel.
   The top panel is connected to the frame of the laser cabinet by a grounding wire. The grounding wire is fastened to the grounding connector (star point) with a flat connector.
1. Disconnect the flat connector of the grounding wire from the grounding connector on the frame.
2. Remove the top panel.



3. Run the power cable through the cable gland on the back of the laser.
4. Connect the protective earth ground PE to the green/yellow terminal.
5. Connect the wires of the power cable to the terminals L1, L2, L3.
6. Attach the power cable to laser frame using cable ties.
7. Secure the power cable against strain with the gland nut.



Ref.	Designation
1	Cable gland
2	Cable gland nut
3	PE earth connection
4	Phase connections L1, L2, L3

8. Reconnect the grounding wire to the lasers top panel and re-install panel.
9. Add additional earth ground to the external earth ground lug (Thread lug M8 x 16mm) for leakage current. The minimum wire should be 8 gauge.

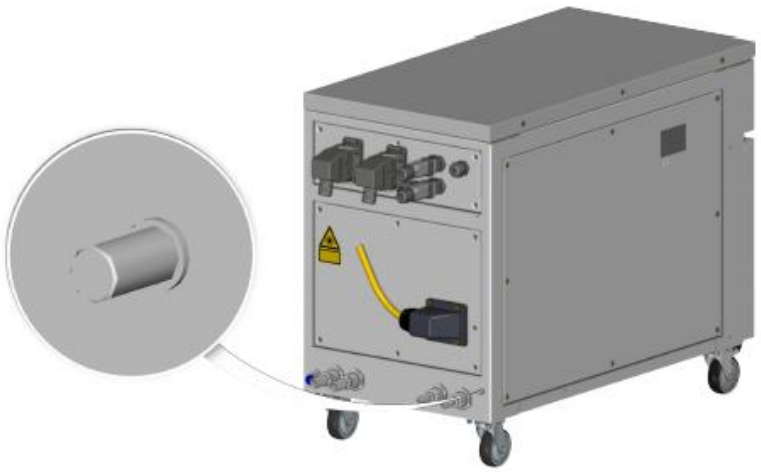


Figure 5-7 Earth Grounding lug

Laser (kW)	Laser main disconnect size (amps)	Laser main disconnect fuse size (amps)
1	30	20
1.5	30	20
2	30	20
2.5	30	20
3	30	20
4	60	30
5	60	50
6	60	50
7	60	50
8	60	50
9	100	60
10	100	60
11	100	60
12	100	80
13	100	80
14	200	90
15	200	90
20	200	100
30	400	100
40	400	225
50	400	300
60	400	350

Table 5-3 Power requirements

Important: If laser system does not fall in one of the above categories use the next larger output power to determine the electrical requirements. Contact IPG Customer Service department with any questions or concerns.

Note: Check the lasers data tag (located above the main disconnect switch) for exact electrical requirements.

5.6.1. Laser interface connections

Section 6 of this manual provides detailed information on all control and status electrical interface connections.

5.7. FIBER CABLE INSTALLATION

WARNING

Remove power from laser before performing any fiber installation or removal. Use lock-out tag-out procedures.

For lasers that have an optional fiber coupler or beam switch, it will be necessary to install a process fiber. The following procedure provides details for installing a process fiber.

The output fiber connector has a strain relief

1. Locate the fiber exit port located on the top of the laser and remove the two fasteners that secure the hood cover.

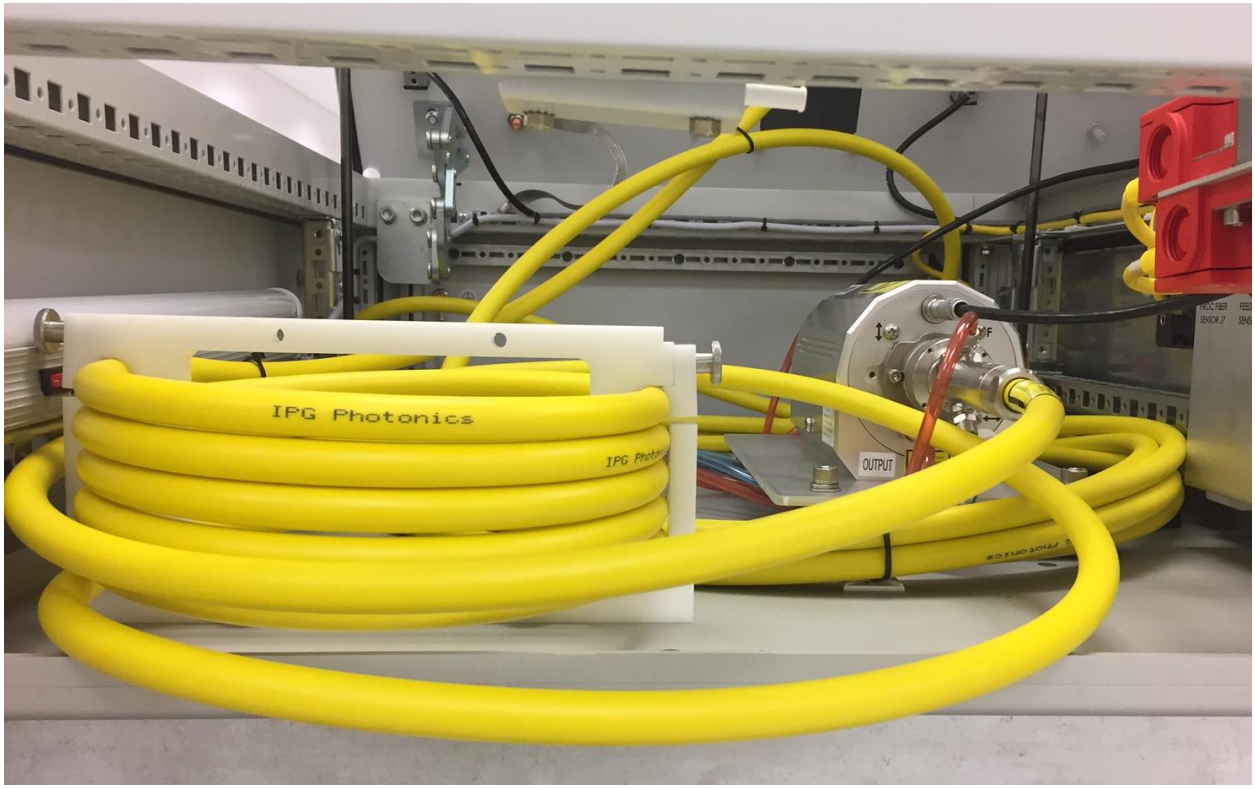
2. Remove the two fasteners securing the fiber clamp

3. Remove the hood cover

4. Run the output fiber connector from inside the laser out the hood

5. Pull the process fiber through the hood to the point where the cable strain relief is positioned to allow a small service loop for opening the top access panel on the laser. (for laser that have a top access panel)

6. Place the fiber strain relief in its mounting position in the laser cabinet. The fiber should be positioned to allow for the correct bend radius of 100mm for stressed and 200mm for unstressed.



7. Reinstall the hood cover and fasteners

8. Secure the fiber strain relief to the cabinet and insert fiber connector to fiber coupler or switch, see section 12.2.1 for proper fiber cleaning before insertion.

Before operating the laser at full power after new cable installation, set the emission level to the 10% current set point and check the FFBD measurement. The FFBD measurement levels are displayed in the fiber coupler or beam switch tabs of LaserNet. Make sure the FFBD values are within a safe operating level.

The FFBD signal should be approximately 100mv/kW

For any questions or concerns, please contact IPG customer support

5.7.1. **Fiber connectors**

All lasers are supplied with a feeding or process fiber with a fiber connector located at the end. The quartz block at the end of the fiber connector is used as an optical output of the laser and is protected against knocks and shocks by a protective conduit or protective glass (depending on the ordered configuration). The protective glass offers protection against contamination of the quartz block and can be exchanged quickly if necessary.

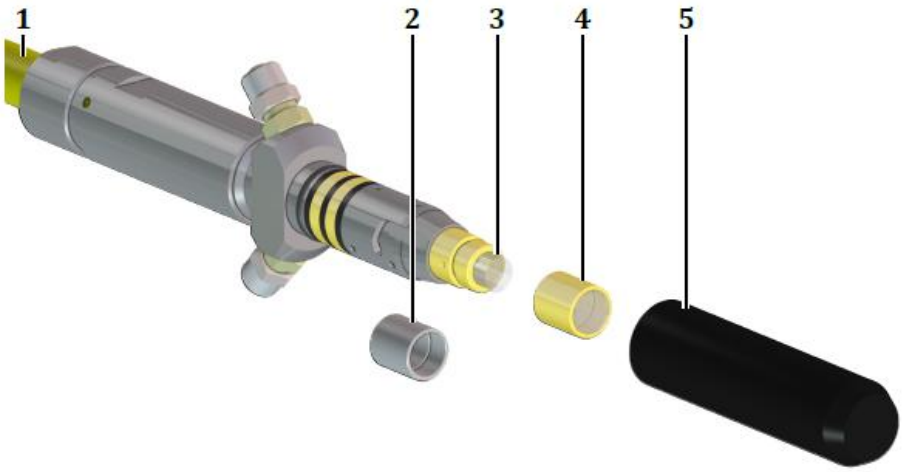


Figure 5-8 Fiber connector with accessories

Ref.	Designation
1	Process fiber
2	Protective conduit
3	Quartz block
4	Protective glass
5	Protective cap

Depending on the ordered configuration and laser power, different fiber connector types are delivered that are designed for optics and laser outputs. The fiber connector types differ in their diameters and shape of the mounting surfaces, core diameters of connected fibers and the way they are assembled in the optics. The existing fiber connector types are shown in the following figure. The exact dimensions of the respective fiber connectors can be found in the appendix.

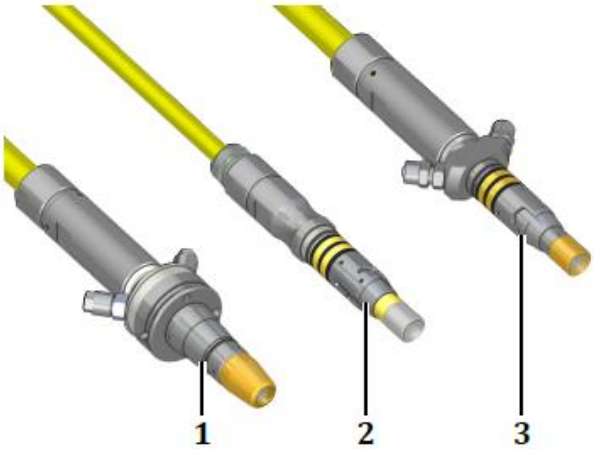


Figure 5-9 Fiber connectors

Ref.	Connector type	Fiber core diameter [µm]	Optional protective conduit	Protective glass option
1	LCA	100,150,200,300,400,600	No	Yes
2	LC-8	100,150,200,300,400,600,800,1000	Yes	Yes
3	HLC-8	100,150,200,300,400,600,800,1000	Yes	Yes

5.7.2. **Fiber connection**

A conical guide positions the fiber connector into the receiving optical connector. The connector is locked in position by a bayonet that ensures correct orientation and safe operation. The safety interlock system is connected via the two ring contacts only when the bayonet is fully inserted. When installing and managing the fiber cable, do not exceed the maximum bend radius of 100mm unstressed and 200mm stressed.

NOTICE

Fiber damage due to contamination of the quartz-block end face

Contamination to the quartz-block end face of the fiber connector can lead to high stray light during laser emission along with reduced output power. Additionally this can cause burning on the quartz-block end face as well as overheating and damage to the optics. Such damage is NOT covered by any warranty.

⇒ Check the quartz-block end-face for soiling before connecting the fiber connector to the optics.
⇒ Clean the quartz-block end-face, if necessary.

NOTICE

The fiber connector is supplied with a protective cap that protects it from dust and mechanical damage.

⇒ Retain the protective cap for use when fiber is not connected to optics.
⇒ When a fiber is not in use install the supplied protective cap on the fiber.

Prior to inserting the fiber connector into the process optics, the quartz-block end face must be checked for contamination and cleaned, if necessary. To do this, proceed as described in section 12.2.1, this section also contains instructions on how to correctly connect the fiber connector to the optics.

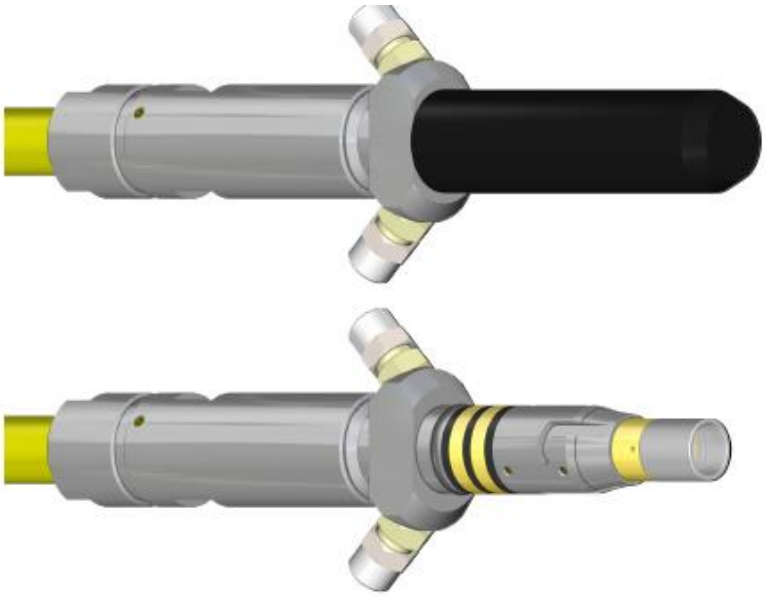


Figure 5-10 Fiber connector without protective cap (top) with protective cap (below)

Protective collars are present on all high power fiber connectors. The use of the connector's protective collar depends on the position and use. Use the reference table and figures below to determine the use requirement.

Recommended usage of aluminum sleeve on IPG Feeding and Process fibers				
Connector series type	Feeding Fiber	Feeding fiber into fiber coupler or beam switch	Input process fiber	Output process fiber
LC	Collar On	N/A	N/A	N/A
LCA	Collar On	Collar On	Collar On	Collar On
HLC	Collar On	Collar Off	Collar Off	Collar On

Table 5-4 Aluminum Sleeve

Follow the high power fiber connector protective collar requirements for use, any deviations may void component and or laser warranty and must be approved by authorized IPG personnel. In some cases, for certain collimators the collar may need to be removed, again this must be approved by authorized IPG personnel.

Recommended usage for IPG Feeding and Process fibers with protective cap and quartz window				
Connection type	Feeding fiber	Feeding fiber into coupler or beam switch	Input of Process fiber	Output of Process fiber
HLC-8, all applications*	Protection cap can be used for laser power levels up to 6 kW	Do not use	Do not use	Protection cap can be used for laser power levels up to 6 kW
LCA, cutting applications (acceleration < 15 m/s^2)	Protection cap can be used on laser power levels up to **6 kW**			
LCA, 3D cutting and welding applications (acceleration < 5 m/s^2)	Protection cap can be used on laser power level up to **10 kW**			

Table 5-5 Protective cap and quartz window

*** - protective caps are not recommended for applications with acceleration > 15 m/s^2**

5.8. SOFTWARE

A copy of the IPG Software **LaserNet** is provided with every YLS laser. This software allows for monitoring and operation of the laser. LaserNet uses a fast 100 M/bit Ethernet connection between the laser and a computer.

Information regarding hardware requirements, installation, configuration, and usage can be found in section 9.7.1 or the accompanying document "LaserNet user's manual".

5.9. PROLONGED SHUTDOWN

If the laser is to be shut down for a prolonged period of time, the procedure below will assist in preparing the laser for storage.

1. Turn the key switch to the off position and turn off the main power disconnect located on the side of the laser (compact models, main switch on front panel).
2. Disconnect power source to laser (lock out tag out)
3. Disconnect power cord
4. Unplug connections to external interface (J33 – J37) from rear of laser and place a protective cover on them.
5. Close water supply and return lines, and remove
6. Drain water from laser, use oil-free compressed air to gently remove cooling water
7. Remove optical fibers from process head(s) and replace protective cap(s).
8. Move laser to storage area, the location should be dry and clean.

NOTICE
Danger of damage due to freezing If laser is located in an environment where temperatures can drop below freezing, damage can occur to the laser. • Do not store laser in a location at risk of freezing temperatures.

5.10. RECOMMISSIONING

After a prolonged shutdown, the laser must be completely inspected before being commissioned again. Additionally the steps in Section 9.1 should be followed.

If necessary, contact IPG to schedule commissioning and acceptance testing.

6. LASER INTERFACE

This section of the manual provides information regarding all of the connections used to control and integrate the laser into a larger system. Each interface connection along with pin definitions and electrical requirements are presented.

All interface connectors are Harting type connectors. The appropriate pins and mating connectors are included with the laser. The pins can be soldered or crimped using a crimping tool from Harting.

⇒ Harting crimping tool part number 09 99 000 0021
⇒ Harting pin extractor part number 09 98 000 0012

The following table (Table 6-1) lists all interfaces with which the product can be equipped with. The actual number and arrangement of the interfaces depends on the installed options.

Note: Mating connectors are shipped connected to laser; pins for mating connectors are located in the accessories package accompanying the laser.

Laser Interface Connectors		
Ref.	**Name**	**Description**
J33	Safety Interface	To be incorporated into the overall system safety circuit
J34	Analog Interface	Analog signals for controlling emission level, monitoring emission level, and monitoring back reflection
J35	Chiller Interface	Communication interface to IPG Chiller
J36	Hardwiring Interface	24Vdc IO for laser control and status
J37	Ethernet Interface	Communication interface to computer (LaserNet / custom control)
Lasers equipped with optical switch		
J21	Interlock 1	Optical channel 1 work cell interlock (1,2,3,4,6 channel switch)
J22	Interlock 2	Optical channel 2 work cell interlock (2,4,3,6 channel switch)
J23	Interlock 3	Optical channel 3 work cell interlock (3,4,6 channel switch)
J24	Interlock 4	Optical channel 4 work cell interlock (4,6 channel switch)
J25	Interlock 5	Optical channel 5 work cell interlock (6 channel switch)
J26	Interlock 6	Optical channel 6 work cell interlock (6 channel switch)
Lasers equipped with field bus interface		
J42 - 1	Fieldbus interface	Lasers can have up to 6* field bus interface connections The following field bus types are currently supported: • Ethernet IP • EtherCAT[1] • PROFINET • PROFIBUS • DeviceNet *QCW lasers can have only 1 DeviceNet or PROFIBUS interface
J42 - 2	Fieldbus interface	
J42 - 3	Fieldbus interface	
J42 - 4	Fieldbus interface	
J42 - 5	Fieldbus interface	
J42 - 6	Fieldbus interface	

Table 6-1 Interface connectors

[1] EtherCAT is a registered trademark of Beckhoff Automation GmbH, Germany

Ultra-Compact Laser Connectors:

Laser Interface Connectors		
Ref.	**Name**	**Description**
XP1	Hardwiring Interface	24Vdc IO for laser control and status
XPIF	Interfaces	Safety, control, and monitoring interface
XP3	Chiller Interface	Communication interface to IPG Chiller
XP5	Ethernet Interface	Communication interface to computer (LaserNet / custom control)

6.1. I/O ELECTRICAL REQUIREMENTS

All +24Vdc signals discussed in this section are subject to the electrical limits indicated in Table 6-2.

Signal	Range	Description
High Signal	+4Vdc … +30Vdc	Any signal in this range is interpreted as a high signal
Indeterminate	+2Vdc … +4Vdc	Any signal in this range is indeterminate in its interpretation
Low Signal	-3Vdc … + 2Vdc	Any signal in this range is interpreted as a low signal

Table 6-2 +24Vdc signal requirements

Any analog signal will indicate requirements/limits where presented.

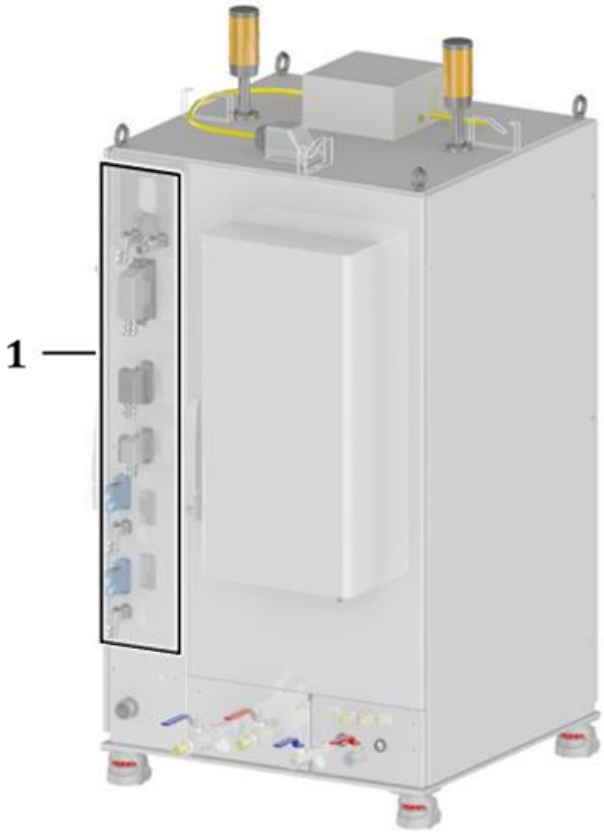


Figure 6-1 Interface connectors location

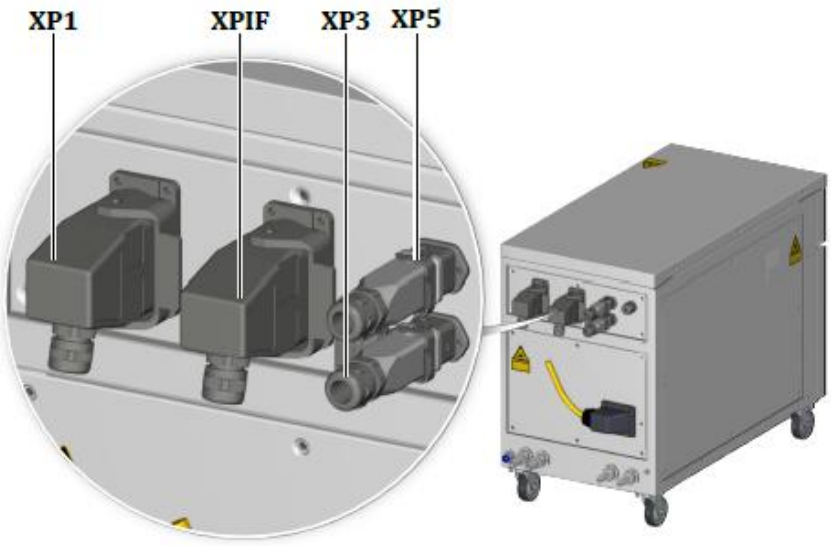


Figure 6-2 Ultra-Compact connector placement

6.2. SAFETY INTERFACE CONNECTOR (J33/XPIF)

The safety interface connector (J33) provides the necessary signals to incorporate the laser into the system level safety circuit.

Two different connectors are used for the safety interface:

- Standard Safety connecter
- Alternate Safety connector

Both connectors are described below.

J33 Safety Interface (Standard connector)				
Pin	Signal Name	Signal Type	Description	Connector
A1*	Modulation Enable	Input	+24Vdc signal	
A2*	Modulation Return	return		
A3	Emission On monitor	Output	Dry contact	
A5	Emission On monitor	Output		
A8	Remote Key switch	Input	Dry contact (Optional) See section 6.2.3	
A9	Remote Key switch	Input		
B3	E-Stop out CH. 1	Output	Dual dry contacts	
B4	E-Stop out CH. 2	Output		
B5	E-Stop out CH. 2	Output		
B6	E-Stop out Ch. 1	Output		
B7	Power supply active	Output	Dry contacts, closed when power supply is active The integrator should use this signal to notify operators that the laser is capable of producing radiation.	
B8	Power supply active	Output		
C1	Interlock CH. 1	Input	Dual dry contacts (*Verify only dry contacts are used)	
C2	Interlock CH. 2	Input		
C3	Interlock CH. 2	Input		
C4	Interlock CH. 1	Input		
C5	External Start	Input	Momentary dry contact	
C6	External Start	Input		

Table 6-3 Standard Safety interface (J33)

*Pins A1 and A2 are not intended as part of functional safety

J33 Safety Interface (Alternate connector)					
Pin	Signal Name	Signal Type	Description		Connector
1*	Modulation Enable	Input	+24Vdc signal		
2*	Modulation Return	return			
3	Emission On monitor	Output	Dry contact		
4	Emission On monitor	Output			
5	Emission On	Output	Sinking Output	See "Emission On and Power Supply On" wiring below	
6	Power supply On	Output	Sinking Output		
7	+24Vdc	Output	Power for pins 5 & 6		
8	Emission On	Output	Sinking Output	See "Emission On and Power Supply On" wiring below	
9	Power supply On	Output	Sinking Output		
10	+24Vdc	Output	Power for pins 8 & 9		
11	E-Stop out CH. 1	Output	Dual Dry contacts		
12	E-Stop out CH. 2	Output			
13	E-Stop out CH. 2	Output			
14	E-Stop out Ch. 1	Output			
15	Power supply active	Output	Dry contact, closed when power supply is active. The integrator should use this signal to notify operators that the laser is capable of producing radiation.		
16	Power supply active	Output			
17	Interlock CH. 1	Input	Dual dry contacts (*Verify only dry contacts are used)		
18	Interlock CH. 2	Input			
19	Interlock CH. 2	Input			
20	Interlock CH. 1	Input			
21	External Start	Input	Momentary dry contact		
22	External Start	Input			
23	Power switch status	Input	Dry contact, Indicates when key switch is on "ON" or "Remote" position		
24	Power switch status	Input			

Table 6-4 Alternate Safety interface (J33)

*Pins A1 and A2 are not intended as part of functional safety

XPIF safety, control, and monitoring connector				
Pin	Signal Name	Signal Type	Description	Connector
A-1	Modulation Enable	Input	+24Vdc signal	
A-2	Modulation Return	return		
A-3	E-Stop out CH. 1	Output	Dual Dry contacts	
A-4	E-Stop out CH. 2	Output		
A-5	E-Stop out CH. 2	Output		
A-6	E-Stop out Ch. 1	Output		
A-7	Interlock CH. 1	Input	Dual dry contacts (*Verify only dry contacts are used)	
A-8	Interlock CH. 2	Input		
A-9	Interlock CH. 2	Input		
A-10	Interlock CH. 1	Input		
A-11	External Start	Input	Momentary dry contact	
A-12	External Start	Input		
A-13+	Power supply active	Output	Solid State relay, conductive(closed) when Power supply(s) are on. The integrator should use this signal to notify operators that the laser is capable of producing radiation.	
A-14-	Power supply active	Output		
A-15+	Power supply On,	Output	24VDC signal supplied from safety relay when power supplies are on.	
A-17-	Power supply On	Output		
B-1+	Analog input	Input	Analog input from customer, 0-10VDC = 0-100% laser output power	
B-2-	Analog input	Input		
B-3	Power out	Analog out	Analog output signal where 0-8VDC = 0 – 100% laser output power	
B-4	Power out common	0VDC		
B-5	Back Reflection	Analog Out	Analog output signal 0-8VDC	
B-6	Back reflection common	0VDC		
B7	Ext Laser Perm	Input	Dry contacts	
B10	Ext Laser Perm	Input		
B8	Ext Laser Perm	Input	Dry contacts	
B9	Ext Laser Perm	Input		
*B11	Frequency control	Analog In	Analog input to control Frequency	Pulse generator inputs. See Table 6-6 below
*B12	Duty Cycle control	Analog In	Analog input to control Duty cycle	
*B13	Power control	Analog In	Analog input to control power	

*B14	ANA Gnd	0VDC	Common for Analog inputs	
B15-	Power supply On	Output	Sinking Output signal	Sinking Output signal from controller.
B17+	Power supply On	Output	+VCC for Sinking Output	
B16	Not used			
PE	Potential Earth	0VDC	Ground for shielding	

Table 6-5 Safety, control, monitoring (XPIF)

*For laser is built with optional pulse generator.

*Pulse Generator parameters		
Parameter	**Range**	**Description**
Frequency	0…+10VDC	0 V – 1.8 V corresponds to 0 Hz (Emission always OFF) 2.0 V corresponds to 200 Hz ± 10 Hz 10 V corresponds to 5 kHz ±250 Hz Frequency from 2 V to 10 V varies linearly
Duty Cycle	0…+10VDC	0 V – 2 V corresponds to 3% DC ± 1 % 10 V corresponds to 100% DC (Emission always ON) Duty Cycle from 2 V to 10 V varies linearly
Power	0…+10VDC	0V - 10 V corresponds to 0 % - 100% Pump Current 0V-1.5V is not allowed for static application as the output power is less than 10 %.

Table 6-6 Pulse Generator parameters

6.2.1. **Modulation Enable**

The modulation enable signal has two functions:

- When set high (+24v) it enables laser emission
- Can be used to modulate laser emission.

6.2.1.1. Setting up modulation enable

Before the *Modulation Enable* input signal can be used, it must be turned on in LaserNet. To turn on this signal run the laser in "ON" mode and establish a connection to the laser with LaserNet. Once LaserNet is communicating select the "Control" tab at the bottom of LaserNet, on the control page located on the right side there will be a box labeled "External control", press the button in this box so it displays "ON". After Modulation Enable has been turned on it will be functional in both "On" and "Remote" operating modes.

Note: The setting of Modulation Enable will be retained between laser power cycles.

6.2.1.2. Using the Modulation signal

Once the modulation enable signal has been turned on in LaserNet a +24Vdc signal must be present on J33 pins A1 and A2 for the laser to emit. This signal can be modulated within the limits indicated in Table 6-7.

Modulation signal limits	
Frequency	0 … 5kHz
Duty cycle	1% to 100%

Table 6-7 Modulation signal limits

6.2.2. **Emission On monitor**

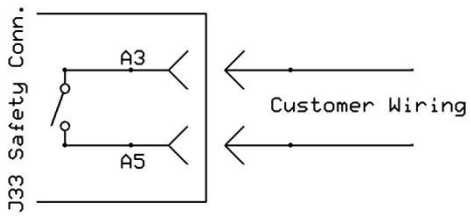
The emissions on monitor signals are internally connected to a switch. When emission is on the contacts of the switch will be closed. Intended to be used by the integrator for indicating the laser emission is turned ON. The signal is available whether the laser is in local or remote mode. The integrator should use this signal to warn operators using the end product that emission is turned ON and the product can be or is emitting laser radiation.

Since the laser emission is delivered through an optical cable which might be tens of meters in length, this signal is provided so proper warnings are made available at the laser aperture and remote control system as defined by the integration.

Note: The signal is active when the emission is turned ON and remains active even if the laser output is set at "zero" and no actual laser emission is present. It is the responsibility of the purchaser/end-user to bring the end system into full compliance with all applicable regulations.

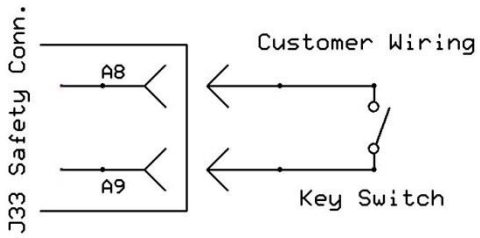
Typically this signal can be used for such things as:

- External stack light
- Laser emission on sign



6.2.3. **Remote Key switch**

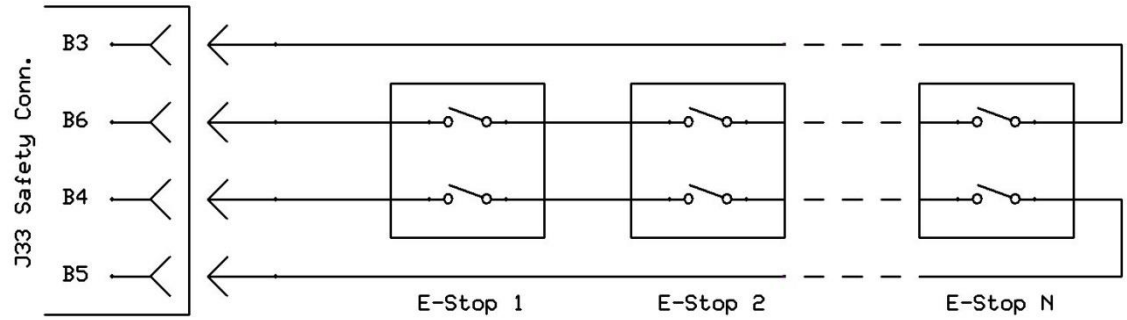
The remote key switch connection allows the laser to be powered up/down at the system level. The remote key switch is only functional when the key switch located on the front of the laser is in the "Remote" key position. A jumper located on the main key switch must be removed in order for this remote key switch to function properly.



6.2.4. **E-Stop out**

The external E-Stop signals can be used to incorporate the laser's E-Stop button into the systems E-Stop safety circuit.

This is an optional output that will tie the laser's E-stop into the overall system. This effectively ties all the E-stops into the system together.



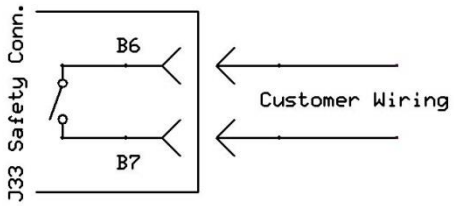
6.2.5. **Power supply active**

Same as emission on indicator, but just for power supply.

The power supply active signals are internally connected to a switch. When laser module power supplies are on the contacts of the switch will be closed. Typically this signal can be used for such things as:

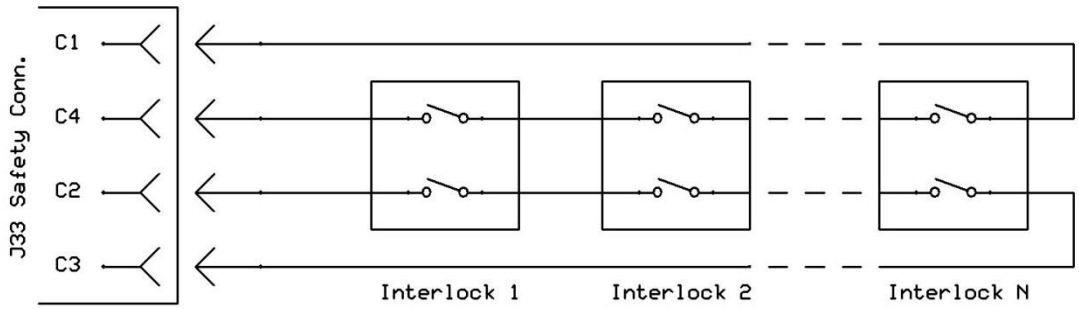
- External signage
- Feedback for external start signal (see External Start).

The integrator should use this signal to notify operators that the laser is capable of producing radiation.



6.2.6. **Interlock**

The interlock signals are a dual loop circuit, that are intended to be integrated into the door interlocks of the system. These signals are also connected to all of the laser cabinet doors. When an interlock is present the laser modules power supply will be turned off and LaserNet will indicate “E-Stop” and “E-Stop External” on the alarms tab.

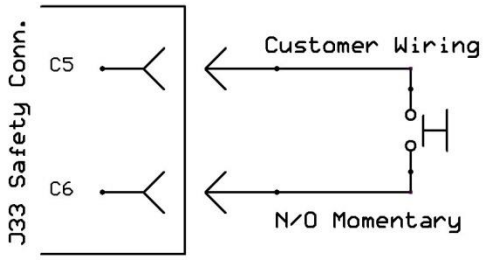


Note: When incorporating these signals into the overall system, verify that both interlock loops will be opened. If only a single loop is opened and closed the laser’s safety system will **NOT** be reset.

6.2.7. **External Start**

A momentary contact closure on the external start pins will turn on the laser modules power supply. This momentary closure must be at least 50ms in duration. The power supply active pins can be used to verify the laser modules power supply is on.

External start is used to turn on the laser modules power supply when the laser is in Remote mode.



Note: For some customer specific laser configurations the power supply can be turned on using the "laser on" button on the front of the laser or the "external start" pins on the safety interface whether in Local or Remote mode.

6.2.8. **Emission ON and Power Supply ON**

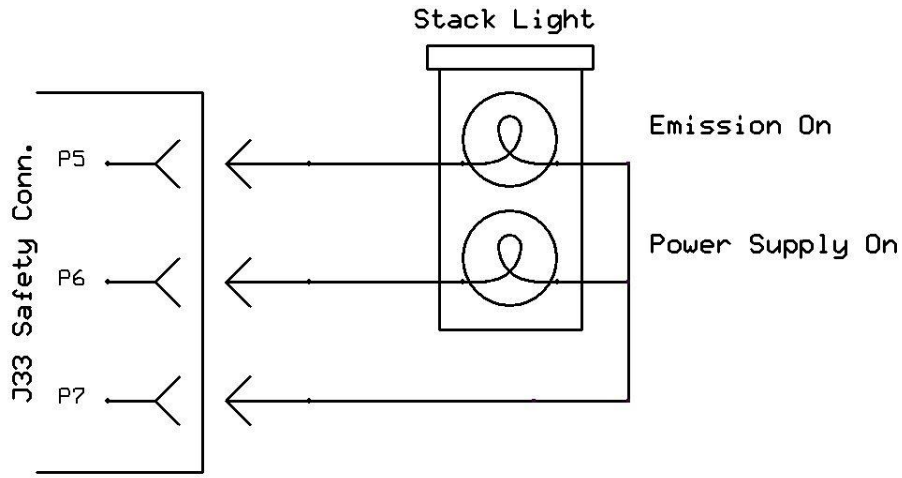
The safety interface connector provides connections to integrate additional stack lights into the overall system. Intended to be used by the integrator for indicating the laser emission is turned ON. The signal is available whether the laser is in local or remote mode. The integrator should use this signal to warn operators using the end product that emission is turned ON and the product can be or is emitting laser radiation.

Since the laser emission is delivered through an optical cable which might be tens of meters in length, this signal is provided so proper warnings are made available at the laser aperture and remote control system as defined by the integration.

Note: The signal is active when the emission is turned ON and remains active even if the laser output is set at “zero” and no actual laser emission is present. It is the responsibility of the purchaser/end-user to bring the end system into full compliance with all applicable regulations.

The integrator should use these signals to notify operators that the laser is capable of producing radiation.

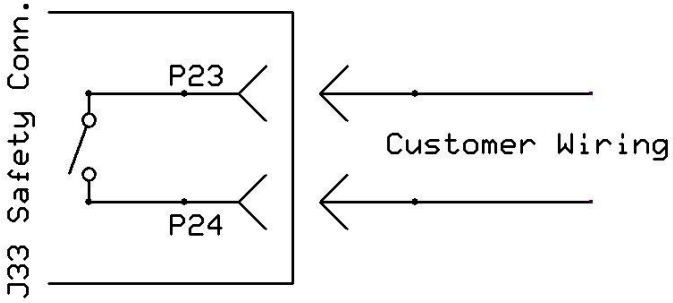
The following diagram provides connection information:



Note: Pins 8, 9, and 10 provide connections for a second stack light.

6.2.9. **Power switch status**

Contact closure to indicate when the power key switch is in the *ON* or *Remote* position.



6.3. ANALOG INTERFACE (J34)

The analog interface connector provides analog signals for control and monitor of several laser parameters.

The following analog parameters are present on J34:

- Analog power control (0 – 10Vdc)
- Analog power monitor (0 – 8Vdc)*
- Analog back reflection monitor (0 – 8Vdc)

* For QCW lasers the analog power monitor is calibrated to give 8 volts out at nominal peak output power.

J34 Analog Control			
Pin	Signal Name	Signal type	Description
1	Power control	Analog input	0 → 10Vdc equals to 0 →105% output power
2	Power control	Common**	Signal return for power control
3	Power monitor	Analog output	0 → 8Vdc equals 0 → nominal output power
4	Power monitor	Common**	Signals return for power monitor
5	Back reflection	Analog output	0 → 8Vdc Back reflection monitor signal
6	Back reflection	Common**	Back reflection signal return
7	Reserved		No connection

Table 6-8 Analog Interface (J34)

** It is not recommended to connect the analog common signals together.

6.3.1. Analog Power control

The analog control feature allows the laser emission level to be set relative to an analog signal. An analog signal with a range of 0 to 10v corresponds to an emission level of 0 to 100%[2]. This signal can also be used for modulation of the laser power by use of a signal generator setup up to provide a 0 – 10Vdc modulation signal. The analog control signal is applied to the analog interface connector J34 with pin 1 being the signal and pin 2 the signal return (see Table 6-8).

Analog control is available in both *ON* mode and *Remote* mode.

[2] Operating the laser below a 10% set point is not recommended and may damage the laser.

6.3.1.1. Enabling Analog Control mode in "ON" mode

The LaserNet application is used to enable analog control when operating the laser in "ON" mode. Below is step by step procedure for enabling analog control.

1. Run the LaserNet application software and establish a connection to the laser.
2. In LaserNet select the "Control" tab.
3. Click on the "Analog control" button located in the lower left of the control tab.

Once the analog control button is pressed it will display "ON" in the button.

6.3.1.2. Enabling Analog Control mode in "Remote" mode

When operating the laser remote mode there are 2 ways in which to enable analog control.

- Hardwiring interface
- Fieldbus interface (optional interface)

The following illustrates enabling of analog control in both laser control interfaces:

- Enabling analog control via hardwiring:
  Applying a +24Vdc signal to J36 pin A6 will enable analog control.

- Enabling analog control via the fieldbus interface:
  In the control word of the field bus protocol there will be a bit labelled "Analog control enable". When this bit is set, analog control is enabled.

6.3.2. **Analog Power monitor**

The analog power monitor located on J34 pins 3 & 4 provides a 0 → 8Vdc signal corresponding to 0 → 100% emission. The analog power monitor signal originates from a photodiode located in the optical combiner and is calibrated as follows:

- For CW lasers this signal is calibrated to produce 8Vdc at the nominal output power.
- For QCW lasers this signal is calibrated to produce 8Vdc at the peak emission level.

QCW Example: For a 2K/20K QCW laser the analog monitor would produce 8Vdc at the peak 20Kw emission level.

This signal can be used to verify that the actual output emission level matches the requested emission level.

6.3.3. **Back Reflection monitor**

The back reflection monitor located on J34 pins 5 & 6 and provides a 0 → 8Vdc signal. This signal can be used to monitor the amount of laser emission that is reflected off of the work piece and back into the laser's optics. The back reflection monitor signal originates from a photodiode located in the optical combiner. The back reflection monitor produces a relative signal. This signal is typically not factory calibrated, however during the laser installation and commission process, the FSE can calibrate it according to customer requirements. Typical calibration can be as follows.

30mv/kW into free space

It is not possible to assign a specific level to this signal, as the level of the back reflection signal level is driven by:

- Process (i.e. cutting, welding ...)
- Emission level
- Material being processed

Note: In addition to the analog back reflection monitor, a high back reflection condition will generate an alarm and shut down emission.

6.4. CHILLER INTERFACE (J35/XP3)

The chiller interface is designed to interface to an IPG chiller or a Riedel chiller.

If a chiller is ordered with the laser, IPG provides the correct chiller interface cable.

Two different connectors are used for the chiller interface:

- Standard Chiller connecter
- Alternate Chiller connector

Both connectors are described below.

J35 Chiller Interface (standard connector)

Pin	Signal Name	Signal type	Description	Connector
A1	Chiller	Input	+24Vdc signal	
A2	Chiller ready	Input	+24Vdc signal	
A3	Spare			
A4	Chiller fault	Input	+24Vdc signal	
A5	Spare			
B1	Analog input 1	0 – 10Vdc	Water temperature 100mv/°C	
B2	Analog input 2	0 – 10Vdc	Tap water temperature 100mv/°C	
B3	Analog input 3	0 – 10Vdc	Water conductivity	
B4	Spare			
B5	Common		Signal common	
C1	Reserved			
C2	Reserved			
C3	CAN Hi	IO Signal	CAN communication interface	
C4	CAN Low	IO Signal		
C5	CAN shield			

Table 6-9 Standard Chiller Interface (J35)

Riedel chiller Signals
IPG chiller signals

J35 Chiller Interface (alternate connector)				
Pin	Signal Name	Signal type	Description	Connector
1	Chiller	Input	+24Vdc signal	
2	Chiller ready	Input	+24Vdc signal	
3	Spare			
4	Chiller fault	Input	+24Vdc signal	
5	Spare			
6	Analog input 1	0 – 10Vdc	Water temperature 100mv/°C	
7	Analog input 2	0 – 10Vdc	Tap water temperature 100mv/°C	
8	Analog input 3	0 – 10Vdc	Water conductivity	
9	Spare			
10	Common		Signal common	
13	CAN Hi	IO Signal	CAN communication interface	
14	CAN Low	IO Signal		
15	CAN shield			

Table 6-10 Alternate Chiller Interface

Riedel chiller Signals
IPG chiller signals

XP3 Ultra-Compact Chiller Interface				
Pin	Signal Name	Signal type	Description	Connector
1	CAN Hi	IO Signal	CAN communication interface	
2	CAN Low	IO Signal		
3	Common			
4	PE	Shield		

Table 6-11 Ultra-Compact Chiller Interface

6.5. HARDWIRING INTERFACE (J36/XP1)

The hardwiring interface is used for control and status of the laser in *Remote* mode. Any signals present on the hardwiring interface when the laser is operated in *ON* mode will be ignored (LaserNet will indicate the presents of asserted signals, but the laser will not act on them).

Depending on options installed in the laser, some signals are not functional and or present.

Hardwiring Signals electrical requirements:

High Signal	+4Vdc … +30Vdc	Any signal in this range is interpreted as a high signal
Indeterminate	+2Vdc … +4Vdc	Any signal in this range is indeterminate in its interpretation
Low Signal	-3Vdc … + 2Vdc	Any signal in this range is interpreted as a low signal

The following table (Table 6-12) defines the pins and signals present on the hardwiring interface connector. A brief description of the signal is also presented in the table. Section 11 provides a detailed explanation of all signals.

Note: See section 11 Laser Control and Status, for all hardwiring signal details.

Note: Hardwiring signals are only available when operating the laser in *Remote* mode.

Note: To activate the hardwiring interface outputs, +24Vdc must be applied to B15 and the ground of the +24Vdc power supply must be applied to pins A16 and B16 on J36. For connector XP1 apply +24Vdc to pin 19, 41 and ground to pin 42

Note: For lasers that are configured with both hardwiring and field bus interface. The first interface to receive the signal **Laser Request** and responds with **Laser is Assigned** has control of the laser.

J36 Hardwiring Interface			
Pin	Signal Name	Type	Description
A1	Laser Request	Input	Request control of the laser
A2	Program Start	Input	Starts a LaserNet program running
A3	PC control Enable	Input	Allows emission level to be control from LaserNet
A4	Reset Alarm	Input	Clears laser alarm
A5	Guide Laser Enable	Input	Enables visible guide laser
A6	Analog control	Input	Enables analog control of emission level (program 0)
A7	Program Stop	Input	Ends a currently running LaserNet program
A8–A14	Program Number	Input	Selection of LaserNet program to run
A15	Synchronize Input	Input	Signal used in laser programs
A16	Signal Common	Input	Signal and power common
B1	Laser Ready	Output	Indicates if a laser program can be run
B2	Emission status	Output	Emission On/Off indication
B3	PC Control status	Output	Feedback for input signal “Enable PC control”
B4	Laser Alarm	Output	Indicates an alarm condition is present
B5	Guide Laser Status	Output	Feedback for input signal “Guide Laser”
B6	Analog control status	Output	Feedback for input signal “Analog Control”
B7	Laser Assigned	Output	Feedback for input signal “Laser Request”
B8	Laser is On	Output	Indicates status of laser module power supply
B9	Program Active	Output	Indicates if a laser program is currently running
B10	Program End	Output	Indicates when a laser program has ended
B11	Program Interrupted	Output	Indicates if a laser program ended prematurely
B12	Synchronize Output	Output	Signal used in laser programs
B13	Warning	Output	Indicates a warning is present in the laser
B14	Dew Point Alarm	Output	Indicates high dew point detected in laser
B15	+24Vdc power	Power	Powers the hardwiring interface
B16	+24Vdc power return	Power	Return for hardwiring interface power
C1	Laser On	Input	Turns on the Laser modules power supply
C2	Reserved	Input	N/A
C3-C6*	Beam switch channel	Input	Binary encoded beam switch channel selection
C7	Pulsed Mode	Input	Enables/Disables Pulsed mode
C8-C16	Reserved	Input	N/A
D1-D4*	Beam switch channel	Output	Binary encoded beam switch channel selection
D5*	Chiller Warning	Output	Indicates a warning is present in the chiller
D6*	Chiller Alarm	Output	Indicates an alarm is present in the chiller
D7*	Pulse mode active	Output	Indicates if pulse mode is currently active
D8*	Chiller Ready	Output	Indicates if the chiller is in the “Ready” state
D9	Laser Module Alarm	Output	Indicates one or more laser modules have an alarm
D10*	Reserved Module	Output	A reserved laser module is enabled
D11*	Reduced Modules	Output	Laser is operating with reduced active modules

Table 6-12 Hardwiring Interface (J36)

*Indicates signals in Table 6-12 that may not be functional or present.

XP1 Hardwiring Interface	

Pin	Signal Name	Type	Description
1	Laser Request	Input	Request control of the laser
2	Program Start	Input	Starts a LaserNet program running
3	PC control Enable	Input	Allows emission level to be control from LaserNet
4	Reset Alarm	Input	Clears laser alarm
5	Guide Laser Enable	Input	Enables visible guide laser
6	Analog control	Input	Enables analog control of emission level (program 0)
7	Program Stop	Input	Ends a currently running LaserNet program
8–14	Program Number	Input	Selection of LaserNet program to run (binary coded)
15	Synchronize Input	Input	Signal used in laser programs
16	Laser On	Input	Turn laser power supplies on
17	Reserved		
18	Pulse Mode	Input	Enables/Disables Pulsed mode
19	VDC common	Common	VDC Common for inputs
21	Laser Ready	Output	Indicates if a laser program can be run
22	Emission status	Output	Emission On/Off indication
23	PC Control status	Output	Feedback for input signal “Enable PC control”
24	Laser Error	Output	Indicates an alarm condition is present
25	Guide Laser Status	Output	Feedback for input signal “Guide Laser”
26	Analog control status	Output	Feedback for input signal “Analog Control”
27	Laser Assigned	Output	Feedback for input signal “Laser Request”
28	Laser is On	Output	Indicates status of laser module power supply
29	Program Active	Output	Indicates if a laser program is currently running
30	Program End	Output	Indicates when a laser program has ended
31	Program Interrupted	Output	Indicates if a laser program ended prematurely
32	Synchronize Output	Output	Signal used in laser programs
33	Warning	Output	Indicates a warning is present in the laser
34	Reserved		
35	Chiller Warning	Output	Indicates a warning is present in the chiller
36	Chiller Alarm	Output	Indicates an alarm is present in the chiller
	Pulse mode active	Output	Indicates if pulse mode is currently active
37	Chiller Ready	Output	Indicates if the chiller is in the “Ready” state
38	Laser Module Alarm	Output	Indicates one or more laser modules have an alarm
39	Reserved Module	Output	A reserved laser module is enabled
40	Reduced Modules	Output	Laser is operating with reduced active modules
41	+VDC	Power	5-24VDC power for outputs
42	VDC Common	Common	Common for outputs

Table 6-13 Hardwiring Interface (XP1)

6.5.1. **Hardwiring Signal Timing**

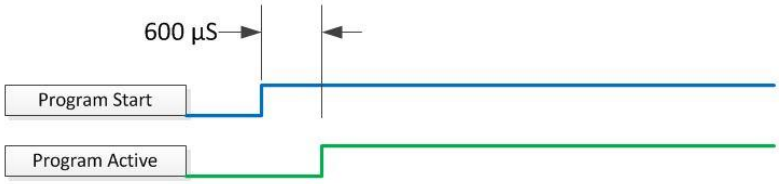
This section provides timing information for some hardwiring signals.

Laser Request signal Vs Laser Assigned signal

Analog Control signal Vs Analog Control On signal

Program Start signal Vs Emission ON signal for program 0

Program Start signal Vs Program Active for program > 0



Program Active Vs Program End

Beam switch channel request Vs Beam switch channel active

Note:

BS Channel Request = pins C3 – C6

BS Channel Active = pins D1 – D4

Laser On Vs Laser is On (Non IS Power Supply)

6.6. ETHERNET INTERFACE (J37/XP5)

The Ethernet interface is intended for providing control and status of the laser. Every YLS laser ships with a current copy of IPG's software application LaserNet. The LaserNet application is presented in detail in a separate document titled LaserNet Users Guide.

In addition to LaserNet, IPG provides the following options for customers who wish to write their own interface for monitoring the status of the laser.

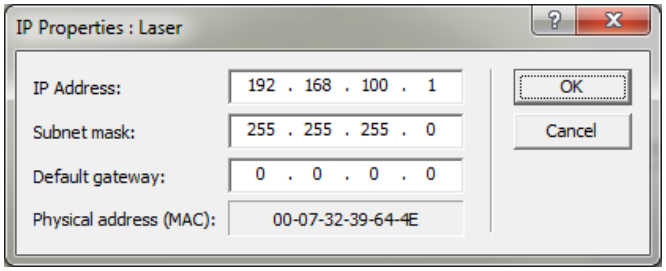
- YLS laser series Ethernet protocol *

**Note: This protocol does not provide laser control in real-time operation mode and cannot be used for laser industrial control. For industrial control applications Fieldbus or Hardwiring interfaces must be used.*

J37 Ethernet Interface				
Pin	Signal Name	Wire Color	Description	Pair Assignment
1	TX+	GRN/WHT	Transmit data +	Pair 2
2	TX-	GRN	Transmit data -	
3	RX+	ORG/WHT	Receive data +	Pair 3
4	N.A.	BLU	Not connected	Pair 1
5	N.A.	BLU/WHT	Not connected	
6	RX-	ORG	Receive data -	Pair 3
7	N.A.	BRN/WHT	Not connected	Pair 4
8	N.A.	BRN	Not connected	

Table 6-14 Ethernet interface connector

The laser ships with the following default network configuration:



These Ethernet network parameters can be changed from LaserNet.

If the laser's network parameters are changed, be sure to record this information in/at the laser. It may not be possible to determine the network parameters if this information is lost.

6.7. BEAM SWITCH INTERLOCK CONNECTORS (J21 – J26 & XPC1 – XPC6)

For laser equipped with a beam switch, each channel of the beam switch has an associated interlock connector. These connectors also provide a mirror position contact closure.

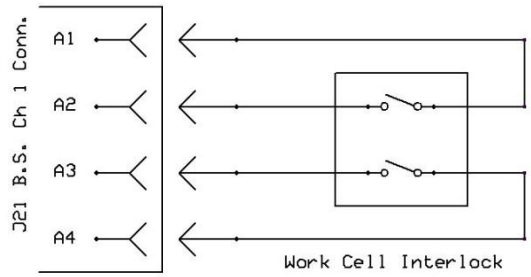
Note: When wiring to the various channel interlock connectors, pay particular attention to the pin connections, as each connector is intentionally wired different.

J21 Beam Switch channel 1			
Pin	Signal Name	Signal type	Description
A1	Interlock 1 Ch. 1	Dry contact	Work cell door (A+)
A2	Interlock 1 Ch. 1	Dry contact	Work cell door (A-)
A3	Interlock 1 Ch. 2	Dry contact	Work cell door (B+)
A4	Interlock 1 Ch. 2	Dry contact	Work cell door (A-)
B2	Mirror 1 On	Dry contact	Contact closed when mirror 1 is active
B3	Mirror 1 On	Dry contact	
A5	Mirror 1 Off	Dry contact	Contact closed when mirror 1 is inactive
B1	Mirror 1 Off	Dry contact	

Table 6-15 Beam switch channel 1 interlock connector

6.7.1. Beam switch interlock contacts

Each beam switch channel connector provides a dual loop safety rated set of contact closures that are to be incorporated into the work cell doors. If the mirror is active when the work cell door is opened, the laser will E-Stop and the laser modules power supply will be shut down. LaserNet will display both an E-Stop and E-Stop external alarm.



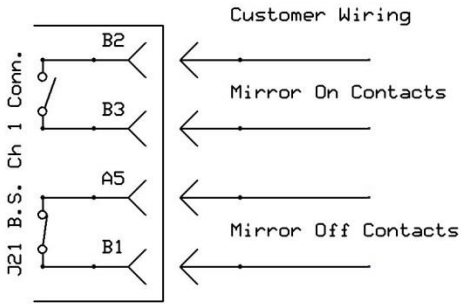
Note:

When integrating the beam switch interlock contacts into the system, ensure that the work cell door opens both contacts. If only one contact is opened and closed a "Workcell interlock malfunction" alarm will be generated. To recover from this alarm condition, both interlock switches must be opened and closed.

6.7.2. **Mirror On/Off contacts**

Mirror position signals are also provided on the channel interlock connectors.

- When the mirror is active, the Mirror On contact is closed
- When the mirror is not active, the Mirror Off contact is closed.



Note: On the following beam switch channel connectors, the interlock pins are different to prevent unintentional connections to the wrong work cell.

J22 Beam Switch channel 2			
Pin	Signal Name	Signal type	Description
B4	Interlock 2 Ch. 1	Dry contact	Work cell door (A+)
A2	Interlock 2 Ch. 1	Dry contact	Work cell door (A-)
B5	Interlock 2 Ch. 2	Dry contact	Work cell door (B+)
A4	Interlock 2 Ch. 2	Dry contact	Work cell door (A-)
B2	Mirror 2 On	Dry contact	Contact closed when mirror 2 is active
B3	Mirror 2 On	Dry contact	
A5	Mirror 2 Off	Dry contact	Contact closed when mirror 2 is inactive
B1	Mirror 2 Off	Dry contact	

Table 6-16 Beam switch channel 2 interlock connector

J23 Beam Switch channel 3			
Pin	Signal Name	Signal type	Description
C1	Interlock 3 Ch. 1	Dry contact	Work cell door (A+)
A2	Interlock 3 Ch. 1	Dry contact	Work cell door (A-)
C2	Interlock 3 Ch. 2	Dry contact	Work cell door (B+)
A4	Interlock 3 Ch. 2	Dry contact	Work cell door (A-)
B2	Mirror 3 On	Dry contact	Contact closed when mirror 3 is active
B3	Mirror 3 On	Dry contact	
A5	Mirror 3 Off	Dry contact	Contact closed when mirror 3 is inactive
B1	Mirror 3 Off	Dry contact	

Table 6-17 Beam switch channel 3 interlock connector

J24 Beam Switch channel 4			
Pin	Signal Name	Signal type	Description
C3	Interlock 4 Ch. 1	Dry contact	Work cell door (A+)
A2	Interlock 4 Ch. 1	Dry contact	Work cell door (A-)
C4	Interlock 4 Ch. 2	Dry contact	Work cell door (B+)
A4	Interlock 4 Ch. 2	Dry contact	Work cell door (A-)
B2	Mirror 4 On	Dry contact	Contact closed when mirror 4 is active
B3	Mirror 4 On	Dry contact	
A5	Mirror 4 Off	Dry contact	Contact closed when mirror 4 is inactive
B1	Mirror 4 Off	Dry contact	

Table 6-18 Beam switch channel 4 interlock connector

J25 Beam Switch channel 5			
Pin	Signal Name	Signal type	Description
C5	Interlock 5 Ch. 1	Dry contact	Work cell door (A+)
A2	Interlock 5 Ch. 1	Dry contact	Work cell door (A-)
A1	Interlock 5 Ch. 2	Dry contact	Work cell door (B+)
A4	Interlock 5 Ch. 2	Dry contact	Work cell door (A-)
B2	Mirror 5 On	Dry contact	Contact closed when mirror 5 is active
B3	Mirror 5 On	Dry contact	
A5	Mirror 5 Off	Dry contact	Contact closed when mirror 5 is inactive
B1	Mirror 5 Off	Dry contact	

Table 6-19 Beam switch channel 5 interlock connector

J26 Beam Switch channel 6			
Pin	Signal Name	Signal type	Description
A3	Interlock 6 Ch. 1	Dry contact	Work cell door (A+)
A2	Interlock 6 Ch. 1	Dry contact	Work cell door (A-)
A1	Interlock 6 Ch. 2	Dry contact	Work cell door (B+)
A4	Interlock 6 Ch. 2	Dry contact	Work cell door (A-)
B2	Mirror 6 On	Dry contact	Contact closed when mirror 6 is active
B3	Mirror 6 On	Dry contact	
A5	Mirror 6 Off	Dry contact	Contact closed when mirror 6 is inactive
B1	Mirror 6 Off	Dry contact	

Table 6-20 Beam switch channel 6 interlock connector

For lasers configured with optional discrete analog control, the following connectors are provided for each beam channel.

XPC1 ⇒ XPC6 (Beam switch channels 1 to 6)			
Pin	Signal Name	Signal type	Description
1	Power control	Analog input	0 → 10Vdc equals to 0 →100% output power
2	Power control	Common	Signal return for power control

Table 6-21 Discrete Analog Control

6.8. SAFETY CH 1 (J38)

The Safety CH1 (J38) connector is installed on laser's that have Integrated Safety power supplies installed. If the laser has an integrated beam switch J38 will **NOT** be present.

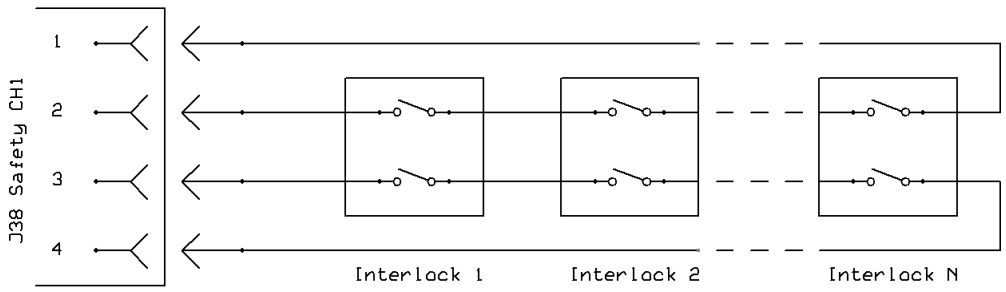
The dual interlock loops of J38 must be closed to turn on the output of the integrated safety power supply.

J38 Safety CH1			
Pin	Signal Name	Signal type	Description
1	Interlock CH. 1	Input	Dual dry contacts (*Verify only dry contacts are used)
2	Interlock CH. 1	Input	
3	Interlock CH. 2	Input	
4	Interlock CH. 2	Input	

Table 6-22 Safety CH 1

The interlock signals of J38 are dual loop circuits that are intended to be integrated into the overall system interlock scheme. If the interlock connected to J38 is opened the laser modules power supplies outputs will be turned off and LaserNet will indicate "E-Stop" and "External permission malfunction" on the alarms tab.

It is necessary to turn off the Integrated Safety power supplies output before opening the J38 interlock. If the power supplies output is off when the interlock is opened no alarms will be raised.



Note: It is necessary to open/close both interlock loops. If only one loop of the interlock is opened and closed again it is not possible to reset the "E-Stop" alarm without first opening and closing both interlock loops.

Figure 6-3 IS Power Supply

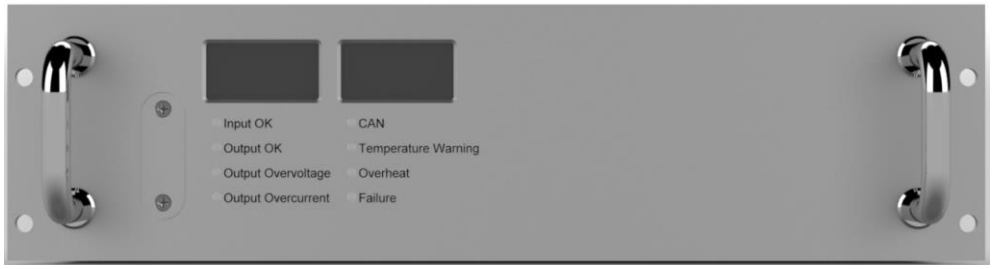


Figure 6-4 Non IS Power Supply

Lasers built with a IS Power supply and **no** beam switch it is necessary to de-assert the “Laser ON” signal before opening the work cell interlock. For laser built with the IS Power Supply and a beam switch it is only necessary to deactivate the mirror for the work cell for which the work cell interlock is to be opened. This functionality is the same for a IS power supply and a standard power supply.

7. FIELDBUS INTERFACE

IPG provides several fieldbus interface types; this section of the manual provides information on the interfaces that are available along with some available field bus protocols.

List of currently supported fieldbus types:

- Ethernet IP
- EtherCAT
- PROFINET
- PROFIBUS*
- DeviceNet*

Lasers can be configured with up to 6 separate field bus connections; however they must all be of the same type. It is not possible to combine 2 or more field bus interface types.

*For QCW lasers only a single POFIBUS or DeviceNet interface is supported.

The fieldbus interface is only active when the laser is operated in “Remote” mode.

Verify that the **Laser Request** signal on the hardwiring connector is not asserted, The first interface that receives a **Laser Request** signal, will be the interface that controls the laser.

The following table maps the field bus connectors to their indicated slot in LaserNet.

Fieldbus connector	Slot number
J42-1	Slot 1
J42-2	Slot 2
J42-3	Slot 3
J42-4	Slot 4
J42-5	Slot 5
J42-6	Slot 6

Table 7-1 Mapping of field bus connectors to slot ID's

The fieldbus interface is designed for real-time distributed control and status of the laser. For lasers that have a beam switch a typical configuration would be to have a fieldbus interface connection for each beam switch channel. From a system level this could be viewed as each robot having its own dedicated laser source. The laser can be configured so that each beam switch channel is assigned to a specific fieldbus connector/slot. See section 11.1 **Laser Request** for details for how to pass control of the laser between robots.

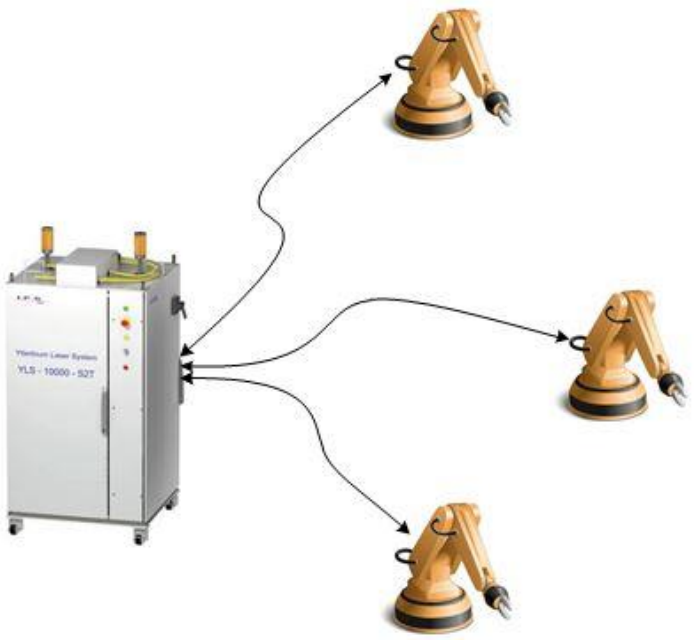


Figure 7-1 Dedicated fieldbus control

7.1. ETHERNET IP

The YLS lasers series uses a Hilscher embedded module to provide the Ethernet IP interface.

Hilscher model: COMX 100CA-RE (Configured as Ethernet IP adapter/slave)

Located on the media accompanying the laser, the Hilscher Ethernet IP EDS file is included. The EDS file is located in the following directory on the media.

\Fieldbus\IG320\Ethernet IP\

Included in the accessory kit will be the Harting Ethernet connectors. The Harting connectors will need to be wired to a CAT 5 cable, Table 7-2 provides wiring information.

J42 - X Ethernet IP				
Pin	Signal Name	Wire Color	Description	Pair Assignment
1	TX+	GRN/WHT	Transmit data +	Pair 2
2	TX-	GRN	Transmit data -	
3	RX+	ORG/WHT	Receive data +	Pair 3
4	N.A.	BLU	Not connected	Pair 1
5	N.A.	BLU/WHT	Not connected	
6	RX-	ORG	Receive data -	Pair 3
7	N.A.	BRN/WHT	Not connected	Pair 4
8	N.A.	BRN	Not connected	

Table 7-2 Ethernet IP connector

The Hilscher Ethernet IP communication module provides diagnostic LED's to indicate the current status of the module. The diagnostic LED's are visible on the lasers control electronics.

When all three LED's are steady green, the module is communicating to the scanner/master.

To view the diagnostic LED's open the laser's side door that provides access to the electrical panel.

DANGER

Risk of death from supply voltage

Coming into contact with the power connection and components can lead to death.

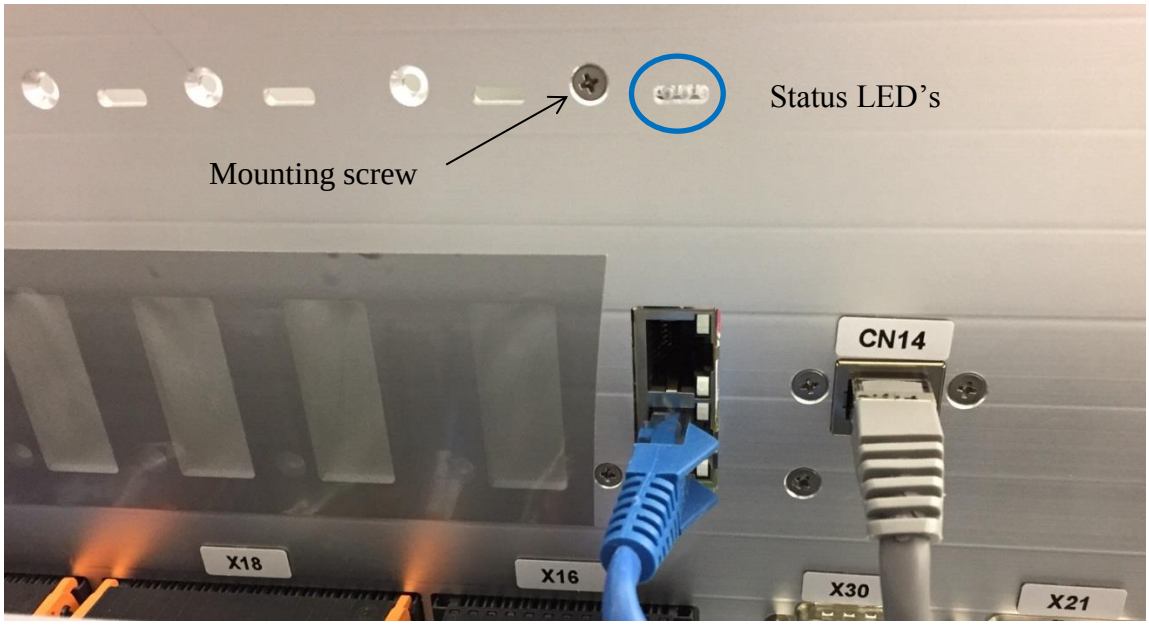
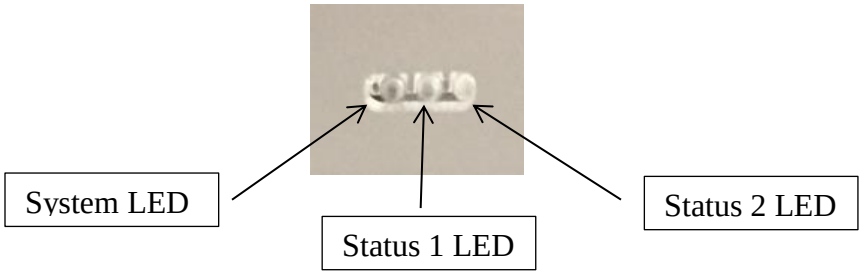


Figure 7-2 Ethernet IP Diagnostic LED's



Note: The system LED is the LED closest to the mounting screw see Figure 7-2.

System LED Status Codes		
Color	State	Meaning
	Off	Power supply off, OR hardware defect
	On	Operating system running
	Blinking	Second stage bootloader is waiting for firmware*
	On	Second stage bootloader missing*

Table 7-3 Ethernet IP System LED

Ethernet IP LED status codes			
LED	Color	State	Meaning
Status 1		Off	No Power
		On	Device operational
		Flashing	Standby: Device not configured
		On	Major Fault: non-recoverable fault *
		Flashing	Minor Fault: recoverable fault
		Flashing	Self-Test: Power up test
Status 2		Off	No communication to master
		On	Connected: Device has established a network connection
		Flashing	No Connection
		On	Duplicate IP: Another device has same IP address
		Flashing	Connection timeout
		Flashing	Self-Test: Power up test
RJ45 Link		On	Ethernet connection is established
		Off	No Connection
RJ45 Activity		Flashing	Transmitting and Receiving data

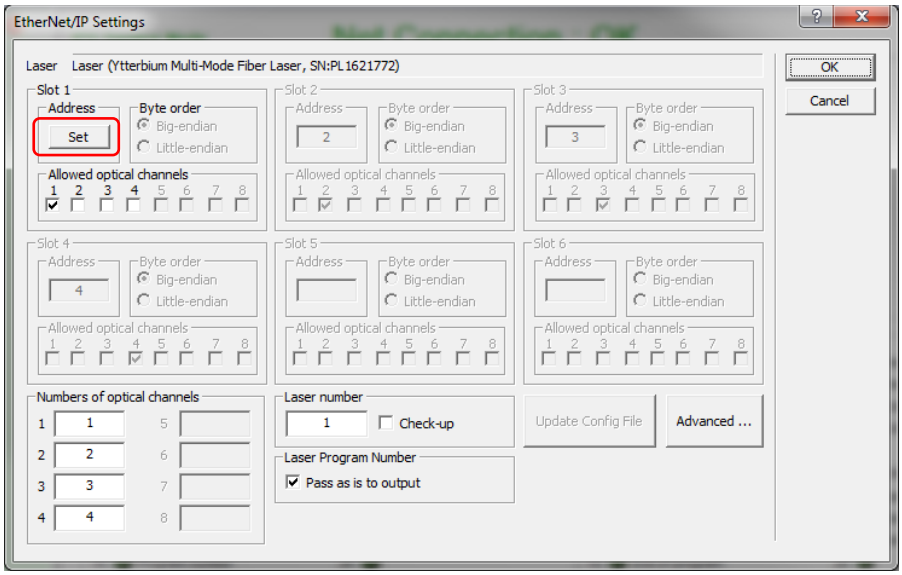
Table 7-4 Ethernet IP Status LED's

*Contact IPG for assistance

7.1.1. Ethernet IP and LaserNet

From within LaserNet it is possible to change the Ethernet IP network parameters. The following steps show how to accomplish this:

1. Launch the LaserNet application and establish a connection to the laser
2. From the *Settings* menu select *Laser* then *Ethernet/IP Settings*
3. The following dialog window will appear:



In the above window "Slot" refers to the location that the fieldbus card is installed in the laser's controller see Table 7-1.

4. To configure the IP settings for Slot 1 press the "Set" button in the address box.
5. The following dialog box will appear

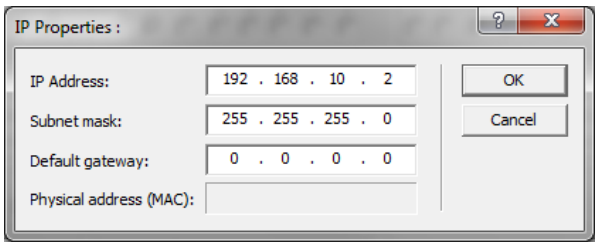


Figure 7-3 Ethernet IP settings

The above figure shows the typical default IP settings for slot 1.

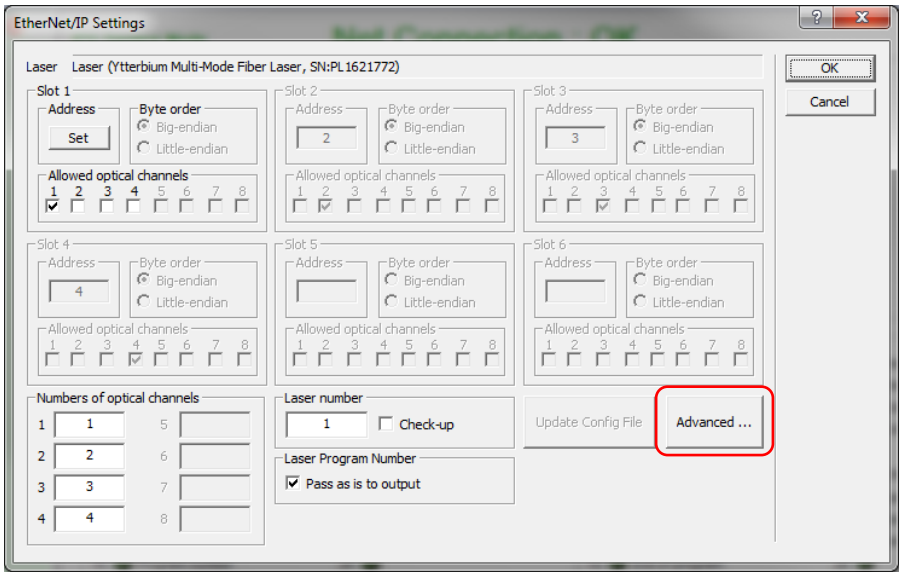
If the Ethernet IP network parameters are changed, be sure to record this information in/at the laser. It may not be possible to determine the network parameters if this information is lost.

7.1.1.1. Ethernet/IP 32bit run idle header

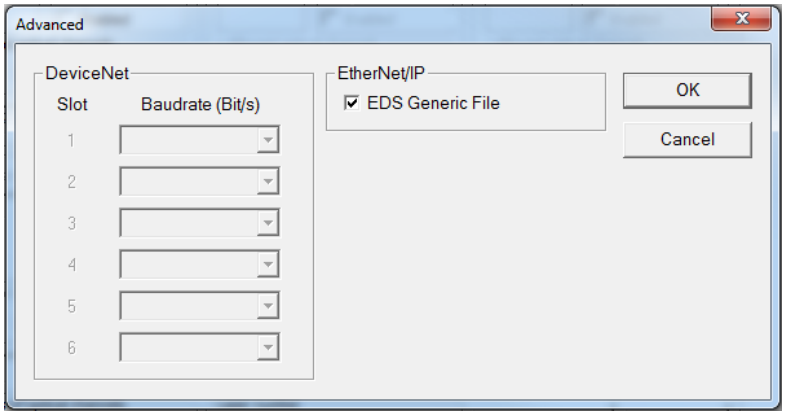
The 32bit run/idle header in the Ethernet/IP communications can be enable/disabled as follows:

Note: LaserNet must be set to “Supervisor” access level.

1. Launch the LaserNet application and establish a connection to the laser
2. From the *Settings* menu select *Laser* then *Ethernet/IP Settings*
3. The following dialog window will appear:



4. Press the *Advanced* button, the following dialog window will open.



When the “EDS Generic File” is checked the, the 32bit run/idle header is not sent as part of the Ethernet/IP message packet.

7.1.1.2. PLC to Ethernet IP Settings

The following table provides some information that a typical PLC would require to communicate to the laser's Ethernet IP interface.

	Assembly Instance	Size (in bytes)
Input	101	10*
Output	100	10*

Table 7-5 Ethernet IP / PLC connection parameters

*The default fieldbus protocol is 10 bytes in and 10 bytes out, however there are several other protocols available where the size is different. If it is not clear on the I/O size of the protocol, look in the Ethernet/IP tab of LaserNet. If the tab indicates 5 words this is a 10 byte protocol, 4 words 8 byte protocol… etc.

7.2. ETHERCAT

The YLS lasers series uses a Hilscher embedded module to provide the EtherCAT interface.

Hilscher model: COMX 100CA-RE (Configured as an EtherCAT slave)

Located on the media accompanying the laser, the Hilscher EtherCAT XML file is included. The XML file is located in the following directory on the media.

\Fieldbus\IG320\EtherCAT\

Included in the accessory kit will be the Harting Ethernet connectors. The Harting connectors will need to be wired to a CAT 5 cable, Table 7-6 provides wiring information.

J42 - X EtherCAT				
Pin	Signal Name	Wire Color	Description	Pair Assignment
1	TX+	GRN/WHT	Transmit data +	Pair 2
2	TX-	GRN	Transmit data -	
3	RX+	ORG/WHT	Receive data +	Pair 3
4	N.A.	BLU	Not connected	Pair 1
5	N.A.	BLU/WHT	Not connected	
6	RX-	ORG	Receive data -	Pair 3
7	N.A.	BRN/WHT	Not connected	Pair 4
8	N.A.	BRN	Not connected	

Table 7-6 EtherCAT connector

The Hilscher EtherCAT communication module provides diagnostic LED's to indicate the current status of the module. The diagnostic LED's are visible on the lasers control electronics.

When the System and Status 1 LED's are steady green, the module is communicating to the master.

To view the diagnostic LED's, open the laser's side door that provides access to the electrical panel.

DANGER

Risk of death from supply voltage

Coming into contact with the power connection and components can lead to death.

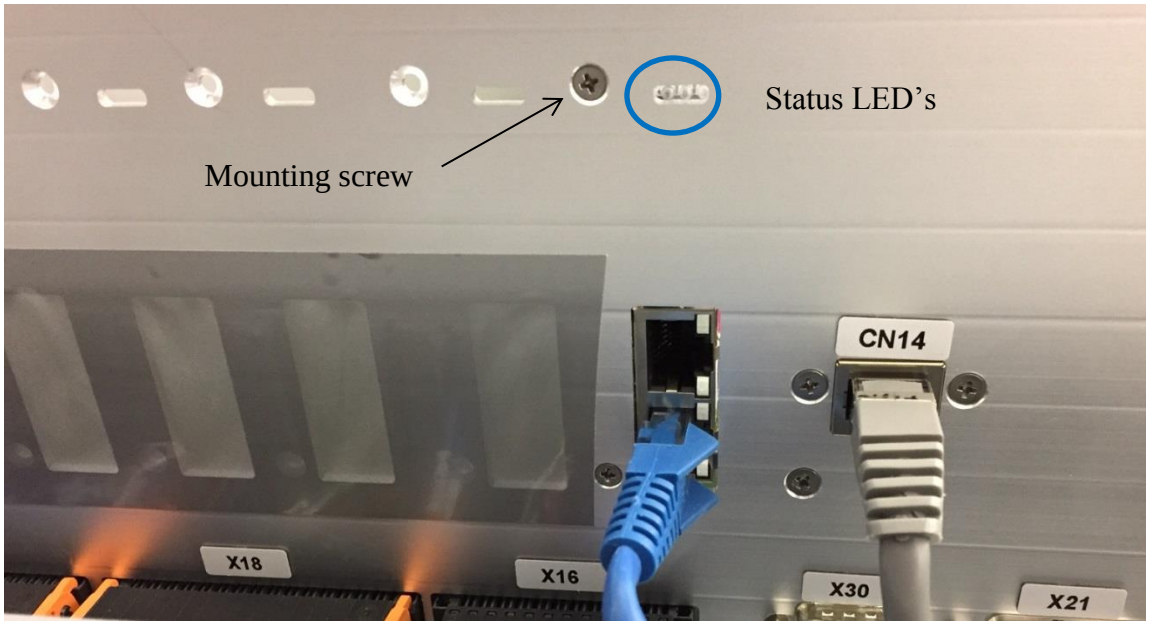
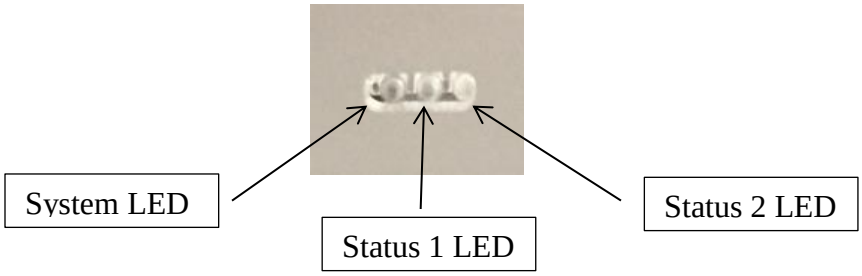


Figure 7-4 EtherCAT Diagnostic LED's



Note: The system LED is the LED closest to the mounting screw see Figure 7-4.

System LED Status Codes		
Color	State	Meaning
	Off	Power supply off, OR hardware defect
	On	Operating system running
	Blinking	Second stage bootloader is waiting for firmware*
	On	Second stage bootloader missing*

Table 7-7 EtherCAT System LED

EtherCAT LED status codes			
LED	Color	State	Meaning
Status 1 (Run)		Off	No Power
		On	Device is operational
		Blinking	Pre-operational state
		Flash	Safe-operational state
Status 2 (Error)		Off	No Power
		Blinking	Invalid configuration*
		1 Flash	Local Error*
		2 Flash	Application watchdog timeout
RJ45		On	Ethernet connection is established
		Flashing	Device sending and receiving Ethernet frames
		Off	No Connection
RJ45			

Table 7-8 EtherCAT Status LED's

*Contact IPG for assistance

7.2.1. **Notes on wiring EtherCAT**

- Use shielded Ethernet cables that meet the requirements of at minimum category 5 (CAT 5) as indicated in EN50173 or ISO/IEC 11801.
- Do not use hubs in an EtherCAT network.
- Use switches only between EtherCAT master and first EtherCAT slave device (100 Mbit/s, Full Duplex).
- The cable length between two EtherCAT devices must not exceed 100 meters.

7.3. PROFINET

The YLS lasers series uses a Hilscher embedded module to provide the PROFINET interface.

Hilscher model: COMX 100CA-RE (Configured as PROFINET IRT Device)

Located on the media accompanying the laser, the Hilscher Ethernet IP EDS file is included. The EDS file is located in the following directory on the media.

\Fieldbus\IG320\Profinet\

Included in the accessory kit will be the Harting Ethernet connectors. The Harting connectors will need to be wired to a CAT 5 cable, Table 7-9 provides wiring information.

J42 - X PROFINET				
Pin	Signal Name	Wire Color	Description	Pair Assignment
1	TX+	GRN/WHT	Transmit data +	Pair 2
2	TX-	GRN	Transmit data -	
3	RX+	ORG/WHT	Receive data +	Pair 3
4	N.A.	BLU	Not connected	Pair 1
5	N.A.	BLU/WHT	Not connected	
6	RX-	ORG	Receive data -	Pair 3
7	N.A.	BRN/WHT	Not connected	Pair 4
8	N.A.	BRN	Not connected	

Table 7-9 PROFINET Connector

The Hilscher PROFINET communication module provides diagnostic LED's to indicate the current status of the module. The diagnostic LED's are visible on the lasers control electronics.

When the System LED is steady green, the module is communicating to the scanner/master. The other two LED's will be off.

To view the diagnostic LED's, open the laser's side door that provides access to the electrical panel.

DANGER

Risk of death from supply voltage

Coming into contact with the power connection and components can lead to death.

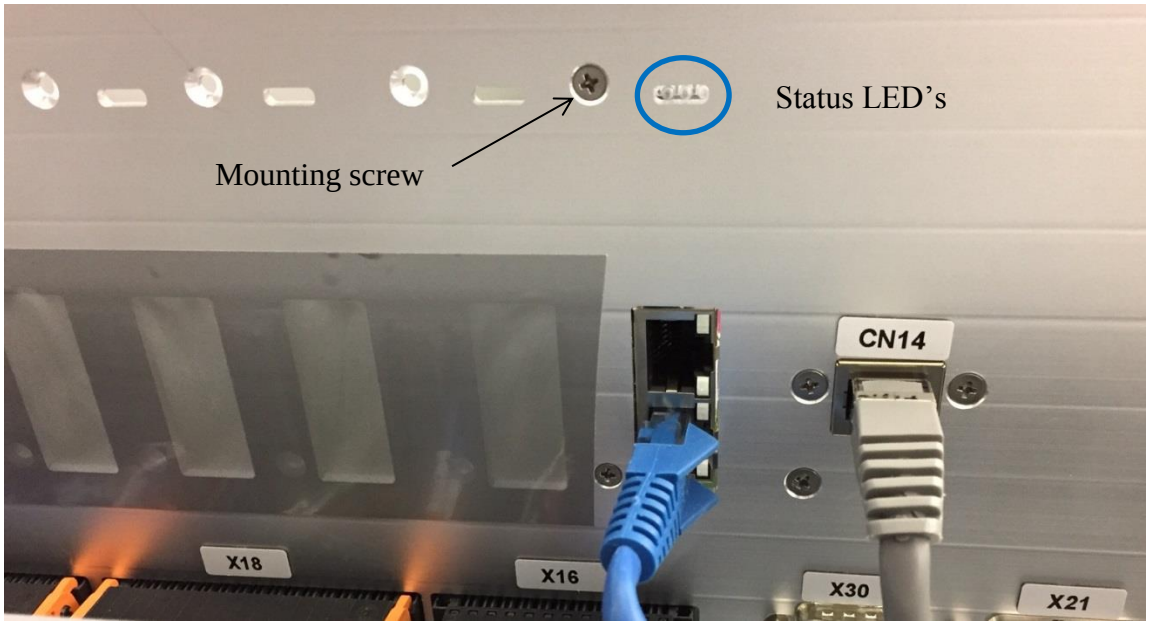
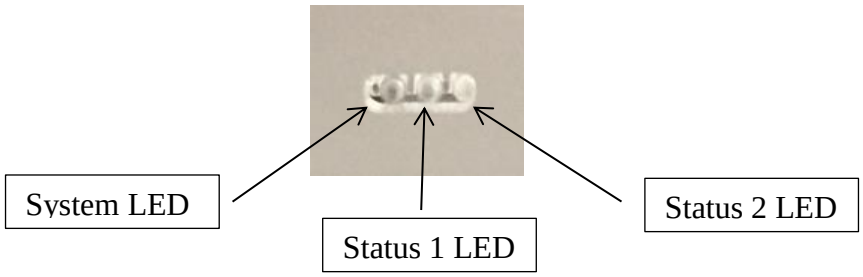


Figure 7-5 PROFINET Diagnostic LED's



Note: The system LED is the LED closest to the mounting screw see Figure 7-5.

System LED Status Codes		
Color	State	Meaning
	Off	Power supply off, OR hardware defect
	On	Operating system running
	Blinking	Second stage bootloader is waiting for firmware*
	On	Second stage bootloader missing*

Table 7-10 PROFINET System LED

PROFINET LED status codes			
LED	Color	State	Meaning
Status 1		Off	No error
		On	Watchdog timeout*
		Flashing	DCP signal service initiated
Status 2		Off	No error
		On	No configuration*
		Flashing	No data exchange
RJ45		On	Ethernet connection is established
		Off	No Connection
RJ45		Flashing	Device sending/receiving Ethernet packets

Table 7-11 PROFINET Status LED's

*Contact IPG for assistance

7.4. PROFIBUS

The YLS lasers series uses a Hilscher embedded module or PC104 card to provide the PROFIBUS interface.

Hilscher model: COMX 100CA-DP (Configured as a PROFIBUS slave)

Hilscher model: CIFX 104-DP (PC104 PC card)

Located on the media accompanying the laser, the Hilscher PROFIBUS GSD file is included. The GSD file is located in the following directory on the media.

\Fieldbus\IG320\Profibus\

\Fieldbus\IG277\Profibus\

Most lasers that have the PROFIBUS option will be built with the IG320 control electronics. All QCW type laser will have the IG277 controller installed.

Included in the accessory kit will be Phoenix PROFIBUS connectors.

⇒ Phoenix PROFIBUS connector SUBCON-PLUS-PROFIB #2744348

J42 - X PROFIBUS				
Pin	Signal Name	Wire color	Phoenix Pin	Description
1				N.C.
2				N.C.
3	Data +	White	1B	Receive and Send data
4				N.C.
5	Ground	Green	2A	Return for +24V power
6	+24Vdc	Yellow	2B	+24Vdc power
7				N.C.
8	Data -	Brown	1A	Receive and Send data
9				N.C.

Table 7-12 PROFIBUS connector

To prevent PBOFIBUS network issues observe the following:

- Termination resisters are installed at each end of the network (see Figure 7-7). If the laser is the last device on the network, enable the terminating resisters by placing the orange switch on the Phoenix connector in the “ON” position.
- Minimize cable length between device nodes.

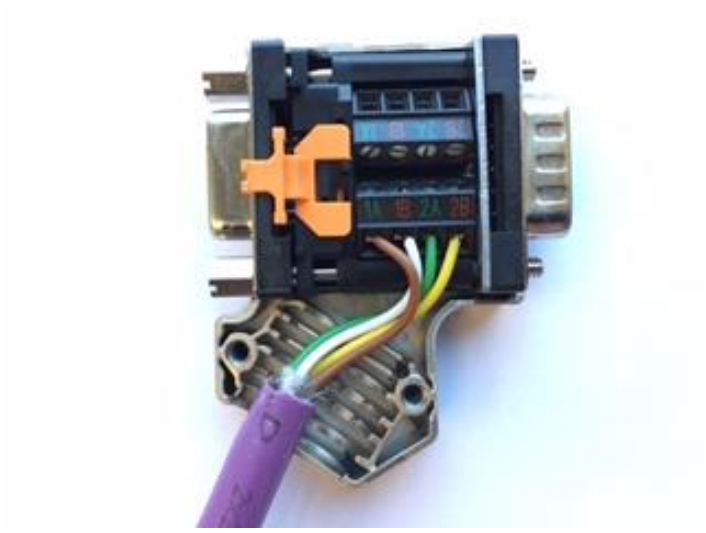


Figure 7-6 PROFIBUS Phoenix connector

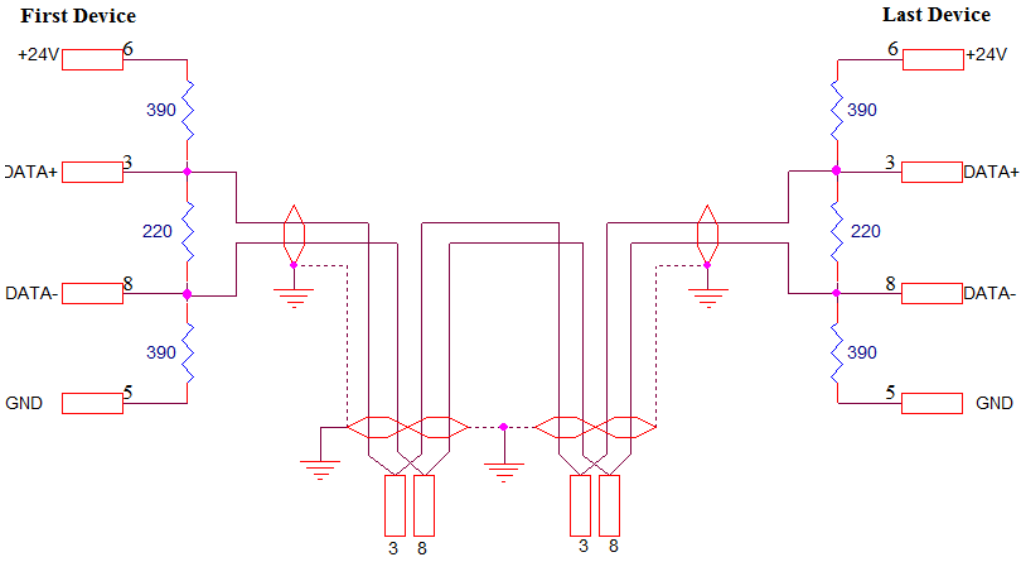


Figure 7-7 PROFIBUS wiring guide

PROFIBUS wiring limitations	
Baud Rate	Max. Distance
9.6k bps	1,200 m
19.2 kbps	1,200 m
93.75 kbps	1,200 m
187.5 kbps	1,000 m
500 kbps	400 m
1.5 Mbps	200 m
3.0 Mbps	100 m
6.0 Mbps	100 m
12.0 Mbps	100 m

Figure 7-8 PROFIBUS wiring limitations

Only use PROFIBUS certified cable, preferably cable type A

The following diagnostic information is only available on Lasers built with the IG320 control electronics.

The Hilscher PROFIBUS communication module provides diagnostic LED's to indicate the current status of the module. The diagnostic LED's are visible on the lasers control electronics.

When the System LED and status LED are steady green, the module is communicating to the scanner/master.

To view the diagnostic LED's, open the laser's side door that provides access to the electrical panel.

DANGER

Risk of death from supply voltage

Coming into contact with the power connection and components can lead to death.

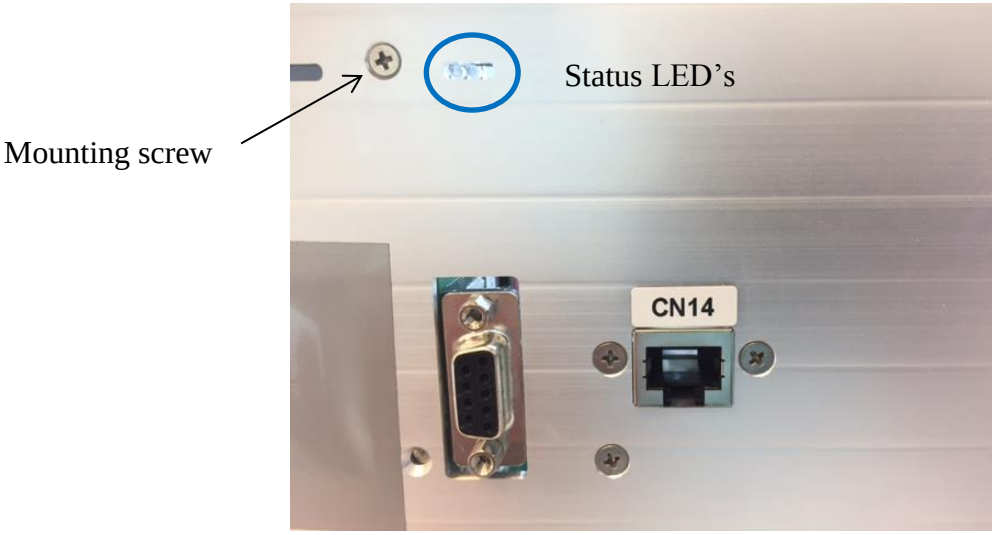
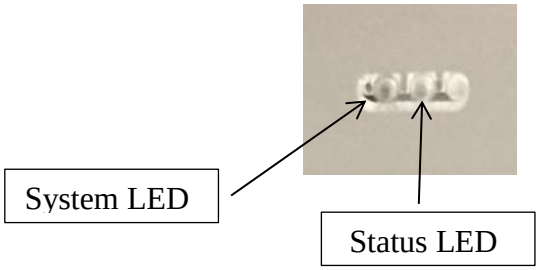


Figure 7-9 PROFIBUS diagnostic LEDs



Note: The system LED is the LED closest to the mounting screw see Figure 7-9.

System LED Codes		
Color	State	Meaning
	Off	Power supply off, OR hardware defect
	On	Operating system running
	Blinking	Second stage bootloader is waiting for firmware*
	On	Second stage bootloader missing*

Table 7-13 PROFIBUS System LED

*Contact IPG for assistance

PROFIBUS Status LED codes			
LED	Color	State	Meaning
Status LED		Off	No Power
		ON	Running, cyclic communication
		ON	Wrong configuration At PROFIBUS slave
		Flashing (cyclic)	Stopped, no communication
		Flashing (acyclic)	Not configured

Table 7-14 PROFIBUS status LED

7.4.1. PROFIBUS and LaserNet

For lasers built with the IG320 controller the following PROFIBUS settings are available.

From within LaserNet it is possible to change the PROFIBUS address. The following steps show how to accomplish this:

1. Launch the LaserNet application and establish a connection to the laser
2. From the *Settings* menu select *Laser* then *Ethernet/PROFIBUS Settings…*
3. The following dialog window will appear:

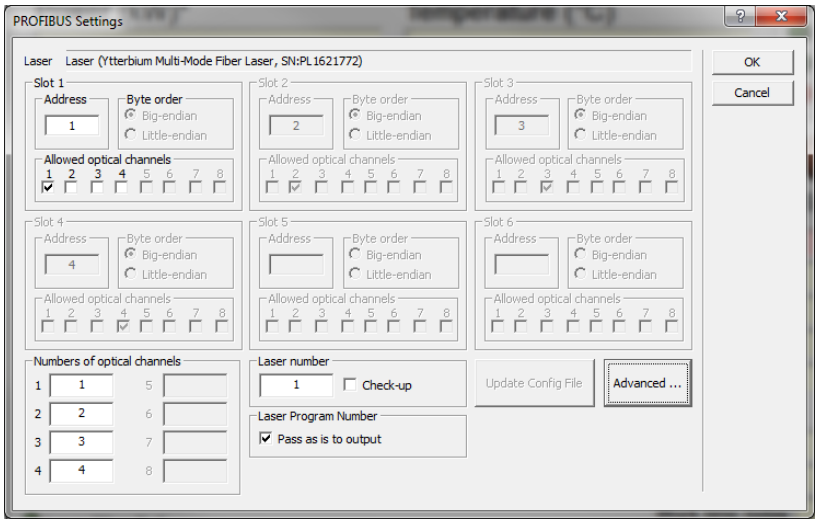


Figure 7-10 PROFIBUS configuration in LaserNet

In the above window "Slot" refers to the location that the fieldbus card is installed in the laser's controller see Table 7-1.

The PROFIBUS Settings dialog window allows address configuration and optical channel assignment.*

*Optical channel assignment is covered in the LaserNet user's manual.

7.5. DEVICENET

The YLS lasers series uses a Hilscher embedded module or PC104 card to provide the DeviceNet interface.

Hilscher model: COMX 100CA-DN (Configured as a DeviceNet slave)

Hilscher model: CIFX 104-DN (PC104 PC card)

Located on the media accompanying the laser, the Hilscher DeviceNet EDS file is included. The EDS file is located in the following directory on the media.

\Fieldbus\IG320\DeviceNet\

\Fieldbus\IG277\DeviceNet\

Most lasers that have the DeviceNet option will be built with the IG320 control electronics. All QCW type laser will have the IG277 controller installed.

Included in the accessory kit will be Phoenix DeviceNet connectors.

⇒ Phoenix DeviceNet connector VS-25-DEVNET #1652240

J42- X DeviceNet			
Pin	Signal	Wire color	Description
1	Ground	Black	Ground
2	CAN low	Blue	Data
3	Shield	Clear	Drain wire for EMI shielding
4	CAN high	White	Data
5	+24Vdc	Red	+24Vdc power

Table 7-15 DeviceNet connector

To prevent DeviceNet network issues observe the following:

- Termination resisters are installed at each end of the network (see Figure 7-12). If the laser is the last device on the network, enable the terminating resisters by means of the terminating switch in the Phoenix connector see Figure 7-11.
- Minimize cable length between device nodes.

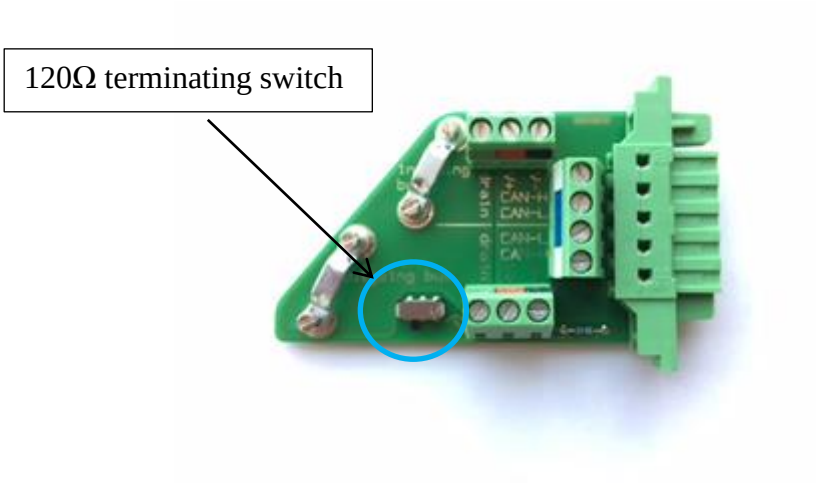


Figure 7-11 DeviceNet Phoenix connector

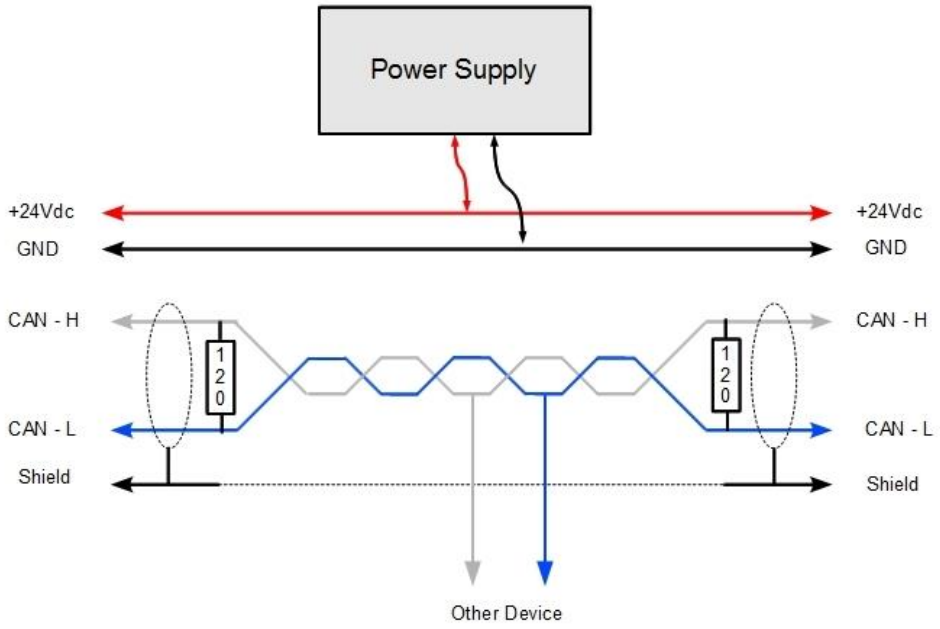


Figure 7-12 DeviceNet wiring guide

DeviceNet wiring limitations	
Baud Rate	Max. Distance
125 kbps	500 m
250 kbps	250 m
500 kbps	100 m

Only use DeviceNet cable that is ODVA compliant

The following diagnostic information is only available on Lasers built with the IG320 control electronics.

The Hilscher DeviceNet communication module provides diagnostic LED's to indicate the current status of the module. The diagnostic LED's are visible on the lasers control electronics.

When the System LED is steady green, the module is communicating to the scanner/master. The other two LED's will be off.

To view the diagnostic LED's, open the laser's side door that provides access to the electrical panel.

DANGER

Risk of death from supply voltage

Coming into contact with the power connection and components can lead to death.

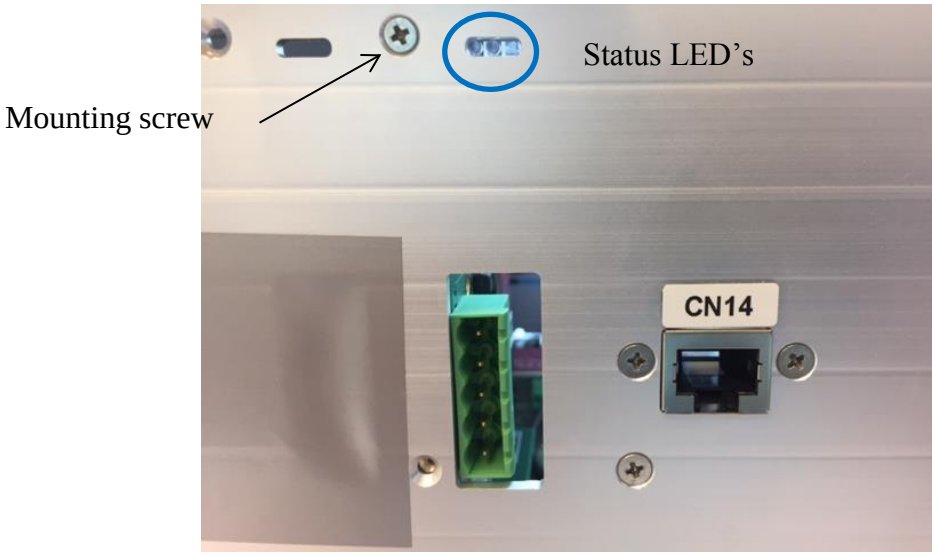
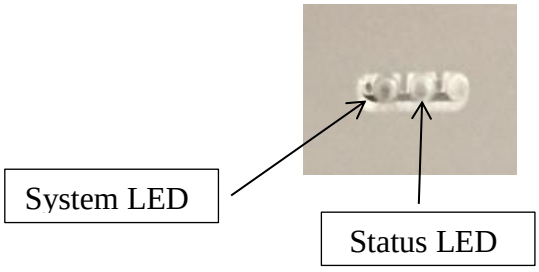


Figure 7-13 DeviceNet Diagnostic LEDs



Note: The system LED is the LED closest to the mounting screw see Figure 7-13.

System LED Codes		
Color	State	Meaning
○	Off	Power supply off, OR hardware defect
●	On	Operating system running
●●	Blinking	Second stage bootloader is waiting for firmware*
●	On	Second stage bootloader missing*

Table 7-16 DeviceNet System LED codes

*Contact IPG for assistance

DeviceNet Status LED codes			
LED	Color	State	Meaning
Status LED		Off	No Power
		ON	Device operational and On-line
		ON	Critical Fault or Critical Link Failure
		Flashing (1Hz)	Critical fault or Connection timeout
		Flashing	Self-test after power on

Figure 7-14 DeviceNet status LED

7.5.1. DeviceNet and LaserNet

For lasers built with the IG320 controller the following DeviceNet settings are available.

From within LaserNet it is possible to change the PROFIBUS address. The following steps show how to accomplish this:

1. Launch the LaserNet application and establish a connection to the laser
2. From the *Settings* menu select *Laser* then *DeviceNet/PROFIBUS Settings…*
3. The following dialog window will appear:

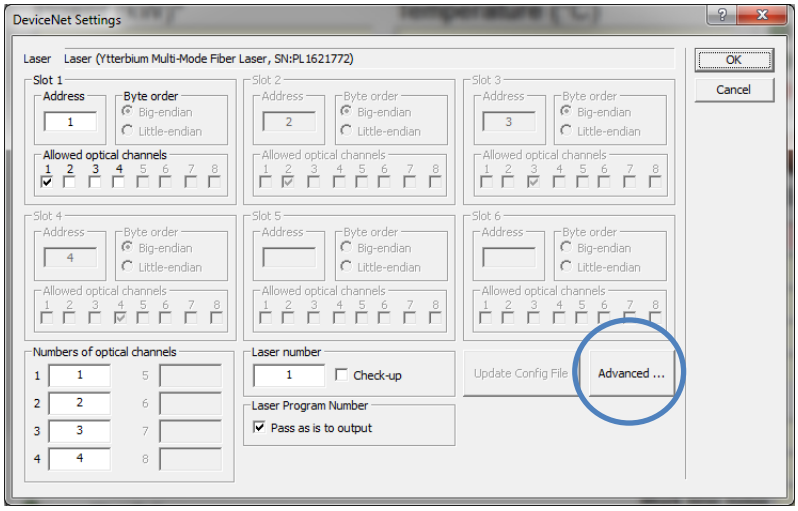


Figure 7-15 DeviceNet configuration in LaserNet

In the above window "Slot" refers to the location that the fieldbus card is installed in the laser's controller see Table 7-1.

The DeviceNet Settings dialog window allows address configuration and optical channel assignment.*

*Optical channel assignment is covered in the LaserNet user's manual.

From within the DeviceNet settings dialog, pressing the *Advanced* button allows for changing the DeviceNet Baud rate.

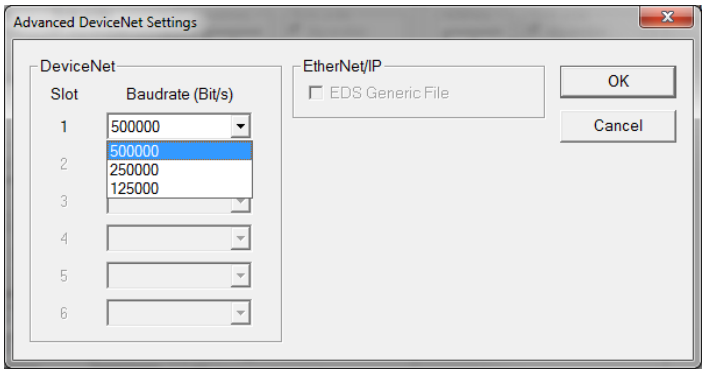


Figure 7-16 Advanced DeviceNet settings

Note: The advanced settings are only available for lasers that have the IG320 controller installed.

8. FIELDBUS PROTOCOLS

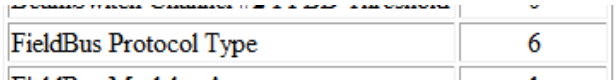
The YLS laser series provides several field bus protocols; Regardless of the field bus type. IPG has implemented the following fieldbus protocols:

- Standard 10 byte protocol (Type 6)
- Standard 8 byte protocol (Type 0)
- QCW protocol (Type 36)

Note: For customer specific protocols, additional documentation is provided.

If it is not clear which protocol the laser is configured with, the following will help to determine this:

1. Launch the LaserNet application and establish a connection to the laser
2. Select the following menu item in LaserNet: *Settings* → *Laser* → *Configuration View…*
3. Look for the following entry in the configuration window.



Typical fieldbus protocols will be Type 0, Type 6 and Type 36. If the laser has been configured with a different fieldbus protocol type, additional documentation will accompany the laser or contact IPG support.

8.1. FIELDBUS PROTOCOL TYPE 6

The following table provides an overview of the standard 10 byte protocol. Section 11 of the user manual provides details on all signals and parameters used in the protocol.

Protocol Type 6				
Byte	Word	Parameter	Brief Description	Un-Assigned Response *
Input signals				
1	1	Control word	Each bit of the control word is a separate controlling signal.	Table 8-2
2				
3	2	Power Request	Emission Power Request	No
4				
5	3	Optical Channel	Optical Channel Request	Table 8-2
6		Program Number	Laser Program number	No
7	4	Ramp time	Emission ramp time in milliseconds	No
8				
9	5	Laser Number	Requested laser number	No
10		Reserved	N/A	N/A
Output Signals				
1	1	Status word	Each bit of the status word is a separate status signal.	Table 8-3
2				
3	2	Delivered Power	Output power as measured at the optical combiner.	0
4				
5	3	Optical Channel	Currently selected optical channel	Yes
6		Program Number	Currently selected laser program	0
7	4	Status word 2	Each bit of the status 2 word is a separate status signal	Table 8-4
8				
9	5	Laser Number	Number of communicating laser	Yes
10		Reserved	N/A	N/A

Table 8-1 Fieldbus Protocol Type 6

*Un-Assigned response: The un-assigned response column indicates if the parameter value is valid if the signal "Laser Request" is not asserted or the value that will be present.

The byte order for fieldbus data is Little-endian.

8.1.1. **Protocol Type 6 Control Signal Definitions**

Control word definition			
Bit	Signal Name	Brief Description	Response State*
0	Laser Request	Requests control of the laser	Yes
1	Laser ON	Turns on the laser module power supply	No
2	Reset Alarm	Clears latched alarm	Yes**
3	Guide Laser	Enables/Disables visible laser	Yes
4	Program Start	Starts selected laser program	No
5	Program Stop	Aborts currently running laser program	No
6	Reserved		No
7	Analog Control	Enables/Disables analog control	No
8	PC Control	Enables some LaserNet or PC program controls	No
9	Ramp Up	Uses value of input word 4 for emission ramp up time	No
10	Ramp Down	Uses value of input word 4 for emission ramp down time	No
11	Sync. Input	Signal used in laser programs	No
12	Reserved		No
13	Reserved		No
14	Single module mode	Enable a single laser module for emission	No
15	System Alarm	A system device (other than laser) is in an alarm state	No

Table 8-2 Protocol Type 6 Control word definitions

*Response State: The response state column indicates if the parameter value is valid if the signal **Laser Request** is not asserted.

** If **Laser Request** is not set, the **Reset Alarm** signal will only reset a **Slot Error** alarm.

8.1.2. **Protocol Type 6 Status 1 Signal Definitions**

Status 1 word signal definitions			
Bit	Signal Name	Brief Description	Response State*
0	Laser is Assigned	Result of sending control signal “Laser Request”	0
1	Laser is ON	The laser module power supply is on	Yes
2	Laser Alarm	The laser is in an alarm state	Yes
3	Guide Laser status	Result of sending control signal “Guide Laser”	Yes
4	Program Active	Indicates if a laser program is currently active	0
5	Program End	Indicates a laser program has ended	0
6	Program Interrupted	Indicates the laser program ended prematurely	0
7	Analog Control Status	Result of sending control signal “Analog Control”	0
8	Warning	The laser is in a warning state	Yes
9	Laser Ready	Indicates if a laser program is ready to emit	0
10	Emission Status	Emission on/off status signal	0
11	Sync. Output	Signal used in laser programs to indicate a specific point in the program has been reached	0
12	“Remote” mode	Indicates if the key switch is in the “REM” position.	Yes
13	Interlock	Status of laser safety circuit	Yes
14	Laser enabled	Fieldbus interface is active	Yes
15	PC Control status	Result of sending control signal “PC Control”	Yes

Table 8-3 Protocol Type 6 Status 1 definitions

*Response State: The response state column indicates if the parameter value is valid when signal **Laser Request** is not asserted.

8.1.3. **Protocol Type 6 Status word 2 Signal Definitions**

Status 2 word signal definitions			
Bit	Signal Name	Brief Description	Response State*
0	Laser Error	Abnormal condition detected in laser	Yes
1	Laser Warning	Abnormal condition leading to a warning condition	Yes
2	Chiller Error**	The chiller is in an error state	Yes
3	Chiller Warning**	Indicates chiller is approaching the alarm state	Yes
4	Safety open	Safety loop is open	Yes
5	Channel alarm	The specified optical channel has an alarm	Yes
6	Laser Busy	Laser currently controlled by another interface.	Yes
7	Slot Error	Invalid laser or channel number	0
8	Door open	Work cell door for selected optical channel is open	Yes
9	Reserved module On	A reserved module has been activated	Yes
10	Reduced Active modules	Laser operating with reduced nominal power	Yes
11	Back Reflection	Back reflection threshold exceeded	Yes
12	Module power supply	One or more laser modules have no electrical power	Yes
13	Reserved		N/A
14	Single module mode	Laser is operating in single module mode	Yes
15	Reserved		N/A

Table 8-4 Protocol Type 6 Status word 2 definitions

*Response State: The response state column indicates if the parameter value is valid when signal **Laser Request** is not asserted.

** Chiller signals only valid if laser connected to an IPG CAN enabled chiller.

Conditions for chiller error: Water conductivity ≥ 50 µS/cm or ≤ 30 µS/cm, water temperature of the laser circuit ≥ T_{Th1} °C or ≤ T_{Th2} °C, water temperature of the optics circuit ≥ T_{Th3} °C or ≤ T_{Th4} °C, CHILLER FAULT.
The bit is active if IPG chiller is connected to laser via CAN-bus interface.

Conditions for chiller warning: Water conductivity ≥45 µS/cm or ≤ 35 µS/cm, the water temperature of the laser circuit ≥ T_{Th1} - 2° C or ≤ T_{Th2} + 2° C, water temperature of the optics circuit ≥ T_{Th3} - 2° C or ≤ T_{Th4} + 2° C.
The bit is active if IPG chiller is connected to laser via CAN-bus interface.

8.2. FIELDBUS PROTOCOL TYPE 0

The following table provides an overview of the standard 8 byte protocol. Section 11 of the user manual provides details on all signals and parameters used in the protocol.

Protocol Type 0			
Byte	Word	Parameter	Brief Description
Input Parameters			
1 2	1	Control word	Each bit of the control word is a separate controlling signal.
3 4	2	Power Request	Emission Power Request
5	3	Optical Channel	Optical Channel Request
6		Program Number	Laser Program number
7 8	4	Ramp time	Emission ramp time in milliseconds
Output Parameters			
1 2	1	Status word 1	Each bit of the status word is a separate status signal.
3 4	2	Delivered Power	Output power as measured at the optical combiner.
5	3	Optical Channel	Currently selected optical channel
6		Program Number	Currently selected laser program
7 8	4	Status word 2	Each bit of the status 2 word is a separate status signal

Table 8-5 Fieldbus protocol type 0

The byte order for fieldbus data is Little-endian.

8.2.1. Protocol Type 0 Control signal definitions

The following table defines all signals available in the control word. A brief description accompanies each signal definition; section 11 provides detailed information on all signals.

Control word definition		
Bit	Signal Name	Brief Description
0	Laser Request	Requests control of the laser
1	Laser ON	Turns on the laser module power supply
2	Reset Alarm	Resets latched alarms
3	Guide Laser	Enables/Disables visible laser
4	Program Start	Starts selected laser program
5	Program Stop	Aborts currently running laser program
6	Set optical channel	Set the optical channel (Activate channel specified in byte 5).
7	Analog Control	Enables/Disables analog control
8	PC Control	Enables some LaserNet or PC program controls
9	Ramp Up	Uses value of input word 4 for emission ramp up time
10	Ramp Down	Uses value of input word 4 for emission ramp down time
11	Sync. Input	Signal used in laser programs
12	B.S. guide lasers	Turns on/off all guide lasers in beam switch
13	Single module mode	Enable a single laser module for emission
14	Reserved	
15	Reserved	

Table 8-6 Protocol type 0 control word bit definitions

8.2.2. **Protocol Type 0 Status word 1 Signal Definitions**

Protocol Type 0 Status word 1 Signal Definitions		
Bit	Signal Name	Brief Description
0	Laser is Assigned	Result of sending control signal “Laser Request”
1	Laser is ON	The laser module power supply is on
2	Laser Alarm	The laser is in an alarm state
3	Guide Laser is On	Result of sending control signal “Guide Laser”
4	Program Active	Indicates if a laser program is currently active
5	Program End	Indicates a laser program has ended
6	Program Interrupted	Indicates the laser program ended prematurely
7	Analog Control Status	Result of sending control signal “Analog Control”
8	Laser Warning	The laser is in a warning state
9	Laser Ready	Indicates if a laser program is ready to emit
10	Emission is On	Emission on/off status signal
11	Sync. Output	Signal used in laser programs to indicate a specific point in the program has been reached
12	Chiller Warning	Chiller out of temperature range
13	Chiller Alarm	Chiller is overheating
14	BS Guide Lasers	Status of all guide lasers in the beam switch
15	Reserved	

Table 8-7 Protocol type 0 Status word 1 definitions

8.2.3. **Protocol Type 0 Status word 2 Signal Definitions**

Status 2 signal definitions		
Bit	Signal Name	Brief Description
0	Reserved Module Active	Laser is operating in single module mode
1	Reduced Active Modules	Laser operating with reduced nominal power
2	Single Module Mode	Laser is operating in single module mode
3	B.S. Ch1 flow status	Low flow condition in BS channel 1
4	B.S. Ch2 flow status	Low flow condition in BS channel 2
5	B.S. Ch3 flow status	Low flow condition in BS channel 3
6	B.S. Ch4 flow status	Low flow condition in BS channel 4
7	B.S. Ch5 flow status	Low flow condition in BS channel 5
8	B.S. Ch6 flow status	Low flow condition in BS channel 6
9	Module Power Supply Warning	One or more laser modules have no electrical power
10	Reserved	
11	Reserved	
12	Reserved	
13	Reserved	
14	Reserved	
15	Reserved	

Table 8-8 Protocol Type 0 Status 2 word definitions

8.3. FIELDBUS PROTOCOL TYPE 36 FOR QCW LASERS

The following table provides an overview of the standard QCW protocol. Section 10 of the user manual provides details on all signals and parameters used in the protocol.

Protocol Type 36				
Byte	Word	Parameter Name	Brief Description	Un-Assigned Response *
Input signals				
1 2	1	Control word	Each bit of the control word is a separate controlling signal. (see Table 8-9)	Table 8-9
3 4	2	Power Request	Emission Power Request	No
5	3	Optical Channel	Optical Channel Request	
6		Program Number	Laser Program number	No
7 8	4	Ramp time/Counter	Emission ramp time in milliseconds	No
9 10	5	Pulse Width	Pulse width in 100µs resolution Only used when "Internal Modulation" active	No
11 12	6	Frequency	Pulse Frequency in Hz Only used when "Internal Modulation" active	No
13 14	7	Reserved		No
15 16	8	Reserved		No
17 18	9	Reserved		No
19 20	10	Reserved		No
Output Signals				
1 2	1	Status word	Each bit of the status word is a separate status signal. (See Table 8-10)	Table 8-10
3 4	2	Delivered Power	Output power as measured in the optical combiner.	0
5	3	Optical Channel	Currently selected optical channel	Yes
6		Program Number	Currently selected laser program	0
7 8	4	Status word 2	Each bit of the status 2 word is a separate status signal. (See Table 8-11)	Table 8-11
9 10	5	Pulse Width	Pulse width 100µs/bit resolution	0
11 12	6	Frequency	Pulse Frequency 1Hz/bit	0
13 14	7	Laser Temperature	Laser temperature in 1/10º C	0
15	8	Laser Humidity	Laser Humidity in 1/10 % relative	0

16			humidity	
17 18	9	Status word 3	Each bit of the status 2 word is a separate status signal.	Table 8-12
19 20	10	Reserved		0

*Un-Assigned response: The un-assigned response column indicates if the parameter value is valid if the signal "Laser Request" is not asserted or the value that will be present.

The byte order for fieldbus data is Big-endian.

8.3.1. **Protocol Type 36 Control Signal Definitions**

Protocol type 36 Control word definition			
Bit	Signal Name	Brief Description	Response State*
0	Laser Request	Requests control of the laser	Yes
1	Laser ON	Turns on the laser module power supply	No
2	Reset Alarms	Clears latched alarm	No
3	Guide Laser	Enables/Disables visible laser	Yes
4	Program Start	Starts selected laser program	No
5	Program Stop	Aborts currently running laser program	No
6	Reserved		N/A
7	Analog Control	Enables/Disables analog control	No
8	PC Control	Enables some LaserNet or PC program controls	No
9	Ramp Up	Uses value of input word 4 for emission ramp up time	No
10	Ramp Down	Uses value of input word 4 for emission ramp down time	No
11	Reserved		N/A
12	Internal Modulation Enable	Enables internal modulation	No
13	Pulse Mode Enable	Enables Pulse Mode	No
14	Single module mode	Enable a single laser module for emission	No
15	System Alarm	A system device (other than laser) is in an alarm state	No

Table 8-9 Type 36 Control word signal definitions

*Response State: The response state column indicates if the parameter value is valid if the signal **Laser Request** is not asserted.

** If **Laser Request** is not set, the **Reset Alarm** signal will only reset a **Slot Error** alarm.

8.3.2. **Protocol Type 36 Status word 1 Signal Definitions**

Protocol type 36 Status word 1 signal definitions			
Bit	Signal Name	Brief Description	Response State*
0	Laser is Assigned	Result of sending control signal “Laser Request”	0
1	Laser is ON	The laser module power supply is on	Yes
2	System Alarm	The laser is in an alarm state	Yes
3	Guide Laser status	Result of sending control signal “Guide Laser”	Yes
4	Program Active	Indicates if a laser program is currently active	0
5	Program End	Indicates a laser program has ended	0
6	Program Interrupted	Indicates the laser program ended prematurely	0
7	Analog Control Status	Result of sending control signal “Analog Control”	0
8	System Warning	The laser is in a warning state	Yes
9	Laser Ready	Indicates if a laser program is ready to emit	0
10	Emission Status	Emission on/off status signal	0
11	Sync. Output	Signal used in laser programs to indicate a specific point in the program has been reached	0
12	“Remote” mode	Indicates if the key switch is in the “REM” position.	Yes
13	Interlock	Status of laser safety circuit	Yes
14	Laser enabled	Fieldbus interface is active	Yes
15	PC Control status	Result of sending control signal “PC Control”	Yes

Table 8-10 Type 36 Status word 1 signal definitions

*Response State: The response state column indicates if the parameter value is valid when signal **Laser Request** is not asserted.

8.3.3. Protocol Type 36 Status word 2 Signal Definitions

Protocol type 36 Status word 2 signal definitions			
Bit	Signal Name	Brief Description	Response State*
0	Laser Error	Abnormal condition detected in laser	Yes
1	Laser Warning	Abnormal condition leading to a warning condition	Yes
2	Chiller Error**	The chiller is in an error state	Yes
3	Chiller Warning**	Indicates chiller is approaching the alarm state	Yes
4	Safety open	Safety loop is open	Yes
5	Channel alarm	The specified optical channel has an alarm	Yes
6	Laser Busy	Laser currently controlled by another interface.	Yes
7	Slot Error	Invalid laser or channel number	0
8	Door open	Work cell door for selected optical channel is open	Yes
9	Reserved module On	A reserved module has been activated	Yes
10	Reduced Active modules	Laser operating with reduced nominal power	Yes
11	Pulse Parameter Warning	A pulse parameter is out of range *Internal oscillator mode only	0
12	Module power supply	One or more laser modules have no electrical power	Yes
13	Pulse Mode Status	Enable status of pulse mode	Yes
14	High Duty Cycle	Alarm signal indicating a too high duty cycle	Yes
15	Pulse too long	Alarm signal indicating the pulse is too long	Yes

Table 8-11 Type 36 Status word 2 signal definitions

8.3.4. Protocol Type 36 status word 3 signal definitions

Protocol type 36 Status word 3 signal definitions			
Bit	Signal Name	Brief Description	Response State*
0	Single shot	Bit set = Indicates laser is operating in Single Shot Mode	Yes
1	Gate mode	Bit set = Indicates laser is operating in Gate Mode	Yes
2	External control	Bit set = Indicates External Control is active	Yes
3	Reserved		N/A
4	Reserved		N/A
5	Reserved		N/A
6	Reserved		N/A
7	Reserved		N/A
8	Reserved		N/A
9	Reserved		N/A
10	Reserved		N/A
11	Reserved		N/A
12	Reserved		N/A
13	Reserved		N/A
14	Reserved		N/A
15	Reserved		N/A

Table 8-12 Type 36 Status word 3 signal definitions

*Response State: The response state column indicates if the parameter value is valid when **Laser Request** is not asserted.

** Chiller signals only valid if laser connected to an IPG CAN enabled chiller.

Conditions for chiller error: Water conductivity ≥ 50 µS/cm or ≤ 30 µS/cm, water temperature of the laser circuit ≥ T_{Th1} °C or ≤ T_{Th2} °C, water temperature of the optics circuit ≥ T_{Th3} °C or ≤ T_{Th4} °C, CHILLER FAULT.
The bit is active if IPG chiller is connected to laser via CAN-bus interface.

Conditions for chiller warning: Water conductivity ≥45 µS/cm or ≤ 35 µS/cm, the water temperature of the laser circuit ≥ T_{Th1} - 2° C or ≤ T_{Th2} + 2° C, water temperature of the optics circuit ≥ T_{Th3} - 2° C or ≤ T_{Th4} + 2° C.
The bit is active if IPG chiller is connected to laser via CAN-bus interface.

8.4. FIELDBUS TERMS AND DEFINITIONS

Little/Big Endian: The order of the bytes within a word.

Little Endian																
16 bit Word																
Bits	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Byte	Byte 0								Byte 1							
Bits	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0

Note: The default laser configuration is Little-Endian.

Decimal Encoding:

Examples:

Value 3 = 0x0003 hex or 0000 0000 0000 0011 Binary

Value 255 = 0x00FF hex or 0000 0000 1111 1111 Binary

Value 1000 = 0x03E8 hex or 0000 0011 1110 1000 Binary

Signal Levels:

High Level = 1, Set, or asserted

Low Level = 0, Cleared or de-asserted

9. LASER OPERATION

This section of the manual discusses the basic operation of the laser. Later sections will provide detailed information for control of the laser from the hardwiring interface and the field bus interface. The LaserNet software application will be covered in a separate manual.

WARNING

Danger of laser radiation

Laser radiation can damage the skin and eyes

⇒ Never disable/defeat any safety device
⇒ Observe all instructions and information included in the safety section

WARNING

Danger of burns

Immediately after laser machining, the work pieces may be very hot.

⇒ Wear protective gloves to prevent accidental burns.

The laser was developed solely for integration into other devices or machines. All fiber outlets of the laser system are products are laser class 4 rated. It is the responsibility of the user to ensure that the fiber outlet or the optical processing head receives a protective housing to ensure laser class 1 according to EN 60825-1:2014. The laser cabinet along with the feeding and process fibers are laser class 1 rated.

9.1. POWER UP

During power up of the laser please observe the following considerations regarding humidity.

1. All doors and panels on the laser should remain closed and installed even when the laser is not being operated.
2. For newly installed lasers it is possible the laser may have been exposed to a high humidity environment during transportation. It is recommended to turn power on to the laser without supplying cooling water and check LaserNet for the current dew point measurement. If the dew point is reporting high, let the built in dryer bring the dew point down to an acceptable level.
3. When the laser is not in operation it is recommended to turn off the cooling water.
4. If the laser requires service in a high humidity environment it is necessary to leave the cooling water off during this period. Upon completion of service and doors/panels have been closed/installed follow procedure in item #2.

9.2. OPERATING MODES

The laser provides two modes of operation; a key switch located on the front of the laser is used to select the mode of operation. The two operating modes are referred to as **ON** and **Remote** labeled on the switch as “ON” and “REM”.

Note: On some lasers the mode switch is labeled Test and Robot, where test is the equivalent of ON and Robot is the equivalent of Remote.

9.2.1. ON mode

When the key switch is placed in the **ON** mode position, the laser can be controlled by the IPG application software “LaserNet”. For the most part operating the laser in this mode is intended but not limited to the following:

- Initial laser setup and testing
- Integrating of laser into a larger system
- Writing/testing LaserNet programs
- Configuring field bus parameters (node ID’s, addresses …)
- Setting laser access levels

9.2.2. **Remote mode**

Operating the laser in Remote mode is designed for automated control of the laser. In this mode the laser can only be controlled from one of the control interfaces, such as hardwiring interface or field bus interface. In Remote mode LaserNet can be used to monitor the operation of the laser. However some LaserNet functions are still operational, such as the "Reset" button.

Note: See **PC Control** (section 11.13) for enabling additional LaserNet functions in remote mode.

9.3. TURNING ON THE LASER

Turning on the laser can be viewed as a two-step process. The first step provides power to the laser's control electronics and the second-step provides power to the laser modules.

Powering up the laser:

1. Water lines connected (for lasers requiring water cooling)
2. AC power source connected
3. Main power switch is on (located on the side of most lasers)
4. External chiller/cooling water is on
5. Turn the key switch to the **ON** or **REM** position

At this stage the laser is powered up to the point that the control electronics are functional and ready to communicate

The second step in powering up the laser is to turn on the power supplies that power the laser modules (~80Vdc). Several methods are available to switch on these power supplies, all methods are explained below.

Note: The power supplies will only turn on if the laser's safety system is satisfied.

High leakage current

High leakage current can be present when switching on the laser module power supplies and can result in the power supplies shutting down. Typically the leakage current at 480 VAC is approximately 60ma.

⇒ Use a residual current circuit breaker with a delay during the start phase.

9.4. POWERING UP IN ON MODE

When operating the laser in **ON** mode there is typically one method for powering up the laser modules power supplies, LaserNet can only be used to power down the supplies. Sections 9.4.1 and 9.4.2 describe these two methods.

9.4.1. Start Pushbutton

The start pushbutton is located on the front of the laser (see Figure 3-2). When this button is pressed the laser modules power supply will turn on provided that the internal and external safety circuits are closed. When the power supplies are on, the start pushbutton will illuminate. At this point the laser is in a state where the LaserNet application can be used to turn on/off emission and provide laser operating information.

Note: Some laser configurations allow for the start button to be used in the REM operating mode.

9.4.2. LaserNet Start

The LaserNet application can only be used to shut off the laser module power supplies. Once a connection between the LaserNet and the laser has been established the following steps can be used.

1. Go to the Control tab on LaserNet
2. Press the button in the box labeled *Laser*
3. The power supplies will shut down, and the button text will display OFF.

9.5. POWERING UP IN REMOTE MODE

When operating the laser in **Remote** mode, there are several options for powering up the laser modules power supplies. The following sections illustrate these options.

9.5.1. Safety Interface

The safety interface is located on the rear of the laser and labelled as J33. The safety interface provides two contacts that require a momentary contact closure between pins 21 and 22 to turn on the laser modules power supply.

Note:

- If a momentary switch is not used to energize the laser module power supplies. The contact must be opened then closed again to turn the power supplies back on.
- CUT type lasers use pins C5 and C6

9.5.2. Hardwiring

The hardwiring interface provides the signal **Laser ON** for enabling the laser modules power supplies. This signal is located on J36 pin C1, for additional information on functional requirements see section 6.5 and section 11.22 for details.

9.5.3. Fieldbus Interface

For lasers that have the optional fieldbus interface installed, a signal within the field bus protocol can be used to turn on/off the laser module power supply. There are several field bus communication protocols available depending on the laser model. Each fieldbus protocol has a control word, and within the control word there will be a signal typically labelled as **Laser ON**. Setting this signal turns on the power supplies and clearing the signal turns them off. See section 11.22 for additional information.

9.6. POWERING DOWN THE LASER

When powering down the laser, follow these steps:

1. Turn the mode key switch to the off position
2. Turn off the external chiller
3. Switch off the laser's main power switch

Notice
Danger due to freezing If the laser is in a location that is subject to freezing conditions, freezing water can damage the laser and the water lines.

⇒ If the laser is not intended to be used for a prolonged period of time, follow steps provided in section 5.9

⇒ When switching off the laser for periods of up to 1 hour time when the ambient temperature is below 5°c, leave the main switch ON. Make certain the water supply continues to circulate. The temperature controlled cooling water protects the laser from freezing damage

⇒ If the laser must be switched off in a location that may see temperatures below 5°c for greater that 1 hour, a glycol antifreeze must be added to prevent freezing.

9.7. ON MODE OPERATION

To run the laser in ON mode, turn the key switch located on the front of the laser to the "ON" position. Operating the laser in ON mode will require an external computer for installing and running the LaserNet software application. The LaserNet application communicates to the laser via a network connection. See section 6.6 for connection information. The document "LaserNet user's manual" provides detailed information on the use of the LaserNet application. Below is a brief description on how to make a connecting to the laser and turn on emission.

9.7.1. Connecting LaserNet

Requirements for LaserNet

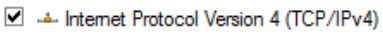
The computer for which LaserNet is to be installed on must meet the following minimum requirements:

- Pentium III/IV 1 GHz or compatible (2GHz Pentium recommended)
- RAM 256MB (512MB or greater recommended)
- Monitor resolution 1024 x 768
- Ethernet 100Mbit
- USB port (For LaserNet installation)
- CD ROM drive (Alternate for LaserNet installation)
- Windows 7/ 8 / 10 operating systems

Note: LaserNet will run under Windows XP, however this is not recommended as Microsoft no longer provides support for this operating system.

Upon initial installation of the LaserNet program, the network connection will need to be configured. However the computer's network configuration must first be configured properly to communicate with LaserNet. The following procedure was written for Microsoft's Windows 7 operating system. It will be necessary to have the laser powered up and connected to the computer in order to access the configuration window.

1. Connect an Ethernet cable from the computer to J37 of the laser
2. Open the Windows 7 Control Panel
3. Select the "Network and Sharing Center" icon  Network and Sharing Center
4. From within the network dialog window select the "Local Area Connection" icon  Local Area Connection
5. A "Local Area Connection Status" window will appear
6. Press the "Properties" button at the bottom
7. A "Local Area Connection Properties" window will appear
8. In the connections list click on the icon for "Internet Protocol Version 4 (TCP/IPv4)"

    Internet Protocol Version 4 (TCP/IPv4)
9. With this icon highlighted, press the properties button below it
10. A "Internet Protocol Version 4 (TCP/IPv4) Properties" window will appear
11. Configure the network parameters as shown in Figure 9-1
12. If it is necessary to place the laser on a different network address, follow the same steps and insert the other network information
13. Upon entering the network information, continue to press the "OK" button to close all configuration windows

Notes:

- If the computer has more than one network connection, you must determine the one connected to the laser.
- The last number in the IP Address must be different from the number configured in LaserNet

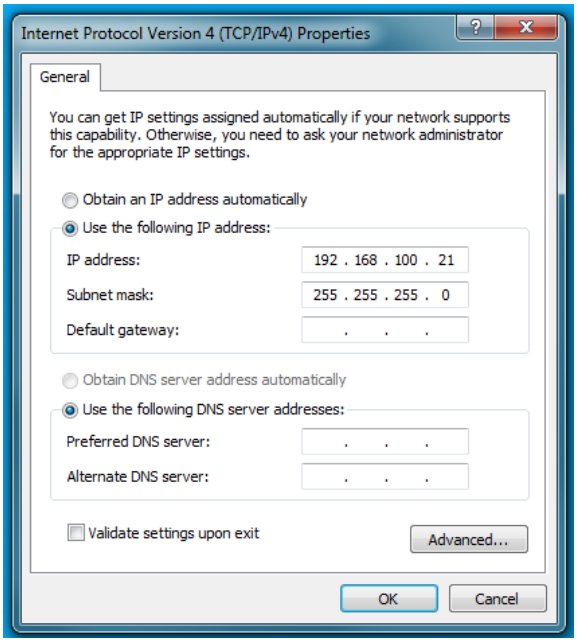


Figure 9-1 Computer Network Configuration

The following steps configure the network information in LaserNet:

1. From the LaserNet menu select *Settings* then *IP Configuration…*
2. A “IP Configuration” dialog window will appear
3. Press the “Add” button located in the lower right corner
4. The dialog window will be as shown in Figure 9-2
5. Under the “State” column, double click the “Disabled” and change to “Enabled”
6. It is recommended that the default “Laser Name” be changed (see important notice box below)
7. Press the “OK” button to complete configuration

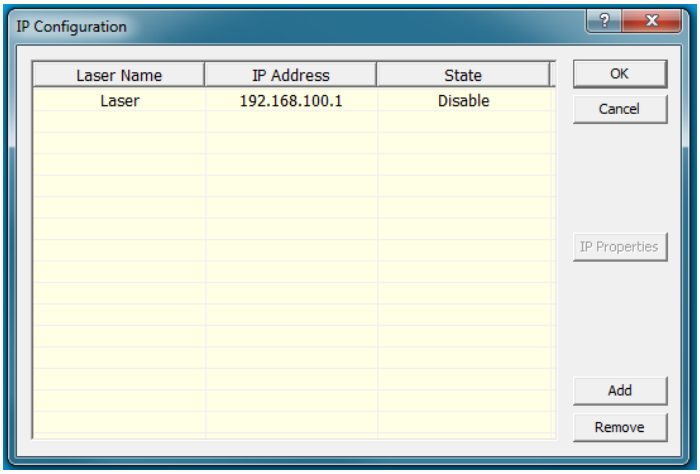


Figure 9-2 LaserNet Network Configuration

If the Ethernet network parameters are changed from the default settings, be sure to record this information in/at the laser. It may not be possible to determine the network parameters if this information is lost.

If the same computer is used to connect to multiple lasers with the same name, the event logs will be copied into a directory on the computer named for the laser. By assigning each laser with a different name, the event files will be placed in separate directories.

The laser allows for up to 3 concurrent LaserNet connections. A single connection for control and 2 connections for monitoring.

The following Figure 9-3 shows the control tab of LaserNet along with a brief description control elements.

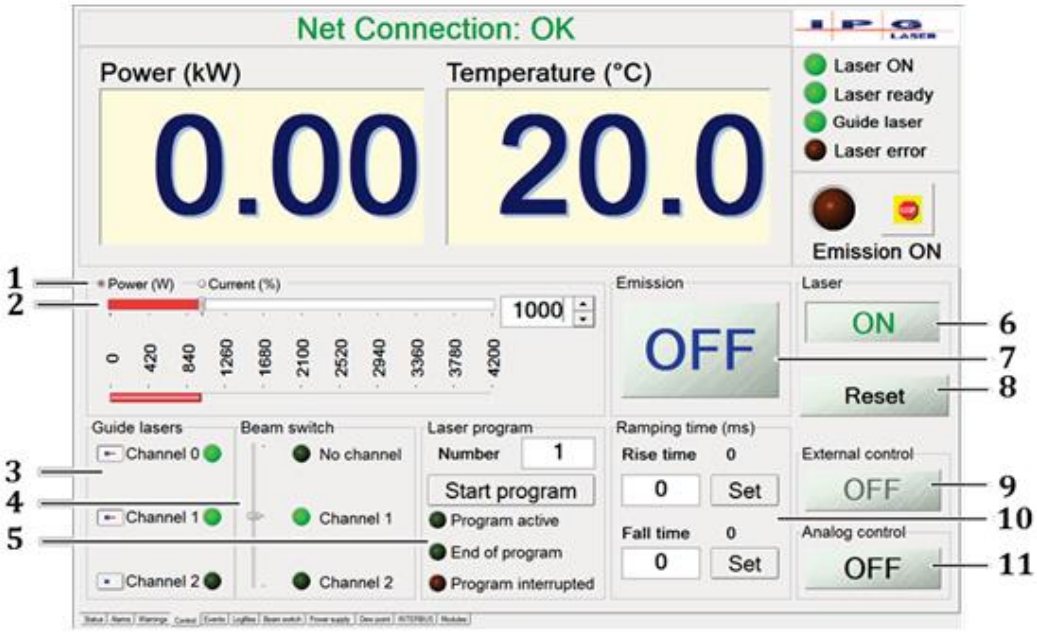


Figure 9-3 LaserNet Control tab

1. Radio button selection for controlling emission level by wattage or percent of total output power.
2. Slider for setting emission level, it is also possible to type in the emission level in the text box to the right of the slider.
3. Guide Laser control, for lasers with a beam switch addition buttons will enable channel specific guide beams. Channel 0 is the guide beam located in the combiner
4. Beam Switch channel selection, if the lasers does not have a beam switch this control will not be visible
5. Laser Program control element allows selection of laser program, control of program, and program status.
6. Laser button allows for turning off laser module power supplies. Green button located on laser panel is used for turning on the power supplies in **ON** mode.
7. Emission button turns on/off laser radiation.
8. Reset button is used to clear any non-fatal latched alarms.
9. External Control button enable/disable external control see section 9.8.2
10. Ramping Time controls for setting emission ramping parameters
11. Analog Control button for enabling/disabling Analog control mode (Only for ON mode)

9.7.2. **Checking beam path**

Upon initial setup of the laser, maintenance work, or prolonged shutdown of the laser, the optical path should be checked. The following procedure illustrates how to use a guide laser to check the optical path.

1. From the LaserNet control tab, enable the guide laser for the optical channel to be checked.
2. Check if the guide laser is visible at the exit point of the selected channel.
3. Check all channels that have a process fiber connected.

9.7.3. **Emission in ON mode**

Once the optical path has been checked emission can be turned on. The following procedure illustrates how to turn on emission in ON mode.

1. Turn the power key switch to the ON position
2. Press the green button on the front of the laser and verify it stays illuminated
3. Verify the lasers bottom stack lights are on steady
4. Launch the LaserNet application and establish a connection to the laser
5. Go to the Control tab of LaserNet and use the slider control to set a emission level
6. For lasers with a beam switch select an optical channel
7. Verify the indicators “Laser ON” and “Laser Ready” in LaserNet are illuminated
8. Press the Emission on button
9. The Emission on indicator in LaserNet will illuminate
10. Pressing the emission button again will shut off laser emission

Notes:

- When the laser is emitting, it is possible to change the emission level in LaserNet.
- During normal operation of the laser it is not necessary to turn off the laser modules power supplies.

Always specify a power level of at least 10% to ensure stable and fault free operation of the laser.

9.7.4. Laser Program in ON mode

This section will provide a very basic introduction to writing and using a laser program. The "LaserNet user's guide" manual covers laser programs in detail.

Note: It is possible to write a laser program when LaserNet is not connected to a laser. This feature provides the ability to install LaserNet on an additional computer to develop laser programs.

1. Turn the power key switch to the ON position
2. Launch the LaserNet application and from the menu select *tools* then *Program Editor…*
3. Enter the sample program in Figure 9-4, if the laser does not have a beam switch, omit program line 1, change timing and emission level as needed.
4. If LaserNet is not connected to a laser, select *File* then *Save*
5. If LaserNet is connected to a laser, Press the "Write" button on the program editor
6. The "Save Program" dialog window will appear see Figure 9-5
7. Select a number to assign to the program and press "OK"
8. In LaserNet set the program number to the number that was just assigned to the example program
9. The laser program can now be run by pressing the *RUN* button
10. When the program is running the *Program active* indicator will be active
11. When the program completes, the *Program active* indicator will no longer be active and the *End of program* indicator will now be active

Notes:

- In a Laser program that selects a beam switch channel, it is only possible to select a channel on the first line of a laser program
- When reading/writing a laser program, you cannot read or write to a selected program (The selected program is the program number indicated in LaserNet control page.
- The *End of program* indicator will remain active until a program is started
- If an alarm occurs while a program is running, the *Program Interrupted* indicator will become active and the *Program active* indicator will no longer be active.
- For complete details on all program related signals see section 11

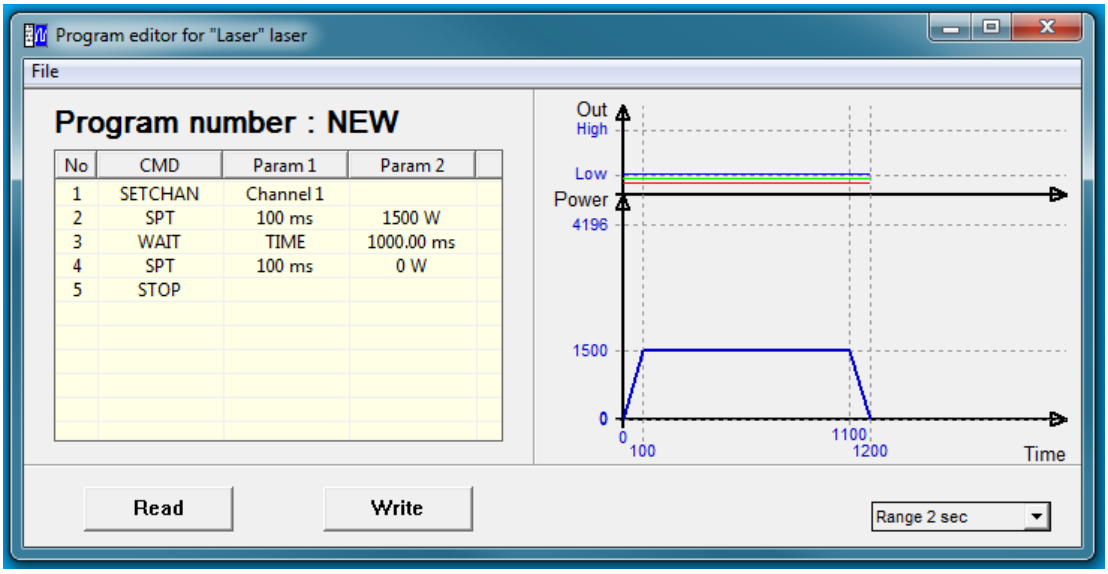


Figure 9-4 Sample LaserNet Program

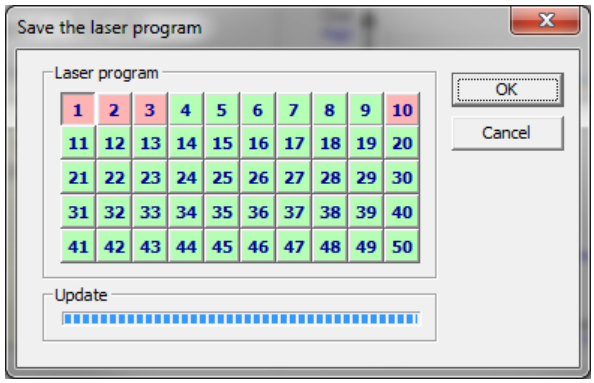


Figure 9-5 Save Laser Program Dialog

9.7.5. **External Control in ON mode**

The external control function provides the ability to turn on/off emission with a 24Vdc signal. This signal can be steady state, or it can be modulated up to a maximum frequency of 5,000Hz. The external control signal is located on the safety interface connecter J33, pins A1 & A2. Where a high signal on these pins is defined as +4Vdc to +30Vdc, and a low signal is defined as -3Vdc to 2Vdc.

External Control and Ramping function

It is not possible to use the ramping function together with external control

Sequence for operating external control:

1. Connect the external control signal to J33, pins A1 & A2
2. Turn the power key switch to the ON position
3. Launch the LaserNet application and establish a connection to the laser
4. Select the control tab in LaserNet
5. Click the *External Control* button so it displays **ON**
6. Press the *Start* button on the front of the laser to enable the laser modules power supply
7. Use the emission level slider control to set an emission level
8. Click the *Emission* button in LaserNet so it displays **ON**
9. Apply an external control signal to J33
10. The laser is now emitting at the prescribed level
11. Click the Emission button again to turn off
12. Clear the external control signal on J33
13. Click the *Laser* button to shut down laser module power supplies

CAUTION

Verify the *Emission* button in step 8 displays **OFF** before making any connections to J33, pins 1 & 2.

9.7.6. **Analog Control in ON mode**

The analog control function allows for setting an emission level from the analog interface J34 see section 6.3. To use the analog control function, a signal in the range of 0Vdc to 10Vdc must be applied to J34, pins 1 & 2. It is also possible to connect a signal generator for modulation of the emission level.

Sequence for operating Analog control:

1. Connect J34, pins 1 & 2 to a source capable of providing up to 10Vdc
2. Clear all program select signals on the hardwiring connector (Select program 0)
3. Turn the power key switch to the ON position
4. Launch the LaserNet application and establish a connection to the laser
5. Select the control tab in LaserNet
6. Click the *Analog Control* button so it displays **ON**
7. Press the *Start* button on the front of the laser to enable the laser modules power supply
8. Set a voltage on J34, pins 1 & 2
9. Click the *Emission* button in LaserNet so it displays **ON**
10. The laser is now emitting at a level determined by the analog control voltage
11. Click the *Emission* button in LaserNet so it displays **OFF** (turn off emission)
12. Click the *Laser* button to shut down laser module power supplies

External Control and Analog Control

It is possible to combine external control with the analog control.

9.8. REMOTE MODE OPERATION

The lasers Remote mode of operation is used to integrate the laser with a PLC/Robot. Remote mode provides two basic interfaces for integration.

- Hardwiring interface
- Fieldbus interface

The hardwiring interface consists of +24Vdc control and status signals see section 6.5. The hardwiring interface provides for easy integration to a PLC.

The Fieldbus interface provides many of the same control and status signals available on the hardwiring interface. Depending on the Fieldbus protocol, some additional features are available, see section 7 for supported fieldbus types and additional details.

To run the laser in Remote mode, turn the key switch located on the front of the laser to the "REM" position.

To activate the hardwiring interface, +24Vdc and ground must be applied to pins B15 and B16. See section 6.5 for additional details

9.8.1. Laser Program in Remote mode

To run a program in Remote mode requires the control of a few signals. The following illustrates a step by step sequence for running a program:

1. Turn the key switch to the REM position
2. Launch the LaserNet application and establish a connection to the laser. In the Remote mode of operation LaserNet is used for monitoring laser status.
3. Assert the Laser *Request signal* and verify the laser responds with asserting signal *Laser is Assigned* signal
4. Assert the *Laser On* signal and verify the laser responds with asserting the *Laser is On* and *Laser Ready* signal.
5. Assert the correct signals to select the laser program to be run.
6. Assert the *Program Start* signal and verify the laser responds with setting the signal *Program Active*.
7. When the laser program completes, the signal *Program active* will be de-asserted and the signal *Program End* will be asserted.
8. When the signal *Program Start* is de-asserted the *Program End* signal will de-assert.

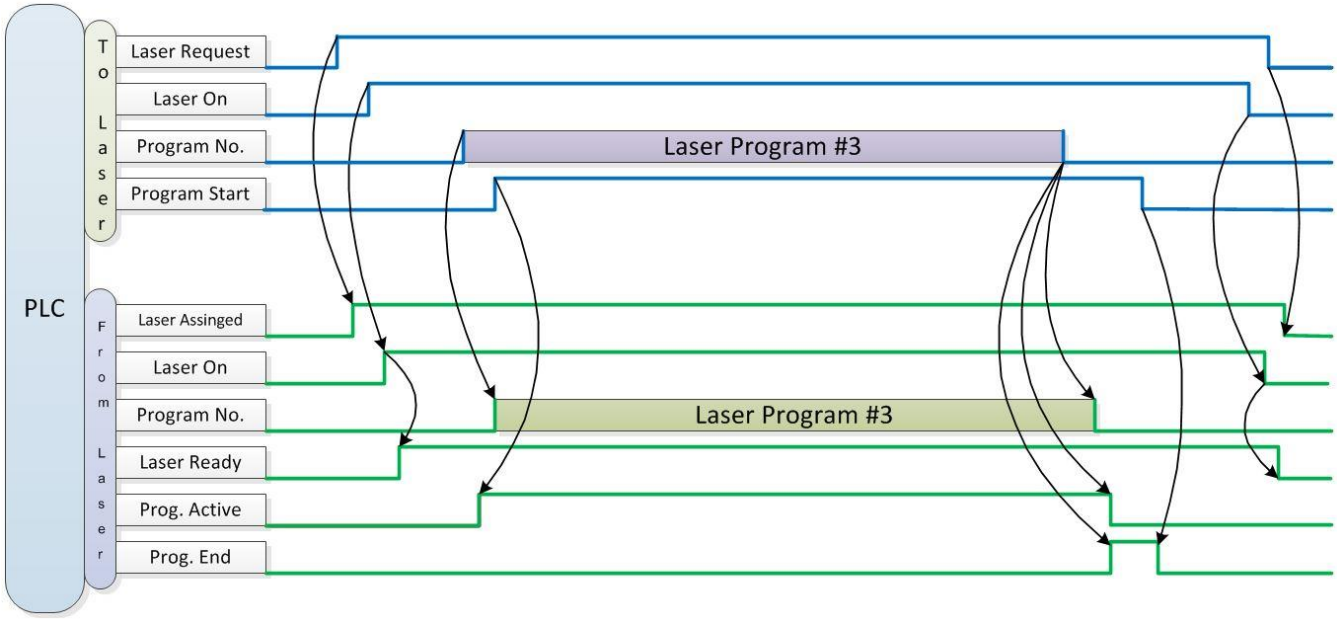


Figure 9-6 Laser Program Sequence

Notes:

- For lasers with a beam switch installed, see Figure 9-8
- If the program ends prematurely the signal *Program Interrupted* will be asserted and a *Reset* signal will be required to clear it.

9.8.2. External/Modulation Control in Remote mode

External control operates the same in Remote mode as it does in ON mode. However to enable External control in Remote mode, the following steps must be followed.

1. Turn the power key switch to ON position
2. Launch the LaserNet application and establish a connection to the laser
3. Select the control tab in LaserNet
4. Click the *External Control* button so it displays **ON**
5. Turn the power key switch to the *off* position

Once the External Control mode has been enabled in ON mode, the setting will be retained through power cycles

The following sequence illustrates using External Control in Remote mode.

1. Connect the external control signal to J33, pins A1 & A2
2. Turn the power key switch to the REM position
3. Launch the LaserNet application and establish a connection to the laser. In the Remote mode of operation LaserNet is used for monitoring laser status.
4. If the laser has a beam switch installed use the signals on the hardwiring interface or the signals in the fieldbus to activate a beam switch channel
5. Apply an external control signal to J33
6. Assert the *Laser Request*, *Laser On* and *Program Start* signals in hardwiring or in the fieldbus interface
7. De-assert the *Program Start* signal to turn off emission

External Control and Ramping function

It is not possible to use the ramping function together with external control

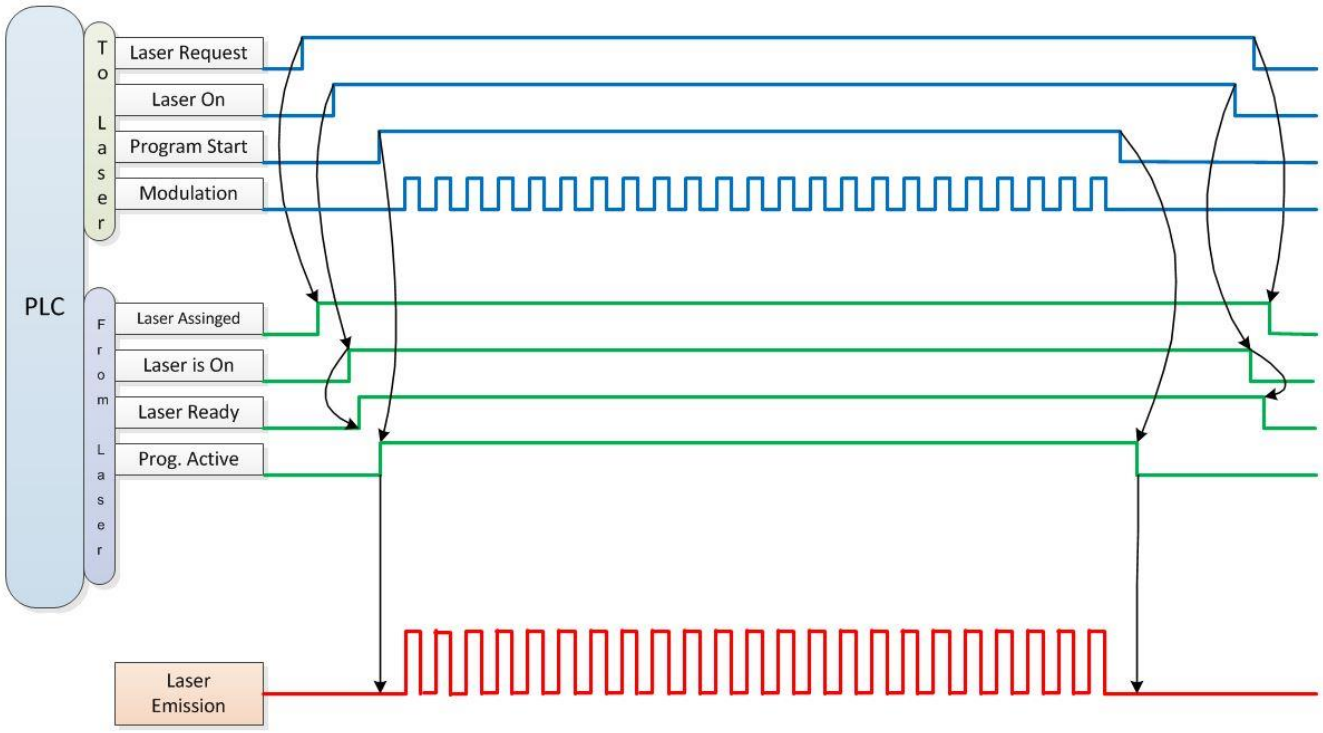


Figure 9-7 External/Modulation control example

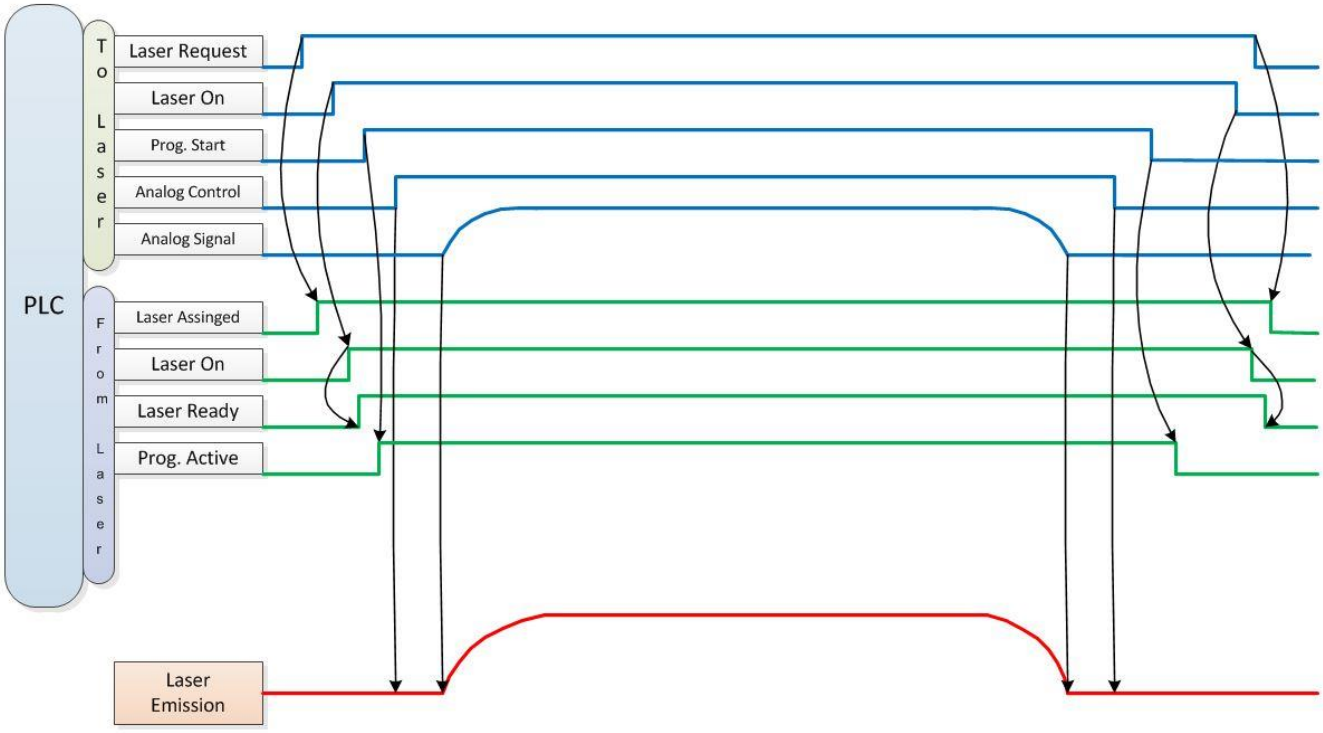
Notes:

- When running External/Modulation control the signals *Program Active* and *Program End* are not available.
- All program selection signals must be cleared (Program 0)
- The modulation signal range is from 0 to 5Khz
- The modulation signal connects to J33, pins A1 & A2

9.8.3. **Analog Control in Remote mode**

Operating analog control in Remote mode requires that program 0 be selected. The following sequence demonstrates how to operate Analog control with the laser in Remote mode.

1. Connect J34, pins 1 & 2 to a source capable of providing up to 10Vdc.
2. Turn the power key switch to the REM position
3. Launch the LaserNet application and establish a connection to the laser. In the Remote mode of operation LaserNet is used for monitoring laser status.
4. Assert the Laser *Request signal* and verify the laser responds with asserting signal *Laser is Assigned*
5. If the laser has a beam switch installed use the signals on the hardwiring interface or the signals in the fieldbus to activate a beam switch channel
6. Select program 0 from the hardwiring interface or fieldbus interface by clearing all program selection signals
7. Assert the signal *Laser ON*, and verify the laser responds with asserting the signal *Laser is On*
8. Assert the signal *Analog Control*, at this point the laser is emitting at the level specified by the voltage on J34, pins 1 & 2
9. De-assert the *Analog control* signal to turn off emission



Notes:

- For lasers with a beam switch installed, the channel selection should be added before asserting the *Program Start* signal (check *Laser Ready* before asserting *Program Start*).
- The Analog signal is connected to J34, pins 1 & 2.

9.8.4. **Laser Control Examples**

The following sequence diagrams illustrate how the lasers control and status signals are used in various operating conditions. As stated in section 11 all laser signals and parameters function the same regardless of their origin. These diagrams can be applied to both hardwiring or fieldbus control, the only requirement is the laser needs to be operated in "remote" mode.

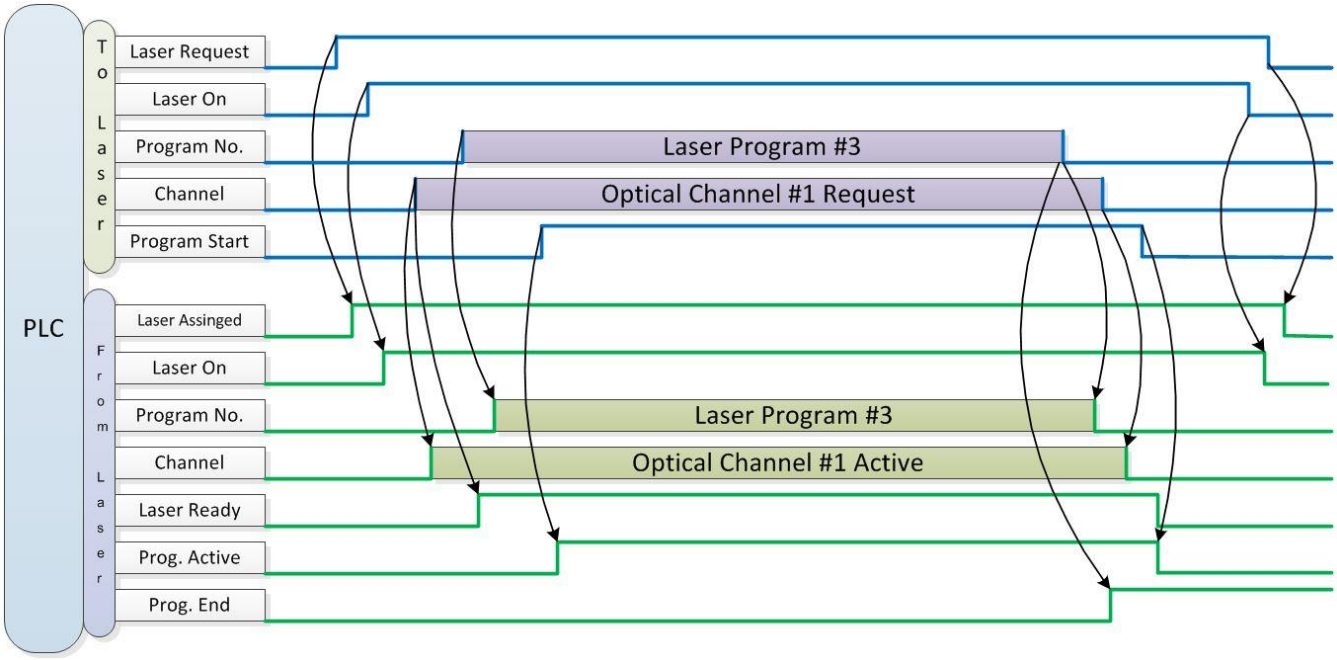


Figure 9-8 Control example with beam switch

Notes:

- The signal *Laser Ready* is not active until the beam switch channel is activated.
- Changing beam switch channel during program execution will result in *Program Interrupted*.
- Changing *Program Number* during program execution will not have any effect on the running program.

The following sequence diagram demonstrates how to combine Modulation control with Analog control.

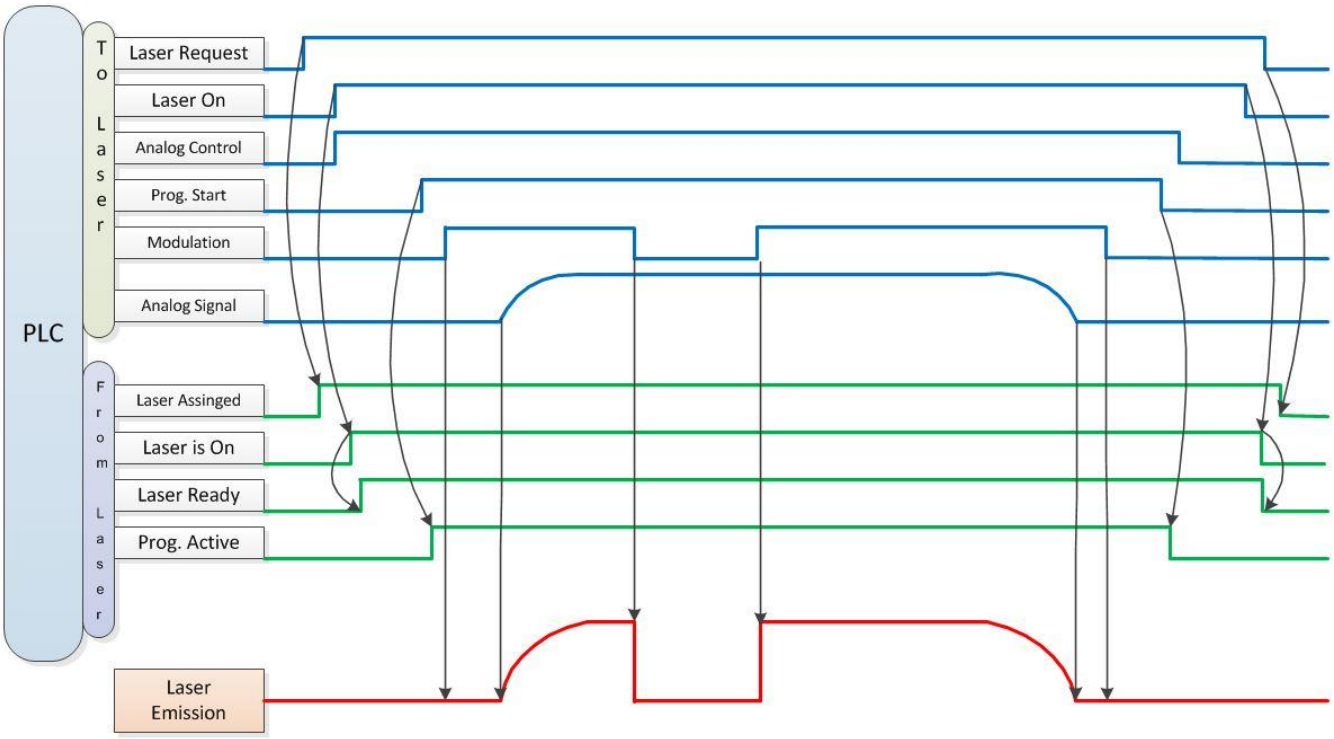


Figure 9-9 Modulation and Analog Control

Notes:

- For lasers with a beam switch installed, the channel selection should be added before asserting the *Program Start* signal.
- Emission is gated on/off by the *Modulation* signal, and emission level is determined by the *Analog Signal* voltage.
- The Analog signal is connected to J34, pins 1 & 2.

9.9. RESETTING THE LASER IP ADDRESS TO DEFAULT

If the IP address of the laser has been changed from the default IP address of 192.168.100.1 and the new IP address is not known, there is a reset IP address switch located on the laser controller. Open the door on the laser that provides access to the laser controller. For larger laser cabinets this door has the data tag installed on it. For compact style lasers remove the panel on the right side of the laser, this will require T35 torque bit. For ultra-compact lasers see section 5.6 for accessing the laser controller. Once access to the controller is obtained the laser needs to be powered up. Press the E-Stop button to ensure the laser is in a state that it is not possible to turn on emission during this procedure.

For the IG277 controller the reset IP button is located inside a small hole drilled into the controller between X18 and X19.

For the IG320 controller the reset IP button is located inside a small hole drilled into the controller between X16 and X18.

For the IG412 controller the reset IP button is located next to the controllers status lights.

Once the reset IP button is located, the button should be pressed in for at least 30 seconds. For the IG277 and IG320 controllers a small tool is required to press the button.

Once the IP Address has been reset, power down the laser and close, re-attach access panels.

DANGER

Risk of death from supply voltage

Coming into contact with the power connection and components can lead to death.

10. QCW LASER

This section of the manual provides information on the YLS QCW type lasers. These sub-series of YLS lasers are available in either air-cooled or water-cooled depending on the emission level. The QCW laser electrical interface is the same as a standard YLS type laser. QCW lasers are provided with an additional software application **Pulse Editor** for designing custom pulse profiles.

10.1. QCW ON MODE OPERATION

When operated in ON mode LaserNet provides an additional tab labeled "Pulse Mode" for configuring pulse Frequency, Length and other QCW parameters. Operating the laser in **ON** mode can assist in determining the allowed Frequency and Pulse width range the laser can operate in **Remote** mode. Pictured in Figure 10-1 is the Pulse Mode tab in LaserNet, when the frequency or Pulse length slider controls are adjusted the limit of the other parameter will automatically change. At full frequency of 500Hz the pulse length is limited to < 1ms, and at maximum pulse length of 10ms the frequency is limited to < 50Hz. In addition to these limits, the maximum peak power is also adjusted based on frequency and pulse length. When operating in ON mode the laser's internal pulse generator is used.

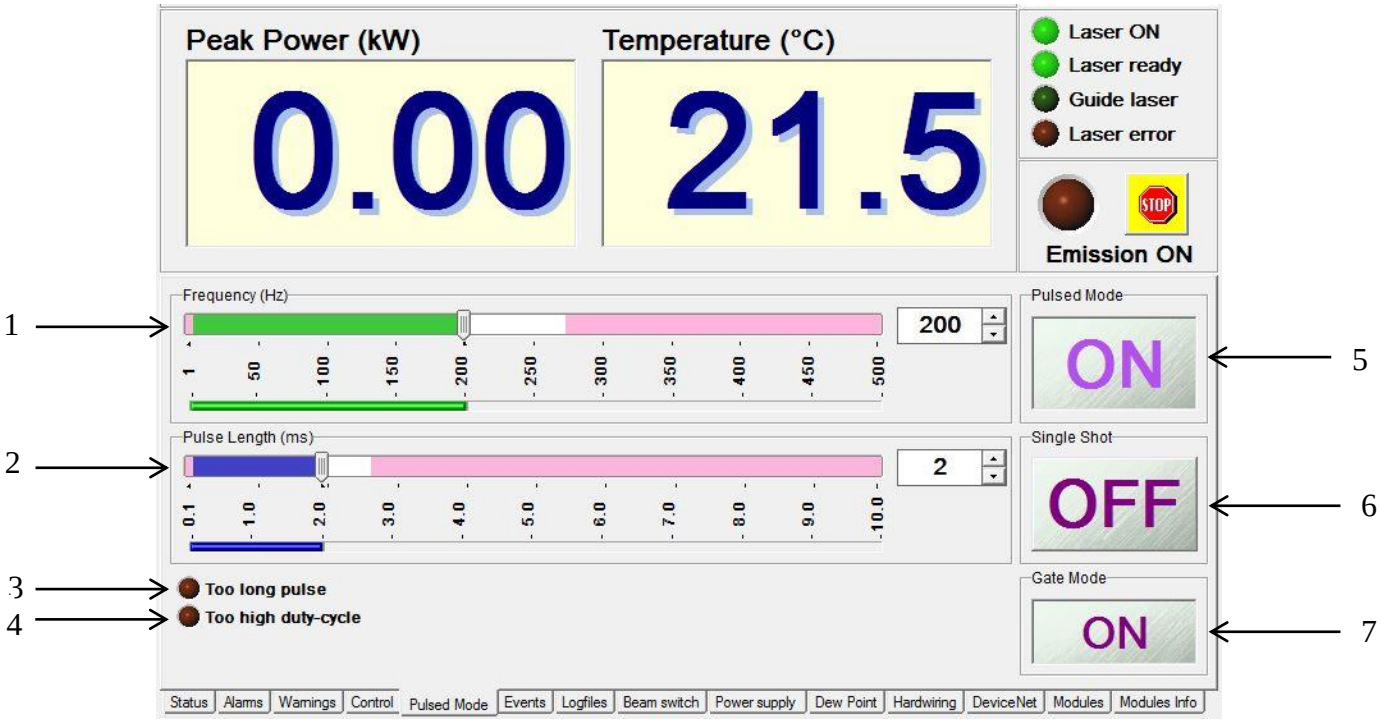


Figure 10-1 QCW Pulsed Mode Tab

1. Pulse Frequency slider control (frequency limit changes based on pulse length)
2. Pulse Length in milliseconds slider control (Pulse length limit changes based on frequency)
3. Too long pulse
4. A signal with a duty cycle greater than 10% is being applied to J33, pins A1 & A2
5. When the Pulse Mode button displays OFF the laser is operating in CW mode. When the button displays ON the laser is operating in QCW mode.*
6. The *Single Shot* button when turned on, allows a single pulse base on the settings of *Frequency*, *Pulse Length* and *Power*.
7. Gate Mode is used to "gate off/on" the frequency laser's internal pulse generator.

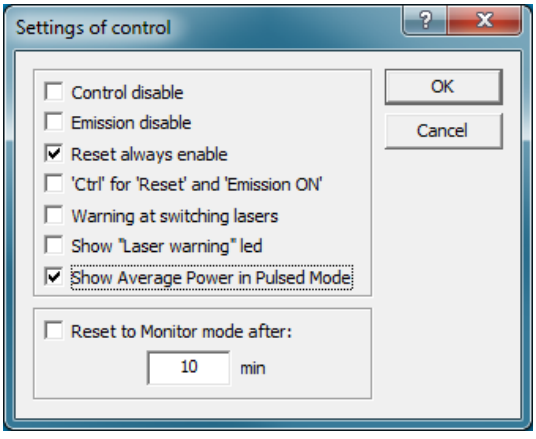
*When operating in QCW mode the power displayed in LaserNet will indicate "Peak Power" Or "Average Power".

10.1.1. Displaying Average Power

LaserNet can be set to display *Average Power* when running the laser in QCW mode.

To display average power in LaserNet:

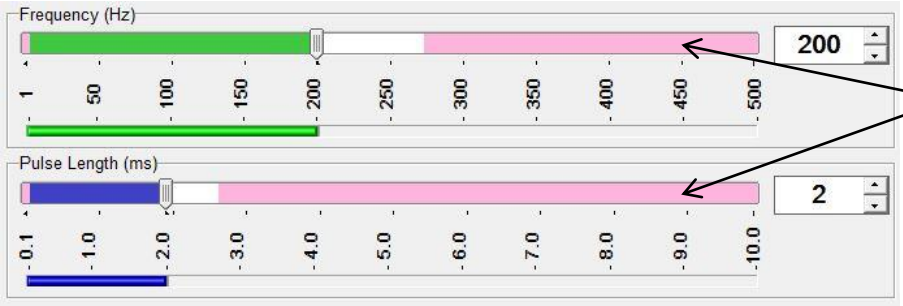
1. Run the LaserNet application and establish a connection to the laser.
2. Select the "Settings" drop down menu, Then *LaserNet Settings* and *Control*.
3. The following window will appear



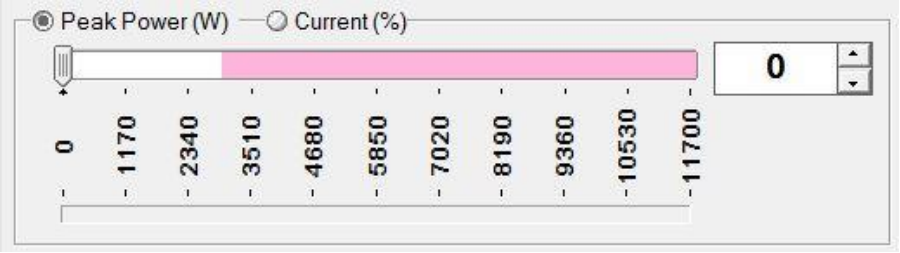
4. Click on the checkbox for "Show Average Power in Pulse Mode"
5. Press the OK button

10.2. SETTING EMISSION LEVEL

The controls for adjusting *Frequency* and *Pulse Length* will dynamically change their limits and not allow a setting beyond the limit. However the power control slider located on the control page of LaserNet provides a visual indication of the limit but does not restrict the control from being set to value beyond the limit.



Shaded area indicates settings out of range. It is not possible to move the slider control to this setting.



Note: The power level slider also indicates settings out of range; however it is still possible to move the slider into this region. If the power slider is positioned in this region, the out of range region is obscured.

It is recommended to use the following procedure for adjusting frequency, pulse length, and power in ON mode.

Using LaserNet:

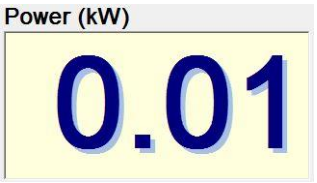
1. Set the power slider on the control tab to zero
2. Set the Frequency to the desired value on the Pulse Mode page
3. Set the Pulse Length to the desired value
4. In the control tab set the peak power to the desired value
5. If further adjustments are needed, start at step 1

Note: This procedure can be used to determine if the external modulation signal connected to J33, pins A1 & A2 in Remote mode is valid.

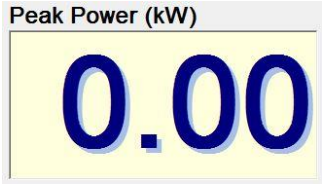
10.3. PULSED MODE IN ON MODE

The button labeled **Pulsed Mode** located on the "Pulse Mode" tab in LaserNet is used to turn on/off QCW mode.

Pulsed Mode OFF, laser operates in CW mode.



Pulsed Mode ON, laser operates in QCW mode. The power indicator in LaserNet will display Peak Power or Average Power.



10.4. SINGLE SHOT MODE

Single shot mode is only available when the laser is operated in ON mode. When single shot mode is enabled, pressing the emission on button on the control tab will generate a single emission pulse based on the Frequency, Pulse Length and power settings.

10.5. GATE MODE

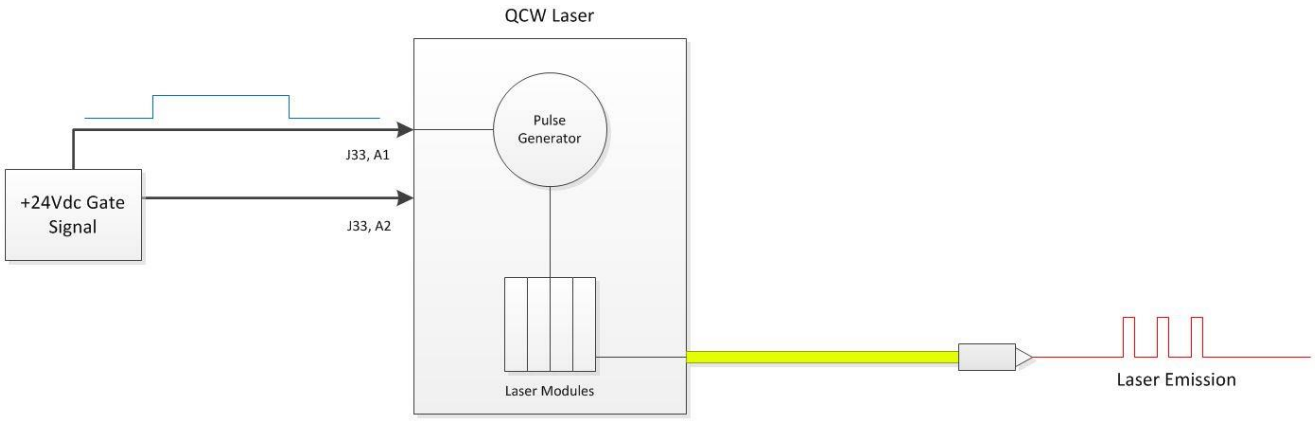
Enabling Gate Mode when the laser is operated in ON mode allows emission to be turned on/off by applying a signal to J33, pin A1 & A2 (Modulation input). The modulation signal has the effect of gating On/Off the internal pulse generator.

Note: Gate mode is not available in Remote operating mode.

Procedure for operating Gate Mode:

In LaserNet

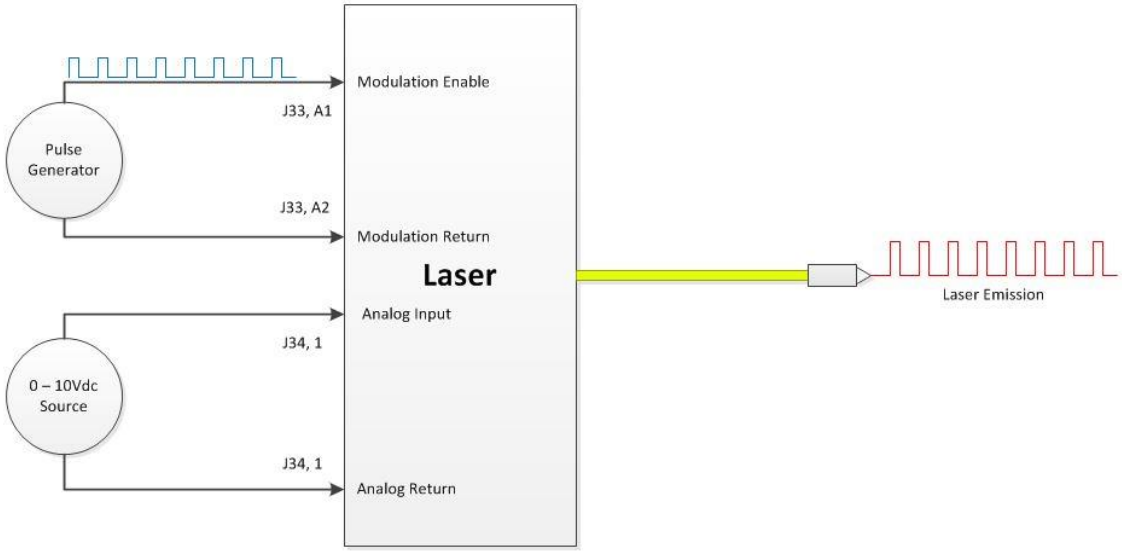
1. On the Pulse Mode tab of LaserNet
    - Set frequency
    - Set Pulse Length
    - Enable Gate Mode
2. On the control tab of LaserNet
    - Set peak power level
    - Select beam switch channel if available
    - Verify the Laser Ready indicator is on
    - Press the emission ON button
3. Apply a signal to J33, pins A1 & A2
4. Emission will remain on at the frequency, Pulse Length, and Power level set in LaserNet as long as the signal is present on J33, pins A1 & A2.



10.6. QCW REMOTE MODE OPERATION

In order to operate a QCW laser in remote mode, you must first run the laser in ON mode and enable *External Control* in the control tab of LaserNet; the laser will retain this setting when powered down.

When operating the laser in Remote mode connector J33, pins A1 & A2 expect to receive a pulse signal. This pulse signal takes the place of the laser's internal pulse generator, and is subject to the same operating limits as the Frequency, and Pulse Width controls in LaserNet. Emission level is determined by the analog signal connected to J34, pins 1 & 2. Analog control must be enabled from the hardwiring interface J36, remember to assert the Laser Request signal before asserting any other hardwiring signal.



Note: When applying a signal to the modulation input, ensure the signal is clean and noise free. Any signal on the modulation input above +4Vdc will be interpreted as a high signal and will most likely generate a *Too long pulse* or *Too high duty-cycle* alarm.

10.7. PULSE EDITOR

This section provides a brief description of the Pulse Editor application.

The Pulse Editor is an additional software application provided with QCW lasers. This application is used for creating a custom pulse profile to be used as an alternative to the modulation and analog control signals. The custom pulse is drawn in the Pulse Editor; downloaded to the laser, incorporated into a laser program, and generated in the laser's internal pulse generator.

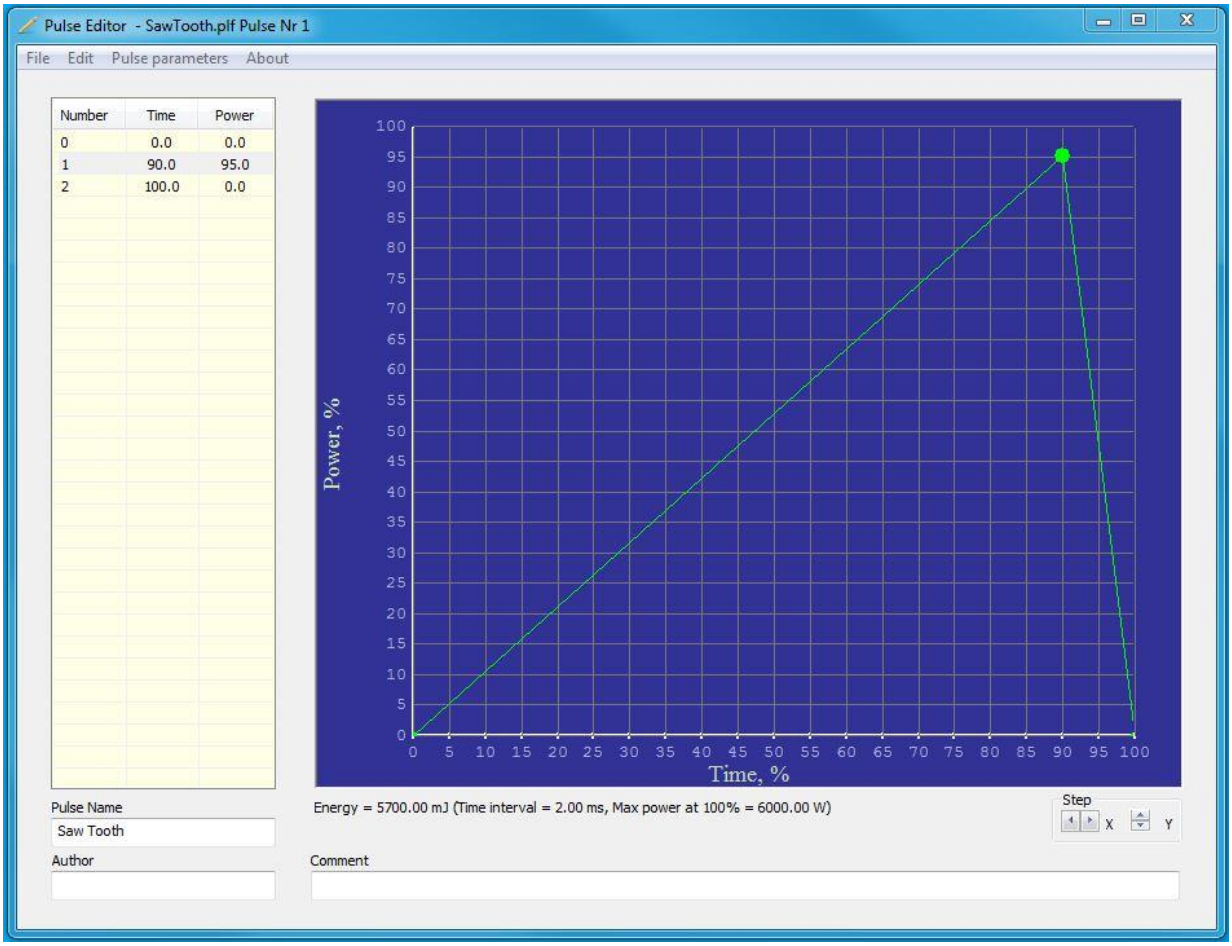


Figure 10-2 Pulse Editor Application

11. LASER CONTROL AND STATUS

This section of the manual provides details on the laser's control/status signals and parameters. The origin of the control and status parameters can be different based on the options installed in the laser. For example the **Laser Request** signal can originate at the hardwiring interface or from a fieldbus interface. Regardless of the origin, the functionality of these control and status parameters remains largely the same. Some signals vary slightly based on their origin; and some signals may be available on one interface but not the other, these variations will be noted in the descriptions.

For clarity, this section defines signals and parameters as follows:

Parameter: A parameter, whether it is an input or an output refers to a value that can have a range of some defined minimum value, to some defined maximum level, such as laser power.

Signal: A signal, whether it is an input or an output refers to a value that has only two states on/off, such as the signal **Laser ON**. A signal origin may be a physical pin, or a software bit in a fieldbus interface.

Note: All signals are active high unless otherwise stated.

11.1. LASER REQUEST

The input signal **Laser Request** is used to obtain control of the laser when the laser is operated in remote mode. When this signal has been successfully accepted by the laser, the output signal **Laser is Assigned** will be set.

Hardwiring: For the hardwiring interface it is recommended that the **Laser Request** signal remain on and the **Laser Assigned** signal be monitored.

Fieldbus: For lasers that have more than 1 fieldbus card installed, it is necessary to use the **Laser Request** and **Laser Assigned** signals to pass control of the laser from one PLC/Robot to another.

A typical control sequence for a laser with 2 fieldbus cards would be as follows:

1. Issue a **Laser Request** to fieldbus slot 1
2. Verify that the **Laser Assigned** bit of status word for fieldbus slot 1 is set
3. Proceed with controlling the laser from slot 1
4. When control from slot 1 is complete, clear the **Laser Request** bit
5. Issue a **Laser Request** to fieldbus slot 2
6. Verify that the **Laser Assigned** bit of status word for fieldbus slot 2 is set
7. Proceed with controlling the laser from slot 2
8. When control from slot 2 is complete, clear the **Laser Request** bit
9. Loop to step 1

Notes:

- The laser will ignore all other fieldbus input signals except the **Guide Laser On** until **Laser Request** is asserted.
- This control signal should always be used in combination with status signal **Laser is Assigned**

11.2. LASER ASSIGNED

The status signal **Laser Assigned** is the complimentary signal to **Laser Request**. When this status signal is set, the PLC/Robot has control of the laser.

Hardwiring: For the hardwiring interface it is recommended that the **Laser Request** signal remain asserted and the **Laser Assigned** signal be monitored.

Fieldbus: For lasers that have more than 1 fieldbus card installed, it is necessary to use the **Laser Request** and **Laser Assigned** signals to pass control of the laser from one PLC/Robot to another.

Notes:

- The **Laser Assigned** signal should always be used in combination with **Laser Request**

11.3. LASER READY

The status signal **Laser Ready** indicates it is possible for the laser to emit. For laser's that have an integrated beam switch the Laser Ready signal will not be active until an optical channel is selected.

Notes:

- The signal **Laser On** must be asserted before **Laser Ready** will be become active
- For lasers with a beam switch, a channel must be active before **Laser Ready** will be active*
- The **Laser Ready** signal should always be checked before asserting control signal **Program Start***

*There is an exception to Laser Ready signal operation, for a laser with a beam switch it is possible to write a laser program that selects a beam switch channel. Under this operating condition it is possible to assert the **Program Start** signal and run a program, once the laser program activates a beam switch channel, **the Laser Ready** signal will be present.

The above exception is not applicable in local mode.

11.4. PROGRAM START

Control signal **Program Start** is used to run a laser program or start laser emission. Depending on how the laser set-up to run, the **Program Start** signal takes on a slightly different meaning, sections 11.4.1 thru section 11.4.3 provide additional details.

Hardwiring: When using the hardwiring interface, the program number to be run is selected on pins A8 through A14.

Fieldbus: When using the fieldbus interface, the input parameter named "Program Number" is used to select a program.

11.4.1. Program Start and running a laser program

When the **Program Start** signal is used with a laser program other than program 0, it starts the specified program running. This signal must remain asserted for the duration of the program, if the signal is cleared before the program completes, a **Program Interrupted** status signal will be generated.

Notes:

- The program will not start unless the status signal **Laser Ready** is active
- After successful program start, the status signal **Program Active** will be active
- The status signal **Program Active** will automatically clear upon program completion
- Upon successful completion of the laser program, status signal **End of Program** will be set
- The **End of Program** status signal will be cleared once the **Program Start** signal is cleared
- The **End of Program** status signal will be cleared if the **Reset** signal is asserted
- If **Program Start** is de-asserted during program execution, the signal **Program is Interrupted** will be set and a **Reset** signal will be necessary to clear the alarm.

11.4.2. Program Start and Analog Control

To run the laser in analog control mode, select program 0 and assert the control signal **Analog Control**. The control signal **Program Start** will now turn on emission at the level indicated at J34 pins 1 & 2.

Notes:

- When operating the laser in this mode, clearing the **Program Start** signal will result in the status signal **Program End** being set (The status signal **Program is Interrupted** will not be set).
- Asserting the signal **Program Stop** will result in the status bit **Program Interrupted** being set
- The status signal **End of Program**, will remain set until the **Program Start** signal is again asserted or the control signal **Reset** is asserted.

11.4.3. Program Start with specified power

This functionality of the **Program Start** signal is only available when using the fieldbus interface, or software control. To command the laser to emit at the level specified by the parameter **Power**, program 0 must be selected, and the control signal **Analog Control** must be cleared.

Notes:

- The Ramp up and ramp down times parameters can be used in this operating mode
- When operating the laser in this mode, clearing the **Program Start** signal will result in the status signal **Program End** being set (The signal **Program Interrupted** will not be set)
- The status signal **Program End**, will remain set until the **Program Start** signal is again asserted or the control signal **Reset Alarm** is asserted
- Do not use program Stop

11.5. PROGRAM ACTIVE

The status signal **Program Active** indicates when a laser program is active. When the laser program completes, this signal will automatically be cleared.

Notes:

- If the **Program Interrupted** signal becomes active during program execution, the **Program Active** signal will be cleared.

11.6. END OF PROGRAM

The status signal **End of Program** will be set upon successful completion of a laser program.

Notes:

- Clearing signal **Program Start** will clear the **End of Program** signal
- Asserting the signal **Reset** will clear the **End of Program** signal
- The **End of Program** signal is not in use when running program 0

11.7. PROGRAM INTERRUPTED

The status signal **Program Interrupted** will become active if a program ends prematurely.

Notes:

- This signal is cleared by asserting the **Reset** signal for a minimum of 5ms.

11.8. PROGRAM STOP

The control signal **Program Stop** can be used to abort a running laser program immediately. The **Reset** signal must be asserted to recover from using the **Program Stop** signal.

Notes:

- Asserting the **Program Stop** signal will set the status signal **Program Interrupted**
- The status signal **Program Active** will be cleared
- The status signal **Program End** will NOT be set
- To recover from asserting the **Program Stop** signal bit, the control signal **Reset** must be used
- For lasers with a beam switch, use the following sequence to recover from **Program Stop**.
    1. De-assert **Program Start** and **Program Stop** signals
    2. Place beam switch mirror in home position
    3. Assert the **Reset** signal for a minimum of 5ms
    4. Place mirror back in active position

11.9. PROGRAM NUMBER

The **Program Number** parameter is used to select the laser program to be run. However program 0 is a special case and functionality is based on the state of the control signal **Analog Control** or LaserNet if **PC Control** is enabled. See sections 9.7.6 and 9.8.3 for additional program 0 details.

Hardwiring: When operating the laser from the hardwiring interface, pins A8 – A14 are used to set the program number. This is a binary encoded selection where A8 is the LSB and A14 is the MSB.

- The program number is read on a low to high transition on the **Program Start** signal

Fieldbus: All fieldbus protocols will have an input parameter named **Program Number**.

- The program number can be sent in the same message packet as the asserted **Program Start** signal

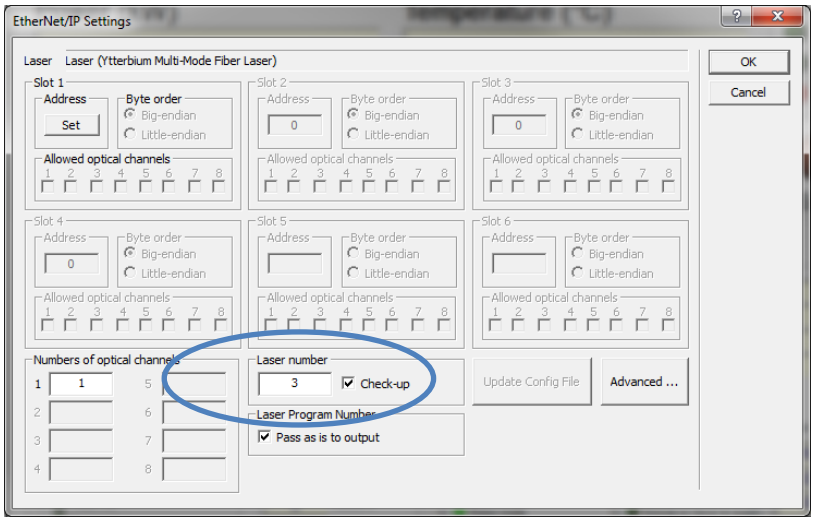
11.10. LASER NUMBER

The input parameter **Laser Number** can be used to address a laser over fieldbus. At the system level there may be more than a single laser on the field bus network. The value entered into **Laser Number** must match the value configured in the target laser if this option is enabled. In the fieldbus protocol there will be an output parameter **Laser Number** that always reports the number configured in the laser.

Hardwiring: This parameter is not available from the hardwiring interface.

To configure a *Laser Number* in the laser:

1. Launch the LaserNet application and establish a connection to the laser
2. From the *Settings* menu select *Laser* then *<field bus> Settings…*
3. The following dialog window will appear:



4. Set the laser number as desired and select the *Check-up* box.

Once the laser number has been configured, the **Laser Number** In parameter of the field bus protocol must match this number. If the numbers do not match when the **Laser Request** signal is set, the **Laser is assigned** signal will not be active and the **Slot error** signal will be active.

Notes:

- This feature is only available on some fieldbus protocols
- If the laser has the "Coding Box" option, the Laser Number is set by this device. Otherwise this number is set in LaserNet.

11.11. POWER REQUESTED

The input parameter **Power Requested** is used to specify an emission power level in a fieldbus message. The power resolution is 1watt/bit.

Hardwiring: This parameter is not available from the hardwiring interface.

Notes:

- See section **Program Start** with specified power for additional details.
- A power level can alternatively be set in a laser program.

11.12. DELIVERED POWER

The output parameter **Delivered Power** value is the emission power level as measured at the optical combiner. The power resolution is 1watt/bit.

Hardwiring: This feature is not available from the hardwiring interface.

11.13. PC CONTROL

The signal **PC Control** is used to enable some LaserNet functionality.

The following parameters are available in LaserNet when **PC Control** is enabled

- Setting of the emission level
- Setting of the Rise time
- Setting of the Fall time

Notes:

- This feature would typically be used for Process development.

11.14. PC CONTROL ENABLED

The status signal **PC Control Enabled** indicates if the control signal **PC Control** is currently active.

11.15. RESET

The control signal **Reset** is used to reset all non-fatal latched alarms. Once the alarm condition has been resolved, asserting the **Reset** signal will clear the following alarm/status bits:

- **Laser Alarm**
- **Program Interrupted**
- **Slot Error** (Fieldbus interface)

Notes:

- If the control signal **Laser On** is set after asserting the **Reset** signal, the laser modules power supply will turn on
- The **Reset** signal must be asserted for a minimum of 5ms

11.16. GUIDE LASER ON

The control signal **Guide Laser On** is used to turn on a visible guide laser. For laser's that are equipped with a beam switch, the guide beams located in the beam switch will be used if the mirror is active.

Notes:

- In hardwiring mode it is necessary to have **Laser Request** asserted to control the guide laser
- It is not necessary to have the **Laser Request** signal asserted to turn on/off the guide laser
- For lasers with an installed beam switch, the guide lasers internal to the beam switch will be used
- This control signal should be used in combination with the status signal **Guide laser is on**

11.17. GUIDE LASER IS ON

The status signal **Guide Laser is On** is the complementary signal to **Guide Laser On**. The status signal indicates when a guide laser is enabled.

11.18. ANALOG CONTROL

The control signal **Analog Control** can be used to operate the laser in analog control mode. See section 9 for additional details and usage.

11.19. ANALOG CONTROL IS ON

The status signal **Analog Control is On** is the complimentary signal to **Analog Control On**. The status signal indicates when the laser is operating in analog control mode.

11.20. SYNCHRONIZED INPUT

The control signal **Synchronized Input** is used in conjunction with laser programs. In a laser program the **WAIT** and **GOTO** commands have several parameters that allow the execution of a laser program to stop and wait for a specific event. In the case of the synchronized input the laser program can be instructed to wait until a specific signal level or signal transition is observed on the Sync. Input pin of J36 pin A15.

The following image shows a simple laser program, line 2 is an example of waiting for a High signal on the Sync. Input pin to shut down emission.

No	CMD	Param 1	Param 2
1	SPT	100 ms	2000 W
2	WAIT	SI	HI
3	SPT	100 ms	0 W
4	STOP		

Hardwiring: For the hardwiring interface the sync. Input is located on J35 pin A15

Fieldbus: For fieldbus interface the sync. Input will be a signal in the control word

Notes:

- It is not possible to reference hardwiring sync. Input from fieldbus control
- It is possible to use the Sync. Input more than once in a laser program
- This function is not available in local mode

11.21. SYNCHRONIZED OUTPUT

The status signal **Synchronized Output** is available from within a laser program. In a laser program the **OUT** command can be programmed to set this signal High or Low. This signal is designed to signal a system level device that the laser program has reached a specific point in the laser program execution.

The following image shows a simple laser program. Line 4 is an example of setting the Sync Output high to indicate to external device that emission is off.

No	CMD	Param 1	Param 2
1	SPT	250 ms	2000 W
2	WAIT	TIME	500.00 ms
3	SPT	250 ms	0 W
4	OUT	SO	HI
5	STOP		

Hardwiring: The Sync. Output signal is located on J35 pin B12

Fieldbus: The Sync. Output signal is typically located in the status 1 word

Note:

- It is not possible to reference hardwiring sync. Output from fieldbus control
- It is possible to use the Sync. Output more than once in a laser program.
- This function is not available in local mode

11.22. LASER ON

The control signal **Laser On** signal is used to turn on/off the laser modules power supply. Applying a +24Vdc signal to this pin enables the laser modules power supplies, removing the signal shuts down the power supplies.

If the laser modules power supply does not turn on, Status bit **Laser is ON** will be 0, and status bit **Laser Warning** will be set.

Note:

- This control signal should be used in combination with the status signal **Laser is ON**
- It is recommended to keep this signal asserted whenever the laser is on
- For lasers with the yellow IS power supplies and no beam switch it is necessary to de-assert the laser on signal before opening the work cell door.

11.23. LASER IS ON

The status signal **Laser is On** indicates the state of the laser module power supply. This status signal is the complimentary signal to **Laser On**.

Note:

- The **Laser Is On** signal should always be used in combination with the signal **Laser On**.

11.24. LASER ENABLED

The status signal **Laser Enabled** indicates the fieldbus controller is functioning.

Hardwiring: This signal is not available from the hardwiring interface.

Fieldbus: This signal is available on some fieldbus protocols.

11.25. LASER BUSY

The status signal **Laser Busy** indicates if the laser is currently assigned to another fieldbus channel or interface.

Hardwiring: This signal is not available from the hardwiring interface.

Fieldbus: This signal is available on some fieldbus protocols.

11.26. EMISSION ON

The status signal **emission ON** indicates if the laser is emitting.

Note: On the hardwiring interface this is not considered a safety signal.

11.27. RAMP UP

The control signal **Ramp Up** is used along with the parameters **Ramp Time** and **Power**. When the Ramp up signal is asserted the laser will ramp up emission from its current level to the value specified by the power parameter over the time specified by ramp time.

Hardwiring: This signal is not available from the hardwiring interface.

Notes:

- It is not possible to set both the **Ramp Up** and **Ramp Down** signal at the same time.
- Ramping is not available when using **Analog control** mode.
- Once the **Ramp Up** or **Ramp Down** signal is cleared, the ramp time reverts to 0.
- Maximum ramp time is 5000ms

11.28. RAMP DOWN

The control signal **Ramp Down** is used along with the parameters **Ramp Time** and **Power**. When the Ramp Down signal is asserted the laser will ramp down emission from its current level to the value specified by the power parameter over the time specified by ramp time.

Hardwiring: This signal is not available from the hardwiring interface.

Notes:

- It is not possible to set both the **Ramp Up** and **Ramp Down** signal at the same time.
- Ramping is not available when using **Analog control** mode.
- Once the **Ramp Up** or **Ramp Down** signal is cleared, the ramp time reverts to 0.
- Maximum ramp time is 5000ms

11.29. RAMP TIME

The **Ramp Time** parameter is used in conjunction with the **Ramp Up** and **Ramp Down** signals.

Hardwiring: This parameter is not available from the hardwiring interface.

In a fieldbus protocol a 16 bit word will be used for specifying a ramp time, where the resolution is 1ms/bit.

To set a ramp up time, enter the ramp time value then set the **Ramp Up** signal.

To set a ramp down time, enter the ramp time value then set the **Ramp Down** signal.

Notes:

- It is not possible to set both the **Ramp Up** and **Ramp Down** signal at the same time.
- Ramping is not available when using **Analog Control**.
- Once the **Ramp Up** or **Ramp Down** signal is cleared, the ramp time reverts to 0.
- Maximum ramp time is 5000ms

Ramp Up Example:

1. Set the signal **Laser Request**
2. Verify signal **Laser is Assigned** is set
3. Set **Program number** to 0
4. Set the signal **Laser On**
5. Verify the signal **Laser is ON** is set
6. Verify the signal **Laser Ready** is set
7. Set the parameter **Power Request**
8. Set the parameter **Ramp Time** (1 second ramp = 0x03E8)
9. Set the signal **Ramp Up**
10. Set the signal **Program Start** to start the emission ramp

Example Notes:

- The value for **Program Number** and **Ramp Time** can be sent in the same message
- A small amount of time is required to process **Program Number** and **Ramp Time**. It may be necessary to provide a small time delay before executing step 10.

11.30. SINGLE MODULE MODE

The control signal **Single Module Mode** can be used to enable emission from a single laser module.

Hardwiring: This signal is not available from the hardwiring interface.

Fieldbus: This signal is available on some fieldbus protocols.

Notes:

- Maximum output power is not recalculated
- The module enabled will be the first available module (not a reserved module)
- Single module power should not be set less than 10% emission of a single module

11.31. EXTERNAL ERROR

The control signal **External Error** can be used to shut down emission as a result of a system level condition. If the PLC/Robot detects an alarm condition in another device in the system, it can set this signal to place the laser in a non-emitting state.

Hardwiring: This signal is not available from the hardwiring interface.

Fieldbus: This signal only available on some fieldbus protocols.

Notes:

- When control signal is set emission will stop.
- If the laser has a beam switch, any active mirror will be deactivated
- The status signal **Slot Error** will be set
- Use the control signal **Reset** to recover

11.32. LASER ERROR

The status signal **Laser Error** will be set high when a condition exists that prevents the laser from emitting. To obtain detailed information on the cause of the alarm, view the Alarm and Events pages of LaserNet.

To clear an alarm, resolve the source of the alarm then assert the reset signal for a minimum of 5ms.

11.33. LASER WARNING

The status signal **Laser Warning** indicates a warning is present in the laser; warnings do not shut off emission. View the Warnings and Events tab in LaserNet to obtain detailed information on the cause of the Warning.

11.34. OPTICAL CHANNEL REQUEST

The input parameter **Optical Channel Request** is used to request activation of a beam switch channel. The optical channel selection is binary encoded.

Hardwiring: For lasers that have a beam switch installed, the hardwiring interface provides 4 signals for activating a beam switch channel. The following table illustrates requesting a channel.

Hardwiring Pin				Requested Channel
C6	C5	C4	C3	
0	0	0	0	No channel requested
0	0	0	1	Request channel 1
0	0	1	0	Request channel 2
0	0	1	1	Request channel 3
0	1	0	0	Request channel 4
0	1	0	1	Request channel 5
0	1	1	0	Request channel 6

Fieldbus: In the fieldbus protocol there will be a single byte parameter for requesting a beam switch channel.

Notes:

- If an attempt is made to activate a beam switch channel without the signal **Laser Request** being set, it will result in the request being ignored.
- For a two channel beam switch configured for energy sharing, requesting channel 1 or channel 2 will select channels 1 and 2.
- Setting the **Optical Channel Request** parameter to 0 will deselect all beam switch channels.
- Opening the work cell door with that work cell mirror active will result in an E-Stop and External E-Stop.

11.35. SET OPTICAL CHANNEL

The control signal **Set Optical Channel** is used in conjunction with the control parameter **Optical Channel**. When this signal is asserted, the beam switch activates the optical channel specified in the parameter **Optical Channel**.

Hardwiring: This signal is not available from the hardwiring interface.

Fieldbus: This signal is only available on some fieldbus protocols.

11.36. OPTICAL CHANNEL STATUS

The output parameter **Optical Channel Status** is the complimentary parameter to **Optical Channel Request**. The optical channel status parameter is binary encoded.

Hardwiring: The hardwiring interface provides 4 signals to indicate what optical channel is active. The following table illustrates active channels.

Hardwiring Pin				Active Channel
D4	D3	D2	D1	
0	0	0	0	No channel active
0	0	0	1	Channel 1 active
0	0	1	0	Channel 2 active
0	0	1	1	Channel 3active
0	1	0	0	Channel 4 active
0	1	0	1	Channel 5 active
0	1	1	0	Channel 6 active

Fieldbus: In the fieldbus protocol there will be a single byte parameter for indicating the currently active optical channel.

Notes:

- Opening the work cell door with that work cell mirror active will result in an E-Stop and External E-Stop.
- For a beam switch configured for energy sharing mode, the appropriate active bits will be set.
- Additionally mirror status is available from the beam switch interlock connectors (section 6.7)

11.37. CHANNEL ERROR

The signal **Channel Error** indicates if an error exists on the requested beam switch channel.

Hardwiring: This signal is not available from the hardwiring interface.

Fieldbus: This signal is available on some fieldbus protocols.

Note: The value in parameter Optical Channel Request indicates the channel with the error.

11.38. BEAM SWITCH GUIDE LASER ENABLE

The control signal **Beam Switch Guide Lasers** is used to turn on/off all guide lasers in a beam switch.

Hardwiring: This signal is not available from the hardwiring interface.

Fieldbus: This signal is available on some fieldbus protocols.

Signal State	Description
0	Set all beam switch guide lasers OFF
1	Set all beam switch guide lasers ON

11.39. BEAM SWITCH GUIDE LASER STATUS

The status signal **Beam Switch Guide Laser Status** indicates if all guide lasers within the beam switch are currently on.

Hardwiring: This signal is not available from the hardwiring interface.

Fieldbus: This signal is available on some fieldbus protocols.

Signal State	Description
0	All beam switch guide lasers are OFF
1	All beam switch guide lasers are ON

11.40. BEAM SWITCH CHANNEL FLOW STATUS

There are a series of 6 flow status signals for indicating the current flow status of a beam switch channel. The signals are labelled **B.S. Ch1 flow status** through **B.S. Ch6 flow status**, a set signal on one of these signals indicates that either a input or output flow switch has detected a low flow condition.

Hardwiring: This signal is not available from the hardwiring interface.

Fieldbus: This signal is available on some fieldbus protocols.

Signal State	Description
0	Low flow condition not present
1	Low flow condition present on input or output flow meter.

11.41. CHILLER WARNING

The status signal **Chiller Warning** is only present when the laser is connected to an IPG CAN enabled chiller. The laser will assert the chiller warning signal if one of the following conditions is present.

- Water conductivity ≥45 µS/cm or ≤ 35 µS/cm
- Water temperature of the laser circuit ≥ T_{Th1} - 2° C or ≤ T_{Th2} + 2° C
- Water temperature of the optics circuit ≥ T_{Th3} - 2° C or ≤ T_{Th4} + 2° C.
- Water level is approaching a critical threshold
- Water temperature is approaching a critical threshold
- DI water conductivity is approaching a critical threshold
- Refrigerant pressure is approaching a critical threshold

LaserNet application will indicate the specific cause of the chiller waring.

Note:

- The chiller will continue to operate with a warning condition present

11.42. CHILLER ERROR

The status signal **Chiller Error** is only present when the laser is connected to an IPG CAN enabled chiller. The laser will assert the chiller error signal if one of the following conditions is present.

- Water conductivity ≥ 50 µS/cm or ≤ 30 µS/cm
- Water temperature of the laser circuit ≥ T_{Th1} °C or ≤ T_{Th2} °C
- Water temperature of the optics circuit ≥ T_{Th3} °C or ≤ T_{Th4} °C
- CHILLER FAULT.
- Water level has exceeded a critical threshold
- Water temperature has exceeded a critical threshold
- DI water conductivity has exceeded a critical threshold
- Refrigerant pressure has exceeded a critical threshold
- Refrigerant pressure has fallen below a critical threshold
- A over current condition exists
- Fan control fault
- Failed sensor
- Electrical phase is wrong
- Temperature difference is to great

LaserNet application will indicate the specific cause of the chiller error.

Note:

- The chiller will not continue to operate with an error condition present

11.43. CHILLER READY

The status signal **Chiller Ready** indicates the chiller is connected and functioning within specifications.

11.44. PULSED MODE

The control signal **Pulsed Mode** is only available on QCW lasers; this signal enables the laser to pulse in QCW mode. When this signal is cleared the laser operates in CW mode.

Hardwiring: This feature is available on J35, pin C7

11.45. PULSED MODE ACTIVE

The status signal **Pulse Mode Active** indicates the signal **Pulse Mode** is asserted and the laser is operating in this mode.

11.46. LASER MODULE ALARM

The status signal **Laser Module Alarm** is asserted if one or more of the laser modules are in an alarm state. The LaserNet alarms page will provide addition alarm information.

11.47. RESERVED MODULE ON

The status signal **Reserved Module On** indicates that a laser module has been disabled, and the reserved module has been enabled. This is an optional feature and is not available on all lasers.

If this signal is active, contact IPG Photonics to schedule service.

Note: Full emission is still possible with reserved module enabled.

11.48. REDUCED ACTIVE MODULES

The status signal **Reduced Active Modules** indicates that the laser is operating and the nominal emission level may not be possible.

If this signal is active, contact IPG Photonics to schedule service.

11.49. REMOTE MODE

The status signal **Remote Mode** indicates if the operating mode key switch is in the REM position.

Hardwiring: This signal is not available from the hardwiring interface.

Fieldbus: This signal is available on some fieldbus protocols.

11.50. POWER SUPPLY INTERLOCK

The status signal **Power Supply Interlock** indicates the internal state of the safety circuit.

Signal State	Description
0	Safety circuit is open
1	Safety circuit is closed

Hardwiring: This signal is not available from the hardwiring interface.

Fieldbus: This signal is available on some fieldbus protocols.

11.51. MODULE POWER SUPPLY WARNING

The status signal **Module Power Supply Warning** indicates that one or more of the laser module power supplies are in a warning state.

Signal State	Description
0	Laser module power supplies are not in a warning state
1	One or more Laser module power supplies are in a warning state

Hardwiring: This signal is not available from the hardwiring interface.

Fieldbus: This signal is available on some fieldbus protocols.

11.52. SAFETY CIRCUIT OPEN

The status signal **Safety Circuit Open** indicates that the external safety circuit is open.

Signal State	Description
0	Safety circuit is closed
1	Safety circuit is open

Hardwiring: This signal is not available from the hardwiring interface.

Fieldbus: This signal is available on some fieldbus protocols.

Notes:

- This signal operates in the reverse state of signal **Power Supply Interlock**

11.53. SLOT ERROR

The status signal **Slot Error** is used to indicate if an error in controlling the laser from a fieldbus interface is present.

The following conditions can produce a slot error:

- No communication to fieldbus slot during assignment
- Unexpected reset of fieldbus assignment
- The control signal **External Control** is set
- The value in fieldbus parameter Laser Number does not match the number configured in the laser (see Figure 11-1).
- The optical channel request does not match the assigned optical channel (see Figure 11-2)

Hardwiring: This signal is not available from the hardwiring interface.

Fieldbus: This signal is available on some fieldbus protocols.

If the laser number configured in LaserNet does not match the Laser Number parameter in the field bus protocol when the "Check-up" box is checked, a Slot Error will be generated.

Figure 11-1 Laser Number Check-up

If the "Allowed optical channel" as configured in LaserNet does not match the optical channel selection in a field bus command, a Slot Error will be generated.

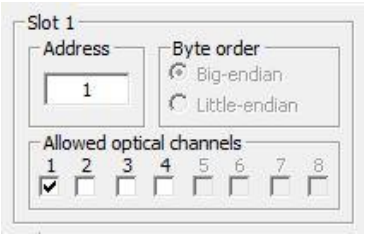


Figure 11-2 Allowed optical channel

11.54. CABINET DOOR OPEN

The status signal **Cabinet Door Open** is used to indicate when a door in the work cell of the selected/requested beam switch channel is open.

Hardwiring: This signal is not available from the hardwiring interface.

Fieldbus: This signal is available on some fieldbus protocols.

11.55. HIGH BACK REFLECTION

The status signal **High Back Reflection** is used to indicate that a photo diode used to monitor the back reflection status has observed a value in excess of the maximum limit.

Hardwiring: This signal is not available from the hardwiring interface.

Fieldbus: This signal is available on some fieldbus protocols.

11.56. PULSE WIDTH

The **Pulse Width** parameter is used in QCW laser's to set the width of a pulse. The pulse width resolution is 100µs/bit. The QCW protocol defines an input and output **Pulse Width** parameter, where the input parameter is a request, and the output parameter is a status.

Hardwiring: This signal is not available from the hardwiring interface.

Fieldbus: This signal is only available on the QCW fieldbus protocol.

Notes:

- This feature is only available on QCW lasers
- Only operational when the **Internal Modulation Enable** signal is asserted
- Can generate **Too Long Pulse Width** status signal

11.57. FREQUENCY

The **Frequency** parameter is used in QCW laser's to specify the pulse frequency. The frequency resolution is 1Hz/bit. The QCW protocol defines an input and output **Frequency** parameter, where the input parameter is a request, and the output parameter is a status.

Hardwiring: This parameter is not available from the hardwiring interface.

Fieldbus: This parameter is only available in QCW fieldbus protocol.

Notes:

- This feature is only available on QCW lasers
- Only operational when the **Internal Modulation Enable** signal is asserted
- Can generate **Pulse Too Long** status signal

11.58. LASER TEMPERATURE

The status parameter **Laser Temperature** reports the laser's internal temperature. The temperature resolution is 0.1ºC/bit.

Hardwiring: This parameter is not available from the hardwiring interface.

Fieldbus: This parameter is only available in QCW fieldbus protocol.

11.59. DEW POINT ALARM

The status signal **Dew Point Alarm** indicates a high dew point condition has been measured inside the laser cabinet.

Hardwiring: This status signal is available on J35, pin B14. See Table 13-1

Fieldbus: This signal not present

Signal State	Description
0	Dew point Alarm State
1	Dew point acceptable

11.60. INTERNAL MODULATION ENABLE

The control signal **Internal Modulation** is used to enable the laser's internal modulation generator.

Signal State	Description
0	Internal Modulation Disabled
1	Internal Modulation Enabled

Hardwiring: This signal is not available from the hardwiring interface.

Fieldbus: This signal is only available on the QCW fieldbus protocol.

11.61. PULSE MODE ENABLE

The control signal Pulse Mode Enable is used to enable/disable pulse mode and is only available for QCW type lasers.

Signal State	Description
0	Pulse Mode Disabled
1	Pulse Mode Enabled

Hardwiring: This signal is available on J35, pin C7

Fieldbus: This signal is only available on the QCW fieldbus protocol.

12. MAINTENANCE

WARNING

Danger from laser radiation

Laser radiation can damage the eyes and skin

⇒ Never disable the prescribed safety equipment

⇒ The work area should be secured while performing maintenance

WARNING

Potential of severe injuries

For maintenance work, there is a danger of severe injuries if safety precautions are not taken.

⇒ Only allow maintenance work to be performed by trained personal or IPG service engineers.

Laser safety glasses required

If the laser is operated in service mode, anyone in the immediate area must wear suitable laser safety glasses

⇒ Immediately after completing maintenance work, restore and or activate all safety and protective equipment

⇒ Check that all safety related components are connected and operating properly

IPG Photonics recommends the maintenance work listed below be performed at the specified intervals.

12.1. SERVICE MODE

WARNING

Danger from laser radiation

Laser radiation can damage the eyes and skin

⇒ Never disable the installed safety equipment

Lasers that have integrated optics such as a beam switch or fiber coupler provide a service mode. The service mode is intended to be used by IPG service personnel or personnel that have been trained by IPG customer representatives. The service mode is enabled from a key switch located on the front of the laser. The service mode key does not ship with the laser. When the laser is placed in service mode, the door interlock that provides access to the switch or coupler is bypassed for a period of 30 minutes and the service mode pushbutton switch will be illuminated. During this time laser emission is possible while the access door is open. After the timer expires, the door interlock will be reactivated.

12.2. MAINTENANCE OPERATIONS

12.2.1. Fiber connector cleaning

The fiber connector must always be cleaned and inspected before it is inserted into the receptacle.

WARNING

Risk of injury from guide laser

The guide laser is a class 2M laser. The guide laser can cause serious eye damage when viewed through an optical instrument such as a microscope.

⇒ Only perform fiber connector cleaning with the laser off
⇒ During the cleaning process use a lock out tag out procedure

NOTICE

Damage to the fiber from soiling of the quarts-block end face

Soiling of the quartz-block end face on the fiber connector can lead to high stray light values during laser emissions and loss of laser output power. In addition, this can cause burning on the quartz-block end face as well as overheating and damage to the optics. Such damage is NOT covered by the warranty.

⇒ Check the quartz-block end face for soiling before inserting into the optical connector

Cleaning Notes

⇒ Only use cleaning materials described in this manual

⇒ Only follow the cleaning procedure described in this manual

⇒ Never touch the quartz-block end face or the protective cap

Never use compressed air in the immediate vicinity of the fiber connector; this can lead to contamination to the quartz-block end face.

Required Materials The following is a list of items required for optics cleaning:

- Lint-free cleaning swabs
- Powder free rubber gloves
- Isopropanol (anhydrous)
- Acetone (anhydrous)
- Canned air (oil-free, anhydrous)
- Microscope, IPG model with light source (Figure 12-1 Microscope Kit)

Canned air, cleaning swabs, and sticklers are included in the microscope kit.

Figure 12-1 Microscope Kit

Preparations:

1. Provide a clean work area close to the process optics and laser. Minimize the risk of re-contamination of the fiber connector after the cleaning process.
2. Keep a clean protective cap available for the optics.
3. Remove any impurities within the protective cap by using the canned air before use.
4. After cleaning, place protective cap on a clean storage surface with the open side facing down.
5. Place microscope on a level surface close to the optics
6. Use a damp cloth to clean and remove coarse dirt from the area around the fiber connector.
7. Disconnect the fiber connector from the optics. To do this, turn the ribbed bayonet mount clockwise (1) until reaching the stop and gently pull out the fiber connector (2).

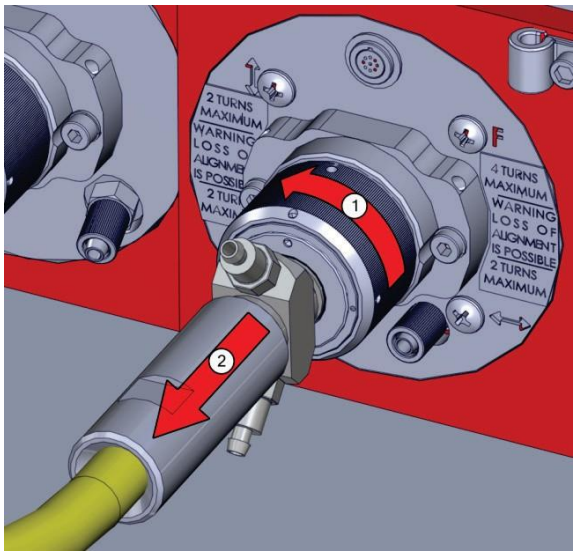


Figure 12-2 Fiber Removal

8. Immediately seal the optics with the cleaned protective cap.
9. Place the fiber connector in the holder on the microscope stand.
10. Turn on the microscopes light source and aim it at the surface to be cleaned.

Figure 12-3 IPG inspection microscope

Note: The microscope assembly shown in Figure 12-3 may differ from the one included with the laser.

Individual cleaning steps differ depending on the fiber connector option (Figure 12-4). For fiber connectors with a protective conduit, the quartz-block end face is cleaned. For fiber connectors with a protective glass, the protective glass is only cleaned if the quartz-block end face is free of impurities. For persistent dirt accumulation, the protective glass may be replaced.

Figure 12-4 Fiber Connector accessories

Item	Description
1	Process fiber
2	Quartz-block
3	Protective Ferrule
4	Protective glass

The following figure shows what to look for when inspecting the Quartz-block end face.

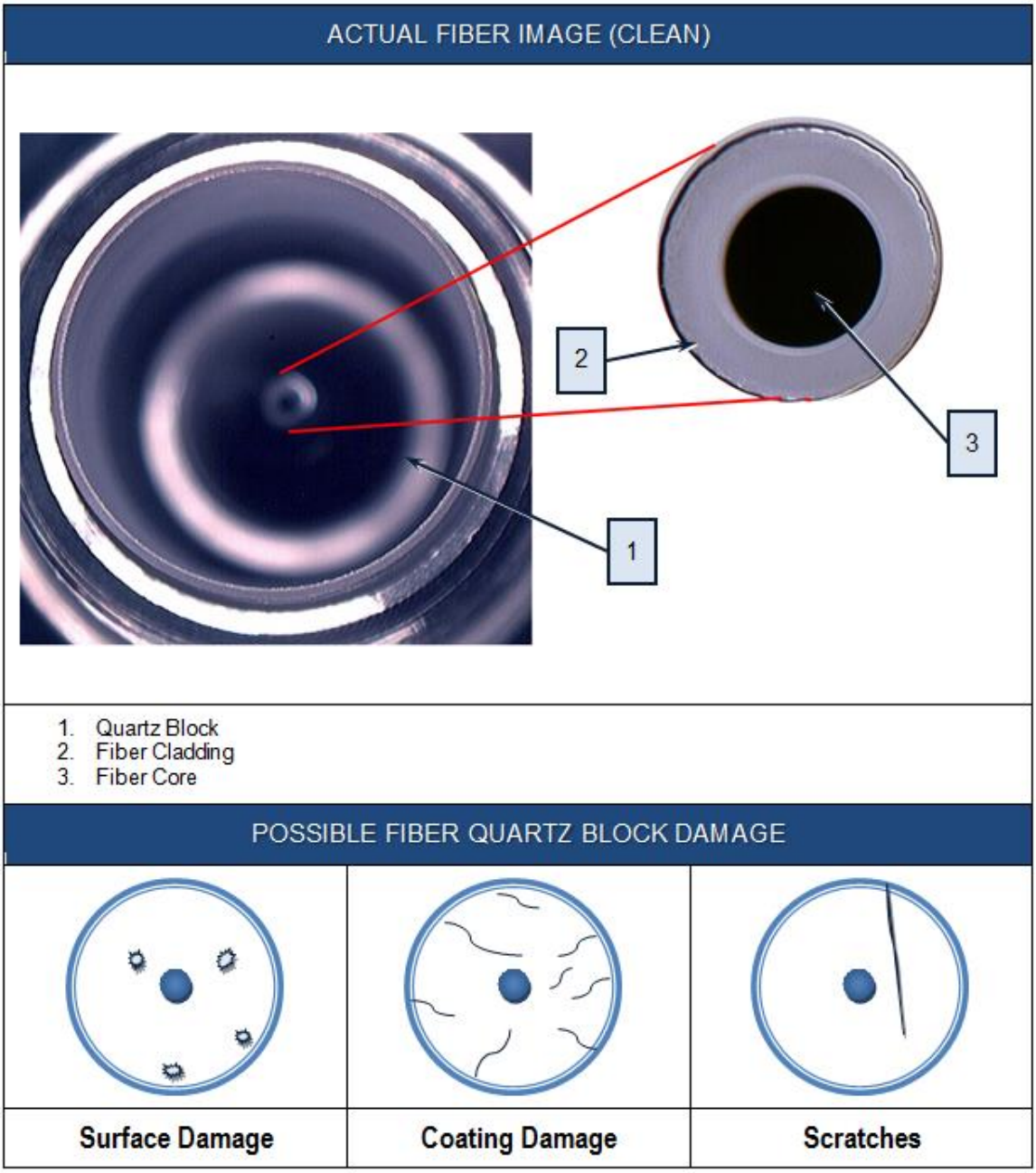


Figure 12-5 Quartz-block end face inspection

Cleaning

WARNING

Risk of injury from cleaning solutions

Isopropanol and acetone are highly volatile and flammable liquids. They can cause serious eye irritation. Repeated exposure may lead to skin dryness and cracking. Vapors may cause drowsiness and dizziness.

⇒ Keep isopropanol and acetone away from heat, sparks, open flames and hot surfaces.
⇒ Avoid contact with eyes and skin
⇒ Wear safety gloves
⇒ Do not inhale vapors
⇒ Refer to the material safety data sheets for isopropanol and acetone for addition considerations

Optional protective conduit

1. Remove the protective ferrule by rotating it counter clockwise
2. Adjust the focus of the microscope to the quartz-block end face.
3. Check the quartz-block end face for impurities. If impurities are observed, perform the following steps.
4. Prepare a swab moistened with a drop of isopropanol
5. Remove any excess isopropanol

It's possible that when cleaning with isopropanol an electrostatic charge may build up on the quartz-block end face. This charge may cause dirt particles to stick to the end face.

⇒ Under these conditions use acetone as a cleaning agent

Acetone may cause streaks on the quartz-block end face. If streaking appears, this may be an indication of low quality acetone.

6. Look through microscope and wipe with a light pressure on the quartz-block end face.

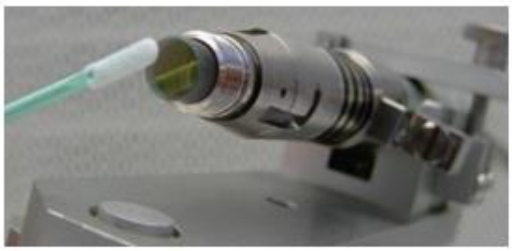


Figure 12-6 Quartz-block end face cleaning

7. Only use a cleaning swab for a maximum time of 20 seconds.
8. Use the canned air to clean off any dust that may have accumulated on the ferrule
9. Remove the fiber connector from the microscope cleaning station
10. When returning the fiber, hold the fiber so the quartz-block is facing down to avoid any dust or debris from settling on it.
11. Screw the ferrule back onto the fiber connector, being careful not to come in contact with any of the cleaned surfaces.
12. Remove the protective cap from the receiving optical connector.
13. Carefully insert the fiber connector into the optics immediately. When inserting the fiber connector, line up the red dots of the fiber connector (a) and receiver (b) and insert the connector gently until it stops (see Figure 12-7).

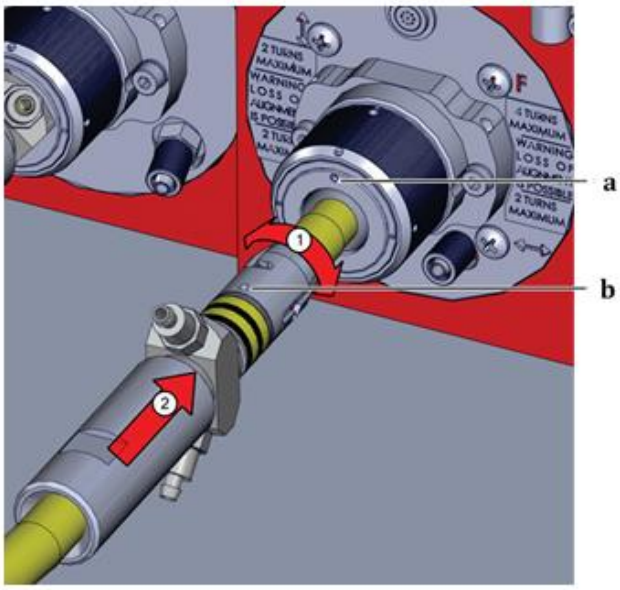


Figure 12-7 Inserting the fiber connector

14. Rotate the large pin behind the bayonet mount clockwise until it clicks into place (3).
15. Rotate the grooved bayonet mount clockwise (4) until it is tight in order to secure the fiber connector (see Figure 12-8).

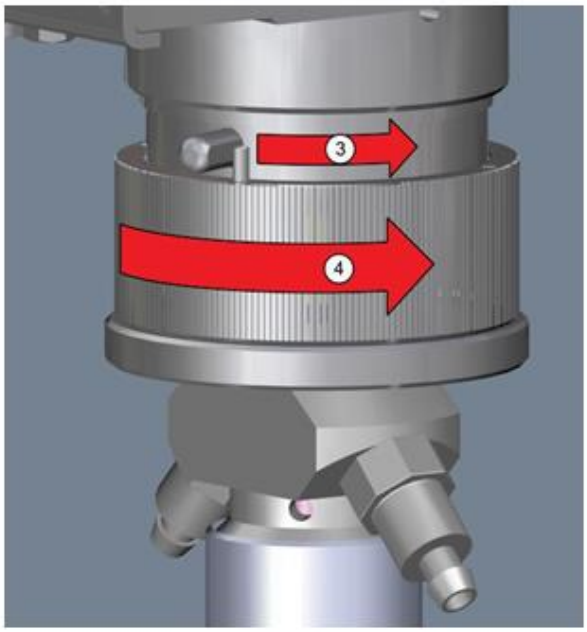


Figure 12-8 securing the fiber connector

Protective glass option

1. Adjust the focus of the microscope to the quartz-block end face.
2. Check the quartz-block end face for impurities. If impurities are observed, remove the protective glass and follow the above steps x threw x.
3. If the protective glass is dirty, use the same method to clean the glass.
4. Alternatively, replace the dirty protective glass. Be careful not to come in contact with any of the cleaned surfaces.

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3. All requests for repair or replacement under this warrantee must be made to IPG within 30 days after discovery of the defect (but no later than 7 days after warranty expiration).
4. All products returned to IPG but which meet applicable specifications, not defectively manufactured or used not in accordance with IPG's User's Guide, will result in the Owner being charged IPG's standard examination charge.
5. Complete packaging list with product model and serial number will ensure prompt repair.
6. Be sure to include with the returned product your "ship to" address for the return of the serviced product.

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Shipping Address for Returns to US

IPG Photonics Corporation
50 Old Webster Road
Oxford, MA 01540
Attn: Product Returns
Tel: (508)-373-1157

Shipping Address for Returns to Germany

IPG Laser GmbH
Siemensstrasse 7, D-57299
Burbach, Germany

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Tel: +49 2736 44 20 8451

E-mail: support.europe@ipgphotonics.com

Italy:

Tel: +39 0331 1706 908

E-mail: support@ipgphotonics.it

Poland:

Tel: +48 32 721 22 22

E-mail: support.poland@ipgphotonics.com

Japan:

Tel: +81-45-716-9833

E-mail: service@ipgphotonics.co.jp

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E-mail: #IPGK-CS@ipgphotonics.com

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E-mail: ipgindia@vsnl.net

Turkey:

Tel: +90 (216) 593 3033

E-mail: support.eurasia@ipgphotonics.com

Taiwan:

Tel: +886(2)27933582

E-mail: Support.Taiwan@ipgphotonics.com

Appendix A: Dew point operating conditions

Dew point temperatures

In order to prevent damage to the laser or the optics due to condensation, the DI water temperature must be adjusted according to the dew point table.

The problem of condensation occurs in environments in which the temperature and humidity are too high.

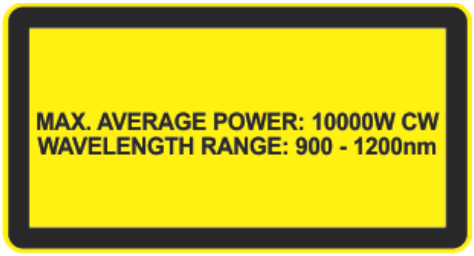
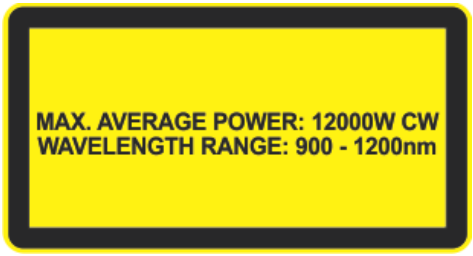
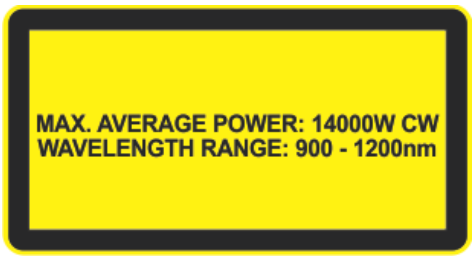
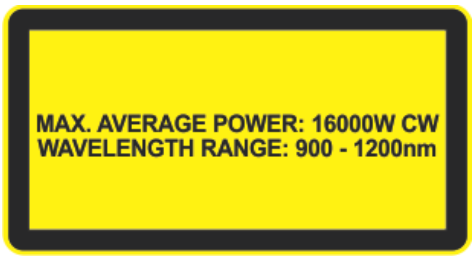
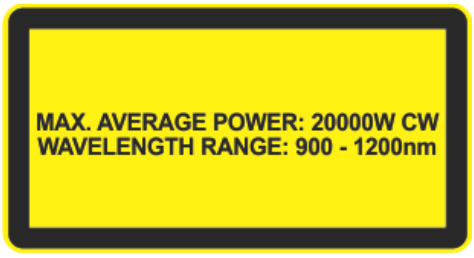
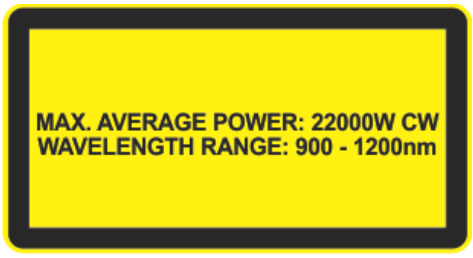
To prevent condensation, the cooling water temperature must always be kept above the dew point.

	Relative air humidity, %															
Air temperature	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**
16°C				0	2	4	5	7	8	9	10	11	12	13	14	15
18°C			1	3	4	6	8	9	11	12	13	14	15	16	17	18
21°C		1	3	5	7	9	11	12	13	14	16	17	18	18	19	21
24°C		3	6	8	9	11	13	14	16	17	18	19	20	21	22	23
27°C	2	5	8	10	12	14	16	17	18	19	21	22	23	24	25	26
29°C	4	7	10	12	14	16	18	19	21	22	23	24	26	27	28	28
32°C	7	10	12	15	17	19	21	22	23	25	26	27	28	29	31	31
35°C	9	12	15	17	19	21	23	24	26	27	29	30	31	32	33	34
38°C	11	14	17	20	22	24	26	27	29	30	31	33	34	35	36	37

Table 13-1 Dew Point Limits

Appendix B: Emission level specific labels

YLS-500	YLS-600
	
YLS-700	**YLS-1000**
	
YLS-1500	**YLS-2000**
	
YLS-2400	**YLS-2500**
	

YLS-3000	YLS-4000
	
YLS-5000	**YLS-6000**
	
YLS-7000	**YLS-8000**
	
YLS-10000	**YLS-11000**
	

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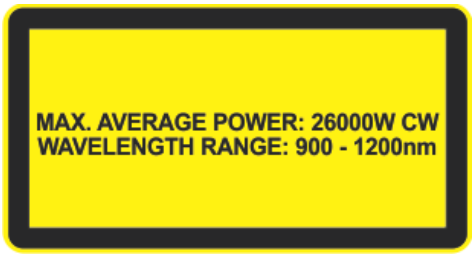
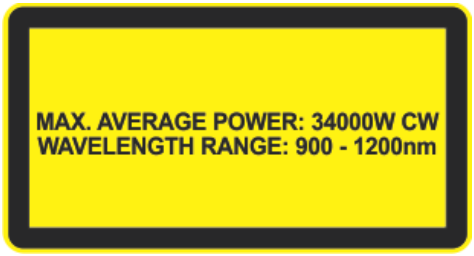
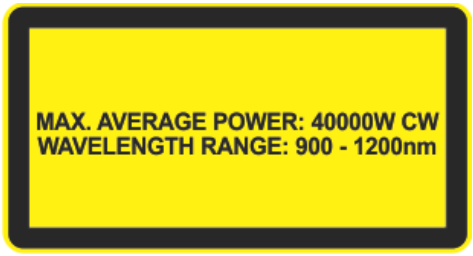
	
YLS-17000	**YLS-20000**
	
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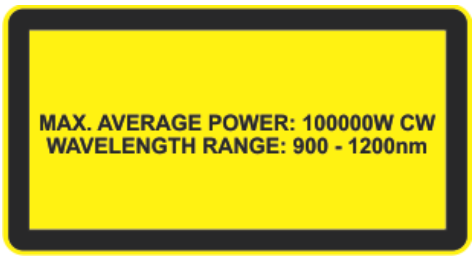	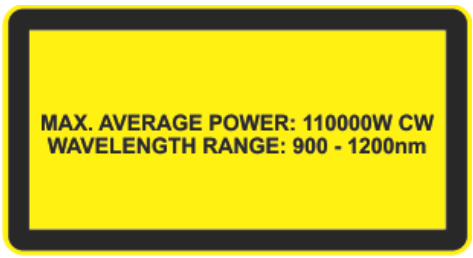
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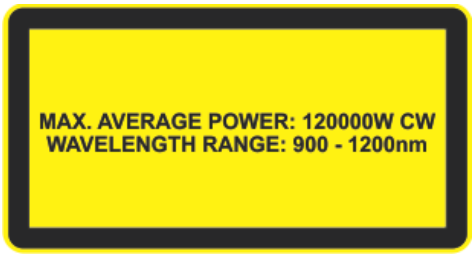	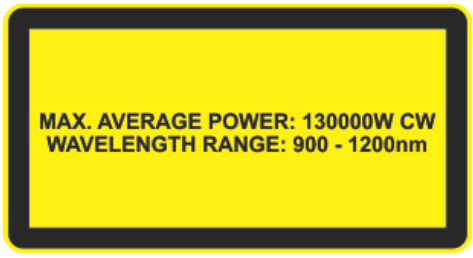

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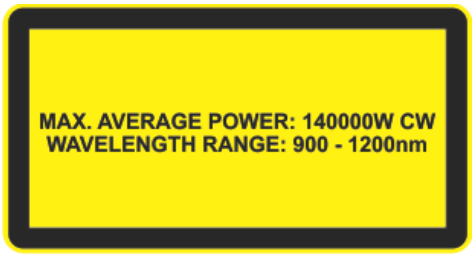	
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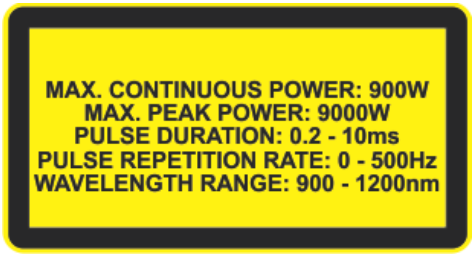	
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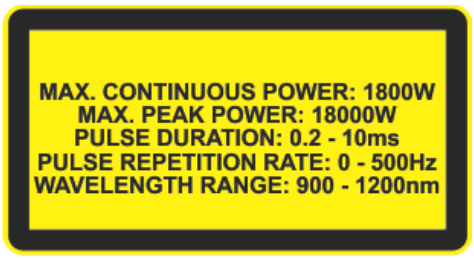
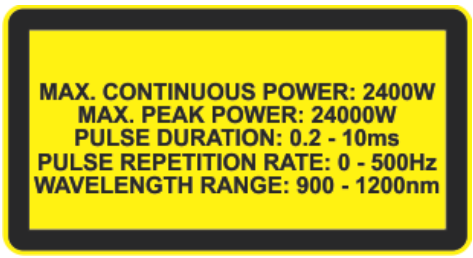
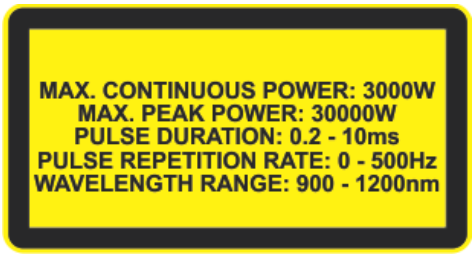
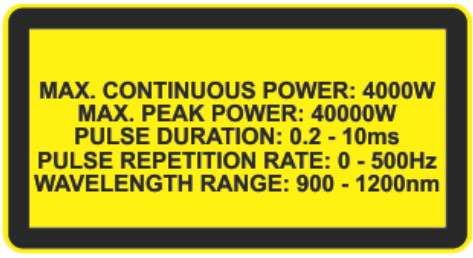
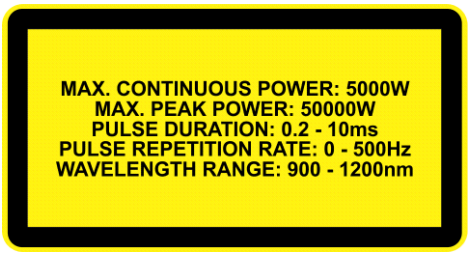
	
YLS-1500/15000-QCW	**YLS-2000/20000-QCW**
	

QCW-YLS-2300/23000-QCW	
	

Appendix C: Installation request form

Please return the following form to IPG Service Department or call the IPG service dept. to schedule a laser installation

Service Number: (508) 373- 1157

Service Fax: (508) 373 - 1242

Thank you,
IPG Service Team
support@ipgphotonics.com

Company Name:		
Address	Street:	
	City:	
	State:	Zip:
Laser	Model Number:	
	Serial Number:	
Chiller	Model Number:	
	Serial Number:	
Site Contact	Name:	
	Primary Phone:	
	Secondary Phone:	
	*Email:	
Integrator Info	Company:	
	Contact:	
	Phone Number:	
	*Email:	
Requested Install Dates	From:	To:
Special Instructions		

***Note:** Email address will be used for receiving, scheduling, confirmation, and service reports from our system.

Appendix D: list of tables and figures

List of Tables:

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