

# Model EQ-1500 LDLS™ Laser-Driven Light Source



## Operation Manual

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Part Number DOC-4958



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## Chapter 1

### GENERAL INFORMATION

#### *Safety*

## WARNING

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This unit emits ultraviolet (UV) radiation that is harmful to humans. Avoid exposure to the direct or reflected output beam. Make certain that the appropriate output beam shields and optics are in place prior to energizing the unit. All interlocks must be satisfied prior to operation; failure to do so may lead to hazardous conditions.

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## CAUTION

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The EQ-1500 emits dangerous levels of UV radiation. Even short exposures to skin or eyes may cause burns. Ensure that only authorized personnel are in the vicinity of source during operation. Personnel in vicinity of operating source should wear protective eyewear, clothing, and gloves. Lighted UV warning lights and signs posted on doors to lab areas may help prevent accidental exposure.

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## WARNING



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The EQ-1500 utilizes an internal Class 4 IR laser capable of causing severe injury to eyes or skin. Do not open or attempt to service this unit. Contact Energetiq regarding any problems with the unit.

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### *General Precautions*

The output beam from the EQ-1500 should be blocked when not in use with an electronic shutter or other appropriate beam blocking device. Due to the absorption of the short wavelength light and the possibility of ozone production, the beam should always be either directly coupled to a fiber optic cable, or enclosed in an appropriate beam pipe, tube, or enclosed space. We suggest purging any beam transport space with dry Nitrogen gas, as this is also required for safe operation of the EQ-1500.

The source must be purged with dry nitrogen gas via the nitrogen input connector on the lamp head. The unit must be purged for a minimum of 10 minutes prior to operation in order to ensure that no ozone is created by residual oxygen inside the unit. It is recommended that any beam transport be purged for a similar amount of time.

The EQ-1500 controller must be connected to an appropriate closed-loop water chiller system. The water system must be capable of maintaining 0.5gpm at 18°C with a minimum of 200W cooling capacity

The EQ-1500 source must also be cabled correctly and connected to a socket with a protective earth ground prior to operation. Failure to do so may result in an electrical shock hazard.

Refer to the Installation section of this manual (Chapter 3) for details of the facilities connections.

There are no user-serviceable parts inside the EQ-1500. For any problems encountered during operation, please refer to the Troubleshooting section of this user manual. **If there is a component failure, do not attempt to open the chassis of the EQ-1500.**

The EQ-1500 utilizes a quartz lamp containing a high-pressure gas fill. Explosion of the lamp and possible injury from flying fragments can occur if the lamp is mishandled. **Never attempt to remove or replace the lamp.** If there is a failure of the lamp, the unit must be shipped back to the factory for refurbishment.

**Do not open the chassis of either the lamp unit or the power supply unit. Dangerous invisible infrared laser beams and hazardous voltages exist inside the units.** Opening the chassis both voids the warranty and exposes the user to dangerous radiation and hazardous voltages.

## CAUTION

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The EQ-1500 must be operated for its intended use and as described in this operating manual. Operation in an un-intended manner may result in dangerous conditions.

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## CAUTION

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

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### *Laser Information*

The EQ-1500 uses a patented (U.S. Patent #7,435,982, others pending) laser drive system to excite a plasma that radiates in the UV as well as the visible bands. Since the lamp unit contains an embedded laser, the EQ-1500 is defined as a Laser Product. However, the drive laser does not exit the system.

The parameters of the non-accessible internal laser are given below in Table 1.

Wavelength	975 nm
Emission Type	CW
Laser Power for classification	<40 mW via 7mm measurement aperture
Beam Diameter	~25 mm at aperture
Divergence	>100 mRad
Transverse Beam Mode	Highly irregular, diffuse

**Table 1:** Embedded Laser Parameters

No regular service or maintenance is required. Any service to the system must be performed only by factory authorized and trained technicians. To avoid eye injury, under no circumstances should the user open or modify the lamp unit.

The unit must not be operated if the covers are removed or it is defective in any way. Contact Energetiq if any problems with the equipment are suspected.

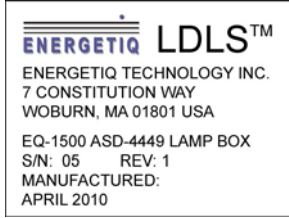
### *Labels and Safety Notification*

The following safety labels appear on the product. Figure 1 shows the location of each label on the EQ-1500 lamp unit.



UV Hazard warning label – indicates hazardous levels of UV light are present.

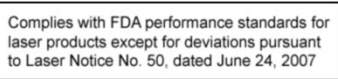




Manufacturer's identification label – gives the manufacturer's name and address, and the model, serial number, and date of manufacture of the equipment.



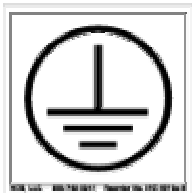
Explanatory label – states the classification of the laser product. Class 1 is the lowest hazard level classification.



Certification label – states that the equipment has been tested and verified to meet the standards indicated.



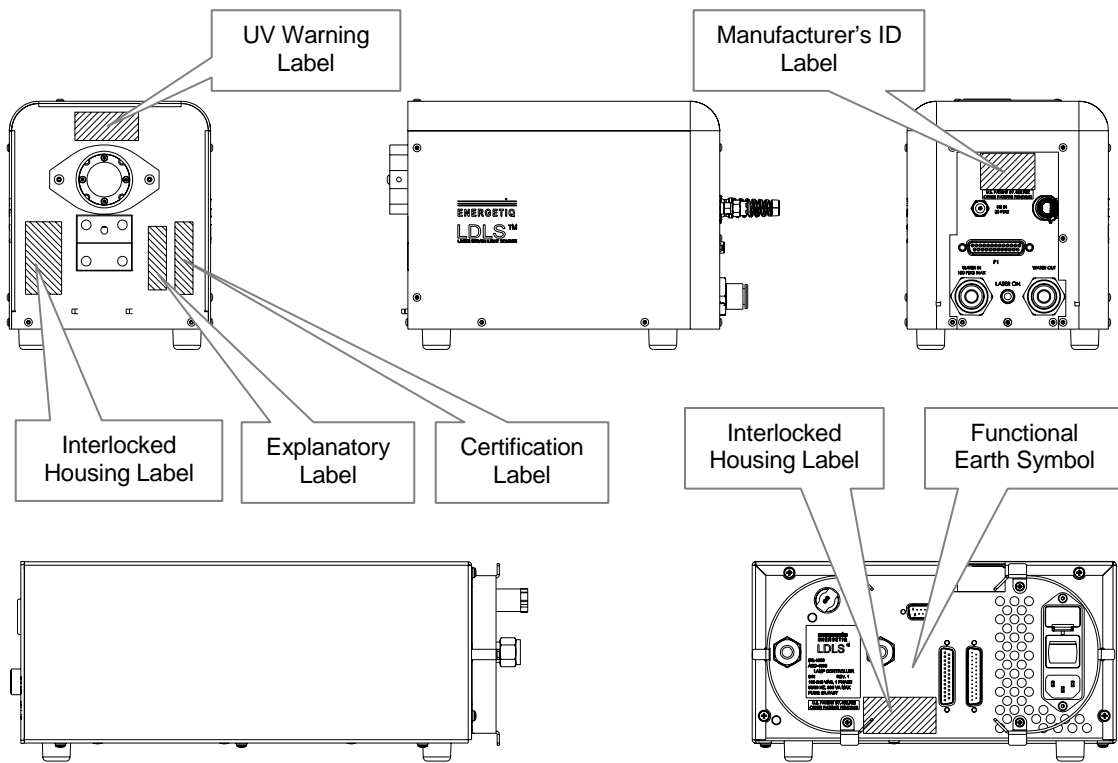
Interlocked housing label – notifies of a potential hazard when covers are removed and interlocks failed or defeated.



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Protective Ground (Functional Earth) symbol

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**Figure 1:** Safety label locations

### *Cover Interlocks*

The EQ-1500 is equipped with cover interlock switches to prevent operation of the source without the lamp unit and controller covers in place. Since no user service is permitted, these switches are intended for the protection of factory service personnel.

### *External Interlock*

An external interlock connector is provided for the customer's use. Any suitable normally-open contact can operate the interlock circuit. The unit is shipped with a shorted connector which may be used to connect to the user's interlock circuitry. The interlock circuit must not be grounded.

The interlock circuit must be connected to enable the operation of the unit. Should the interlock connection open during operation or standby, the source is immediately disabled, and all light output from the aperture ceases. The source is then latched off and will not restart until the interlock is restored and the lamp manually restarted.

## Chapter 2

### DESCRIPTION

#### *General*

The EQ-1500 is a DUV lamp system for a wide variety of applications. The lamp features high brightness, broad-band light from DUV wavelengths through visible and beyond. The output is very stable, and has a long lifetime before any service is required. The interface is quite simple, but robust enough for any lab or industrial environment.

The EQ-1500 system consists of a Controller unit, Lamp House unit, interconnecting signal/power cable, and interconnecting laser fiber optic cable. Connections to AC power, cooling water, and purge gas are required for operation.

The Controller unit contains the IR laser, laser power supply, laser cooling, a permanently attached laser fiber optic cable, and control electronics.

The Lamp House unit contains the lamp, igniter, laser focusing optics, and interlocks.

#### *Specifications*

##### *DUV Performance*

- Typical output spectrum: see Figure 2.
  - Upper, Blue line: typical EQ-1500 output
  - Lower, Red line: typical D2 lamp output

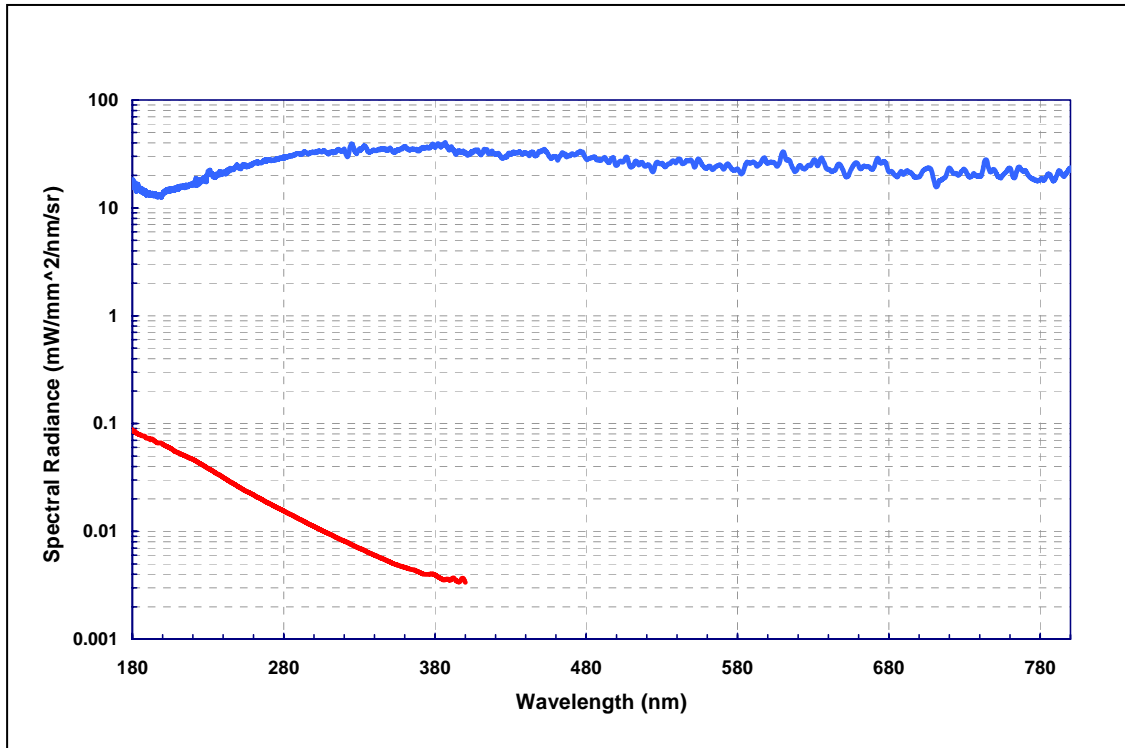


Figure 2: Typical output spectrum

### *Physical Specifications*

#### *System Dimensions (H x W x D), Weight*

- Lamp House 175 x 142 x 218 mm (6.9 x 5.6 x 8.6 in)
- Controller 142 x 254 x 419 mm (5.6 x 10.0 x 16.5 in)

#### *Weight*

- Lamp House 5 kg (11 lbs)
- Controller 6.5 kg (14.3 lbs)

### *Utility Requirements*

- Electrical 100–120/200–240 VAC  $\pm 10\%$ , 50/60Hz, 300VA max.
- Fuse: 250VAC, 8A Fast
- Cooling Water 0.03–0.07 MPa (5–10 psi) differential, 1.9–3.8 lpm (0.5–1 gpm), 18°C inlet temperature, controlled within  $\pm 1.0^\circ\text{C}$
- Purge Gas: Dry nitrogen, grade 6 preferred, 0.14 MPa (20 psig), 1 lpm

## Environmental Requirements

### Operating

- Temperature: 5–40°C
- Relative Humidity: non-condensing, 80% max. for temperatures up to 31°C, decreasing linearly to 50% max. at 40°C
- Altitude: 2000 m (6562 ft) max.
- Pollution Degree 2 (normally only non-conductive pollution; occasional, temporary condensation possible)
- Installation Category II
- Indoor use only

### Transport

- Temperature: -5–95°C
- Relative Humidity: non-condensing, 95% max.

### Identification of Controls

The following sections show the location of controls and other features, and give an overview of their functions. Refer to the “Installation” section of this manual (Chapter 3) for more detailed information.

### Controller Unit

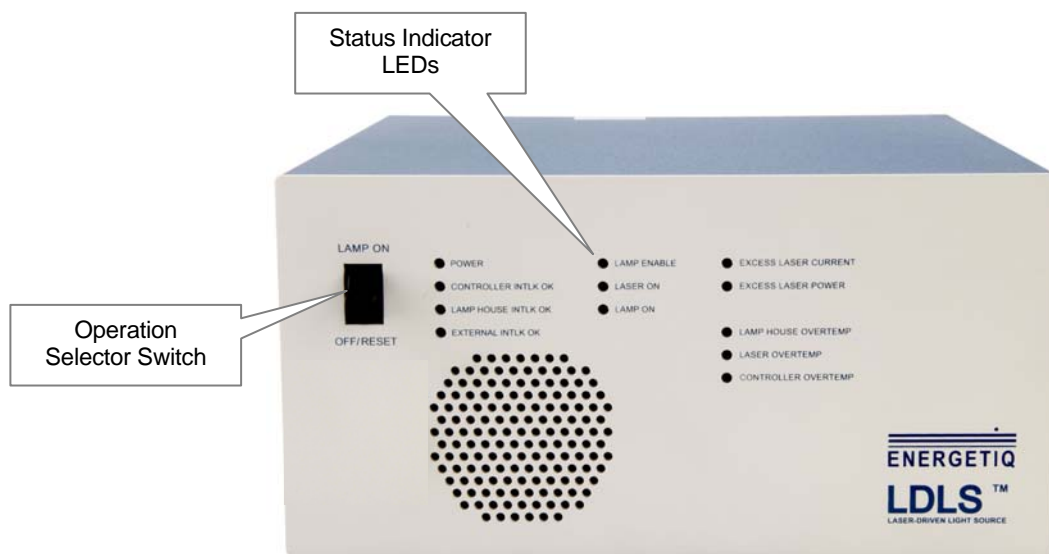


Figure 3: Controller front panel

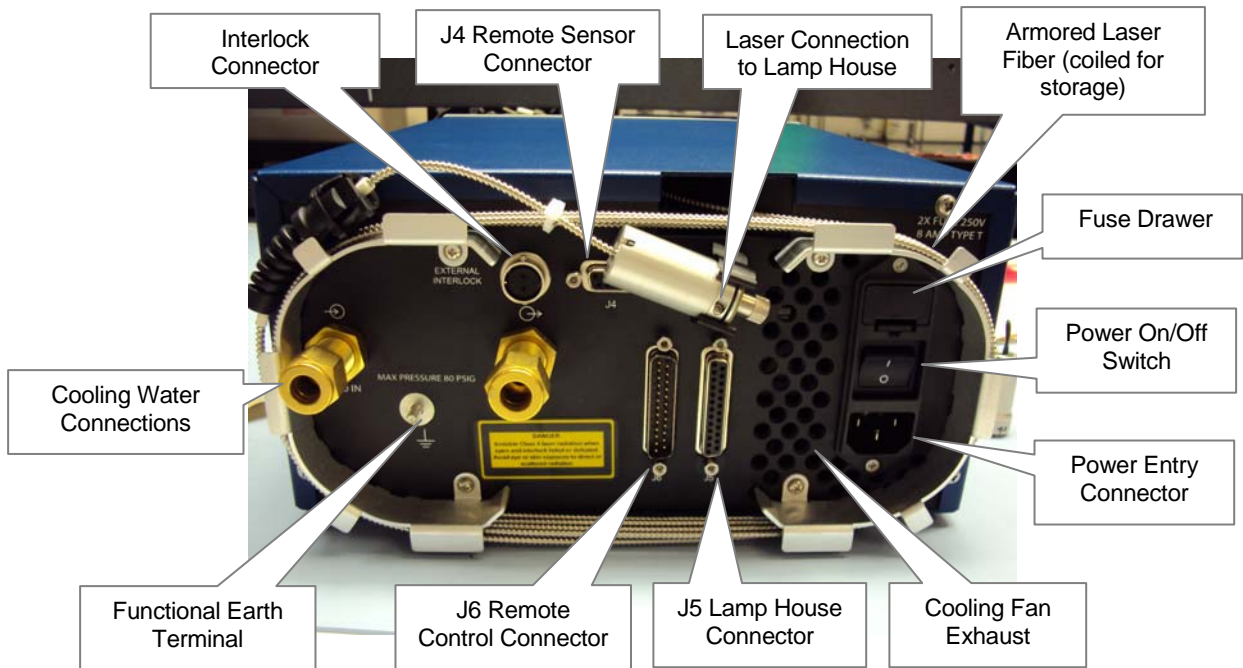
*Operation Selector Switch*

Momentary switch used to start or stop UV light output, or to clear a Fault condition.

*Status Indicator LEDs*

<b>Lamp controller Status LEDs</b>	<b>LED Color</b>	<b>Functional Description</b>
Power	Green	AC power is applied and power switch is on
Controller Interlock OK	Green	All interlocks in the Lamp Controller are satisfied
Lamp House Interlock OK	Green	All interlocks in the Lamp House are satisfied
External Interlock OK	Green	External interlock is satisfied
Remote Control	Green	Remote Control has been activated via connector J6. Local Control via the front panel Operation Selector Switch is disabled.
Laser On	Green	Laser current is on (Lamp on command has been asserted)
Lamp On	Green	Plasma has ignited and is operating
Lamp House Overtemp	Red	Bulb housing temperature has exceeded 90C (cooling failure)
Lamp Controller Overtemp	Red	Safety interlock for cold plate temperature has exceeded 70C (cooling failure)
Laser Overtemp	Red	Unit has shut off due because laser temperature has exceeded 40 degC. Cooling water flow or temperature for Lamp Controller is insufficient.
Excess Laser Current	Red	Laser current has exceeded 9A (does not stop operation)
Laser Fault	Red	Indicates that the laser has been disabled due to a fault. The Controller has requested laser power, but an IR sensor in Lamp House did not detect laser power. <b>Prior to Ignition:</b> <ol style="list-style-type: none"> <li>1. The unit has shut down due to a separate interlock fault</li> <li>2. The plasma has failed to ignite.</li> <li>3. A failure has occurred in the laser fiber.</li> </ol> <b>After Ignition:</b> <ol style="list-style-type: none"> <li>1. A failure has occurred in the laser fiber or laser delivery optics.</li> </ol>

Table 2: Front Panel LED functions



**Figure 4:** Controller rear panel

#### *Interlock Connector*

Connection point for a user-supplied external interlock contact. Contact must be closed or connector jumpered to enable operation. We recommend that any door or enclosure switches in the user's system be wired in series with this interlock connection.

#### *Laser Connection to Lamp House*

Connects to the Lamp House to supply laser energy to the lamp via the fiber cable.

#### *J4 Remote Sensor Connector*

Connection point for a user-supplied photosensor, when using remote control/remote sensing mode.

#### *Armored Laser Fiber*

Transmits laser energy from the Controller to the Lamp House. Handle the fiber gently and avoid creating sharp bends or kinks in the cable. Minimum bend radius for the cable is 30 mm (1.2 in). See instructions in Chapter 3 under “Installation Procedure” for details on inspecting, cleaning and installing the fiber.

#### *Fuse Drawer*

Two AC line fuses are installed in this fuse holder. The fuse type is 250V, 8A, Fast, 5 x 20mm

#### *Power On/Off Switch*

This switch is used as a main AC power switch. It can also be used as an emergency off switch.

#### *Power Entry Connector*

The power input connection to the EQ-1500 is made via a standard IEC 3-pin power entry module. A power cable is included with the system, but any standard cable can be used.

#### *Cooling Fan Exhaust*

The internal laser power supply is air cooled. To avoid overheating, do not obstruct this fan exhaust.

#### *J5 Lamp House Connector*

Provides power and control signals to the Lamp House. No connector or cable may be used with the EQ-1500 other than the one supplied.

#### *J6 Remote Control Connector*

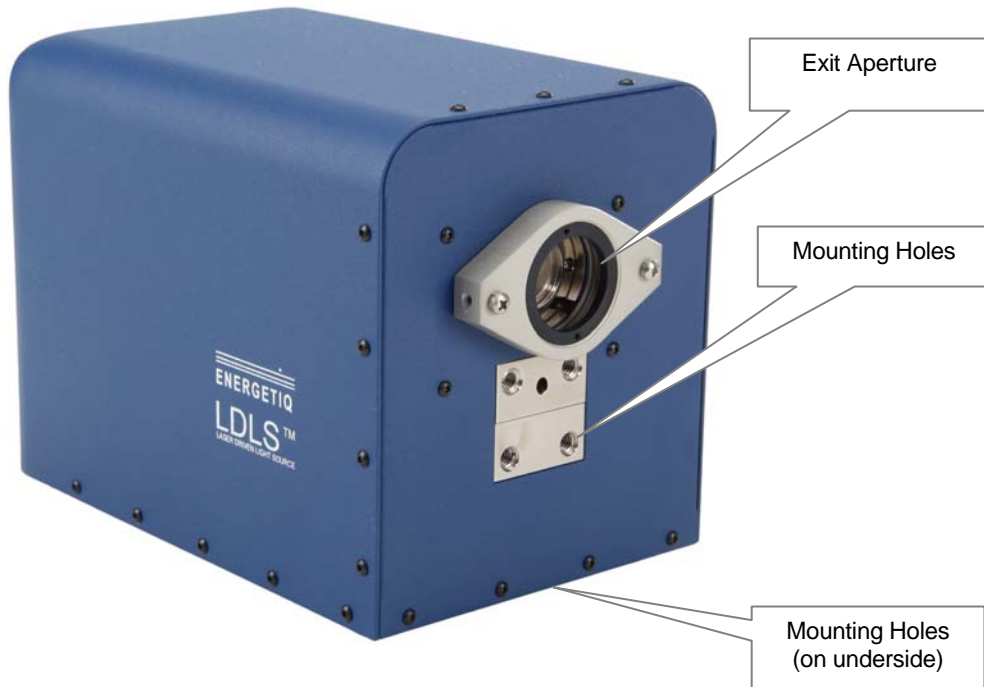
Provides access to control and status signals when operating the EQ-1500 in remote control mode.

#### *Cooling water connections*

Standard Swagelok® connectors for cooling water supply and return, providing cooling for the internal diode laser.



## *Lamp House Unit*



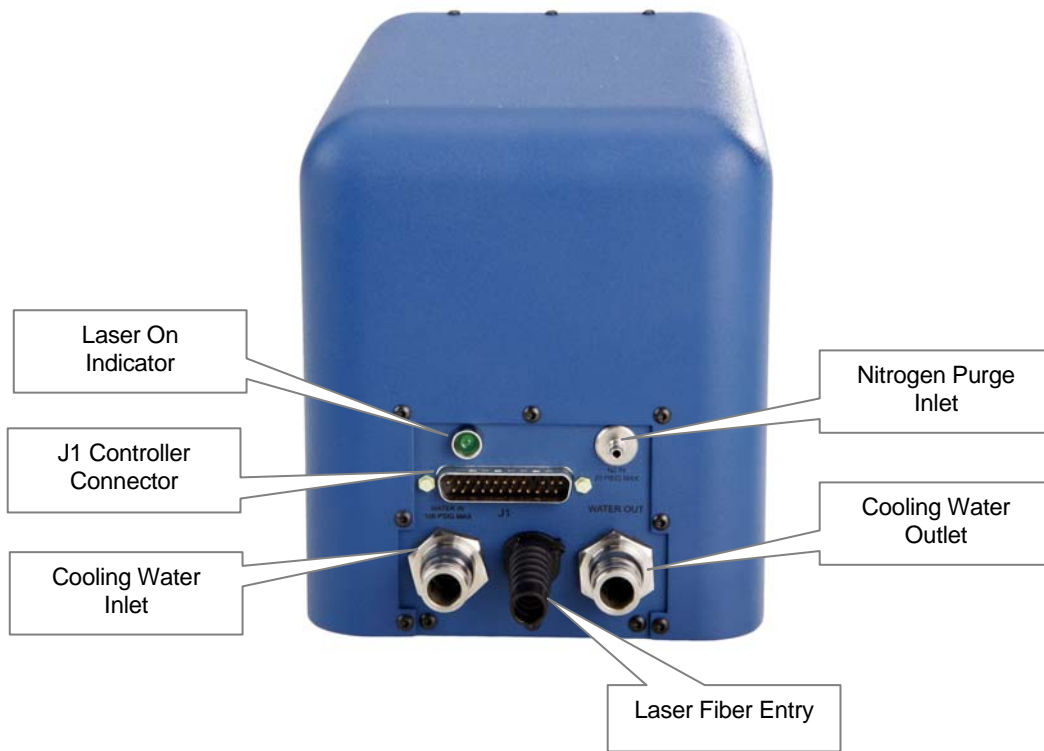
**Figure 5:** Lamp house unit front panel

### *Exit Aperture*

The exit aperture is a standard 1-inch threaded lens holder. The exit aperture also includes a high UV transmission quartz window. Do not attempt to remove or otherwise disturb this window. Doing so voids your warranty and may result in unsafe operating conditions

### *Mounting Holes*

The Lamp House may be free standing or mounted rigidly via threaded holes situated on the front and bottom of the unit. The  $\frac{1}{4}$ -20 threaded mounting holes are spaced on a 1-inch grid pattern.



**Figure 6:** Lamp house unit rear panel

*Laser On Indicator*

Indicates that the drive laser is on, and laser power is being transmitted to the Lamp House.

*J1 Controller Connector*

Interface for power and control signals from the Controller.

*Nitrogen Purge Inlet*

Inlet fitting for nitrogen purge gas, which is required to keep the optics clean, and to purge oxygen from the Lamp House to prevent the formation of ozone by UV radiation. There is no return fitting for the purge nitrogen. The purge flow normally escapes within the Lamp House enclosure, and then to atmosphere. The fitting is for ¼" OD tubing, and is a push-lock style connection.

### *Cooling Water Inlet/Outlet*

Push-lock tube fittings for the Lamp House cooling water.

### *Laser Fiber Entry*

Entry point and strain relief for the laser fiber optic cable. The cable is connected inside the Lamp House enclosure using a proprietary SMA-type connector. The EQ-1500 system is shipped with this connection already made.

## Chapter 3

### INSTALLATION

Installation of the EQ-1500 consists of connecting electrical, water, and gas supplies, and connecting the lamp output to the user's equipment.

#### *Unpacking*

Upon arrival, start by inspecting all parts of the system for completeness and any damage incurred in shipping. The EQ-1500 shipping box should contain: 1) EQ-1500 Controller unit, 1) EQ-1500 Lamp House, 1) Lamp House Signal/Power Cable, and 1) 2m IEC power cord. If any part is missing or appears damaged, contact the manufacturer. Do not attempt to substitute any parts. There are no user-serviceable parts inside the EQ-1500 Lamp House or Controller unit.

The EQ-1500 system is shipped with the laser fiber optic cable already connected between the Controller and Lamp House. Use care during installation and operation to avoid creating sharp bends or kinks in the cable. Minimum bend radius for the cable is 60 mm (2.4 in).

#### *Facilities Connections*

##### *Electrical Service*

The EQ-1500 can be operated from 100–120/200–240VAC, single-phase, 50-60Hz. Power consumption is approximately 200VA during normal operation, 300VA during lamp starting.

The EQ-1500 uses a detachable three-wire standard IEC 60320 C13 cord for connection to the power source. The cord also provides the connection to the protective earth circuit. Exposed metal parts of the EQ-1500 are connected to the protective earth ground via the cord and the outlet ground, providing protection against electrical shock. Never operate the EQ-1500 from an outlet without a properly connected protective earth ground.

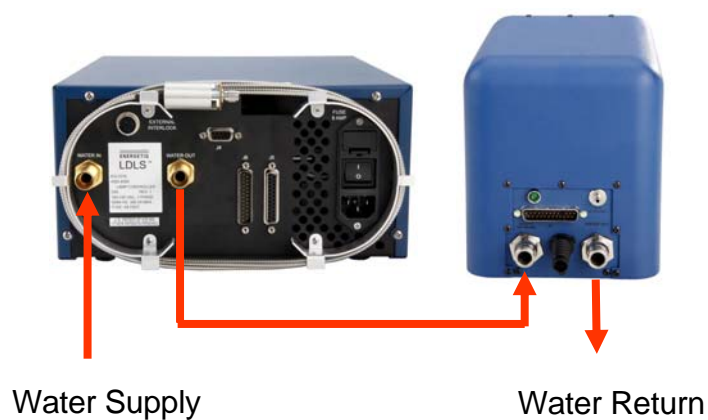
There is no selection switch for line voltage, it is automatically adjusted internally.

### *Cooling Water*

The EQ-1500 requires 1.9–3.8 lpm (0.5–1 gpm) water at a minimum of 0.14 MPa (20 psi). The temperature must be held at  $18 \pm 1$  degrees C. The pressure drop at 3.8 lpm (1 gpm) through the cold plate is less than 0.07 MPa (10 psi). There are several thermoelectric and direct water-to-water chillers that can satisfy these requirements. Tight temperature regulation is required for tight regulation of the lamp's output. If there are any questions or concerns, please contact the manufacturer for recommendations or guidance.

The Lamp House water connection fittings are push-to-connect fittings sized for 3/8" O.D. tubing. The Controller water connection fittings are 3/8" Swagelok® tube fittings.

The Lamp House and Controller should be connected in series, with the Controller upstream. See **Error! Reference source not found.** below.



**Figure 7:** Cooling water circuit layout

### *Purge Gas*

The EQ-1500 requires grade 6 or better nitrogen purge gas. The requirement for purge gas is a result of the EQ-1500 lamp's unique performance and operating principles. The EQ-1500

produces UV radiation capable of generating ozone gas when exposed to atmospheric oxygen. So first and foremost, the nitrogen purge gas is intended to displace any oxygen in the system's optical chamber. The optics assembly is in direct contact with this purge gas. UV optics are quite prone to UV photo contamination. Clean and pure nitrogen from either a dewar or research-grade N<sub>2</sub> bottle is recommended. **Do not use any other purge gas. Usage of clean dry air (CDA) may cause damage to internal optical components, and is likely to produce ozone gas, which is a potential inhalation hazard.**

The fitting is a push-to-connect fitting sized for 1/4" O.D. tubing. The suggested hose to mate to this fitting is either Nylon: Shore D 50-70, Polyethylene: Shore D 50-196, or Teflon 1/4" O.D. tubing.

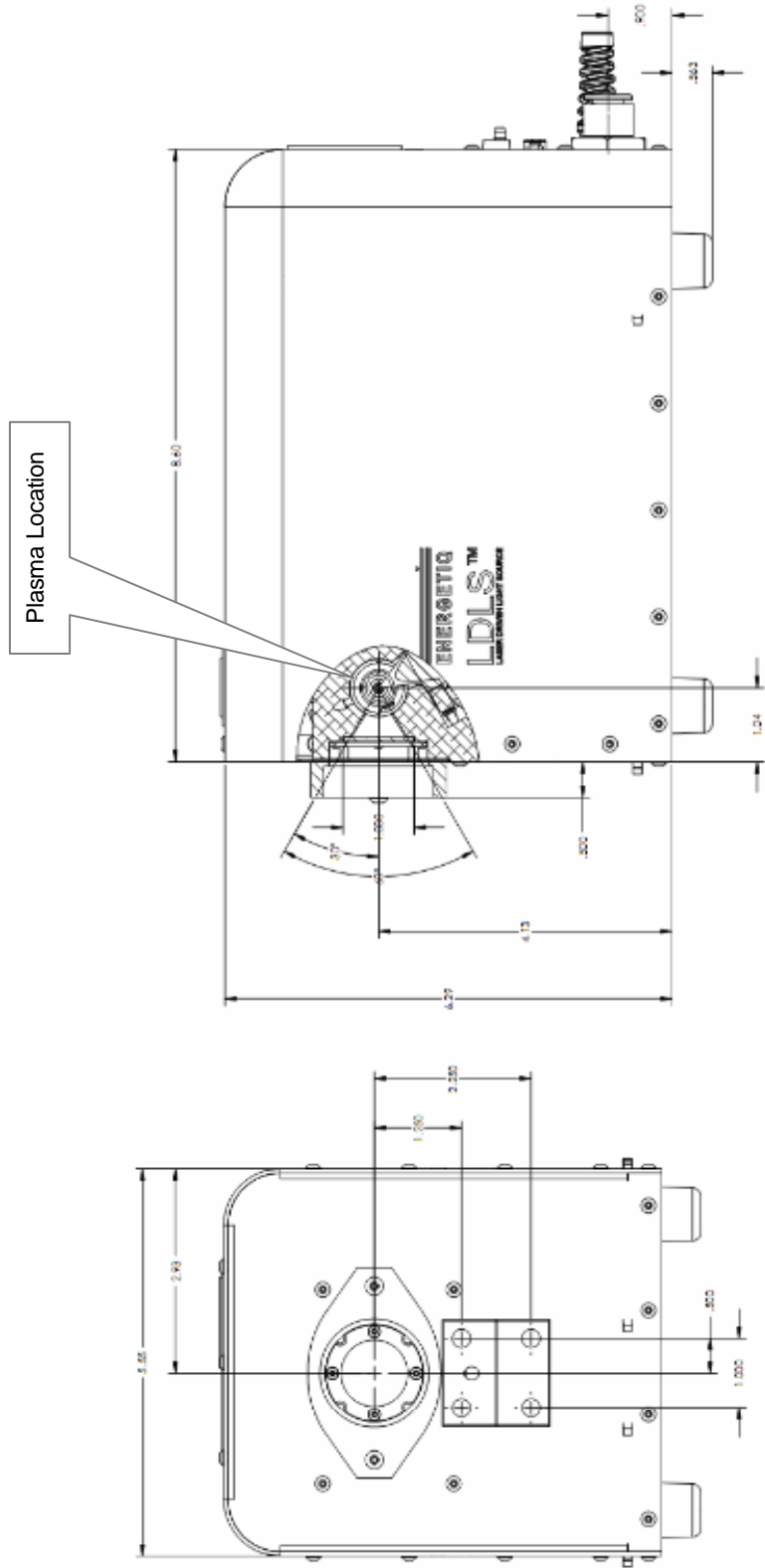
There is no return fitting for the purge nitrogen. The purge flow normally escapes within the lamp unit enclosure, and then to atmosphere.

#### *Optical Interface*

The exit aperture consists of a Newport LH-1-5 1.5" lens mount. This incorporates a 1.563-20 thread. Optionally, to utilize the full 0.5 NA output of the EQ-1500, this lens mount can be removed. With the lens mount removed, the machined mounting holes on the front panel can be used to interface to the EQ-1500 to external optics. Figure 7 shows the details of the optical interface. See Figure 8. below.

Any beam transport space should be purged with dry nitrogen to prevent the formation of ozone from atmospheric oxygen.

Figure 7: Optical interface



### *External Interlock*

The connector is a 2-pin circular connector, Hirose part no. RM12BPE-2PH. It can be connected to any suitable dry-contact switch, such as a snap switch for a beam line cover or other door switch. The contact should be rated for a minimum of 15mA at 15VDC.

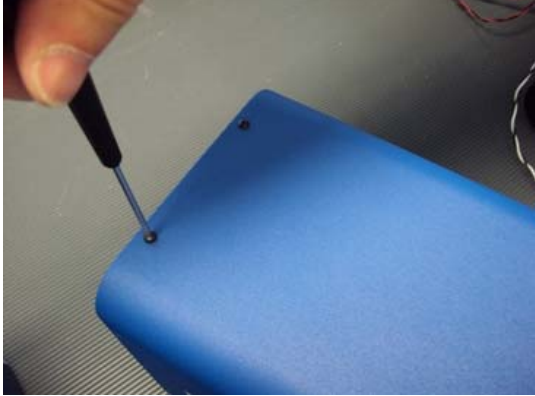


In order for the EQ-1500 to operate, this circuit must be closed. The system is shipped with a jumpered connector installed.





### *Installation procedure*

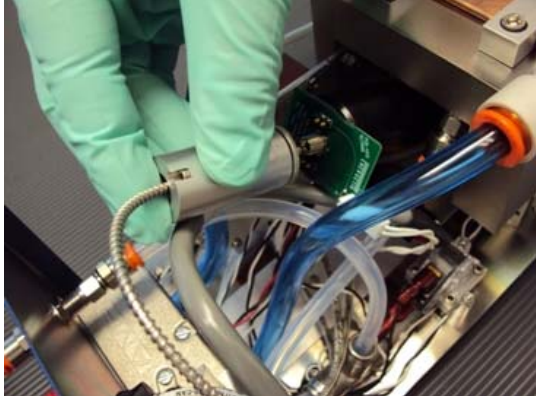
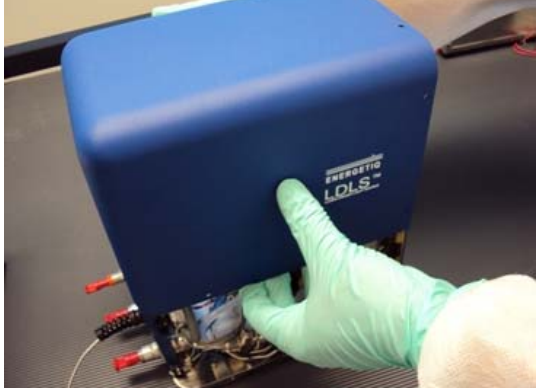
1. Mount the Lamp House rigidly to either an optical breadboard plate or another suitable mounting structure using the threaded holes on the bottom or front of the unit. The holes are sized to accept standard 1/4-20 optical bench hardware, and spaced to be compatible with a standard 1" grid mounting hole pattern..
2. Connect the Lamp House output aperture to the user equipment. The light output is coupled via a standard optical 1" threaded barrel. The beam should always be either directly coupled to a fiber optic cable, or enclosed in an appropriate beam pipe, tube, or enclosed space and purged with nitrogen. Operating the source without any output target or beam transport is not recommended, and may lead to unsafe operating conditions. Consult Energetiq for applications information and suggested configurations.
3. Set up the Lamp House with appropriate ultraviolet safety measures and laser light safety measures in place. It is recommended that any enclosure or aperture-blocking hardware utilize cover switches wired to the EQ-1500 external interlock circuit.
4. Place the Controller unit no farther than 6 feet from the lamp unit, as the supplied cable is only 2 meters long. Do not block the air vents at the front or rear of the Controller.
5. Connect the supplied Signal/Power Cable to the Lamp House and the Controller. The connectors are polarized to prevent errors in setup. Be sure to screw the attached flathead connector mounting screws fully with 12 in-lbs torque.
6. Connect cooling water and nitrogen purge gas to the Lamp House. Refer to "Facilities Requirements" above.
7. Connect cooling water to the Controller unit.
8. Verify that the main power switch on the back of the Controller is in the "OFF" position.



### Fiber installation procedure

Step	Picture	Description
8.1.		<p>Using the supplied 1/16" hex driver, remove the screws securing the lamp house cover. Carefully lift the cover straight up.</p>
8.2.		<p><b>CAUTION:</b> The shielded fiber located on the back of the controller has a minimum bend radius of 30mm. Use care not to bend the fiber too tightly.</p> <p>Cut the zip-tie securing the fiber to the back of the controller and then unwrap the fiber.</p>
8.3		<p>Remove the SMA cap located inside the lamp house.</p>

8.4a		<p>While supporting the end of the fiber, place the strain relief against the side of the lamp house. You will see two ‘fingers’ that lock the strain relief in place from the back side. These will need to slide over the inside surface of the panel.</p>
8.4b		<p>Rotate the strain relief around the corner while keeping the locking ‘fingers’ on the inside.</p>
8.4c		<p>Move the strain relief all the way to the left. You should not be able to pull the strain relief straight out.</p>
8.5		<p>Carefully remove the cap from the end of the fiber. Use care not to touch the end of the fiber. <b>THE FIBER END MUST BE KEPT VERY CLEAN.- VERY IMPORTANT – See section on “Fiber Cleaning” at the end of this section.</b></p>

8.6		<p>Again, use extreme care not to touch the end of the fiber. Carefully slide the fiber into the SMA connector and tighten finger tight.</p>
8.7		<p>Using care not to pinch any wires, slide the lamp house cover back into place and install the cover screws.</p> <p>The fiber installation is now complete.</p>

9. Connect the supplied IEC cord from the Controller to the power source.
10. Purge the EQ-1500 unit for at least 10 minutes prior to operation. **Failure to purge the system properly may damage the optics and may produce ozone gas.**
11. Verify that cooling water is flowing and the temperature is at maximum 18 degrees C. Operation of the EQ-1500 lamp at a higher temperature will result in reduced performance and possibly shorter lamp life.

Note: cooling water should be turned off when the lamp is not operating, to avoid condensation on internal and external cooling lines.

The system is now ready to operate.

## Fiber Cleaning Process

### *Fiber Cleaning Basics:*

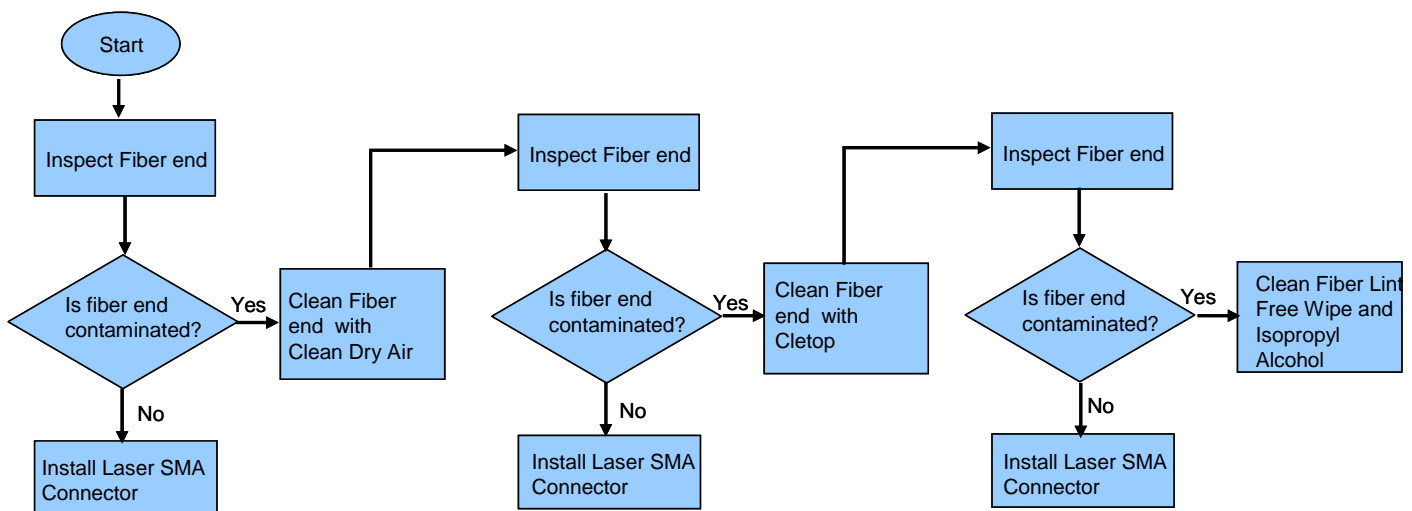
- The LDLS laser fibers contain very high power densities, and are susceptible to damage if the LDLS is operated when the fiber connector is not clean.
- Leave Laser Fiber SMA connected whenever possible
- Minimize the number of fiber connections
- If the SMA fiber must be disconnected, always use a cap on both ends:
  - Store caps open side down when possible
  - Blow out caps with CDA (Clean Dry Air) prior to use
- Never leave the fiber disconnected without a cap
- Follow the fiber inspection and cleaning process before making an laser fiber SMA connection
- Operating the LDLS with a contaminated fiber introduces the risk of decreased performance or damage to the unit
- Always remove AC power from the EQ-1500 before performing a fiber inspection or cleaning.



### *Fiber Inspection and Cleaning Process:*

Note - Fiber Inspection should only be performed with power removed from the EQ-1500 Power Supply Controller Unit

Figure 6: Fiber Cleaning Process Flowchart

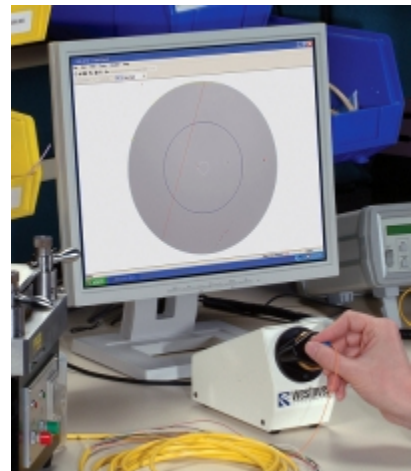


*Fiber Inspection Tools:*

Figure 7: Thorlabs CL-200 Handheld Fiber Inspection Scope



Figure 8: Westover FVD-2400: Benchtop USB / PC Operated fiber viewer



*Examples of Fiber Images:*

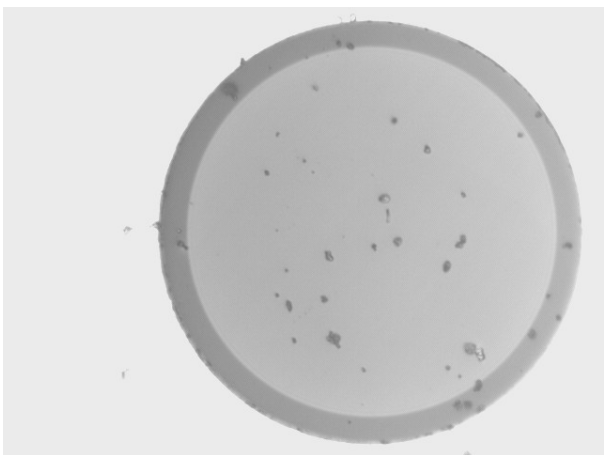


Figure 9: Contaminated Fiber end  
*Fiber Cleaning Tools:*

Figure 10: Clean Fiber End

1. Clean Dry Air
2. Dust Off (or similar clean, compressed air)
3. Cletop

[www.cletop.com](http://www.cletop.com)

Cletop Type A SMA cleaner with Blue tape	14100500
Box of 6 Replacement Blue Tape Reels	14100700

4. Lint Free Wipe with Isopropyl Alcohol
5. A modified adapter for the fiber inspection scopes is available through Energetiq.

## Chapter 4

### OPERATION

Once the lamp is set up properly, verify that all personnel that will be in contact with the lamp system are aware of the potential hazards involved with its operation. It is the responsibility of the user to verify that the lamp is being used safely.

To start the lamp:

1. Verify that all safety measures are in place, and that cooling water and purge gas are flowing.
2. Turn on the main power switch on the back of the unit.
3. The lights on the front panel of the Controller will indicate power and interlock status. Verify that the following indicators are lit:
  - POWER OK
  - CONTROLLER INTLK OK
  - LAMP HOUSE INTLK OK
  - EXTERNAL INTLK OK
4. Push the Operation Selector Switch momentarily up to the LAMP ON position. The EQ-1500 enters the start mode. While in the start mode, the LASER ON indicators will light (both on the Controller and the Lamp House). After 60 seconds, the lamp will ignite and the LIGHT ON indicator will light.
5. If the lamp does not start within approximately 60 seconds, start mode will terminate (i.e., the lamp stops trying to ignite), and the “Laser Fault” LED will illuminate. If this happens, push the Operation Selector Switch to OFF / RESET to clear the fault, then to LAMP ON to try again. [If the lamp still does not ignite after 1 or 2 more attempts, raise the cooling water temperature to 25°C and try again. Once the lamp ignites, lower the temperature setpoint back to 18°C for normal operation.]
6. For optimal results (best stability), the EQ-1500 should be allowed to complete a warmup period of 5 minutes.

#### *Stopping*

To shut off the lamp, push the Operation Selector Switch down momentarily to the OFF/RESET position. The lamp can also be shut off by shutting off the main power switch on the rear panel.

Opening the interlock chain will also stop the lamp, and the EXTERNAL INTLK OK indicator will go out. Closing the interlock will not restart the lamp; the fault must be cleared by pushing the Operation Selector Switch to the OFF/ RESET position, and then the EQ-1500 can be started again by pushing the Operation Selector Switch to LAMP ON again.

Cooling water should be shut off when the lamp is not operating, to avoid condensation on internal and external cooling lines. When shutting down for long periods, the main power switch may be shut off.

### *Remote Mode*

The EQ-1500 is controlled remotely using the 25-pin connector on the rear of the controller unit..

Electrical specifications are given below. Pin connections and descriptions of signals are given in Table 1.

### *Specifications*

#### *Connector*

- J6, 25-pin male d-sub
- Mating connector: standard 25-pin female d-sub, AMP part number 5-747913-2 or equivalent

#### *Digital inputs*

- Type: optocoupler LED input, anode internally connected to +5VDC through a 1K resistor, cathode connected to input pin
- Logic: active low (input is on when input pin is pulled to ground return pin)
- On state current: 3.8 mA
- Isolation: 5000 VRMS

#### *Digital outputs*

- Type: open collector to digital ground
- Logic: active low (output pin is at <0.8V when output is on)
- Maximum voltage: 15 VDC (internal surge protector clamps at 15V)
- Maximum load current: 30mA at 5VDC, 12mA at 12VDC
- Pullup resistor: none



- Surge- and ESD-protected to 15kV

<b>Control Connector:</b>	J6 DB25 male on Lamp Controller	
<b>Status Signals from Lamp Controller</b>	<b>Description:</b>	<b>Pin</b>
Lamp Controller Thermal Interlock OK		25
Lamp House Cover Interlock OK		3
Lamp House Thermal Interlock OK		24
External Interlock OK		4
Lamp Enable Active		23
Laser On		5
Lamp On Status		22
Laser Overtemp		6
Laser Fault	See page 10 for detailed description	2
Digital Signal Ground		1
<b>Command Signals from the tool controller:</b>		
Remote Control Enable	Disables Front panel switch	11
Remote Control Enable Return		16
Lamp Enable		13
Lamp Enable Return		14
Lamp On		12
Lamp On Return		15
Unused pins:	8,9,10,17,18,19,20,21	

## Chapter 5

### TROUBLESHOOTING

See below if any problems are encountered in operating the EQ-1500.

Also see page 10 for detailed description of LED signals.

Condition	Action
POWER OK indicator not lit	<ul style="list-style-type: none"> <li>• Check line cord and fuse.</li> <li>• Check that the main power switch on the rear panel is in the ON position.</li> </ul>
EXTERNAL INTLK OK indicator not lit	<ul style="list-style-type: none"> <li>• Check external interlock circuit or jumper plug</li> </ul>
CONTROLLER INTLK OK indicator not lit	<ul style="list-style-type: none"> <li>• Internal cover switch in the Lamp Controller is open. Install Cover.</li> </ul>
LAMP HOUSE INTLK OK indicator not lit	<ul style="list-style-type: none"> <li>• N2 purge pressure &lt; 15 psi</li> <li>• Cover switch is open on Lamp house</li> <li>• Laser Fiber SMA connector is not properly installed at lamp house.</li> <li>• Control cable between Controller and Lamp house is not installed.</li> </ul>
LAMP HOUSE OVERTEMP indicator lit	<ul style="list-style-type: none"> <li>• Check for sufficient Lamp House cooling water flow and temperature.</li> <li>• Allow system to cool and try operating again. If condition persists, contact Energetiq.</li> </ul>
LASER OVERTEMP or CONTROLLER OVERTEMP indicator is lit	<ul style="list-style-type: none"> <li>• Check for sufficient Controller cooling water flow and temperature.</li> <li>• Ensure that Controller air vents are not obstructed.</li> <li>• Allow system to cool and try operating again. If condition persists, contact Energetiq.</li> </ul>
Lamp fails to ignite	<ul style="list-style-type: none"> <li>• Ensure that cable from Controller to Lamp House is securely attached.</li> <li>• Ensure that Controller cooling water flow and temperature are within spec.</li> </ul>

	<ul style="list-style-type: none"> <li>• Contact Energetiq if condition persists.</li> </ul>
Laser Fault	<p><b>Prior to Ignition &amp; No Other Faults:</b></p> <ul style="list-style-type: none"> <li>• Clear Fault (Operation Selector Switch to Reset) and attempt again. If Laser Fault appears immediately, there is likely a problem with the laser delivery optics; contact Energetiq.</li> </ul> <p><b>Prior to Ignition &amp; Other Faults Occur</b></p> <ul style="list-style-type: none"> <li>• Correct the other indicated fault condition, clear the fault (Operation Selector Switch to Reset) and attempt again.</li> </ul> <p><b>After Ignition (Plasma On):</b></p> <ul style="list-style-type: none"> <li>• Attempt again. If a Laser Fault appears immediately, there is a likely a problem with the Laser delivery optics; contact Energetiq.</li> </ul>

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