

# Model TLS-EQ-9-S

## LDTLS<sup>®</sup>

# Laser-Driven Tunable Light Source



## Operation and Maintenance Manual

Revision 8

November 2024

DOC-9220

ENERGETIQ  
A **HAMAMATSU** Company

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Energetiq Laser-Driven Light Source (LDLS®) products are designed to be RoHS and REACH compliant and possess a CE marking. For a list of compliance documentation, including the Declaration of Conformity, visit [www.energetiq.com/compliance](http://www.energetiq.com/compliance).

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## Chapter 1. Safety and Warranty Information

### 1.1 Safety Warnings

The TLS-EQ-9-S system is a Class 1 laser product. All appropriate laser safety measures should be in place before operating the system. Consult your facility's laser safety officer. Laser protective eyewear should be worn at all times while operating the system.

For further safety information, refer to ANSI Z136.1, Standard for Safe Use of Lasers, available from Laser Institute of America ([www.lia.org](http://www.lia.org)).

This product is designed and tested for use in an industrial environment. If this product is used in residential areas, EMI (electro-magnetic interference) may occur. This product must not be used in residential areas.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

**Note:** This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

#### WARNING



This system emits ultraviolet (UV) radiation that is harmful to humans. Avoid exposure to the direct or reflected output beam. Ensure 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.

#### CAUTION



The TLS-EQ-9-S system 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.

## WARNING



The TLS-EQ-9-S system 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.

## WARNING



- If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. Energetiq is not liable for damage or losses resulting from failure to comply with precautions or instructions listed in this manual.
- The power supply must be properly grounded by the outlet to prevent electrical shocks.
- Securely plug in the power supply cable to avoid looseness or play. Loose connections may result in faulty operation.
- When using the optional AC power adapter, never use a power supply voltage other than the one specified.
- If using the optional AC power adapter, you must use the associated AC power cord provided by Energetiq.

## WARNING



When working near the emitted light, always wear protective devices (conforming to ISO 4007/4849/4850/4854/4855 or equivalent regulations). The lamp installed in this housing emits intense ultraviolet rays, which are harmful to the eyes and skin. Looking directly into the emitted light or allowing the light to fall on the skin will damage eyesight or cause skin burns. The following label indicates hazardous radiation:



## 1.2 General Precautions

The output beam from the TLS-EQ-9-S system should be blocked when not in use with an electronic shutter or other appropriate beam blocking device. Due to the possibility of generating ozone with some models of TLS-EQ-9-S system when ambient oxygen is exposed to short wavelength light, the beam should always be enclosed in an appropriate beam pipe, tube, or enclosed space. Energetiq recommends purging any beam transport space with dry nitrogen gas.

The TLS-EQ-9-S system source must also be cabled correctly and connected to a power source with a protective earth ground prior to operation.

See [Chapter 4. Installation](#) for details of the facilities connections.

There are no user-serviceable parts inside the TLS-EQ-9-S system. For any problems encountered during operation, please contact Energetiq for assistance. If there is a component failure, do not attempt to open the TLS housing of the TLS-EQ-9-S system.

The TLS housing of the TLS-EQ-9-S system 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.

Do not open the enclosure of the TLS housing. Dangerous invisible infrared laser beams and hazardous voltages exist inside the lamp head. Opening the chassis both voids the warranty and exposes the user to dangerous radiation and hazardous voltages.

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

### 1.3 Laser Information

The TLS-EQ-9-S system uses a patented laser drive system to excite a plasma that radiates in the UV as well as the visible bands. Visit [www.energetiq.com/patents](http://www.energetiq.com/patents) for a list of product patents. A Class 4 laser is located in the TLS housing enclosure. The optical configuration of the housing ensures that the direct laser beam cannot exit the unit. The TLS-EQ-9-S system laser product is designated as Class 1 during all normal operation in accordance with IEC 60825-1.

The parameters of the non-accessible internal laser are given below in the table [Embedded Laser Parameters](#).

**Table 1. Embedded Laser Parameters**

Parameter	Value
Wavelength	974 nm
Emission Type	CW
Laser Power for Classification	< 8 mW via 7 mm measurement aperture
Beam Diameter	~25 mm at aperture

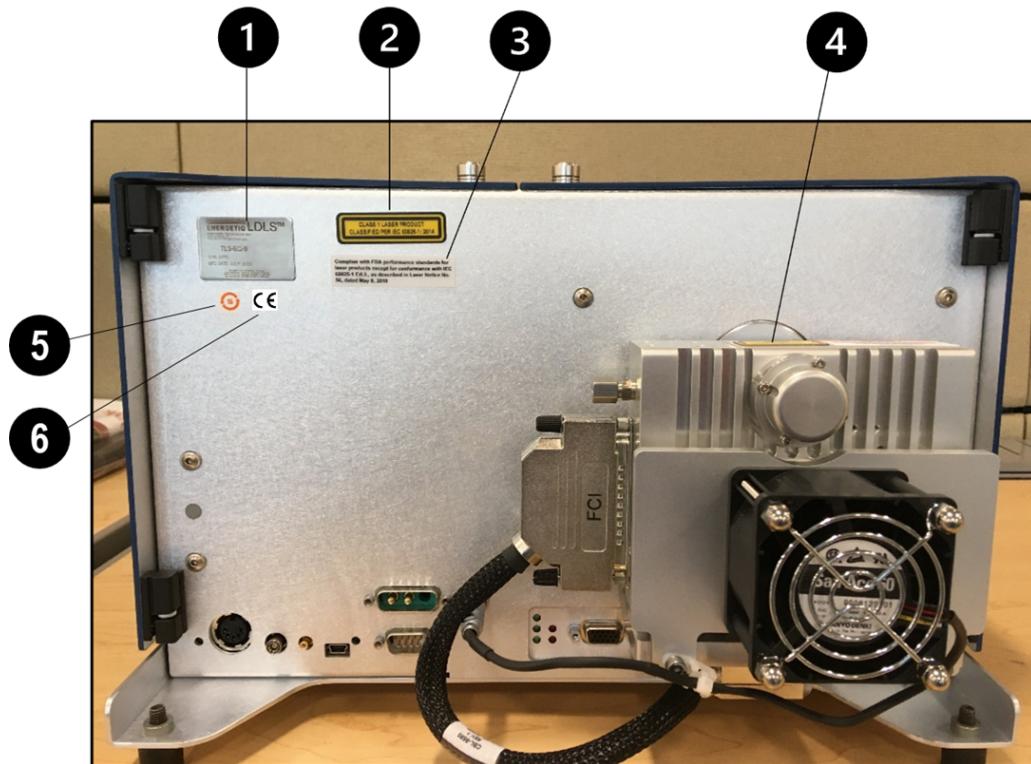
Parameter	Value
Divergence	> 100 mRad
Transverse Beam Mode	Diffuse

Any service to the system must be performed only by factory authorized and trained technicians. To avoid injury, under no circumstances should the user open or modify the EQ-9-HP lamp head enclosure or TLS-EQ-9-S system power supply.

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.

## 1.4 Labels and Safety Notifications

The following safety labels appear on the TLS-EQ-9-S system. The figure [TLS-EQ-9 Safety Label Locations](#) shows the location of each label on the TLS-EQ-9-S system. This also includes the the EQ-9-HP lamp head, which is part of the TLS-EQ-9-S system.



**Figure 1. TLS-EQ-9 Safety Label Locations**

**Table 2. TLS-EQ-9 Safety Label Meanings**

Label #	Label Picture	Description
1		<b>Manufacturer's Identification Labels</b> – Gives the manufacturer's name and address, and the model, serial number, and date of manufacture of the equipment.
2		<b>Explanatory Label</b> – States the classification of the laser product. Class 1 is the lowest hazard level classification.
3	<div style="border: 1px solid black; padding: 10px;">       Complies with FDA performance standards for laser products except for conformance with IEC 60825-1 Ed.3., as described in Laser Notice No. 56, dated May 8, 2019     </div>	<b>Certification Label</b> – Based on the requirements of 21 CFR 1010.2 “CERTIFICATION” and Laser Notice 56, the end product Model shall be provided with a label in a visible location when product is in use, indicating that the product “Complies with FDA performance standards for laser products except for conformance with IEC 60825-1 Ed. 3., as described in Laser Notice No. 56, dated May 8, 2019.”
4	 	<b>Non-Interlocked Housing Label</b> – Notifies of a potential hazard when covers are removed <b>UV Hazard Warning Label</b> – Indicates hazardous levels of UV light are present.

Label #	Label Picture	Description
5		<b>RoHS Label</b> – Indicates compliance with Restriction of Hazardous Substances laws.
6		<b>CE Label</b> – Indicates compliance with EU directives related to consumer safety, health, and environmental health.

### 1.4.1 Definition of Equipment and Document Symbols

The following symbols are found on the TLS-EQ-9-S system and in this document. The meaning of each symbol is listed below:



**CAUTION:** Controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.



**WARNING:** Invisible laser radiation. Avoid eye or skin exposure to direct or scattered radiation from Class 1 laser product.



Alternating current

### 1.5 Safety Interlocks

The TLS-EQ-9-S system is equipped with interlocks to prevent operation of the device when any of the following conditions are present:

1. Lamp bulb is not properly installed in the lamp head.
2. The laser fiber is not properly connected to the lamp head.
3. An external interlock is open.

#### 1.5.1 External Interlocks

External interlock pins are provided for the customer's use. Any suitable normally open contact or solid-state switch can operate the interlock circuit. The contact or switch should be rated for 80 mA minimum at 5 VDC.

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.

### 1.6 Warranty

For information on your TLS-EQ-9-S system's warranty, [contact your local distribution representative](#).

## 1.7 Correct Disposal of the Unit

When the TLS-EQ-9-S system has finally been removed from service, observe all local environmental regulations for proper disposal.

## 1.8 EMC Compliance Standards

- **IEC 61326-1 Emission Limits:** CISPR 11, Group 1, Class A
- **Immunity Requirements:** Table 2
- **Performance Level:**

- **Criteria A**

Light output	Light output remains above 80% and does not turn off.
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- **Criteria B**

Light output	Light output remains above 50% and does not turn off.
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- **Criteria C**

Light output	Even if the light turns off, it can be turned on again by manual operation of the operator.
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## Chapter 2. System Description

### 2.1 System Overview

The TLS-EQ-9-S system is a compact, highly stable tunable light source (TLS). It utilizes the Energetiq EQ-9-HP Laser-Driven Light Source (LDLS<sup>®</sup>) as a broadband light source. A monochromator is used to select the desired output wavelength. The monochromator output is fiber-coupled to the TLS-EQ-9-S system output.

The TLS-EQ-9-S system consists of a main TLS housing that includes the internal lamp controller unit and monochromator. The TLS-EQ-9-S system lamp head is installed on the exterior of the TLS housing. Connected to the TLS housing are the remote control, lamp head power supply, monochromator power supply, and interconnecting cables. Connection to nitrogen purge gas is strongly recommended for optimal performance.

For additional information, contact Energetiq Technology Technical Support Services at +1-781-939-0763 x111 or email: [SERVICE@Energetiq.com](mailto:SERVICE@Energetiq.com).

### 2.2 Description of System Components

The TLS-EQ-9-S system consists of a main TLS housing that includes the internal lamp controller unit and monochromator. Connected to the TLS housing are the remote control unit, lamp head power supply, monochromator power supply, and interconnecting cables. The system incorporates the Energetiq EQ-9-HP LDLS, a monochromator, and custom optics.



**Figure 2. TLS-EQ-9 System**

The following subsections provide descriptions of the system components and controls, and give an overview of their functions.

## 2.2.1 TLS Housing

The TLS housing contains:

- Monochromator Power Port
- Monochromator Control Port
- Lamp Head Power Port
- RS-485 Port
- Status Indicator LEDs
- Remote Control Port
- Lamp Head Nitrogen Purge Port
- Retroreflector Nitrogen Purge Port
- EQ-9-HP Lamp Head

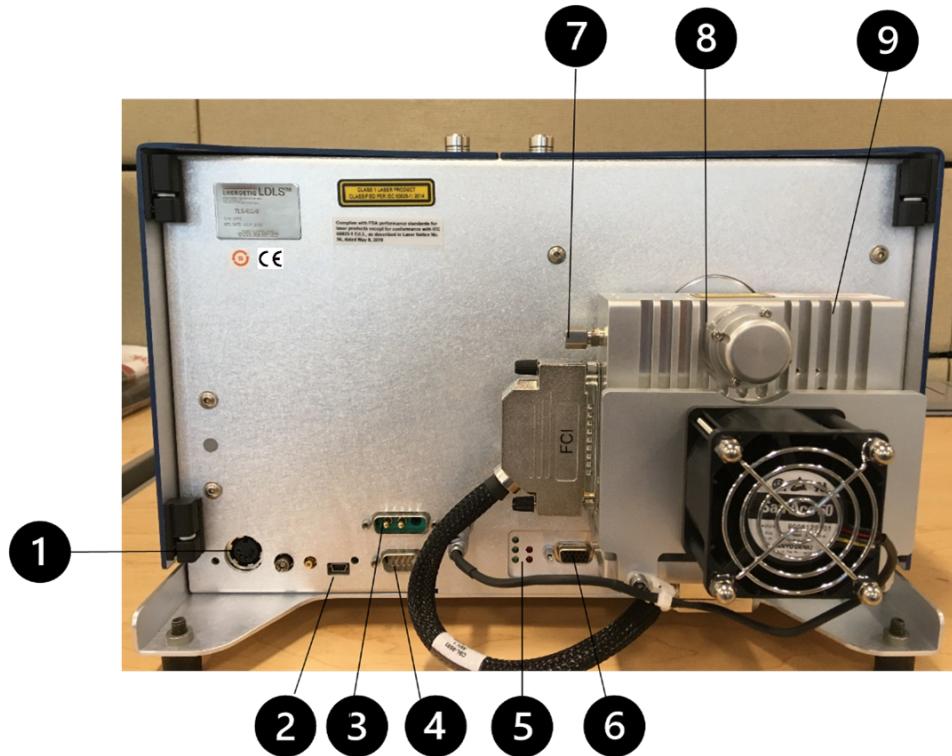


Figure 3. TLS Housing View

Table 3. TLS Housing Components

#	Component	Description
1	Monochromator Power Port	This port is a DIN connector for monochromator power (from external power supply).

#	Component	Description
2	Monochromator Control Port	This port is a standard mini-USB connector for control of the internal monochromator.
3	Lamp Head Power Port	This port is a jack-screw-secured input for 12 VDC power.
4	RS-485 Port	This port is for the optional RS-485 interface. See <a href="#">Appendix A. RS-485 Interface Commands and Pin Assignments</a> for electrical details and commands.
5	Status Indicator LEDs	See the table <a href="#">Status Indicator LEDs</a> for a list of descriptions. See <a href="#">Chapter 7. Troubleshooting</a> for more information.
6	Remote Control Port	This port provides access to control and status signals.
7	Lamp Head Nitrogen Purge Port	This is a fitting for the nitrogen purge gas. See <a href="#">3.4 Utility Requirements</a> for more information.
8	Retroreflector Nitrogen Purge Port	This is a fitting for the nitrogen purge gas. See <a href="#">3.4 Utility Requirements</a> for more information.
9	EQ-9-HP Lamp Head	This is the Laser-Driven Light Source that powers the TLS-EQ-9-S system.

Located on the TLS housing are LED system status indicators. The function of these indicators is described below in the table [Status Indicator LED Functions](#).

**Table 4. Status Indicator LED Functions**

LED Label	Meaning (When Lit)
POWER ON	DC power is connected to the lamp head power supply
LAMP ON	UV Light is on
LASER ON	Laser power is ON and laser light is being produced within the lamp head
CONTROLLER FAULT	<p>One of the following has occurred in the LDLS controller inside the TLS housing:</p> <ul style="list-style-type: none"> <li>• External interlock open</li> <li>• Controller internal temperature too high</li> <li>• Laser power not reaching setpoint</li> <li>• Laser temperature fault</li> <li>• Internal power supply voltage low</li> </ul>

LED Label	Meaning (When Lit)
LAMP MODULE FAULT	<p>One of the following has occurred in the lamp head in the TLS housing:</p> <ul style="list-style-type: none"> <li>• Control cable not connected properly</li> <li>• Lamp head internal temperature too high</li> <li>• Ignition failure</li> </ul>

## 2.2.2 TLS-EQ-9 Internal Components

The internal components of the TLS-EQ-9-S system include:

- Coupling Optics
- LDLS Controller
- Monochromator
- Optical Output SMA Connector
- Filter Wheel
- Kinematic Mount

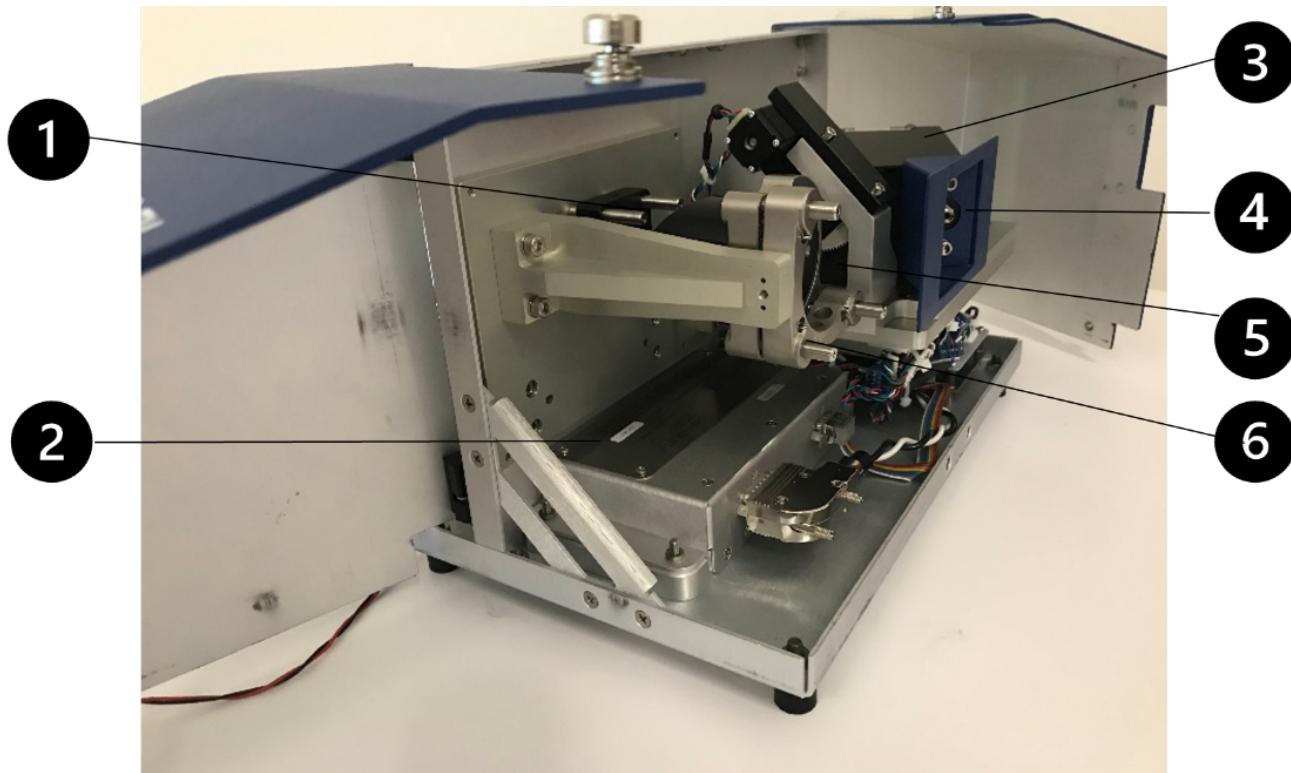


Figure 4. TLS-EQ-9 Internal Components View

**Table 5. TLS-EQ-9 Internal Components**

#	Component	Description
1	Coupling Optics	The coupling optics focuses light into the monochromator.
2	LDLS Controller	The LDLS controller contains the control electronics for the lamp head.
3	Monochromator	The monochromator is used to tune the system to the desired wavelength bands.
4	Optical Output SMA Connector	This connector is the SMA connector for light output.
5	Filter Wheel	Provides three options for the optical path: 1. Closed 2. Open 3. Order Sorting Filter
6	Kinematic Mount	The coupling optics is mounted on the kinematic mount. This mount has three (3) adjustment screws that can be used to align the input into the monochromator to maximize the output of the tunable light source.

## Chapter 3. System Specifications and Requirements

### 3.1 Optical Performance

- **Wavelength Range:** 380 nm – 1100 nm
- **Wavelength Step Size:** 2 nm
- **Sweep Time, 2 nm Step:** 20 ms
- **Output Connector:** SMA

### 3.2 Physical Specifications

#### Dimensions (H x W x D)

- **TLS Housing:** 244 x 360 x 284 mm (9.6 x 14.2 x 11.2 in)

#### Weight

- **TLS Housing:** 7.9 kg (17.5 lb)

### 3.3 Remote Interface Specifications

#### Digital Inputs

- **Type:** Optocoupler LED
- **Logic:** Active High
- **Input Voltage:** 5VDC
- **Input Current:** 8 mA

#### Digital Outputs

- **Type:** Open collector to ground (digital common)
- **Logic:** Active Low
- **Voltage:** 30VDC max
- **Sink Current:** 8 mA max

#### Power

- **Voltage:** 5VDC, referenced to digital common
- **Current:** 50 mA maximum

#### Serial Interface

- **Type:** RS-485 2-wire (half-duplex)
- **Connector:** Male 9-pin d-sub
- **Termination:** 120 ohms across receiver input (pins 2 and 7)
- **Interface Protocol:** See [Appendix A. RS-485 Interface Commands and Pin Assignments](#)
- **Port Settings:** 9600 bps, 8 data bits, 1 stop bit, no parity, no handshaking.

## 3.4 Utility Requirements

### Lamp Controller Electrical

- **Voltage:** 12 VDC  $\pm$  5% at 11.7A minimum (140W rating). Power consumption is approximately 100W during normal operation.
  - **Optional AC Adapter:** 100-240V  $\sim$   $\pm$  10%, 2.5A, 50-60Hz.

### Monochromator Electrical

- **Voltage:** 24 VDC
- **Power:** 50 W
- **Connector:** 5-pin DIN female
- **Mating Connector:** 5-pin DIN male, Switchcraft 05GM5MX or equivalent
- **Pin Connections:** pins 3, 5: 24 VDC; pins 1, 2, 4: 24 V return

### Purge Gas

- It is strongly recommended that nitrogen purge gas is used during operation of the TLS-EQ-9-S system. For optimal product performance, nitrogen gas purging of the TLS-EQ-9-S system is required.
- If nitrogen purge gas is not used, shorter lifetime and faster output degradation (especially in the ultraviolet wavelength range) is expected. Product use without nitrogen purge gas will result in the buildup of ozone (from atmospheric oxygen) and attenuate the light output in the 220-280 nm band, as well as below 200 nm in the presence of atmospheric oxygen and water vapor.
- Clean dry nitrogen, grade 4.8 or higher, filtered to 5um, 20 psig (0.14 MPa) supply pressure. With a 20 psig inlet pressure, the EQ-9-HP lamp head will consume approximately 0.5 slm of flow.
- **Fittings:** 4 mm push-to-connect

### Cooling Fan

- **30 CFM Forced Air Cooling** – Provided with TLS-EQ-9-S system

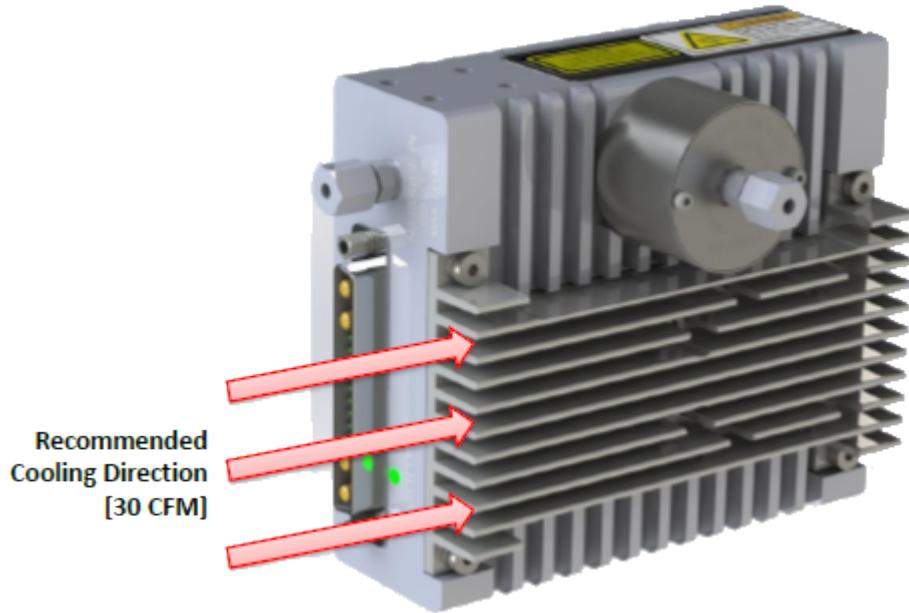


Figure 5. Recommended Cooling Direction

## 3.5 Environmental Requirements

### Operating

- **Ambient Temperature:** 15–30 °C.
- **Relative Humidity:** non-condensing, 80% max. for temperatures up to 31 °C, decreasing linearly to 50% max. at 40 °C.
- **Pollution Degree:** Pollution Degree 2 (normally only non-conductive pollution; occasional, temporary condensation possible).
- **Installation Category:** Installation Category II.
- **Indoor/Outdoor Use:** Indoor use only.
- **Overvoltage Category:** Overvoltage Category I.
- **Operating Altitude:** 2,000 m max.
- **IP Code:** IP20.

### Transport

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

## Chapter 4. Installation

### 4.1 Unpacking the System

Upon arrival, inspect all parts of the TLS-EQ-9-S system for completeness and damage incurred in shipping.

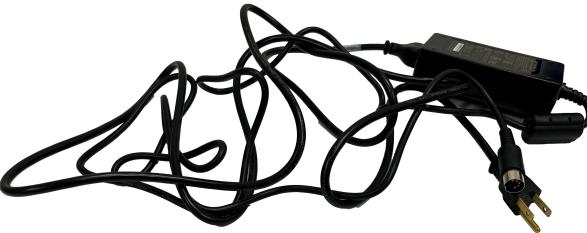
If any part is missing or appears damaged, contact Energetiq immediately. Do not attempt to substitute any parts.

#### 4.1.1 Required Contents

At a minimum, the TLS-EQ-9-S system shipping box contains the following required items:

**Table 6. Required Contents of Shipping Box**

Qty	Item Description	Picture
1	TLS Housing	 A blue rectangular housing labeled "ENERGETIQ LDLS™" and "LASER-DRIVEN TUNABLE LIGHT SOURCE". A coiled fiber optic cable is attached to the side.
1	Fiber (1,500 um diameter, 0.39 NA, metal jacket)	—
1	EQ-99-RC Remote Control with Interlock Jumper Plug and 15-Pin D-Connector I/O Cable	 A blue rectangular remote control unit with a keypad and several status LEDs. It is connected to a cable with a 15-pin D-connector.

Qty	Item Description	Picture
1	Mini-USB Cable (for monochromator)	
1	12 VDC Lamp Head Power Supply with 3-Pin Connector <ul style="list-style-type: none"> <li>• <b>NA AC Cable</b> – Assmann model no. AK500/U-1</li> <li>• <b>EU AC Cable</b> – Qualtek model no. 364002-D01</li> </ul> <p><b>Note:</b> If using the 12 VDC power supply, you must use the associated AC cable provided by Energetiq.</p>	
1	24VDC Monochromator Power Supply <ul style="list-style-type: none"> <li>• <b>EU AC Cable</b> – Qualtek model no. 364002-D01</li> </ul>	

#### 4.1.2 Unpacking Guide

1. Remove the straps and corner protectors from the pallet.



**Figure 6. Removing Straps and Corner Protectors**

2. Carefully cut the taped seams using a sharp utility knife – cut the two end seams first. Lift the top panel slightly and cut the center seam.
3. Open the box and remove all padding materials from the top to expose the equipment.



**Figure 7. Removing Padding**

4. Remove the fiber and accessory box. Set aside. Remove the cardboard filler panel. Carefully remove the foam spacers. Carefully remove the TLS housing.
5. Open the accessory box. Carefully cut the seams using a sharp utility knife. Use the checklist to verify that all components are present.

## 4.2 Installation Procedure

**Caution:** Mounting the housing in a different orientation will cause the plasma position inside the bulb to shift slightly and may cause performance variations.

The following section details how to install the TLS-EQ-9-S system.

To install the TLS-EQ-9-S system:

1. Place the TLS-EQ-9-S system on a stable surface. Ensure the inlet and outlet air vents of the TLS-EQ-9-S system are not blocked and are at least 6 inches away from any obstacles.



**Figure 8. Setting Up TLS-EQ-9 System**

2. Remove the protective cap from the TLS-EQ-9-S system optical output.



**Figure 9. Removing Protective Cap**

3. Connect the laser output fiber to the TLS-EQ-9-S system.

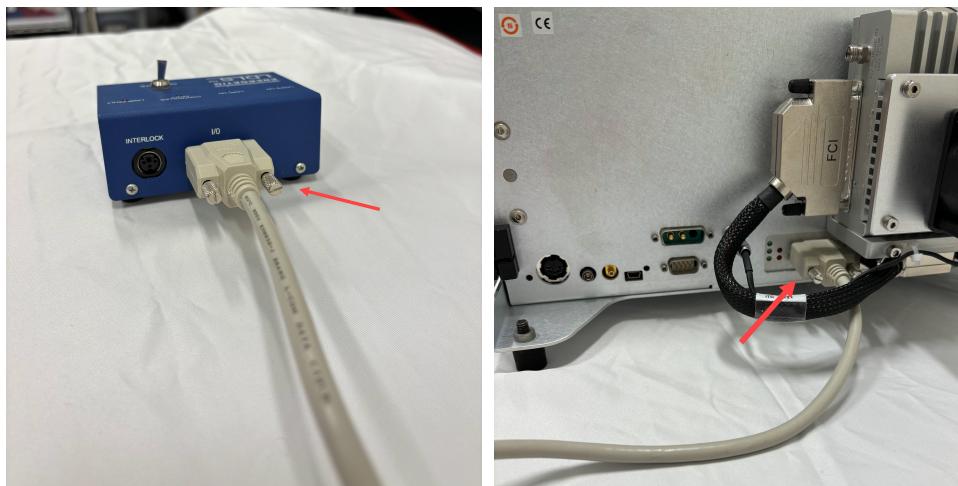


**Figure 10. Connecting Output Fiber**

4. If using nitrogen purge gas, connect nitrogen purge gas to the EQ-9-HP lamp head on the back of the TLS-EQ-9-S system.

Be sure that the nitrogen source is connected to the nitrogen purge port on the lamp head and nitrogen purge port on the retroreflector. Both fittings contain a flow restrictor to limit gas flow. The lamp head requires 1/8" OD tubing and the retroreflector requires 4 mm OD tubing.

5. Place the EQ-99-RC remote control on a clean, rigid surface. Install the supplied 15-pin I/O cable from the TLS-EQ-9-S system to the EQ-99-RC remote control.



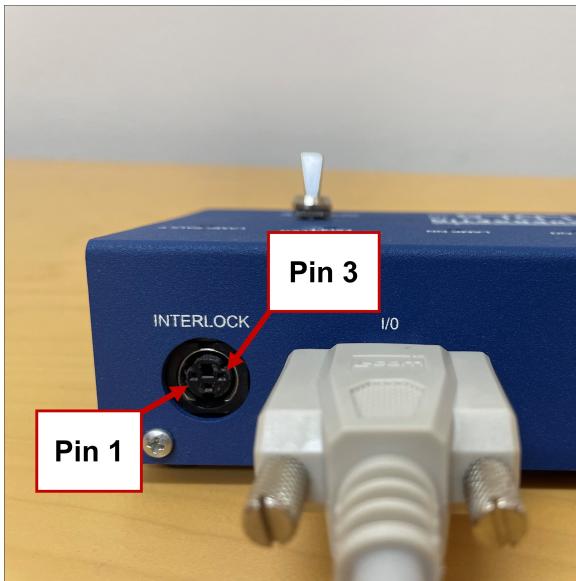
**Figure 11. Connecting the Remote Control to TLS Housing**

On the back of the remote control, insert the interlock jumper plug into the interlock port.



**Figure 12. Inserting the Interlock Jumper Plug**

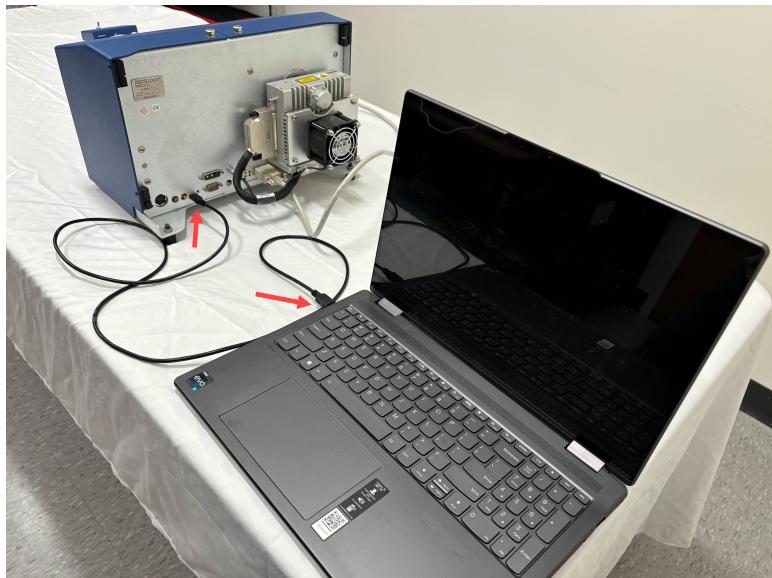
Alternatively, if you are integrating the TLS-EQ-9-S system into your own interlock system, connect a remote contact or solid-state switch across pins 1 and 3 in the interlock port.



**Figure 13. Interlock Pin Locations**

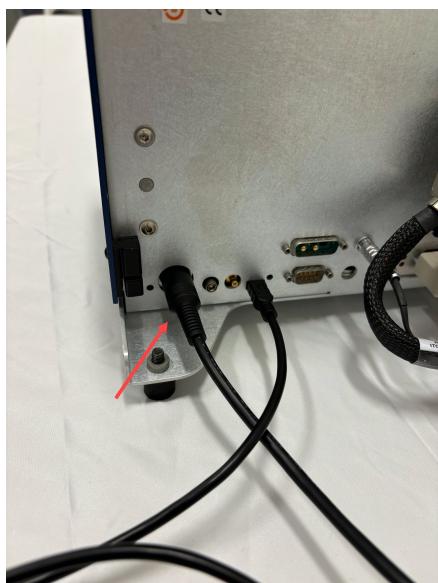
If using another remote control system, see [4.3.2 Installing Alternative Remote Control](#) for more information.

6. If using the RS-485 interface, connect the host computer to the RS-485 port on the back of the TLS-EQ-9-S system. For more information on the RS-485 interface, see [Appendix A. RS-485 Interface Commands and Pin Assignments](#).
7. Connect the host computer to the monochromator control port on the TLS-EQ-9-S system using the supplied mini-USB cable.



**Figure 14. Connecting to Monochromator Control Port**

8. Connect the monochromator power supply to the monochromator power port on the TLS-EQ-9-S system.



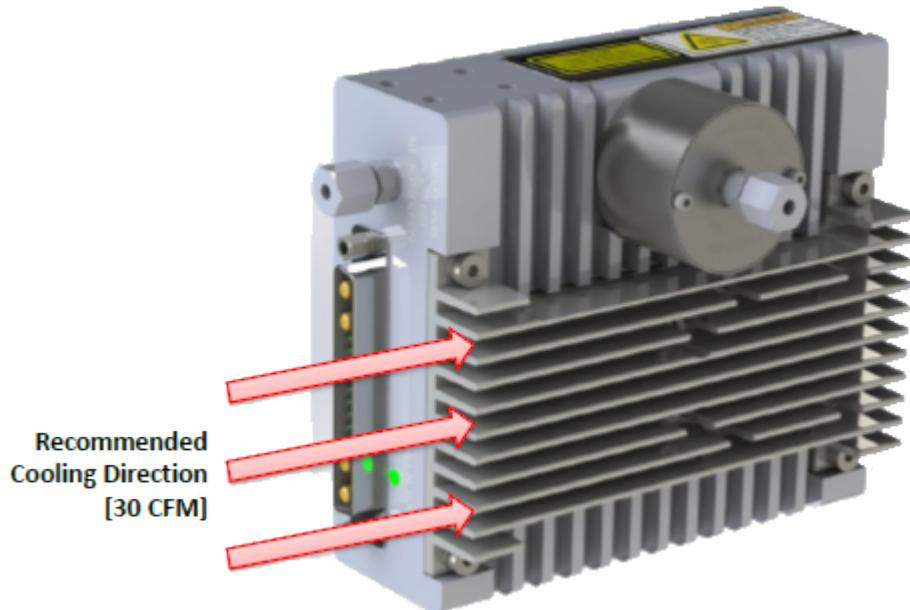
**Figure 15. Connecting to Monochromator Power Supply Port**

9. Connect the lamp head power supply to the lamp head power port on the TLS-EQ-9-S system.



**Figure 16. Connecting to Lamp Head Controller Port**

10. Set up the cooling fan so that it is blowing on the TLS-EQ-9-S system lamp head in the recommended direction as shown below.



**Figure 17. Recommended Cooling Fan Direction**

11. Connect the TLS-EQ-9 optical output to the user's equipment.
12. Plug the monochromator lamp head power supplies into 120VAC outlets. Position the lamp head AC adapter so that the AC inlet and power cord are readily accessible.



**Figure 18. Plugging Power Supplies into 120VAC Outlets**

**Note:** Never use a power supply voltage other than the one specified. Use only the supplied AC cable for the lamp head power connection.

The system is now ready to operate.

## 4.3 Installing Alternative Power Supply or Remote Control

If you are using a or a remote control other than the EQ-99-RC Remote Control, the following section details how to install an alternative power supply or remote control for the TLS-EQ-9-S system system.

### 4.3.1 Installing Alternative Power Supply

The TLS-EQ-9-S system requires 12VDC at 11.7A minimum (140W rating). Power consumption is approximately 100W during normal operation.

Power can be provided using the optional 12VDC power supply. Alternatively, power can be provided directly via a user-provided 12VDC power supply. The power port on the TLS-EQ-9-S system is a latching port. Once fully inserted, the power cable will not release unless the body of the cable is pulled first. This protects from accidental removal of power if the power cable is pulled. Connect to a 12VDC source as follows:

**Table 7. Types of Connectors**

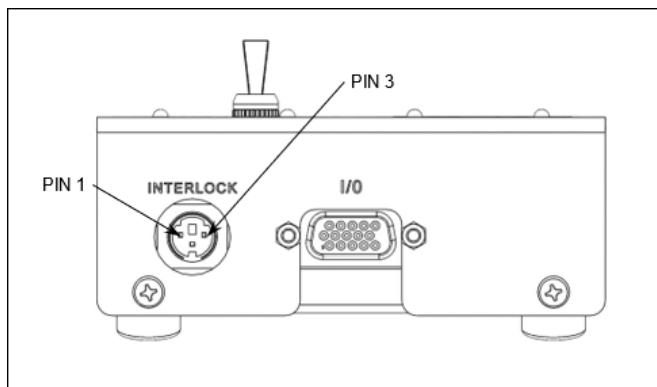
Connector	Kycon KPPX-4P
Pins 3 & 4	+12VDC
Pins 1 & 2	12VDC return

### 4.3.2 Installing Alternative Remote Control

The TLS-EQ-9-S system is controlled through the remote I/O port.

The table [I/O Port Pin Assignments](#) gives the pin assignments and functions for this interface. Connect to the user's control system using a suitable cable. The mating connector is a standard high-density 15-pin d-sub male (for example, Amp part no. 748364-1 with contacts 1658670-2).

Optionally, connect a model EQ-99-RC Remote Control to the I/O port using the supplied cable. The EQ-99-RC is shipped with an interlock jumper plug installed. To use the remote interface function, connect a remote contact or solid-state switch across pins 1 and 3. Mating connector is a standard 3-pin mini-DIN, CUI Inc. part no. MD-30 or equivalent. See the figure [EQ-99-RC Remote Control Rear Panel](#) for pin connections.



**Figure 19. EQ-99-RC Remote Control Rear Panel**

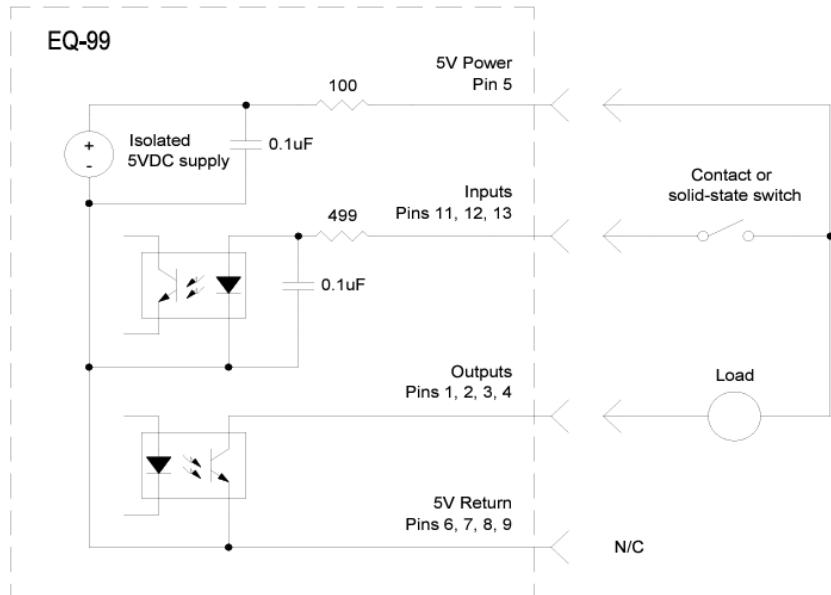
**Table 8. I/O Port Pin Assignments**

Description	Pin #	Details
<b>Commands (Inputs)</b>		
LAMP OPERATE	12	OPERATE REQUEST, apply +5V (referenced to digital common) to initiate ignition
EXTERNAL INTERLOCK	13	EXTERNAL INTERLOCK, apply +5V (referenced to digital common) to close interlock and allow operation
<b>Status Indicators (Outputs)</b>		
LAMP ON	1	Pulled to digital common when ON
LASER ON	2	Pulled to digital common when ON
LAMP MODULE FAULT	3	Pulled to digital common when OK, float on FAULT
CONTROLLER FAULT	4	Pulled to digital common when OK, float on FAULT

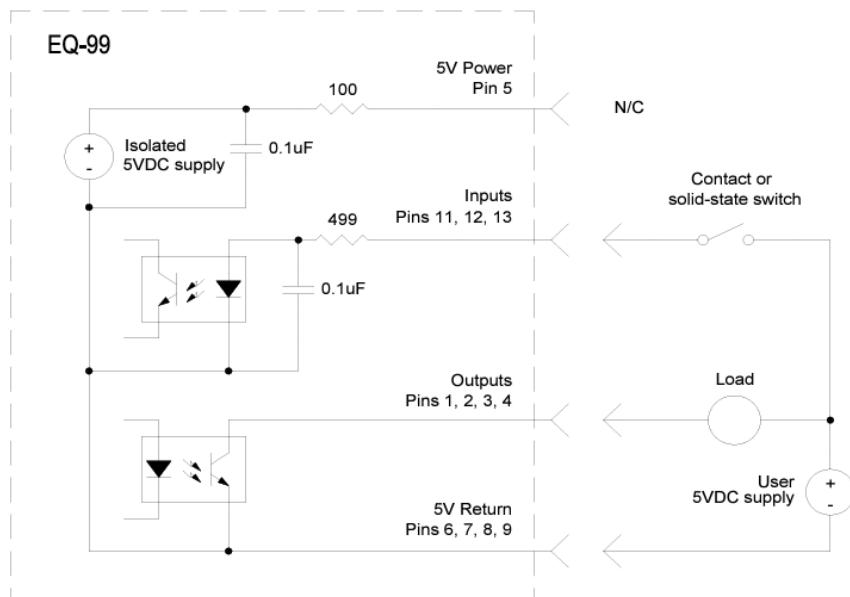
Description	Pin #	Details
ISOLATED +5V SUPPLY	5	200mA maximum, referenced to digital common
DIGITAL COMMON	6,7,8,9	Galvanically isolated from system
RESERVED	10, 11	Do not connect
RESERVED	14,15	Do not connect

The user's remote I/O port can be powered either by the TLS-EQ-9-S system internal isolated power supply, or an external supply.

The figure [Remote Interface Schematic](#) below shows connection schematics for both configurations.



#### USING EQ-99 POWER SUPPLY



**Figure 20. Remote Interface Schematic**

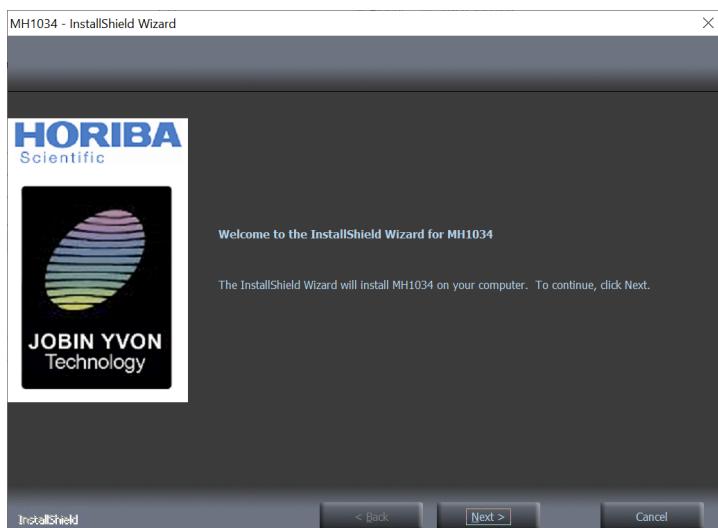
## 4.4 Installing the Monochromator Software

The monochromator is controlled through a USB interface. A simple Windows application is available to communicate with the monochromator from a host PC and control the basic functions of the instrument. You can download the latest version of the application by visiting [www.energetiq.com/resources](http://www.energetiq.com/resources).

To install the monochromator software:

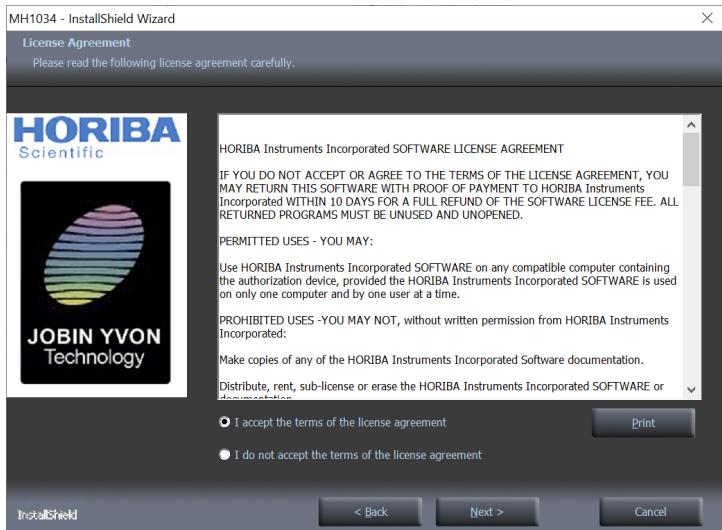
1. In an internet browser, navigate to [www.energetiq.com/resources](http://www.energetiq.com/resources). Click on the link labeled "TLS Software Driver" to begin downloading a zip file of the application installer.
2. When the download is complete, extract the files to a new folder.
3. Click on the program labeled **MH1034.exe**. The installation prompt appears.

**Note:** Before the installation prompt appears, you may be asked to if you want to allow this application (MH1034) to make changes to your device. To continue, click **Yes**.



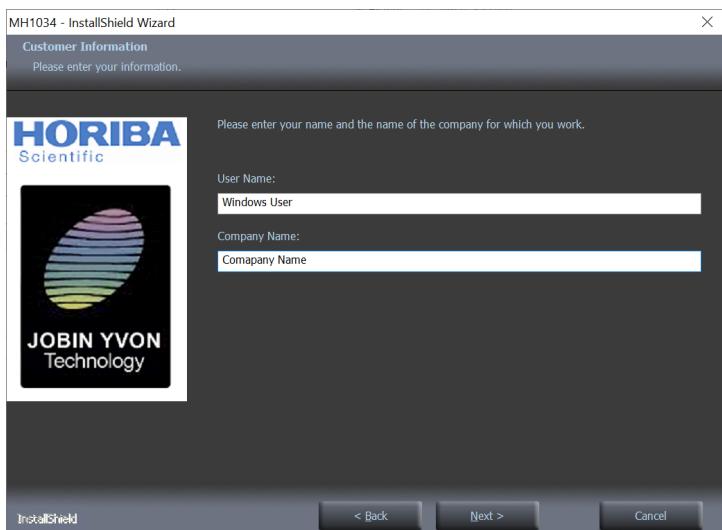
**Figure 21. Horiba MH1034 Installation Prompt**

4. Click **Next**. The License Agreement screen appears.



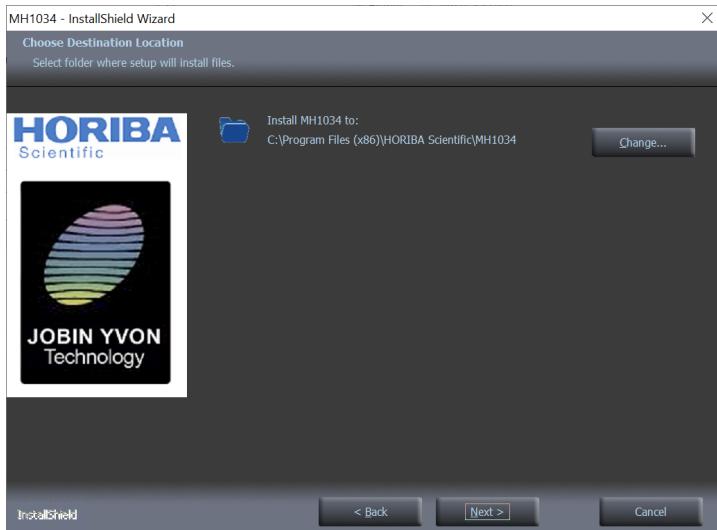
**Figure 22. License Agreement Screen**

5. Click the **I accept the terms of the license agreement** radio button. Then, click **Next**. The Customer Information screen appears.



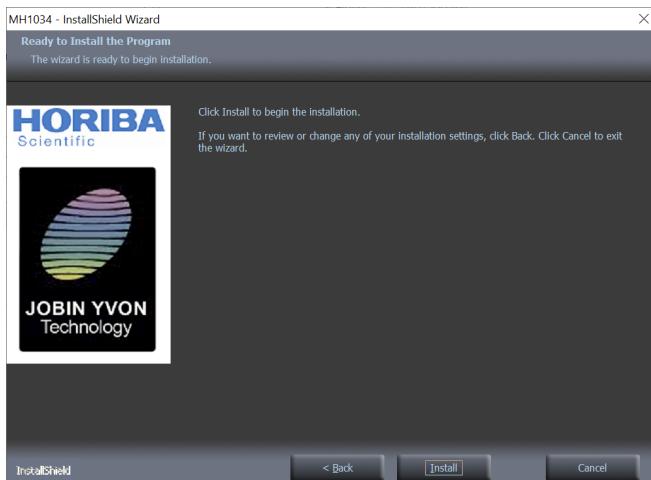
**Figure 23. Customer Information Screen**

6. In the User Name field, enter a user name. In the Company Name field, enter the name of your company. Click **Next**. The Choose Destination Location screen appears.



**Figure 24. Choose Destination Location Screen**

7. To change the default location where the program will be installed, click **Change** and use the file explorer that appears to select a new location. When the location has been selected, click **Next**. The **Ready to Install the Program** screen appears.



**Figure 25. Ready to Install the Program Screen**

8. Click **Install**. Allow the monochromator software to be installed. When the installation is complete, in the window that appears, click **Finish**.

**Note:** During the installation process, you may be asked if you would like to install this device software. To continue, click **Install**.

9. To launch the monochromator software, click the **MH1034 icon** located on your desktop.



**Figure 26. MH1034 Icon**

# Chapter 5. Operating the System

## 5.1 Starting the System

**Caution:** Once the TLS-EQ-9-S system is properly set up, verify that all personnel that will be in contact with the system are aware of the potential hazards involved as described in [Chapter 1. Safety and Warranty Information](#). It is the responsibility of the user to verify that the TLS-EQ-9-S system is safely being used.

This section assumes you are using of the EQ-99-RC Remote Control to provide local control. If using an alternative control system, substitute the appropriate digital input and output lines from the table [I/O Port Pin Assignments](#) for the switches and LEDs described below.

1. Review the status LEDs on the TLS housing. The POWER ON LED should be lit, and neither the CONTROLLER FAULT nor LAMP MODULE FAULT LEDs should be lit.
2. On the EQ-99-RC Remote Control, turn the OPERATE switch ON by placing the switch in the "up" position. The LASER ON LED light illuminates, and laser light is now present in the lamp head.



**Figure 27. LASER ON LED Illuminated**

3. In approximately 20-150 seconds, the igniter automatically turns on and the plasma ignites. The LAMP ON LED light illuminates.



**Figure 28. LAMP ON LED Illuminated**

4. Allow the TLS-EQ-9-S system to warm up for 30 minutes.

The system is now ready to be used.

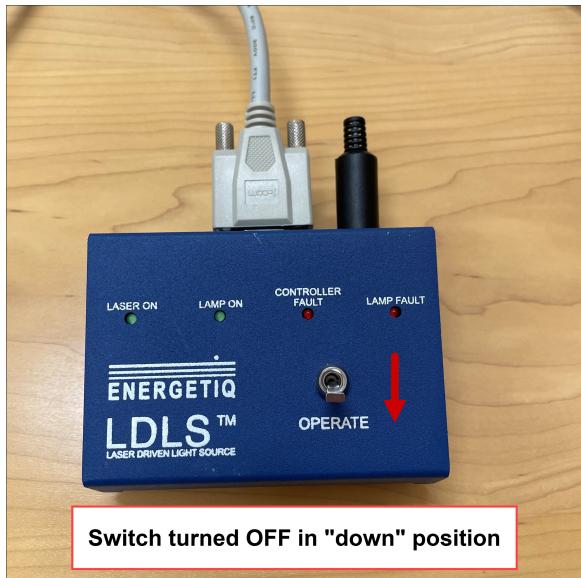
**Notes:**

- The duration of time needed for the plasma to ignite (20-150 seconds) will depend on the temperature and previous operating condition of the TLS-EQ-9-S system. The TLS-EQ-9-S system will automatically detect when the unit has reached the optimum conditions for ignition.
- If a bulb fails to ignite, 150 seconds after the OPERATE switch is turned ON:
  - the LASER ON LED will be OFF.
  - the LAMP FAULT LED will be ON.
  - the LAMP ON LED will remain OFF.

This is very unusual. However, if this occurs, turn the OPERATE switch to the OFF position ("down" position) and restart this procedure at Step 1. If this issue occurs multiple times, see [Chapter 7. Troubleshooting](#) or contact Energetiq's Service department.

## 5.2 Stopping the System

1. To turn the TLS-EQ-9-S system OFF, simply turn the OPERATE switch OFF by placing the EQ-99-RC Remote Control switch in the "down" position.



2. If the system will not be used for some time, turn the power supply off.

**Note:** To minimize wear on the ignition components, it is best to avoid frequently starting and stopping the TLS-EQ-9-S system. It is recommended to run the system continuously rather than turn the system off and on several times in one day.

## 5.3 Using the Monochromator Software

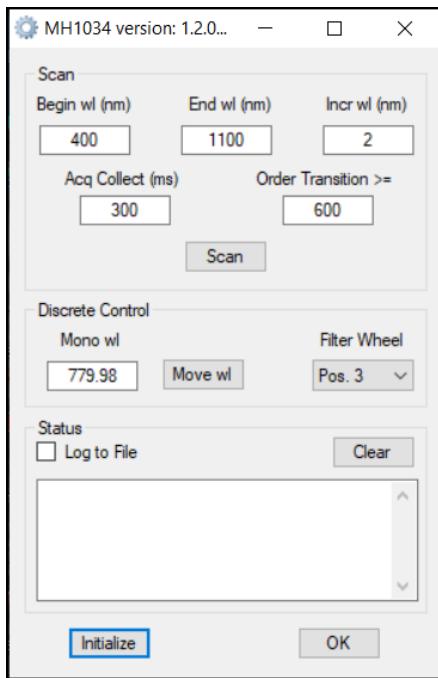
The TLS-EQ-9-S system monochromator software allows you to adjust the filter wheel transition for the order sorting filter. You can operate the system in two modes: *go-to-wavelength* or *wavelength sweep*. Before using either *go-to-wavelength* or *wavelength sweep* mode, you must first initialize the system.

### 5.3.1 Initializing the System

Before using the monochromator software, you must first initialize the system.

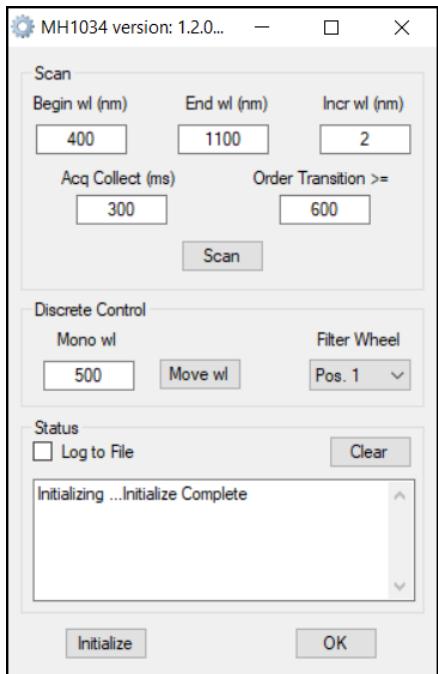
To initialize the system:

1. Ensure the TLS-EQ-9-S system is connected to the computer containing the monochromator software via a mini USB cable.
2. Click the **MH1034 icon** on your desktop to launch the MH1034 monochromator software. The MH1034 home screen appears.



**Figure 29. MH1034 Home Screen**

3. Click **Initialize**. When initialization is complete, an "Initialization Complete" message appears in the Status box at the bottom of the screen.



**Figure 30. "Initialization Complete" Message**

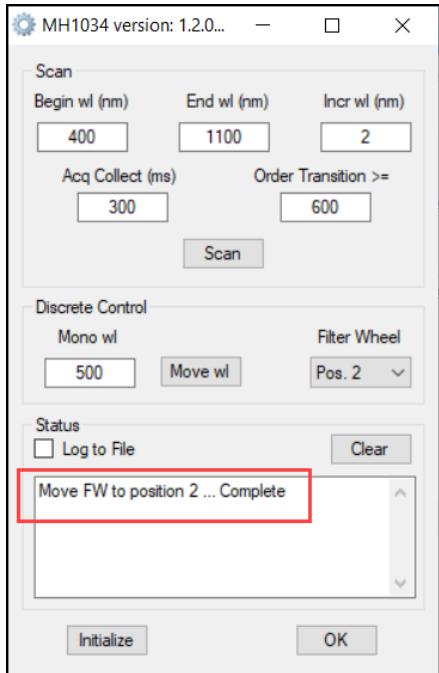
4. The monochromator software is now ready to be used with your TLS-EQ-9-S system.

### 5.3.2 Using the Filter Wheel

You can use the software to adjust the filter wheel transition for the order sorting filter.

To use the filter wheel:

1. From the MH1034 home screen, in the Discrete Control box, select a filter wheel position from the Filter Wheel dropdown box.
2. When the filter wheel position has been moved, a success message appears in the Status box at the bottom of the screen.



**Figure 31. Success Message**

3. The table below describes the system's filter wheel positions.

**Table 9. Filter Wheel Positions**

Position	Light Path
1	Closed
2	Open
3	Order sorting filter, 593 nm long wavelength pass

### Recommendation for Transitioning Filter Wheel

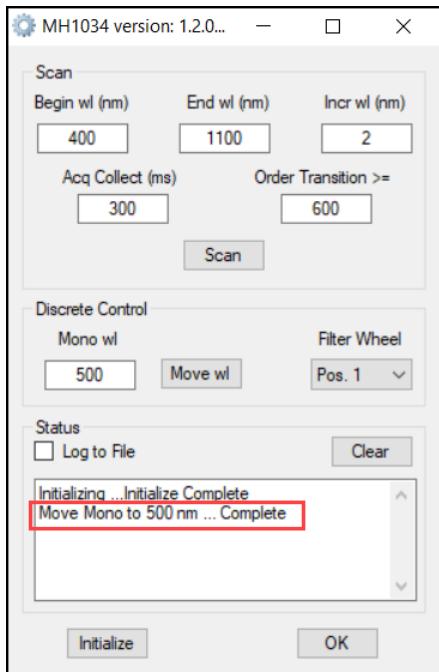
During a wavelength sweep, it is recommended that you transition to the order sorting filter position (position 3) for wavelengths of **620 nm and greater**.

#### 5.3.3 Using Go-To-Wavelength Mode

If you require a particular wavelength for your output, you can use *go-to-wavelength* mode to select a specific wavelength.

To use go-to-wavelength mode:

1. From the MH1034 home screen, in the Mono wl field, enter a wavelength value.
2. Click **Move wl**. When the monochromator has been moved to the selected wavelength, a success message appears in the Status box at the bottom of the screen.



**Figure 32. Success Message**

3. To log the results of the wavelength sweep, check the **Log to File** box. A text file is created in the MH1034 application folder containing the results of the wavelength sweep.

### Selecting a "White Light"

1. To select a white light, or broadband spectrum, in the Mono wl field, enter a wavelength value of **0**.
2. Click **Move wl**. When the monochromator has been moved to the selected wavelength, a success message appears in the Status box at the bottom of the screen.

### 5.3.4 Using Wavelength Sweep Mode

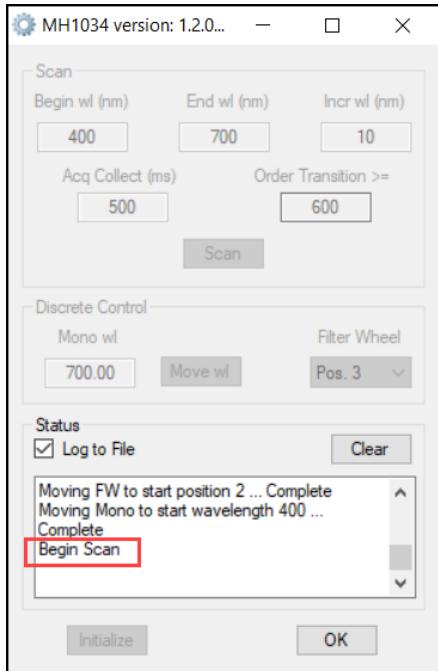
You can use wavelength sweep mode to perform a wavelength scan within a specific spectral range.

To use wavelength sweep mode:

1. From the MH1034 home screen, in the Mono wl field, enter a wavelength value.
2. From the Filter Wheel dropdown box, select a filter wheel position. See [5.3.2 Using the Filter Wheel](#) for more information.
3. In the Begin wl (nm) field, enter a beginning wavelength value in nanometers.
4. In the End wl (nm) field, enter an ending wavelength value in nanometers.

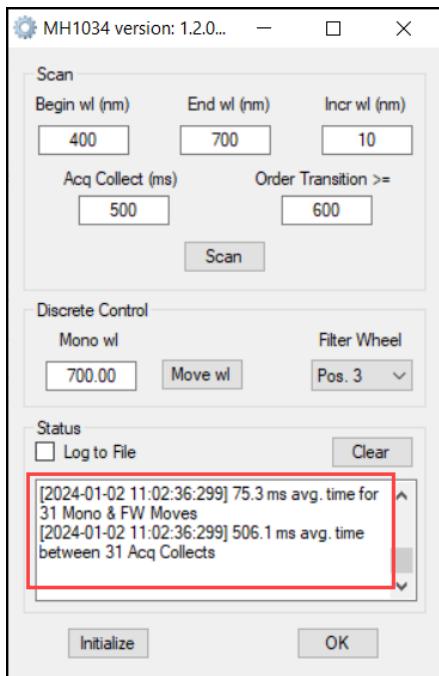
5. In the **Incr wl (nm)** field, enter the wavelength increment value for the wavelength sweep.
6. In the **Acq Collect (ms)** field, enter the step time value in milliseconds.
7. When all parameters of the wavelength sweep have been entered, click **Scan**. The status message "Begin Scan" is displayed in the Status box.

**Note:** The Order Transition field displays the wavelength value at which the filter wheel will transition. It is not **editable**.



**Figure 33. "Begin Scan" Status Message**

8. When the sweep is complete, the results of the scan are displayed in the Status box.

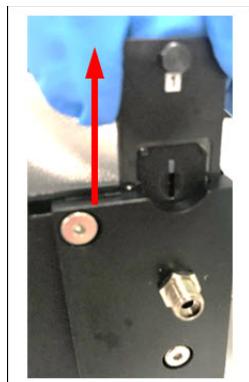


**Figure 34. Wavelength Sweep Results**

9. To log the results of the wavelength sweep, check the **Log to File** box. A text file is created in the MH1034 application folder containing the results of the wavelength sweep.

## 5.4 Changing Monochromator Slits

The monochromator of the TLS-EQ-9-S system comes standard with 1 mm wide entrance and exit slits installed. The 1 mm slit width was chosen to provide an optimal combination of narrow band width and high flux throughput. An optional monochromator slit kit with several alternative pairs of slits (0.1 mm, 0.25 mm, and 0.5 mm) is available. To change the slits, slide the installed slit upward to remove it from the monochromator as shown below. To install, slide the slit into the same location. The monochromator is designed to be operated with the same width slit in the entrance and exit apertures. The slits must be replaced in pairs of the same width.



**Figure 35. Replacement of Monochromator Slit (exit aperture shown)**

# Chapter 6. Maintenance

## 6.1 Service Requirements

There are no user-serviceable parts inside the TLS-EQ-9-S system. For any problems encountered during operation, please contact Energetiq for assistance.

If there is a component failure, do not attempt to open the lamp head or TLS housing enclosure of the TLS-EQ-9-S system.

Any service to the system must be performed only by factory authorized and trained technicians. To avoid injury, under no circumstances should the user open or modify the TLS housing enclosure or lamp head.

## 6.2 Optical Alignment

In some cases, it may be necessary to re-align the internal optics. Use the following procedure for alignment.

### 6.2.1 Objective

Provide instructions for alignment of the TLS-EQ-9-S system.

### 6.2.2 Safety Warnings and Personal Protective Equipment (PPE)

Follow all applicable safety procedures. Use proper PPE as required.

**Table 10. Required PPE**

Part Number	Description	Quantity
TN120X-B	Gloves, Nitrile rubber, TechNiGlove (replace X with digit for desired size)	As required
LG-1	Laser safety glasses, ThorLabs	As required

### 6.2.3 Supplies and Tools Required

**Table 11. Required Supplies and Tools**

Part Number	Description	Quantity
1919-R	Power Meter, Newport Model 1919-R	1
818-UV/DB	Newport Power Detector, 818-UV with the OD3 Filter Installed	1
884-SMA	SMA Fiber Adapter, Newport	1
5682A28	#2 Phillips Screwdriver, McMaster-Carr or equivalent	1

7122A15	5/64" Allen wrench, McMaster-Carr or equivalent	1
7122A43	7/64" Allen wrench, McMaster-Carr or equivalent	1

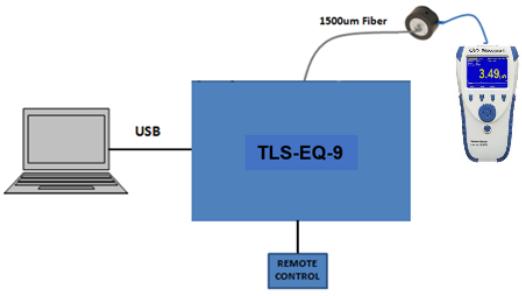
## 6.2.4 Parts Required

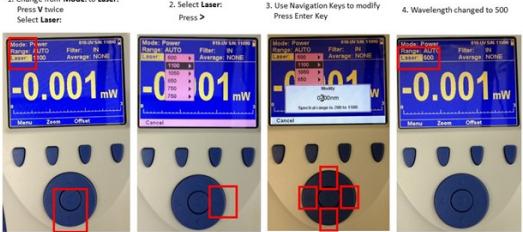
Table 12. Required Parts

Part Number	Description	Quantity
-----	TLS-EQ-9-S system	1
-----	Fiber	1

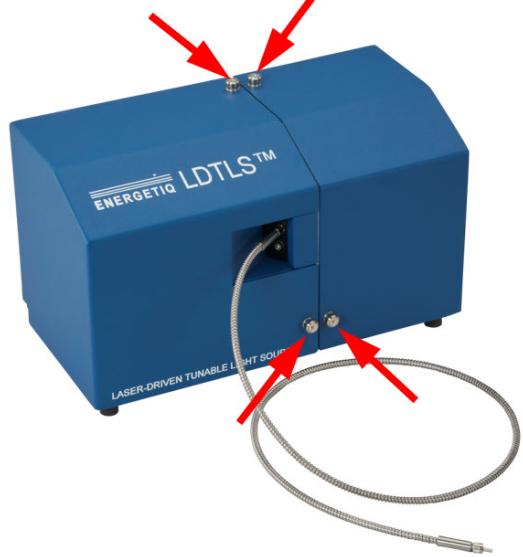
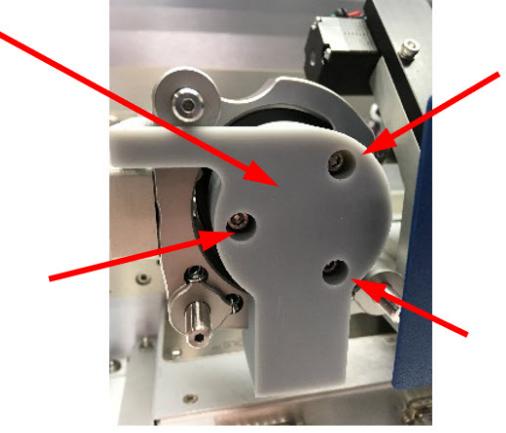
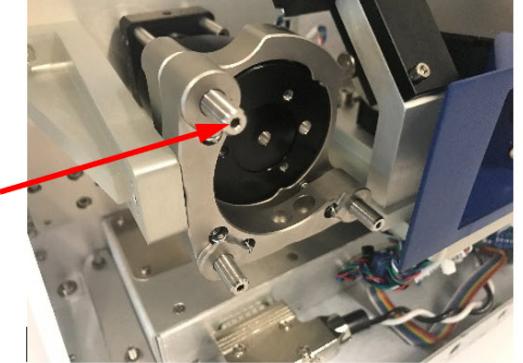
## 6.2.5 Procedure

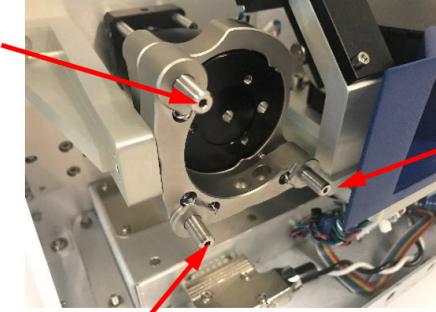
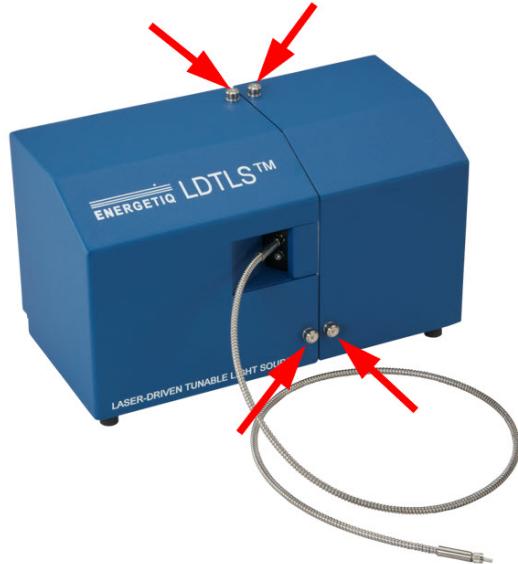
**Warning:** Wear laser safety glasses. Notify others of hazard. Always wear clean gloves when handling components.

Step	Instructions	Visual Aid
1.	<p>Prepare the TLS-EQ-9-S system as shown:</p> <ul style="list-style-type: none"> <li>• Connect one end of the 1500 <math>\mu\text{m}</math> fiber to the TLS-EQ-9 SMA output connector.</li> <li>• Connect the opposite end of the 1500 <math>\mu\text{m}</math> fiber to the Power Detector</li> <li>• Connect the Power Detector to the Power Meter.</li> <li>• Connect the EQ-9-HP Power Supply to the Lamp power input connector.</li> <li>• Connect the Monochromator Power Supply to the TLS-EQ-9 Monochromator power connector.</li> <li>• Connect the USB cable to the PC and TLS-EQ-9 Monochromator control USB Connector.</li> <li>• Connect the Remote Control to the EQ-9-HP Controller.</li> <li>• Connect the EQ-9-HP Power Supply to a 120V AC outlet.</li> <li>• Connect the Monochromator Power Supply to a 120V AC outlet.</li> </ul>	

2.	<p>a. Turn the power meter <b>ON</b>.</p>	 <p>The image shows the Newport Power Meter Model 1919-R. The main screen displays '3.49 μW'. Callouts point to the following components: 'Main Screen with Sensor Connected' (the digital display), 'Sensor Input' (the port at the top), 'Battery Indicator' (the blue bar on the right), 'Serial Number' (the text '116200'), 'Sensor Name' (the text 'Newport'), 'Soft Keys' (the four blue buttons on the right), 'Enter Key' (the central blue button), 'Navigation Keys' (the four buttons around the center), 'On/Off Switch and LCD Backlight Control' (the blue button at the bottom), and 'LCD Backlight Control' (the small button to the left of the main button).</p>
3.	<p>Zero the power meter.</p>	 <p>Eight screenshots illustrating the steps to zero the power meter:</p> <ol style="list-style-type: none"> <li>1. Select Menu</li> <li>2. Press &gt; and V Select Instrument</li> <li>3. Select Zero</li> <li>4. Select Start</li> <li>5. Zeroing in progress</li> <li>6. Zeroing completed Select Save</li> <li>7. Values saved Select Exit</li> <li>8. Returns to main menu</li> </ol>
4.	<p>Change the power meter wavelength to 500 nm.</p>	 <p>Four screenshots illustrating the steps to change the wavelength to 500 nm:</p> <ol style="list-style-type: none"> <li>1. Change from Mode: to Laser: Press V twice Select Laser:</li> <li>2. Select Laser: Press &gt;</li> <li>3. Use Navigation Keys to modify Press Enter Key</li> <li>4. Wavelength changed to 500 nm</li> </ol>

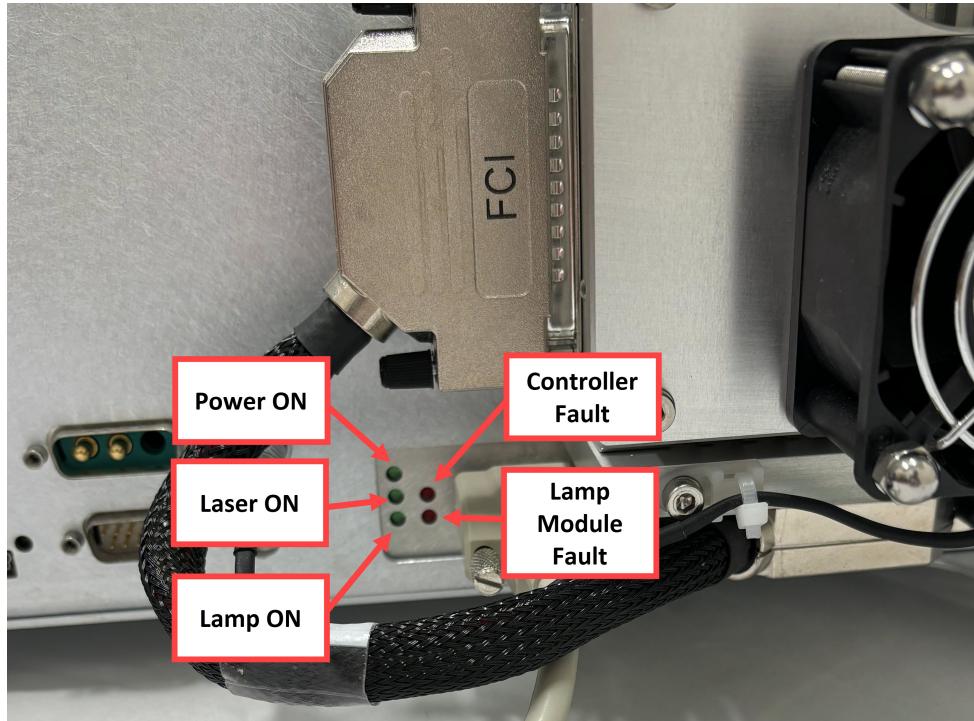
5.	<ol style="list-style-type: none"> <li>Turn the Remote Control OPERATE switch on.</li> <li>Clear any faults if required by turning the OPERATE switch OFF-ON.</li> <li>The LASER ON LED will illuminate.</li> <li>Wait for the LAMP ON LED to illuminate.</li> <li>Wait 10 minutes for system warm-up.</li> </ol>	 
6.	Change the Monochromator wavelength to 500 nm and Filter Wheel position to Pos. 2.	
7.	<p>Measure the output of the TLS-EQ-9. At the chosen wavelength of 500 nm, the expected minimum output is 1.3 mW.</p> <ol style="list-style-type: none"> <li>If the output is 1.3 mW or greater, no adjustment is necessary. Stop here.</li> <li>If the output is below 1.3 mW, continue with the alignment steps below.</li> </ol>	

8.	<p>Open the doors of the TLS-EQ-9 using a #2 Phillips Screwdriver. There are (4) captive screws.</p>	
9.	<p>a. Remove the shipping bracket using a 7/64" Allen wrench. Set the bracket aside.</p> <p>b. There are 3 screws holding the bracket in place. Save the bracket and screws.</p>	
10.	<p><b>Alignment</b></p> <p>a. Using a 5/64-inch Allen wrench, rotate one of the 3 adjustment screws on the kinematic mount while monitoring the output on the meter.</p> <p>b. Rotate the screw one direction and then the other to determine which direction results in an increase in the meter reading.</p> <p>c. Continue turning in the appropriate direction until the meter reading is maximized.</p>	

11.	<ol style="list-style-type: none"> <li>After turning the first adjustment screw, move to the next screw and follow the same process to maximize the meter reading.</li> <li>Continue to move from one screw to the next, progressively turning each one to maximize the meter reading.</li> <li>Continue the adjustments until the meter reading is at least 1.3 mW.</li> </ol>	
12.	<ol style="list-style-type: none"> <li>Close the doors of the TLS-EQ-9 after alignment.</li> <li>Tighten the (4) captive screws using a #2 Phillips Screwdriver.</li> </ol>	

## Chapter 7. Troubleshooting

As shown in the figure [TLS Housing LED Lights](#) below, there are five LED lights on the back of the TLS housing that indicate the current status of the TLS-EQ-9-S system.



**Figure 36. TLS Housing LED Lights**

During normal operation, the three green LED lights on the left-hand side (POWER ON, LASER ON, LAMP ON) should be turned **ON**. The two red LED lights on the right-hand side (CONTROLLER FAULT, LAMP MODULE FAULT) should be turned **OFF**.

In the event that a green LED light turns **OFF** or a red LED light turns **ON** during normal operation, see the following section for a list of potential issues and remedies.

## 7.1 Issues and Remedies

See below for a list of possible issues that may be encountered while operating the TLS-EQ-9-S system and the potential steps to resolve those issues.

**Table 13. Possible Issues and Remedies**

LED Light Name and Status	Possible Issues	Troubleshooting Steps
LAMP MODULE FAULT is <b>ON</b>	<p>One of the following has occurred in the lamp head:</p> <ol style="list-style-type: none"> <li>1. A control cable is not connected.</li> <li>2. The lamp head has overheated (above 85 °C).</li> <li>3. The laser subminiature assembly (SMA) is not connected.</li> <li>4. The lamp bulb is not properly installed.</li> <li>5. There was a failure to ignite the plasma inside the lamp bulb, or the plasma inside the lamp bulb has been extinguished after ignition. This also causes the LAMP ON light to turn <b>OFF</b> and LASER ON light to turn <b>OFF</b>.</li> </ol>	<ol style="list-style-type: none"> <li>1. Clear the fault lights by toggling the EQ-99-RC Remote Control between the ON and OFF positions. The TLS-EQ-9-S system will not start if a fault condition exists.</li> <li>2. Confirm that the black jumper plug is fully inserted into the back of the EQ-99-RC Remote Control (or, if using another remote control, confirm that the external interlock contact is closed).</li> <li>3. Check that the bulb and laser fiber optic cable are properly connected to the lamp head.</li> <li>4. If either the LAMP MODULE FAULT or CONTROLLER FAULT light will still not clear, contact Energetiq.</li> </ol>
CONTROLLER FAULT is <b>ON</b>	<p>One of the following has occurred in the LDLS controller:</p> <ol style="list-style-type: none"> <li>1. An external interlock is open.</li> <li>2. The LDLS controller printed circuit board has overheated (above 82 °C).</li> <li>3. The laser has overheated (above 66 °C).</li> <li>4. There is a regulation error with the laser current.</li> <li>5. There is a regulation error with the laser temperature.</li> <li>6. There is a laser failure.</li> </ol>	

LED Light Name and Status	Possible Issues	Troubleshooting Steps
LAMP ON is <b>OFF</b>	<p>The plasma inside the lamp bulb has been extinguished after ignition. This also causes the LAMP MODULE FAULT light to turn <b>ON</b> and LASER ON light to turn <b>OFF</b>.</p>	
LASER ON is <b>OFF</b>	<p>There was a failure to ignite the plasma inside the lamp bulb.</p> <p>This also causes the LAMP MODULE FAULT light to turn <b>ON</b> and LAMP ON light to turn <b>OFF</b>.</p>	<p>If the lamp bulb fails to ignite after several attempts, contact Energetiq.</p>

## Appendix A. RS-485 Interface Commands and Pin Assignments

The RS-485 serial interface is provided for user adjustment of laser operating power, in order to increase or decrease light output. The TLS-EQ-9-S system is shipped with the laser power set to a factory default value of 100% of full scale power. The user has the ability to adjust the actual operating power between 80% and 100% of full scale in 0.5% increments.

Commands consist of a single ASCII character, case-sensitive. This can be transmitted to the TLS-EQ-9-S system via a terminal emulation program, or the user's control system. Response from the TLS-EQ-9-S system will be a string of ASCII characters, format depending on the command issued.

The following table describes the serial commands and their functions.

**Note:** The RS-485 port supports Logwatch.

**Table 14. RS-485 Commands**

Command Character	Function	Reply from EQ-9-HP
U	Increases the present laser power setpoint by 0.5% of full scale	Power = XXX.X %
D	Increases the present laser power setpoint by 0.5% of full scale	Power = XXX.X %
Q	Queries the value of the present laser power setpoint (in % of full scale)	Power = XXX.X %
F	Resets laser power setpoint to factory default value	Power = XXX.X %
B	Saves present settings to flash memory. This command should be issued after the settings are at their desired values. If not, changes will be lost if power to the TLS-EQ-9-S system is interrupted.	Calibration data copied to FLASH Memory
H	Query bulb operating hours	Bulb time = XXXX.X hrs
Z	Zero bulb operating hours	Send "z" within 10 sec. to confirm.
z	Confirm zeroing of bulb hours	Bulb hours zeroed & flash saved

Command Character	Function	Reply from EQ-9-HP
L	Query laser operating hours	Laser time = XXXX.X hrs
T	Query lamp head temperature	LH temp = XX.X degC
S	Query system status. Returns a 16-bit decimal number representing the present system status. See below for bit mapping.	00000 to 65535
?	Displays a help menu listing the available commands	<p>EQ-9-HP firmware vXXX build date mm/dd/yy</p> <p>(c) Energetiq Technology, Inc.</p> <ul style="list-style-type: none"> <li>• U/D – Inc/Dec laser pwr (by 0.5% full scale)</li> <li>• Q – Query laser pwr setpoint</li> <li>• F – Reset laser pwr to default</li> <li>• B – Burn settings to flash memory</li> <li>• H – Query bulb operating hrs</li> <li>• Z – Zero bulb operating hrs</li> <li>• z – (confirm above within 10 sec)</li> <li>• L – Query laser operating hrs</li> <li>• T – Query lamp head temp</li> <li>• S – Query system status</li> <li>• ? – This menu</li> </ul>

## System Status Word

**Table 15. System Status Word**

Bit #	Definition
0 (LSB)	Fault status: 1 = one or more faults present, 0 = no faults
1	Laser status: 1 = on, 0 = off
2	Laser status: 1 = on, 0 = off
3	Laser temperature: 1 = overtemperature, 0 = OK

Bit #	Definition
4	Reserved – always 0
5	Reserved – always 0
6	Lamp head temperature: 1 = overtemperature, 0 = OK
7	Reserved – always 0
8	Lamp head interlock: 1 = open, 0 = OK
9	External interlock: 1 = open, 0 = OK
10	Reserved – always 0
11	Lamp photodiode signal: 1 = low, 0 = OK
12	Lamp photodiode signal: 1 = low, 0 = OK
13	Ignition status: 1 = failed to ignite, 0 = OK
14	Reserved – always 0
15	Reserved – always 0

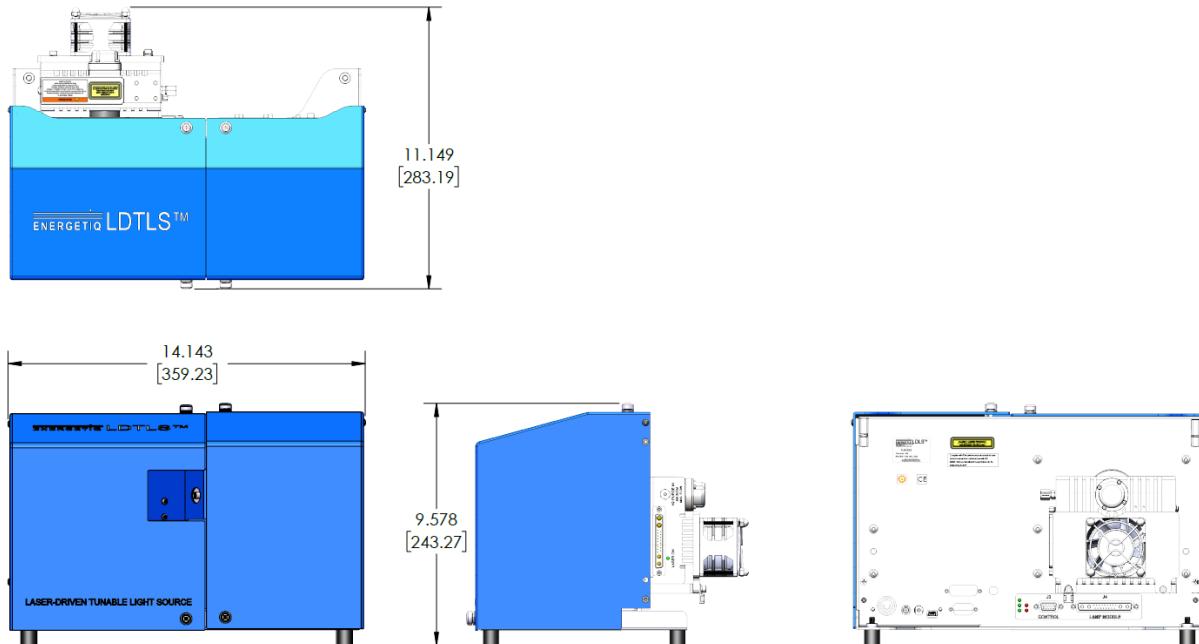
The following table provides pin assignments for the RS-485 interface.

**Table 16. RS-485 Interface Pin Assignments**

Description	Pin #	Details
DATA – (A)	7	Connect to host DATA -
DATA – (B)	2	Connect to host DATA +
GROUND	5, 9	Galvanically isolated from system
RESERVED	1, 3, 4, 6, 8	Do not connect

## Appendix B. Dimensional Drawings

### TLS Housing



Units in brackets are millimeters. Units outside of brackets are inches.

**Figure 37. TLS Housing Dimensional Drawing**

## Appendix C. Revision History

Date	Revision No.	Author	Description
09/09/2019	1	–	Initial release.
11/19/2020	2	–	Updated labels and CE Declaration of Conformity
06/28/2022	3	Heidi Teng	Document style, format, labels and compliance changes
06/23/2023	4	Eric Burz	Updated labels and patent information. Changed nitrogen purging from “required” to “recommended.” Updated Declaration of Conformity. Minor edits.
07/05/2023	5	Ann Chojnacki	Updated Certification label description in "Labels and Safety Notifications" to conform to UL requirements. Corrected ECO number in previous row of this table.
01/20/2024	6	Eric Burz	Reformatted using new product manual template. Updated the following section: "Installing the Monochromator Software." Added the following section: "Using the Monochromator Software." Compliance Updates. Minor edits.
04/05/2024	7	Eric Burz	Minor compliance updates.
11/11/2024	8	Eric Burz	Updated product dimensions and dimensional drawings. Revised "Installation" and "Troubleshooting" chapters. Minor edits.