

# Laser-Driven Tunable Light Source (LDTLS<sup>®</sup>)

Models: TLS-EQ-77-S, TLS-EQ-77-UV, TLS-EQ-77-NIR



## Operation and Maintenance Manual

Revision 6

November 2024

DOC-10977



Copyright © 2024 Energetiq Technology Inc. All rights reserved.

For a list of Energetiq product patents, visit [www.energetiq.com/patents](http://www.energetiq.com/patents).

All technical information, including drawings, schematics, and specifications contained in this manual are the property of Energetiq and shall not be reproduced in whole or in part without the written consent of Energetiq. The content of this manual is subject to change without notice.

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).

## Manufacturer Information

Energetiq Technology Inc.  
205 Lowell St., Wilmington, MA 01887 USA  
Phone: +1 (781) 939-0763  
Email: [service@energetiq.com](mailto:service@energetiq.com)  
Web: [www.energetiq.com](http://www.energetiq.com)



## Contents

<b>Contents.....</b>	<b>3</b>
<b>Chapter 1. Safety and Warranty Information .....</b>	<b>5</b>
<b>1.1 Safety Warnings.....</b>	<b>5</b>
<b>1.2 General Precautions .....</b>	<b>6</b>
<b>1.3 Laser Information .....</b>	<b>7</b>
<b>1.4 Labels and Safety Notifications .....</b>	<b>8</b>
1.4.1 Definition of Equipment and Document Symbols .....	11
<b>1.5 Safety Interlocks .....</b>	<b>11</b>
1.5.1 External Interlocks .....	11
<b>1.6 Warranty .....</b>	<b>11</b>
<b>1.7 Correct Disposal of the Unit.....</b>	<b>11</b>
<b>1.8 EMC Compliance Standards .....</b>	<b>11</b>
<b>Chapter 2. System Description .....</b>	<b>13</b>
<b>2.1 System Overview .....</b>	<b>13</b>
<b>2.2 Description of System Components .....</b>	<b>13</b>
2.2.1 LDLS Controller .....	14
2.2.2 TLS Housing .....	15
<b>Chapter 3. System Specifications and Requirements .....</b>	<b>17</b>
<b>3.1 Optical Performance .....</b>	<b>17</b>
<b>3.2 Physical Specifications .....</b>	<b>17</b>
<b>3.3 Remote Interface Specifications.....</b>	<b>17</b>
<b>3.4 Utility Requirements.....</b>	<b>18</b>
<b>3.5 Environmental Requirements .....</b>	<b>19</b>
<b>3.6 Chiller Information .....</b>	<b>19</b>
<b>Chapter 4. Installation .....</b>	<b>20</b>
<b>4.1 Unpacking the System .....</b>	<b>20</b>
4.1.1 Required Contents .....	20
<b>4.2 Installation Procedure.....</b>	<b>23</b>
<b>4.3 Installing Alternative Remote Control .....</b>	<b>28</b>
<b>4.4 Installing the Monochromator Software .....</b>	<b>31</b>
<b>Chapter 5. Operating the System .....</b>	<b>34</b>
<b>5.1 Starting the System.....</b>	<b>34</b>
<b>5.2 Stopping the System .....</b>	<b>37</b>

<b>5.3 Using the Monochromator Software.....</b>	<b>38</b>
5.3.1 Initializing the System.....	38
5.3.2 Using the Filter Wheel .....	39
5.3.3 Using Go-To-Wavelength Mode.....	41
5.3.4 Using Wavelength Sweep Mode.....	42
<b>Chapter 6. Maintenance .....</b>	<b>44</b>
<b>6.1 Optical Alignment.....</b>	<b>44</b>
6.1.1 Objective .....	44
6.1.2 Safety Warnings and Personal Protective Equipment (PPE) .....	44
6.1.3 Supplies and Tools Required .....	44
6.1.4 Parts Required .....	45
6.1.5 Procedure .....	45
<b>6.2 Packing the System .....</b>	<b>56</b>
6.2.1 Objective .....	56
6.2.2 Safety Warnings and Personal Protective Equipment (PPE) .....	56
6.2.3 Supplies and Tools Required .....	56
6.2.4 Procedure .....	57
<b>Chapter 7. Troubleshooting .....</b>	<b>65</b>
<b>7.1 Issues and Remedies.....</b>	<b>66</b>
<b>Appendix A. RS-485 Interface Commands and Pin Assignments .....</b>	<b>68</b>
<b>Appendix B. Dimensional Drawings .....</b>	<b>70</b>
<b>Appendix C. Revision History .....</b>	<b>72</b>

## Chapter 1. Safety and Warranty Information

### 1.1 Safety Warnings

The TLS-EQ-77 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-77 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-77 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

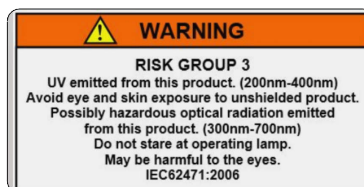


- If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. Energetiq is not liable for damage or losses resulting from failure to comply with precautions or instructions listed in this manual.
- The power supply must be properly 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.
- This AC power cable supplied is for the TLS-EQ-77 system only. This AC cord cannot be used with other electrical equipment. The power shutdown mechanism of this laser unit functions via the AC power cable. Do not arrange the equipment in such a way that becomes difficult to connect or disconnect the AC power cable.

## 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-77 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-77 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-77 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-77 system. For any problems encountered during operation, please contact Energetiq for assistance. If there is a component failure, do not attempt to open the LDLS controller or TLS housing of the TLS-EQ-77 system.

The TLS housing of the TLS-EQ-77 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 either the LDLS controller or 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-77 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-77 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	< 36 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-77X lamp head enclosure or TLS-EQ-77 system LDLS controller enclosure.

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


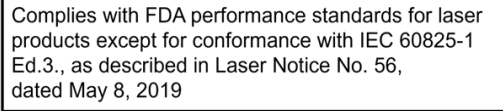


The following safety labels appear on the TLS-EQ-77 system. The figure [TLS-EQ-77 Safety Label Locations](#) shows the location of each label on the TLS-EQ-77 system. The figure [EQ-77 Safety Label Locations](#) shows the location of each label on the EQ-77X lamp head, which is part of the TLS-EQ-77 system.



Figure 1. TLS-EQ-77 Safety Label Locations



Table 2. TLS Housing Safety Label Meanings

Label #	Label Picture	Description
1		<b>Explanatory label</b> – states the classification of the laser product. Class 1 is the lowest hazard level classification.
2		<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.”
3		<b>CE label</b> – indicates compliance with EU directives related to consumer safety, health, and environmental health.
4		<b>Manufacturer's identification label</b> – gives the manufacturer's name and address, and the model, serial number, and date of manufacture of the equipment.

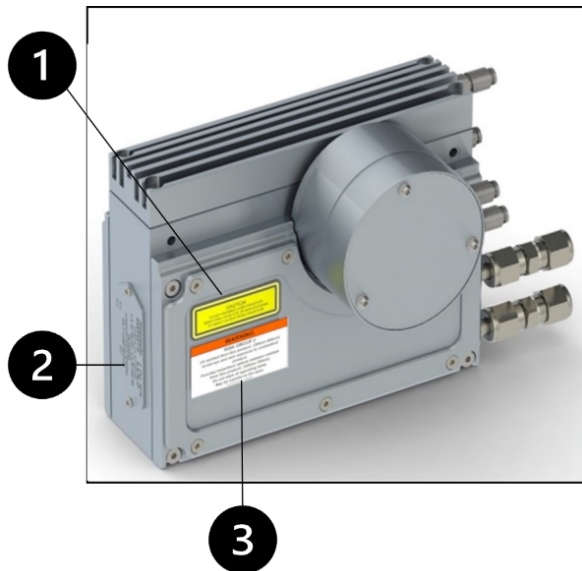




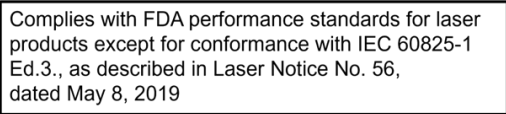



Figure 2. EQ-77 Safety Label Locations



Table 3. Safety Label Meanings

Label #	Label Picture	Description
1		<b>Non-interlocked housing label</b> – notifies of a potential hazard when covers are removed
2		<b>Manufacturer's identification label on lamp head</b> – gives the manufacturer's name and address, and the model, serial number, and date of manufacture of the equipment.
3		<b>UV Hazard warning label</b> – indicates hazardous levels of UV light are present.
4		<b>Explanatory label</b> – states the classification of the laser product. Class 1 is the lowest hazard level classification.
5		Certification label – 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.”
6		<b>Manufacturer's identification label on controller</b> – gives the manufacturer's name and address, and the model, serial number, and date of manufacture of the equipment.

### 1.4.1 Definition of Equipment and Document Symbols

The following symbols are found on the TLS-EQ-77 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-77 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-77 system's warranty, [contact your local distribution representative](#).

## 1.7 Correct Disposal of the Unit

When the TLS-EQ-77 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.
--------------	---

◦ **Criteria B**

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

◦ **Criteria C**

Light output	Even if the light turns off, it can be turned on again by manual operation of the operator.
--------------	---

## Chapter 2. System Description

### 2.1 System Overview

This manual describes the standard TLS-EQ-77-S model and the UV/NIR models (TLS-EQ-77-UV and TLS-EQ-77-NIR) of the Laser-Driven Tunable Light Source (LDTLS®). In most instances, these products will be collectively referred to as the TLS-EQ-77 system, or "TLS system."

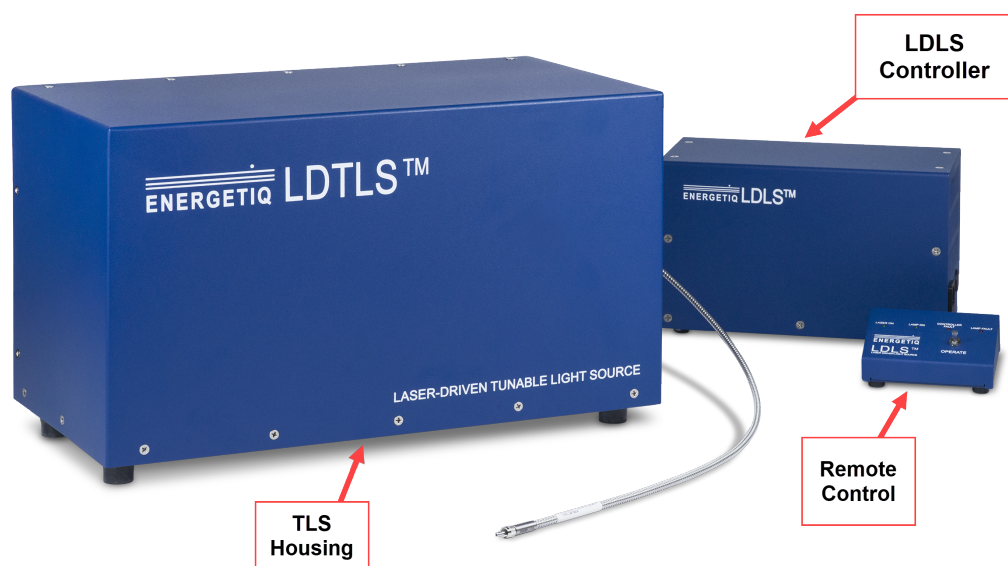
The TLS-EQ-77 system is a compact, highly stable tunable light source (TLS). It utilizes the Energetiq EQ-77X Laser-Driven Light Source (LDLS®) as a broadband light source. A monochromator is used to select the desired output wavelength. The monochromator output is fiber coupled to the TLS-EQ-77 system output.

The TLS-EQ-77 system consists of an LDLS controller, TLS housing, remote control, monochromator power supply, and interconnecting cables. Connections to AC power and cooling fluid are required for operation. 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-77 system consists of an LDLS controller, TLS housing, remote control, monochromator power supply (not shown), and interconnecting cables (not shown). The system incorporates the Energetiq EQ-77X LDLS, a monochromator, and custom optics.



**Figure 3. TLS-EQ-77 System**

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

### 2.2.1 LDLS Controller

The LDLS controller contains:

- Power Port
- Status Indicator LEDs
- I/O Port
- Lamp Control Port
- RS-485 Port
- Laser Power Supply (internal, not shown)
- Thermo-electric Cooler Control System (internal, not shown)
- Control Electronics (internal, not shown)



Figure 4. LDLS Controller

Table 4. LDLS Controller Components

#	Component	Description
1	Power Port	This is an IEC 320 port for an AC power input. See <a href="#">3.4 Utility Requirements</a> for detailed information.
2	Status Indicator LEDs	See the table <a href="#">Status Indicator LED Functions</a> for a list of descriptions.
3	I/O Port	This port provides access to control and status signals.
4	Lamp Control Port (21-pin mixed D-sub)	This port provides various power and control signals to/from the TLS housing. No other connector or cable may be used with the TLS-EQ-77 system other than the one supplied.

#	Component	Description
5	RS-485 Port (9-pin D-sub)	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.

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

**Table 5. Status Indicator LED Functions**

LED Label	Meaning (When Lit)
POWER ON	AC power is connected to the LDLS controller
LAMP ON	UV Light is on
LASER ON	Laser power is ON and laser light is being produced within the lamp head
CONTROLLER FAULT	One of the following has occurred in the LDLS controller: <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>
LAMP MODULE FAULT	One of the following has occurred in the lamp head in the TLS housing: <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 Housing

The TLS housing contains:

- Nitrogen Purge Inlet/Outlet
- Cooling Fluid Inlet/Outlet
- Laser On Indicator
- Control Port
- Monochromator Port
- Monochromator Power Supply Port
- Optical Output Port
- EQ-77X Lamp Head (internal, not shown)

- Monochromator (internal, not shown)
- Optics (internal, not shown)

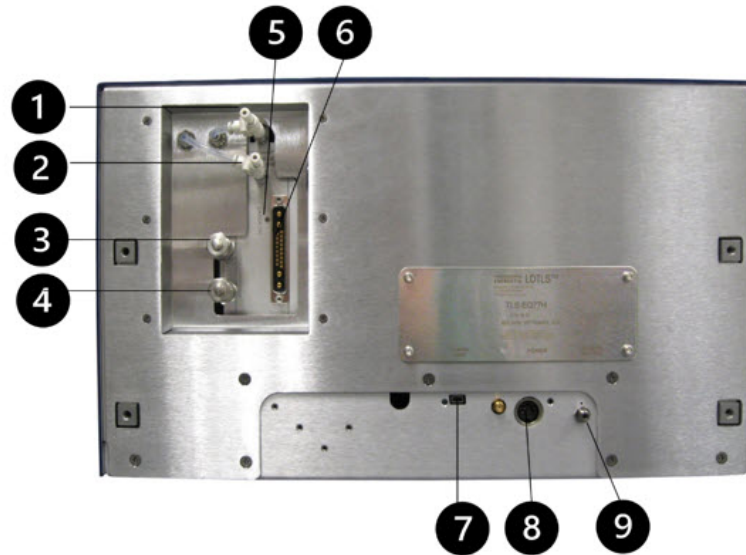


Figure 5. TLS Housing (rear view)

Table 6. TLS Housing Components

#	Component	Description
1	Nitrogen Purge Inlet	These fittings are for the nitrogen purge gas. See <a href="#">3.4 Utility Requirements</a> for more details.
2	Nitrogen Purge Outlet	
3	Cooling Fluid Inlet	These fittings are for connection of cooling fluid required by the EQ-77X lamp head.
4	Cooling Fluid Outlet	
5	Laser On Indicator	This LED is illuminated when the laser is ON.
6	Control Port (21-pin mixed D-sub)	This port provides various power and control signals to/from the LDLS controller. No other connector or cable may be used with the TLS-EQ-77 system other than the one supplied.
7	Monochromator Port	This port is a standard mini-USB port for control of the internal monochromator.
8	Monochromator Power Supply Port	This port is a DIN port for monochromator power (from external power supply).
9	Optical Output Port	This port is a sub-miniature A (SMA) port for light output.



## Chapter 3. System Specifications and Requirements

### 3.1 Optical Performance

- **Wavelength Range:**
  - **TLS-EQ-77-S:** 350 nm – 11,00 nm
  - **TLS-EQ-77-UV:** 200 nm – 770 nm
  - **TLS-EQ-77-NIR:** 800 nm – 1,700 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:** 278 x 455 x 242 mm (11 x 17.9 x 9.5 in)
- **LDLS Controller:** 156 x 299 x 132 mm (6.2 x 11.8 x 5.2 in)

#### Weight

- **TLS Housing:** 16.6 kg (36.5 lb)
- **LDLS Controller:** 2.9 kg (6.5 lb)

### 3.3 Remote Interface Specifications

#### Digital Inputs

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

#### External Interlock Input Only (pin 13)

- **Type:** Relay Coil
- **Logic:** Active High
- **Input Voltage:** 5VDC
- **Input Current:** 80 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:** 400 mA maximum

### Serial Interface

- **Type:** RS-485 4-wire (full duplex)
- **Connector:** Male 9-pin d-sub
- **Mating Connector:** Female 9-pin d-sub (for example, AMP part no. 205203-3 with contacts 1-66504-0)
- **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

### LDLS Controller Electrical

- **Voltage:** 100 – 240 V  $\sim \pm 10\%$ , 50/60 Hz, 350 W (Fuse: F5AL250V) Frequency: 50/60 Hz (some OEM versions have higher current requirements).
- **Power:** 350 W max
- **Connector:** IEC320 C14 inlet

### Monochromator Electrical

- **Voltage:** 24VDC
- **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-77 system. For optimal product performance, nitrogen gas purging of the TLS-EQ-77 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-77X lamp head will consume approximately 0.5 slm of flow.
- **Fittings:** 4 mm push-to-connect

### Cooling Fluid

- Use of cooling fluid is required.  $\geq 1$  liter/minute, 18 – 25 °C, 100 psig (0.69 MPa) max. inlet pressure
- **Fittings:** ¼ inch Swagelok

### 3.5 Environmental Requirements

#### Operating

- **Ambient Temperature:** 15–35 °C.
- **Relative Humidity:** non-condensing, 80% max. for temperatures up to 31 °C, decreasing linearly to 50% max. at 35 °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 II.
- **Operating Altitude:** 2,000 m max.
- **IP Code:** IP20.

#### Transport

- **Temperature:** -5–70 °C.
- **Relative Humidity:** non-condensing, 95% max.

### 3.6 Chiller Information

The TLS-EQ-77 system requires a chiller to maintain the cooling requirements in [3.4 Utility Requirements](#). For your convenience, Energetiq offers a suitable chiller produced by Solid State Cooling, Inc. You may also choose to procure a chiller directly through your local Solid State Cooling, Inc representative (SSC Model U190 W Chiller).

**Table 7. Energetiq Chiller Kit Details**

PN	Description
EQ-77-CHILLER-KIT	EQ-77 Chiller / with Tubing Kit

**Note:** Cooling fluid is not included and must be locally sourced.

# Chapter 4. Installation

## 4.1 Unpacking the System



Upon arrival, inspect all parts of the TLS-EQ-77 system for completeness and damage incurred in shipping. Use care when unpacking to avoid damaging the laser fiber optic cable.

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


At a minimum, the TLS-EQ-77 system shipping box contains the following required items:

### 4.1.1 Required Contents

Table 8. Required Contents of Shipping Box

Qty	Item Description	Picture
1	LDLS Controller	
1	TLS Housing	
1	Fiber (1,500 um diameter, 0.39 NA, metal jacket)	—

Qty	Item Description	Picture
1	TLS Housing/LDLS Controller Interconnecting Cable (21-pin mixed D-sub)	
1	EQ-99-RC Remote Control with Interlock Jumper Plug and 15-Pin D-Connector I/O Cable	
1	Mini USB Cable (for monochromator)	

Qty	Item Description	Picture
1	<p>LDLS Controller Power Cable</p> <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>	
1	<p>24VDC Monochromator Power Supply</p> <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>	–

## 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.

1. Place the LDLS controller and TLS housing on a stable surface. The LDLS controller must be placed within 2 meters of the TLS housing due to the length of the interconnecting cable. Ensure the inlet and outlet air vents of the LDLS controller are not blocked and are at least 6 inches away from any obstacles.



2. Connect the TLS housing optical output to the user equipment using a suitable SMA fiber optic cable. The TLS housing should be mounted in the orientation shown above, with the housing resting horizontal on its rubber feet. The housing has been factory aligned in this position.

There are two optical output ports on the system: one on front of the unit, and one on the back of the unit.

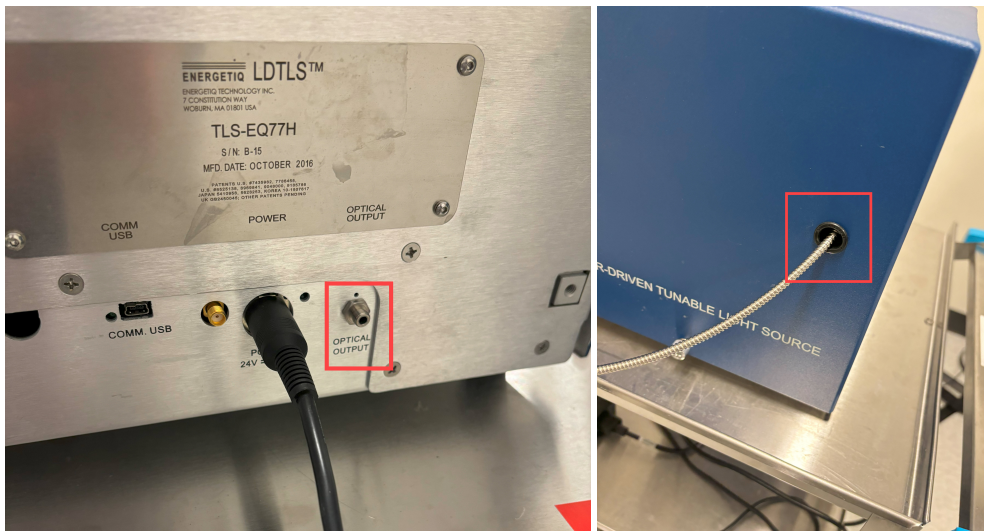
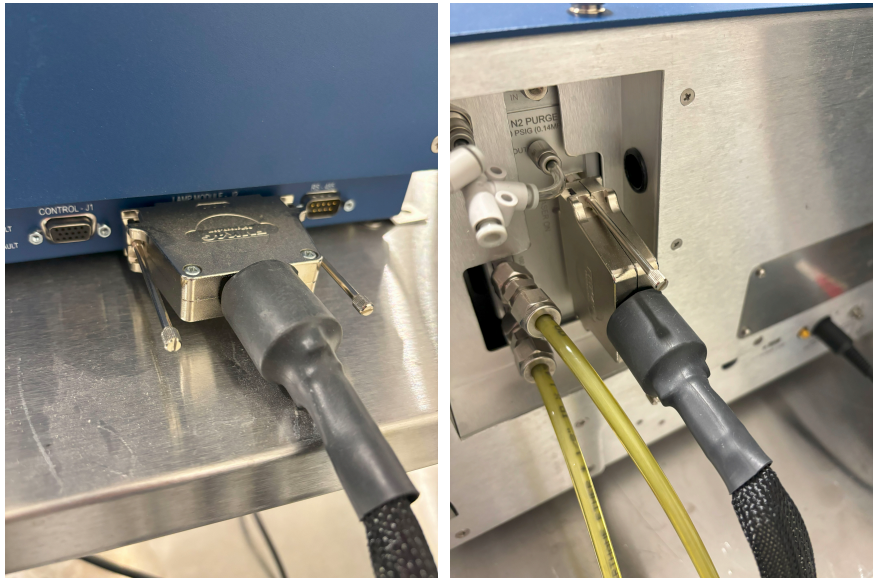


Figure 6. TLS Housing Optical Output Ports



3. Connect the TLS housing/LDLS controller interconnecting cable (black 21-pin mixed D-sub) from the LDLS controller to the TLS housing. This cable must be connected before AC power is applied to the LDLS controller.



**Figure 7. Connecting the TLS Housing/LDLS Controller Interconnecting Cable**

4. If using purge gas, connect nitrogen purge gas to the TLS housing. See [3.4 Utility Requirements](#) for details on nitrogen purity requirements.

Be sure that the nitrogen source is connected to the upper fitting on the TLS housing. This fitting contains a flow restrictor to limit gas flow to the necessary level.

5. Connect the cooling fluid chiller to the TLS housing.

Care must be taken when making connections to the TLS housing to avoid damage to the fittings and tubing.

Two wrenches must always be used – one to hold the fitting body, and another to tighten the nut. To make the connection: first insert tubing into the fitting and tighten the nut finger tight. Then, tighten the nut 1-1/4 turns from the finger-tight position, using two wrenches as shown.



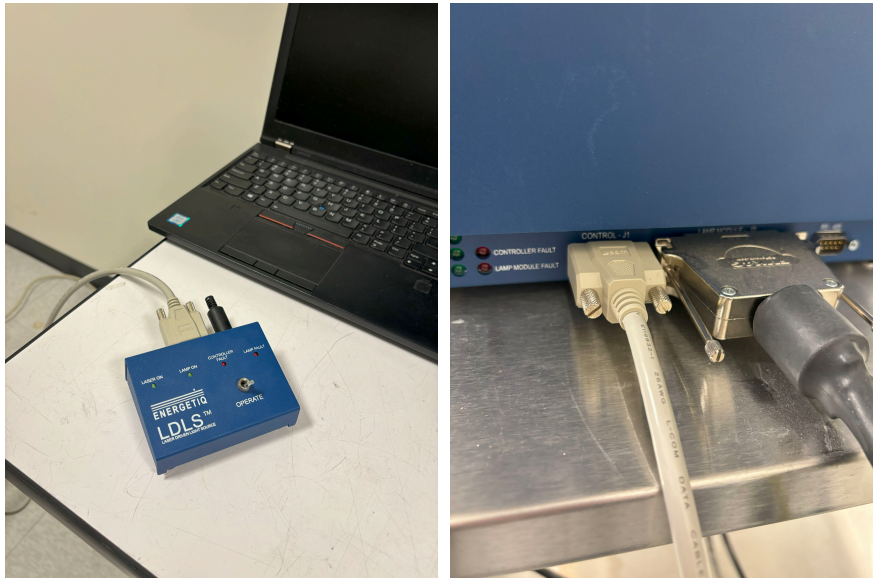
**Figure 8. Cooling Fluid Fittings**

6. Connect the cooling fluid chiller power cable to the chiller and a power outlet.



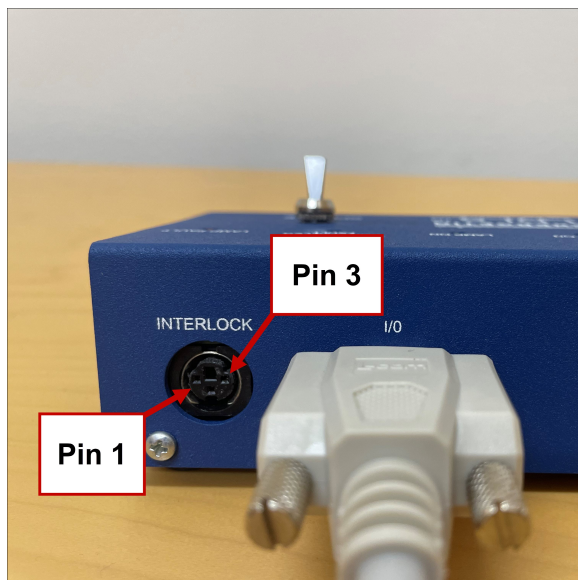
**Figure 9. Connecting Chiller Power Cable**

7. Place the EQ-99-RC remote control on a clean, rigid surface. Install the supplied 15-pin I/O cable from the LDLS controller to the EQ-99-RC remote control.



**Figure 10. Connecting the I/O Cable to Remote Control**

Ensure the interlock jumper plug is inserted into the interlock port on the back of the remote control. Alternatively, if you are integrating the TLS-EQ-77 system into your own interlock system, connect a remote contact or solid-state switch across pins 1 and 3 in the interlock port.



**Figure 11. Interlock Pin Locations**

If using another remote control system, see [for more information](#).

8. Connect the host computer to the monochromator control port on the TLS housing using a suitable USB cable.





**Figure 12. Connecting Host Computer to Monochromator Control Port**

9. If using the optional RS-485 interface, connect the host computer to the RS-485 port on the LDLS controller.
10. Connect the external monochromator power supply to the monochromator power supply port on the TLS housing. Position the AC adapter so that the AC inlet and power cord are readily accessible.



**Figure 13. Connecting Monochromator Power Supply**

11. Connect AC input power cord to the LDLS controller. Position the LDLS controller so that the power cord is readily accessible.



**Figure 14. Connecting AC Power Source**

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

The system is now ready to operate.

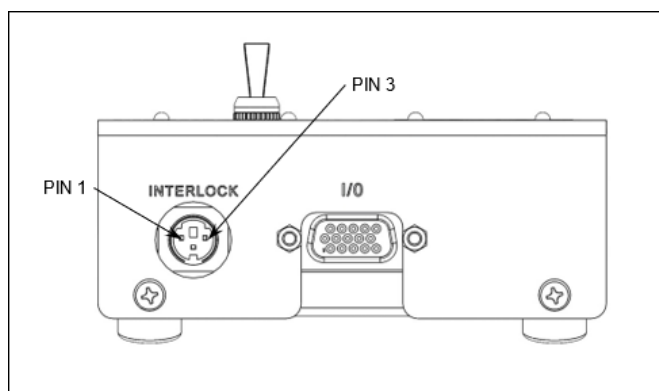
### 4.3 Installing Alternative Remote Control

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 remote control for the TLS-EQ-77 system.

The TLS-EQ-77 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 15. EQ-99-RC Remote Control Rear Panel**

**Table 9. 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
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-77 system internal isolated power supply, or an external supply.

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

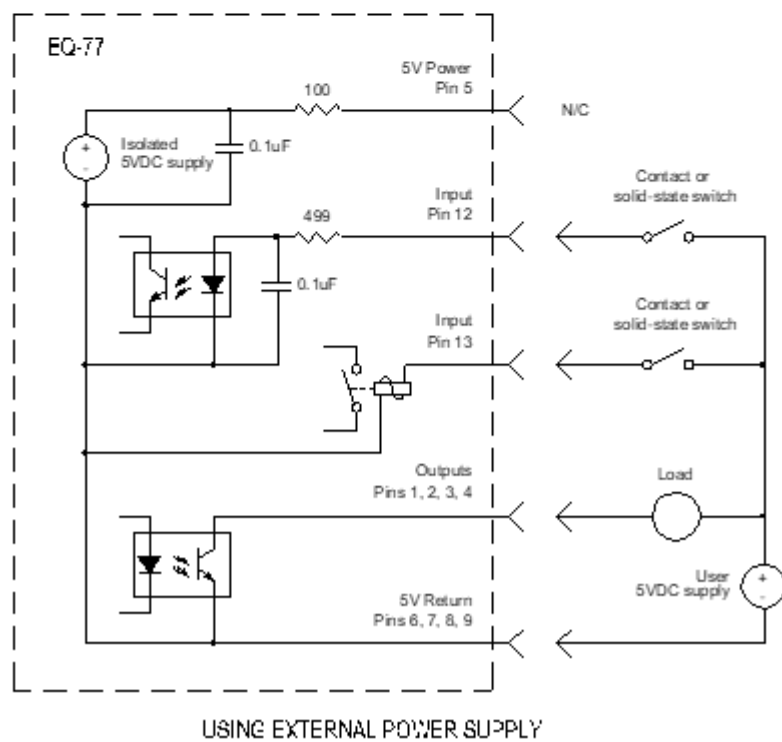
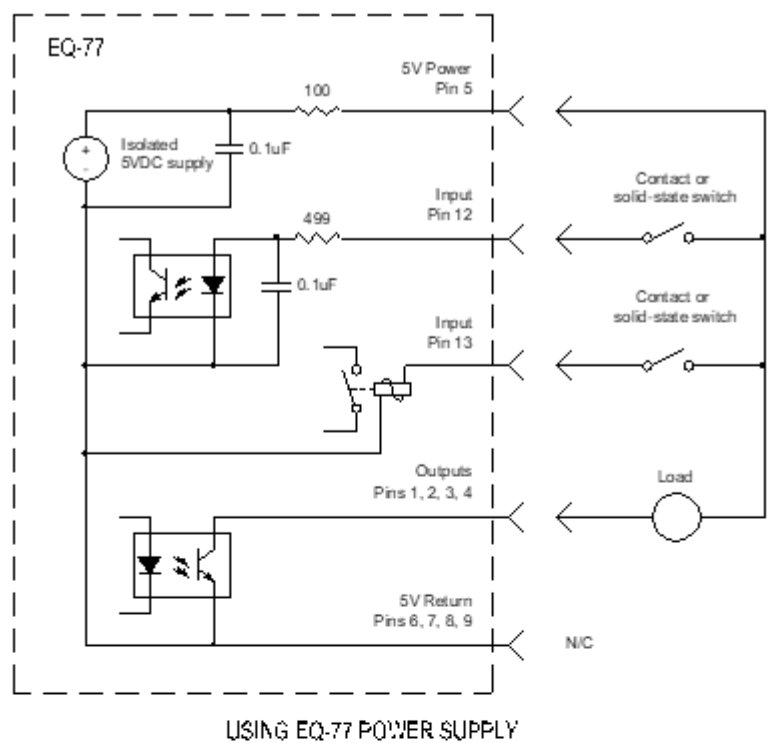


Figure 16. Remote Interface Schematic



## 4.4 Installing the Monochromator Software

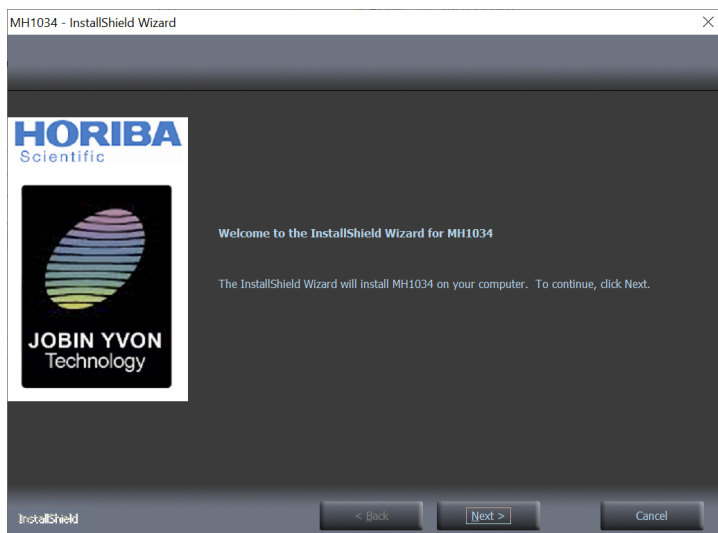
The monochromator is controlled through a USB interface. A simple Windows application is available to communicate with the monochromator from a host PC and control the basic functions of the instrument. You can download the latest version of the application by visiting [www.energetiq.com/resources](http://www.energetiq.com/resources).

**Note:** For users of the TLS-EQ-77-NIR system, the screenshots shown below may appear slightly different.

To install the monochromator software:

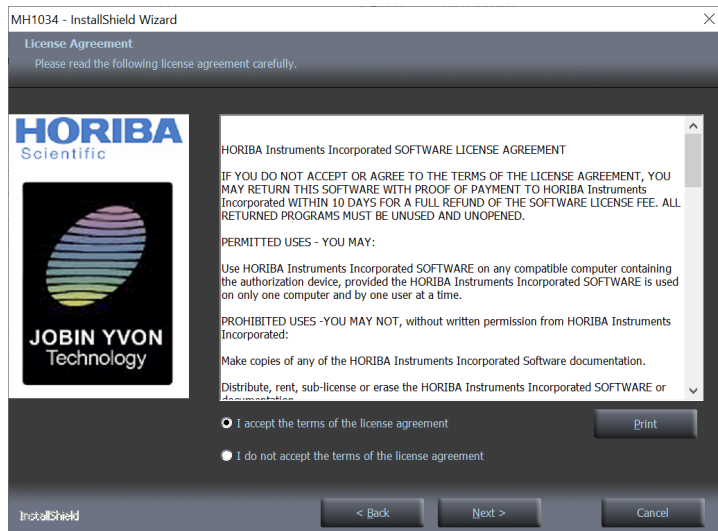
1. In an internet browser, navigate to [www.energetiq.com/resources](http://www.energetiq.com/resources). Click on the link labeled "TLS Software Driver" to begin downloading a zip file of the application installer.
2. When the download is complete, extract the files to a new folder.
3. Click on the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



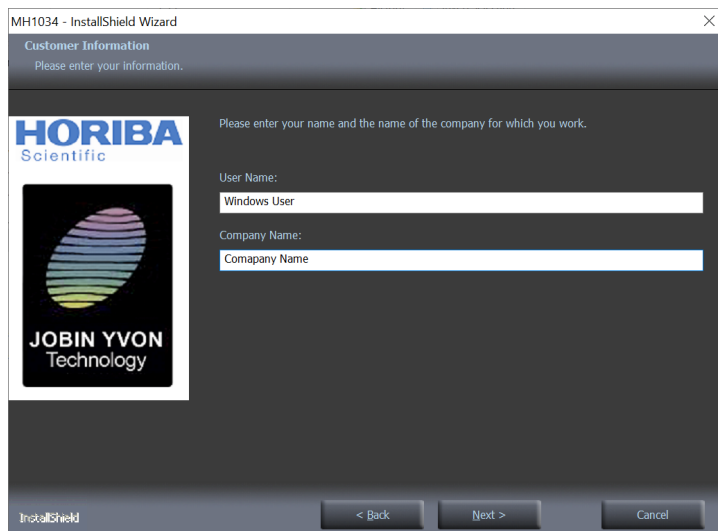
**Figure 17. Horiba MH1034 Installation Prompt**

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



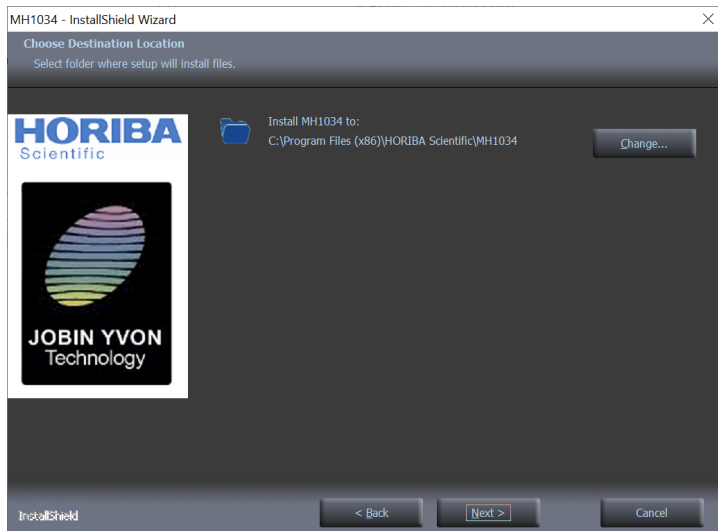
**Figure 18. License Agreement Screen**

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



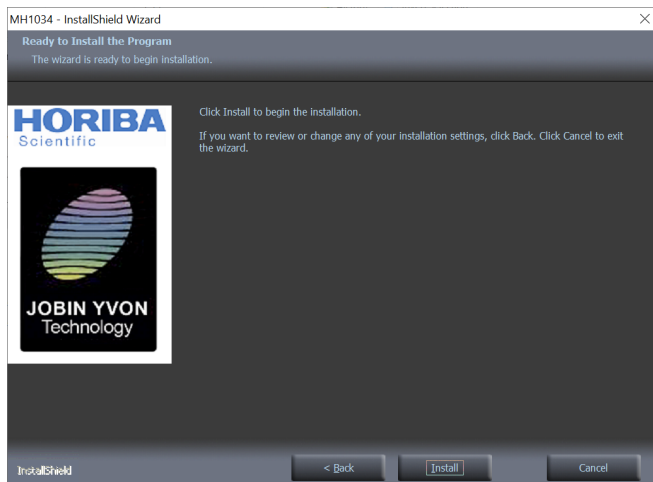
**Figure 19. Customer Information Screen**

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 20. 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.

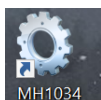


**Figure 21. Ready to Install the Program Screen**

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 22. MH1034 Icon**

## Chapter 5. Operating the System

### 5.1 Starting the System

**Caution:** Once the TLS-EQ-77 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-77 system is safely being used.

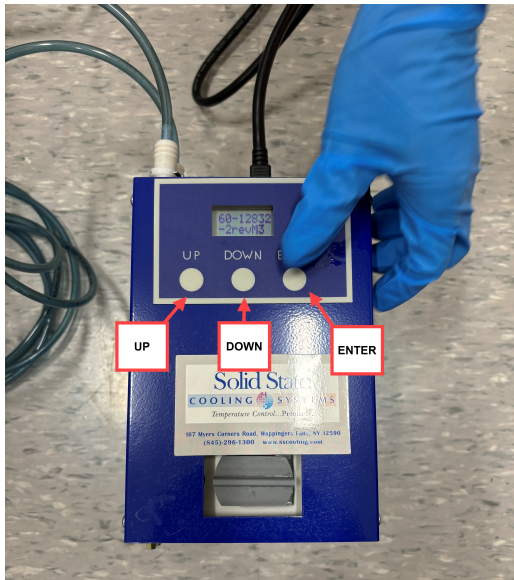
This section assumes you are using of the EQ-99-RC Remote Control to provide local control. If using an alternative control system, substitute the appropriate digital input and output lines from the table [I/O Port Pin Assignments](#) for the switches and LEDs described below.

1. On the back of the cooling fluid chiller, press the power switch to turn on the chiller.



**Figure 23. Turning on Chiller Power**

2. On the top of the chiller, use the UP and DOWN buttons to set the temperature of the cooling fluid. When the desired temperature is selected, press **ENTER** to set the chiller temperature.



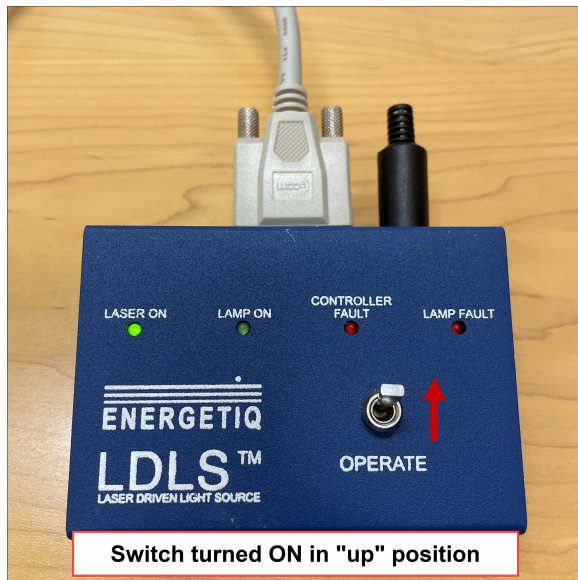
**Figure 24. Setting Chiller Temperature**

3. Review the status LEDs on the LDLS controller. The POWER ON LED should be lit, and neither the CONTROLLER FAULT nor LAMP MODULE FAULT LEDs should be lit.



**Figure 25. LDLS Controller "POWER ON" LED Illuminated**

4. 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 26. LASER ON LED Illuminated**

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



**Figure 27. LAMP ON LED Illuminated**

6. Allow the TLS-EQ-77 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-77 system. The TLS-EQ-77 system will automatically detect when



the unit has reached the optimum conditions for ignition.

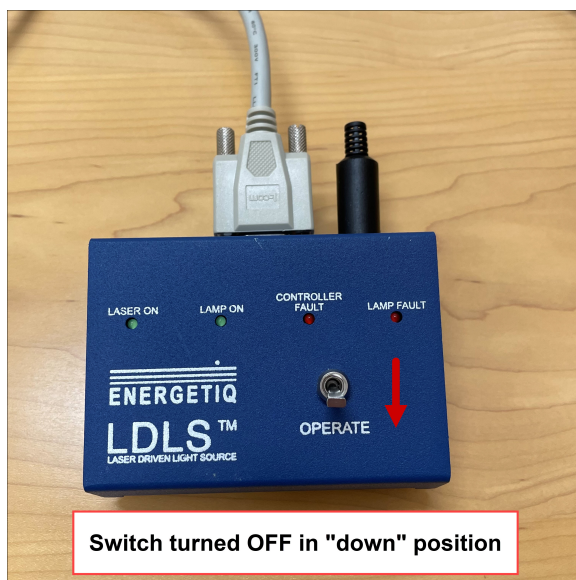
– If a bulb fails to ignite, 150 seconds after the OPERATE switch is turned ON:

- 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-77 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-77 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-77 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.

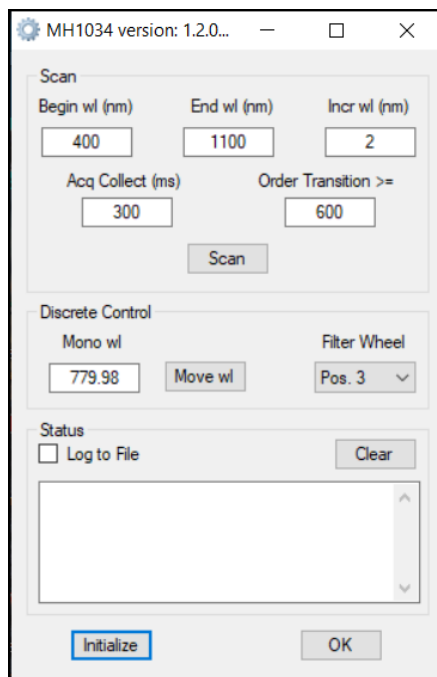
**Note:** For users of the TLS-EQ-77-NIR system, the screenshots shown below may appear slightly different.

### 5.3.1 Initializing the System

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

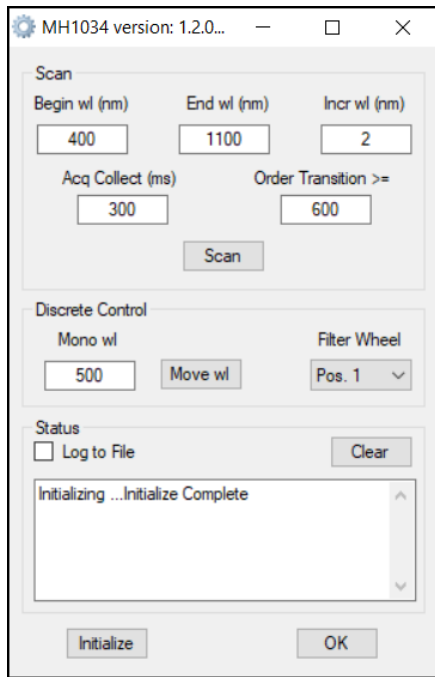
To initialize the system:

1. Ensure the TLS-EQ-77 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 28. 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 29. "Initialization Complete" Message**

4. The monochromator software is now ready to be used with your TLS-EQ-77 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.

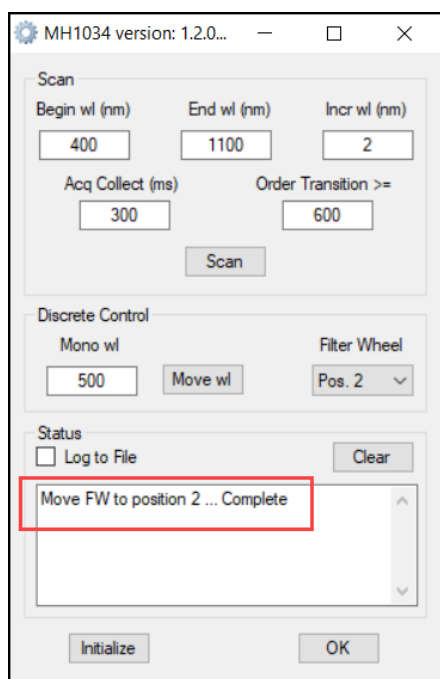


Figure 30. Success Message

3. The tables below describe the system's filter wheel positions. See the appropriate table below depending on your TLS system model.

Table 10. Filter Wheel Positions for TLS-EQ-77-S

Position	Light Path
1	Closed
2	Open
3	Order sorting filter, 575 nm long wavelength pass

Table 11. Filter Wheel Positions for TLS-EQ-77-NIR

Position	Light Path
1	Closed
2	Order sorting filter, 760 nm long wavelength pass
3	Order sorting filter, 1,000 nm long wavelength pass

Table 12. Filter Wheel Positions for TLS-EQ-77-UV

Position	Light Path
1	Closed
2	Open
3	Order sorting filter, 380 nm long wavelength pass

## Recommendation for Transitioning Filter Wheel

### TLS-EQ-77-S Models

During a wavelength sweep, it is recommended that you transition to the order sorting filter position (position 3) for wavelengths of **600 nm and greater**.

### TLS-EQ-77-NIR Models

During a wavelength sweep, it is recommended that you use position 2 for wavelengths between **800 nm and 1299 nm** and transition to position 3 for wavelengths of **1300 nm or greater**.

### TLS-EQ-77-UV Models

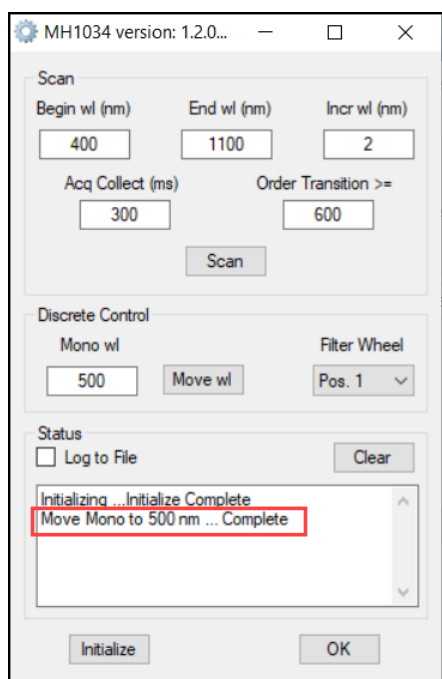
During a wavelength sweep, it is recommended that you transition to the order sorting filter position (position 3) for wavelengths of **400 nm and greater**.

## 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 31. 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.

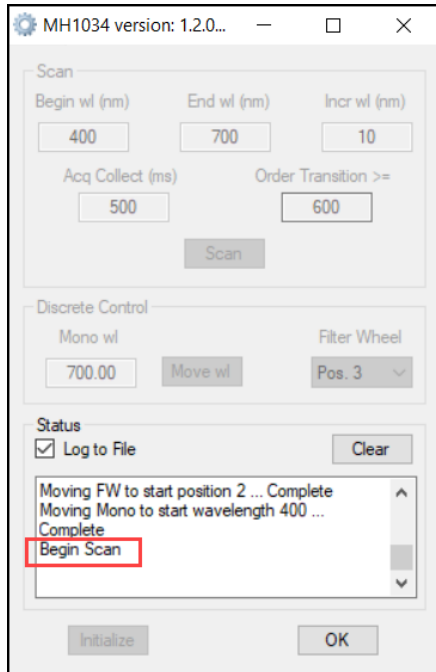
### 5.3.4 Using Wavelength Sweep Mode

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

To use wavelength sweep mode:

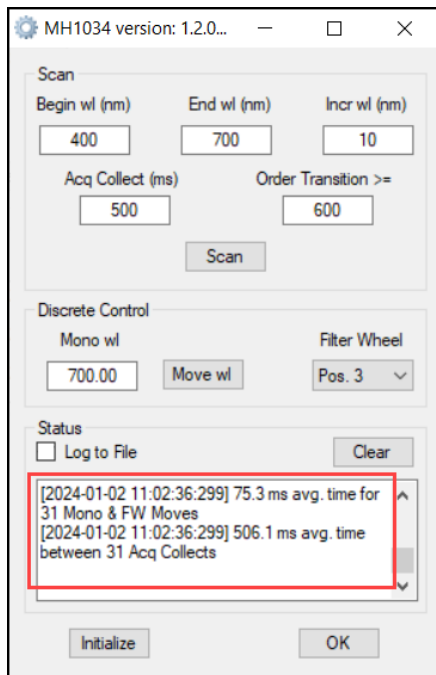
1. From the MH1034 home screen, in the Mono wl field, enter a wavelength value.
2. From the Filter Wheel dropdown box, select a filter wheel position. See [5.3.2 Using the Filter Wheel](#) for more information.
3. In the Begin wl (nm) field, enter a beginning wavelength value in nanometers.
4. In the 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 32. "Begin Scan" Status Message**

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



**Figure 33. 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.

## Chapter 6. Maintenance

### 6.1 Optical Alignment

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

#### 6.1.1 Objective

Provide instructions for alignment of the TLS-EQ-77 system.

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

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

**Table 13. 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

#### 6.1.3 Supplies and Tools Required

**Table 14. Required Supplies and Tools**

Part Number	Description	Quantity
843-R-USB	Power Meter, Newport Model 1919-R	1
-----	Newport Power Detector, 818-UV with the OD3 Filter Installed	1
884-SMA	SMA Fiber Adapter, Newport	1
-----	Thorlabs FT1500EMT, 1500um, 0.39NA, 0.9M Length Fiber	1
-----	Chiller	1
TLS 4	5-10 in-lbs adjustable torque screwdriver #1 Phillips Torque Blade	1
TLS 8	Adjustable torque wrench, 1/4" drive 4mm Hex Bit Socket, 1/4" drive	1
TLS 12	10-50 in-lbs adjustable torque screwdriver #2 Phillips Torque Screwdriver Blade	1
TLS 23	9- in/lb adjustable torque screwdriver w/Hex Inch Torque Blade 5/64"	1
TLS 24	(15-in/lb) adjustable torque screwdriver w/ Hex Metric Torque Blade 2.5mm, ball end	1



## 6.1.4 Parts Required



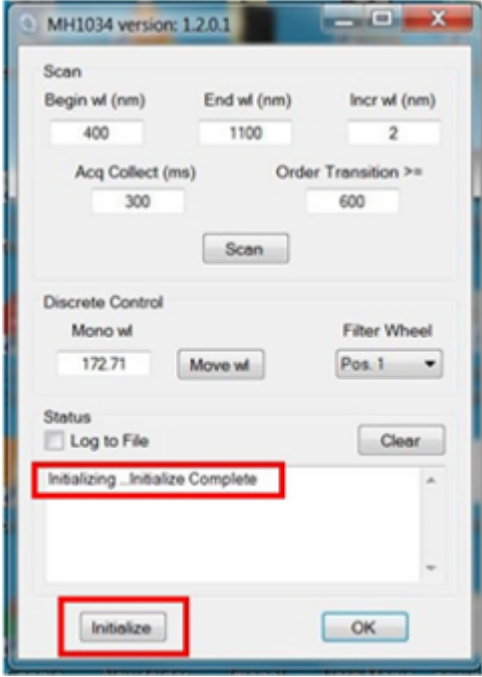
Table 15. Required Parts

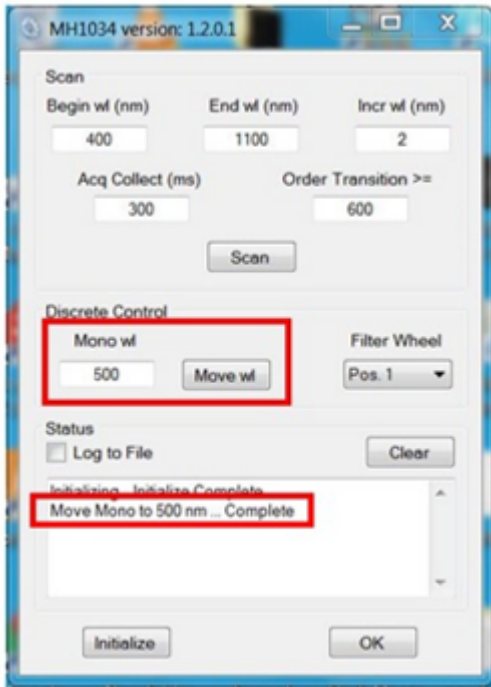
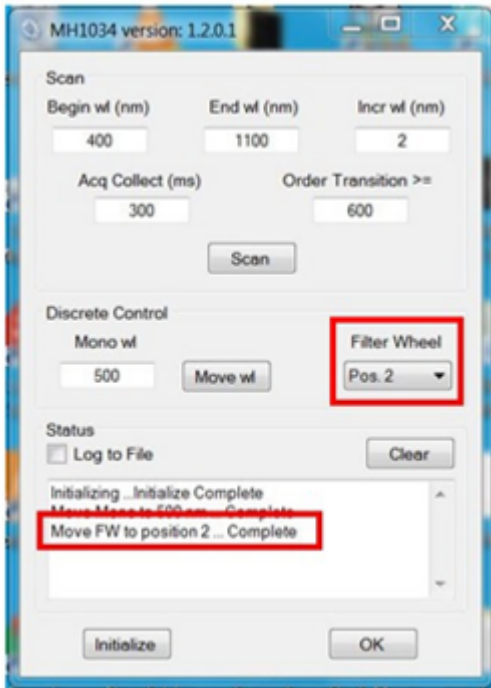
Part Number	Description	Quantity
----	TLS-EQ-77 system	1
ASD-4686	Remote Control	1
WC00064	Power Cable	2

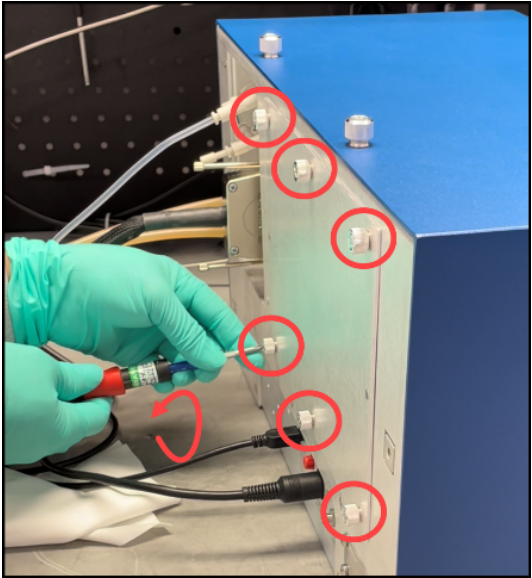
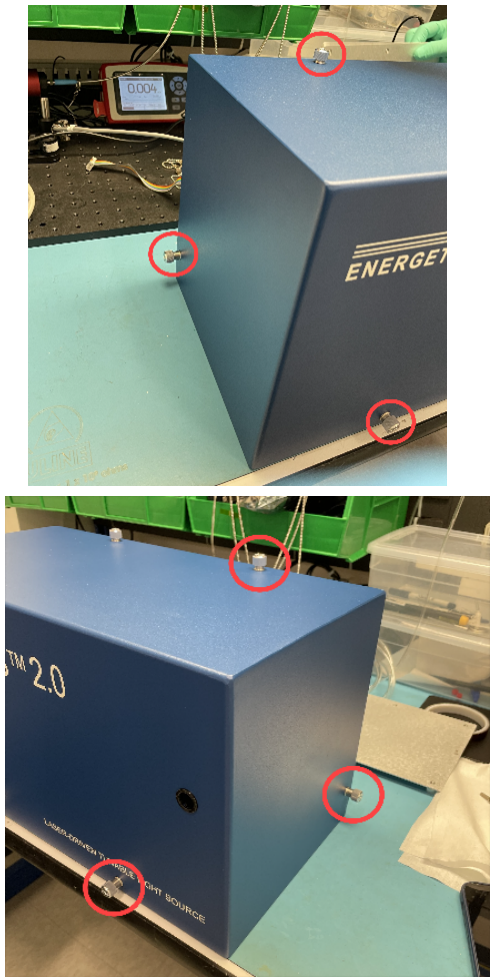
## 6.1.5 Procedure

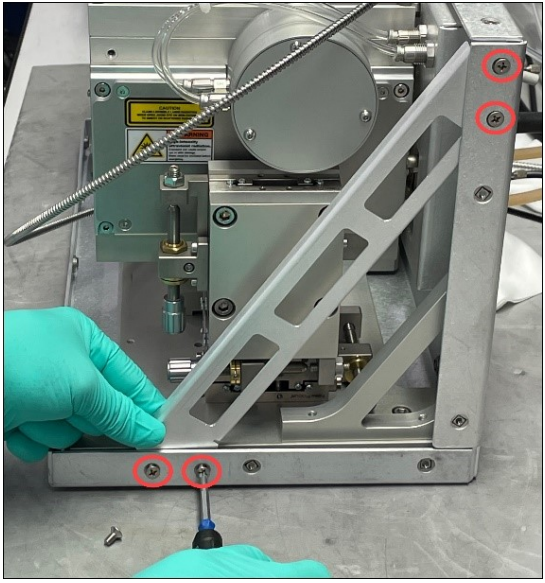
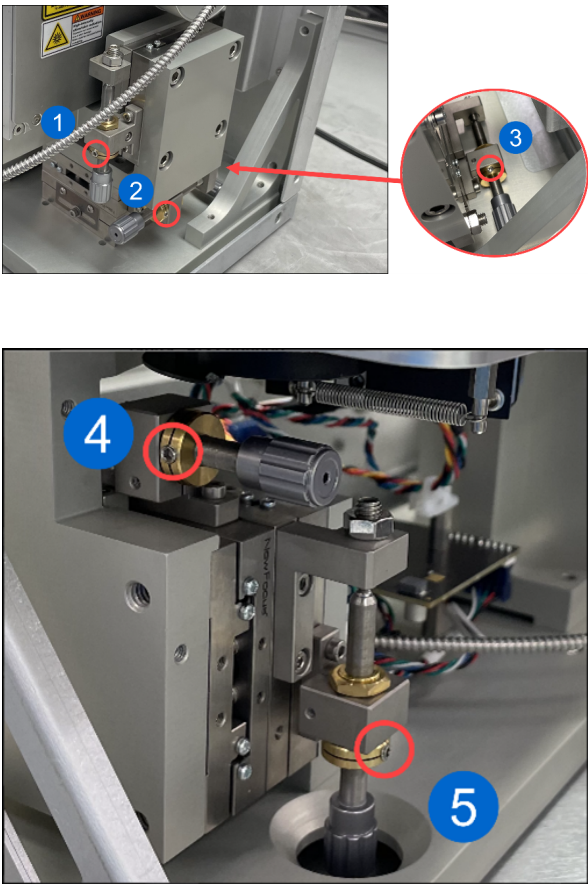
**Warning:** Wear laser safety glasses. Notify others of hazard. Always wear clean gloves when handling components.

Step	Instructions	Visual Aid
1.	<p>Connect to the test equipment and TLS-EQ-77 system as shown:</p> <ul style="list-style-type: none"> <li>• Connect one end of the 1500 <math>\mu</math>m fiber to the TLS housing connector labeled OPTICAL OUTPUT.</li> <li>• Hand tighten the SMA connector.</li> <li>• Connect the opposite end of the 1500 <math>\mu</math>m fiber to the power detector.</li> <li>• Hand tighten the SMA connector.</li> <li>• Connect the power detector to the power meter.</li> <li>• Connect the TLS housing cable to the TLS housing and LDLS controller.</li> <li>• Connect the monochromator power supply to the TLS housing connector labeled <b>POWER</b>.</li> <li>• Connect the USB cable to the PC and TLS housing connector labeled <b>COMM USB</b>.</li> <li>• Connect the remote control to the LDLS controller.</li> <li>• Connect the LDLS controller to a 120V AC outlet.</li> <li>• Connect the monochromator power supply to a 120V AC outlet.</li> <li>• Connect the cooling lines to the TLS housing.</li> <li>• Start the chiller and ensure there are no leaks.</li> <li>• Set to 22 °C and press START.</li> </ul>	<p>The diagram illustrates the setup of the TLS-EQ-77 system. A blue Chiller unit (labeled 'CHILLER @ 22°C') is connected to the TLS Housing via cooling lines. A black Monochromator Power Supply (labeled 'MONO PWR PS') is connected to the TLS Housing via a cable labeled 'POWER'. A laptop is connected to the TLS Housing via a USB cable. The TLS Housing is connected to an LDLS Controller via a cable labeled 'LH CABLE'. The LDLS Controller is connected to a Remote Control. A 1500 <math>\mu</math>m Fiber is connected from the TLS Housing (labeled 'OPTICAL OUTPUT') to a Power Detector. The Power Detector is connected to a Power Meter (labeled 'POWER METER').</p>

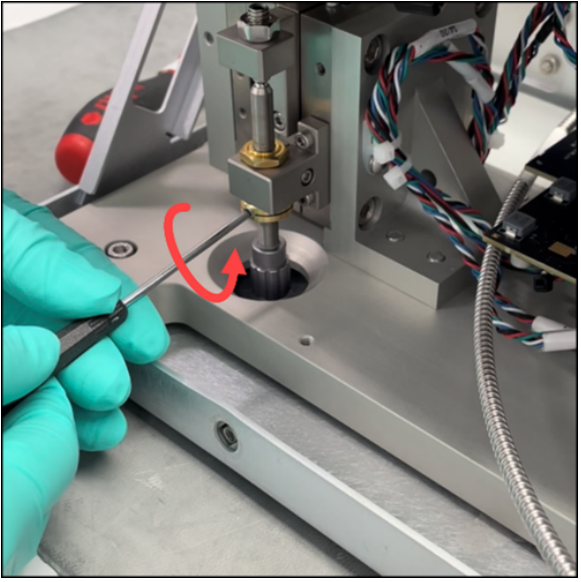
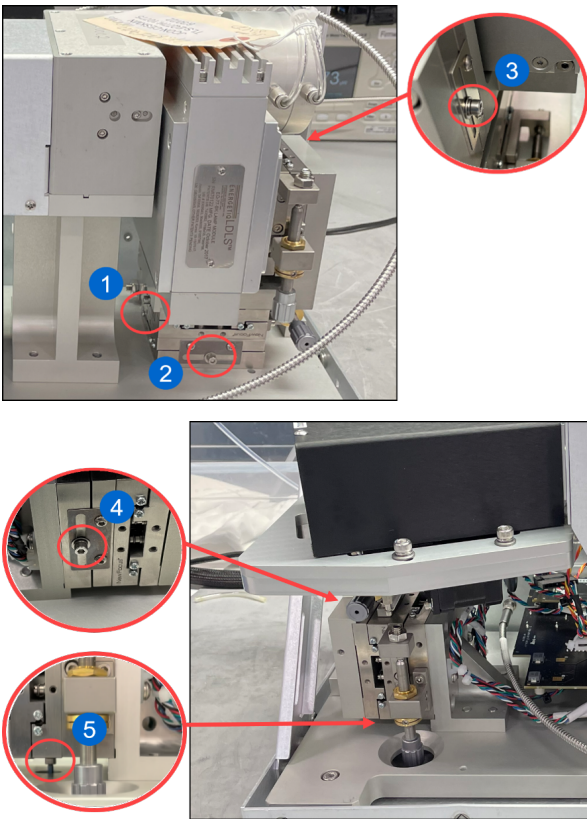
2.	<p>a. Turn the power meter <b>ON</b>.</p> <p>b. Zero the power meter.</p> <p>c. Set <i>Range</i> to <b>AUTO</b>.</p> <p>d. Set <i>Laser</i> to <b>500</b>.</p> <p>e. Set <i>Filter</i> to <b>IN</b>.</p>	 <p>The image shows a Newport 1919-R Power Meter. Labels point to various components: 'Sensor Input' at the top; 'Main Screen with Sensor Connected' pointing to the LCD display showing '3.49 μW'; 'Battery Indicator' and 'Serial Number' on the top right; 'Sensor Name' below the serial number; 'Soft Keys' on the right side; 'Enter Key' and 'Navigation Keys' in the center; and 'On/Off Switch and LCD Backlight Control' at the bottom. The device is labeled 'Power Meter Model 1919-R'.</p>
3.	<p>a. Turn the remote control <b>ON</b>.</p> <p>b. Wait 1 to 3 minutes for <b>LAMP ON</b> LED light to illuminate.</p>	 <p>The image shows the front panel of an Energetiq LDLS (Laser Driven Light Source). It features four status LEDs: 'LASER ON' (green), 'LAMP ON' (green), 'CONTROLLER FAULT' (red), and 'LAMP FAULT' (red). Below the LEDs is a gold-colored 'OPERATE' button. The text 'ENERGETIQ LDLS™ LASER DRIVEN LIGHT SOURCE' is printed on the panel.</p>
4.	<p>a. On the computer, start the <b>MH1034</b> application.</p> <p>b. Initialize the monochromator.</p>	 <p>The image shows a screenshot of the MH1034 application window. The title bar says 'MH1034 version: 1.2.0.1'. The 'Scan' section has input fields for 'Begin wl (nm)' (400), 'End wl (nm)' (1100), 'Incr wl (nm)' (2), 'Acq Collect (ms)' (300), and 'Order Transition' (600). The 'Discrete Control' section has 'Mono wl' (172.71) and 'Filter Wheel' (Pos. 1). The 'Status' section has a 'Log to File' checkbox and a 'Clear' button. A red box highlights the 'Initializing... Initialize Complete' status text. Another red box highlights the 'Initialize' button at the bottom left.</p>

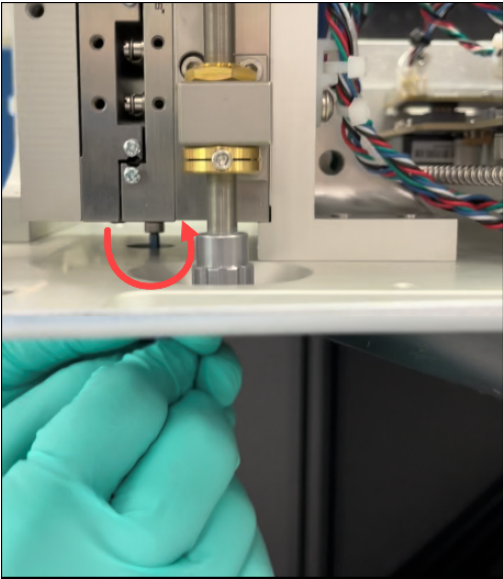
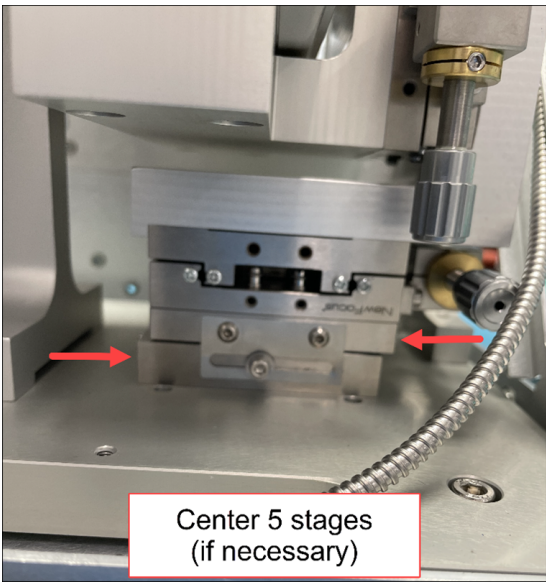
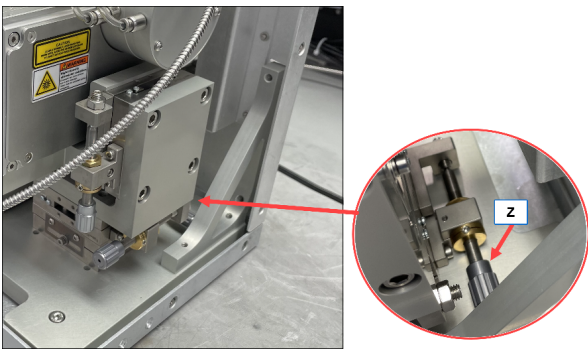
5.	Change Mono wl to <b>500nm</b> .	 <p>The screenshot shows the MH1034 software interface (version 1.2.0.1). The 'Scan' section has 'Begin wl (nm)' at 400, 'End wl (nm)' at 1100, and 'Incr wl (nm)' at 2. 'Acq Collect (ms)' is 300 and 'Order Transition &gt;=' is 600. In the 'Discrete Control' section, the 'Mono wl' is set to 500, and the 'Filter Wheel' is at 'Pos. 1'. The 'Status' section has 'Log to File' unchecked. The status window shows 'Initializing... Initialize Complete' and 'Move Mono to 500 nm ... Complete'. The 'Initialize' and 'OK' buttons are at the bottom.</p>
6.	Change Filter Wheel to <b>Pos. 2</b> .	 <p>The screenshot shows the MH1034 software interface (version 1.2.0.1). The 'Scan' section has 'Begin wl (nm)' at 400, 'End wl (nm)' at 1100, and 'Incr wl (nm)' at 2. 'Acq Collect (ms)' is 300 and 'Order Transition &gt;=' is 600. In the 'Discrete Control' section, the 'Mono wl' is set to 500, and the 'Filter Wheel' is at 'Pos. 2'. The 'Status' section has 'Log to File' unchecked. The status window shows 'Initializing... Initialize Complete' and 'Move FW to position 2 ... Complete'. The 'Initialize' and 'OK' buttons are at the bottom.</p>

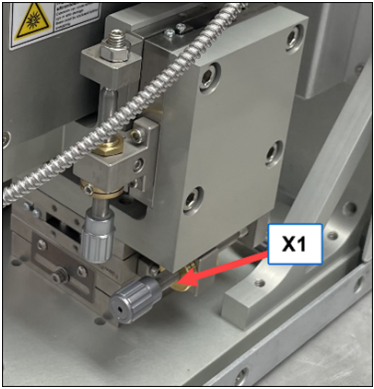
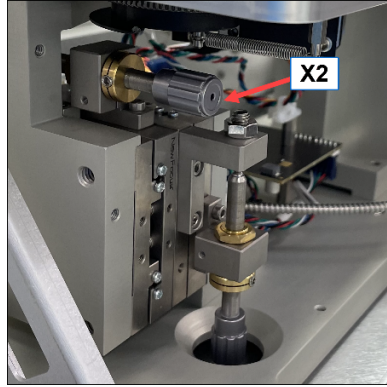
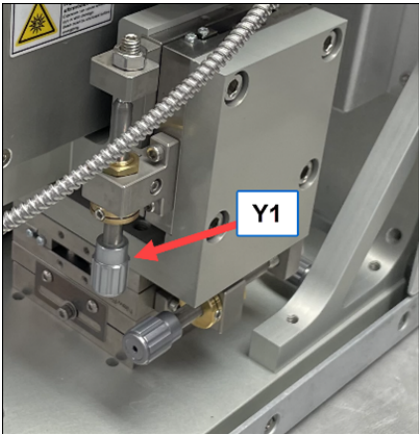
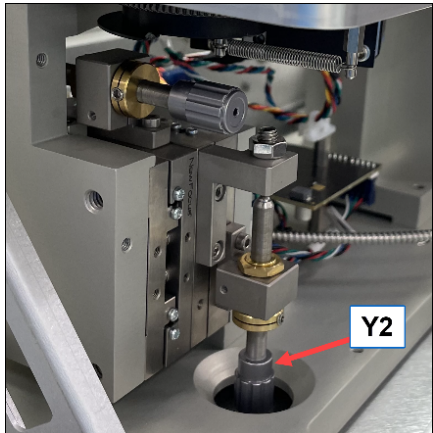
7.	Remove TLS housing rear access panel. Loosen the 6 access panel screws using <b>TLS 4</b> .	
8.	Remove TLS housing cover. Loosen the 6 cover screws using <b>TLS 4</b> .	

9.	<p>On the right-hand side of the TLS housing, remove support bracket. Loosen the 4 support bracket screws using <b>TLS 12</b>.</p>	
10.	<p>Locate the 5 shaft lock screws.</p>	

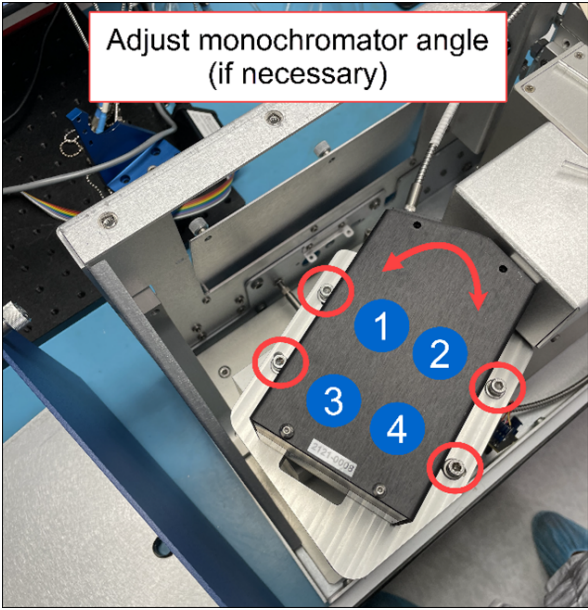
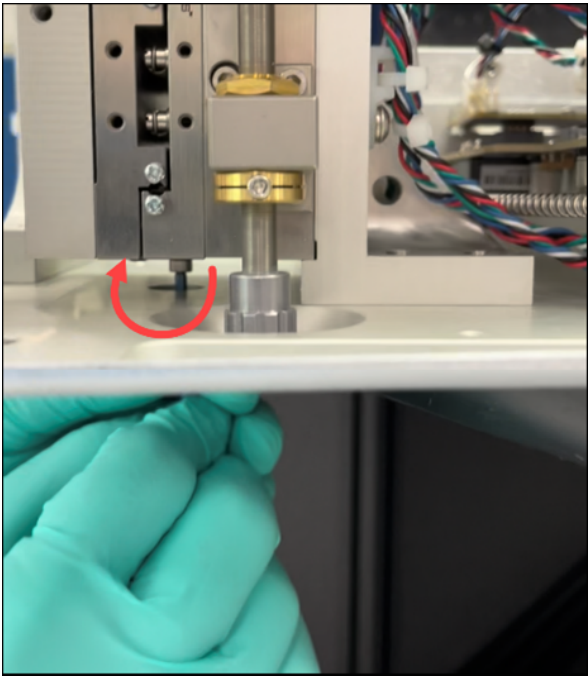


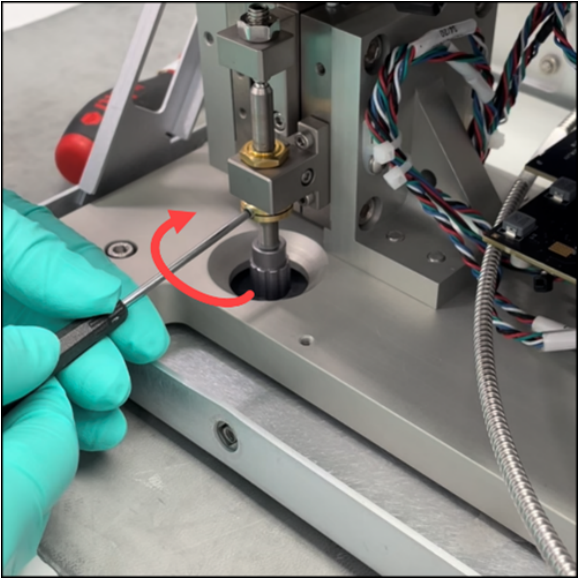
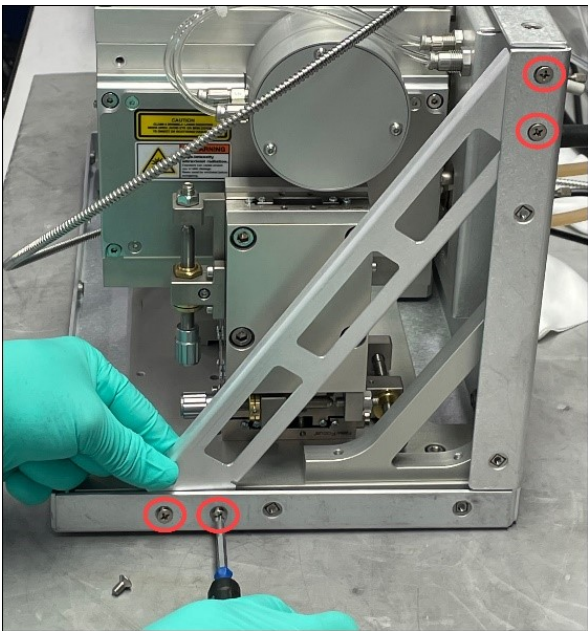
11.	<p><b>Caution:</b> To avoid damaging the TLS system, you must perform this step.</p> <p>Loosen the 5 shaft lock screws using <b>TLS 23</b>.</p>	
12.	Locate the 5 stage lock screws.	

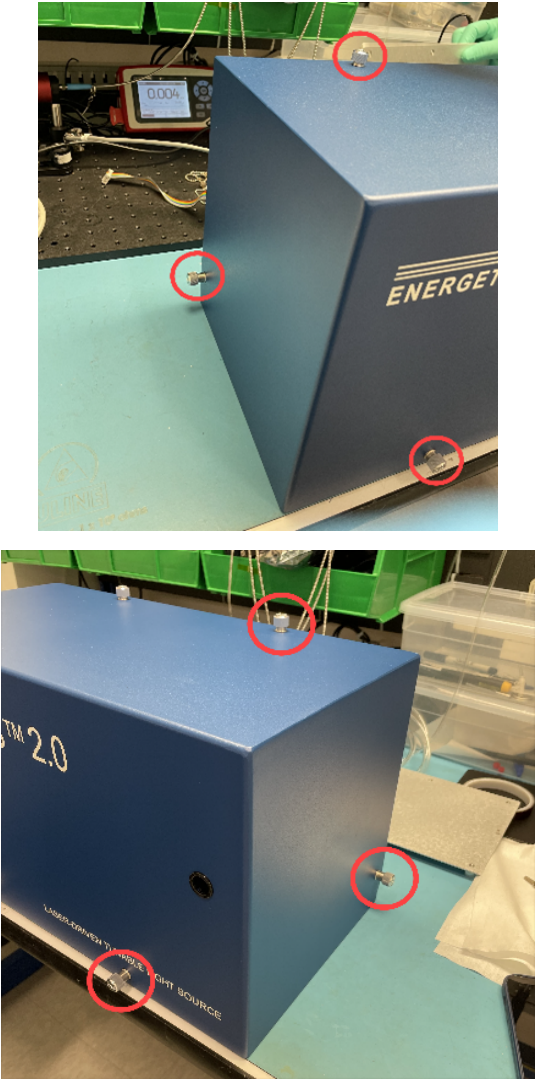
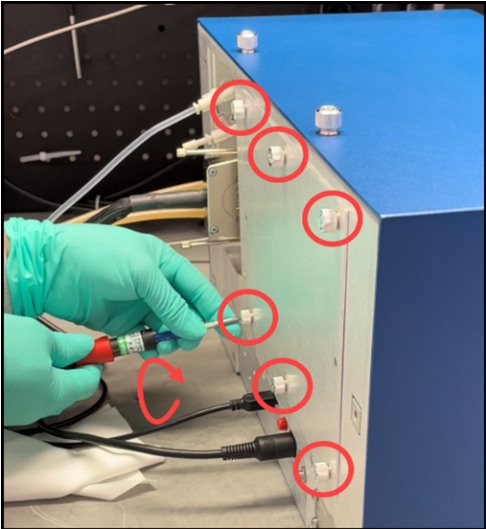
13.	<p><b>Caution:</b> To avoid damaging the TLS system, you must perform this step.</p> <p>Loosen the 5 stage lock screws using <b>TLS 24</b>.</p>	
14.	<p>a. Ensure all 5 stages are centered.</p> <p>b. If necessary, center each stage using the corresponding adjustment knob.</p>	 <p>Center 5 stages (if necessary)</p>
15.	<p>a. Locate the <b>Z</b> adjustment knob.</p> <p>b. Use fingers to adjust knob until the highest value is reached on the power meter.</p>	

16.	<p>a. Locate the <b>X1</b> and <b>X2</b> adjustment knobs.</p> <p>b. Use fingers to adjust one knob at a time. Adjust knobs until the highest value is reached on the power meter.</p>	 
17.	<p>a. Locate the <b>Y1</b> and <b>Y2</b> adjustment knobs.</p> <p>b. Use fingers to adjust one knob at a time. Adjust knobs until the highest value is reached on the power meter.</p>	 



18.	<p>If the highest value on the power meter is still not reached, complete the following steps:</p> <ul style="list-style-type: none"><li>a. Loosen the 4 monochromator screws using <b>TLS 8</b>.</li><li>b. Adjust monochromator angle until the highest value is reached on the power meter.</li><li>c. Tighten the 4 monochromator screws using <b>TLS 8</b>.</li><li>d. Repeat <b>Z</b>, <b>X</b>, and <b>Y</b> adjustments until the highest value is reached on the power meter.</li></ul>	
19.	<ul style="list-style-type: none"><li>a. Tighten the 5 stage lock screws using <b>TLS 24</b>.</li><li>b. Verify that Maximum Power has not changed on the power meter.</li></ul>	

20.	<p>a. Tighten the 5 shaft lock screws using <b>TLS 23</b>.</p> <p>b. Verify that Maximum Power has not changed on the power meter.</p>	
21.	<p>On the right-hand side of the TLS housing, install support bracket. Tighten the 4 support bracket screws using <b>TLS 12</b>.</p>	

22.	Install TLS housing cover. Tighten the 6 cover screws using <b>TLS 4</b> .	
23.	Install TLS housing rear access panel. Tighten the 6 access panel screws using <b>TLS 4</b> .	

## 6.2 Packing the System

### 6.2.1 Objective

Provide instructions for packaging the TLS-EQ-77 system for return shipping to Energetiq.

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

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

**Table 16. Required PPE**

Part Number	Description	Quantity
TN120X-B	Gloves, Nitrile rubber, TechNiGlove (replace <b>X</b> with digit for desired size)	As required

### 6.2.3 Supplies and Tools Required




**Table 17. Required Supplies and Tools**


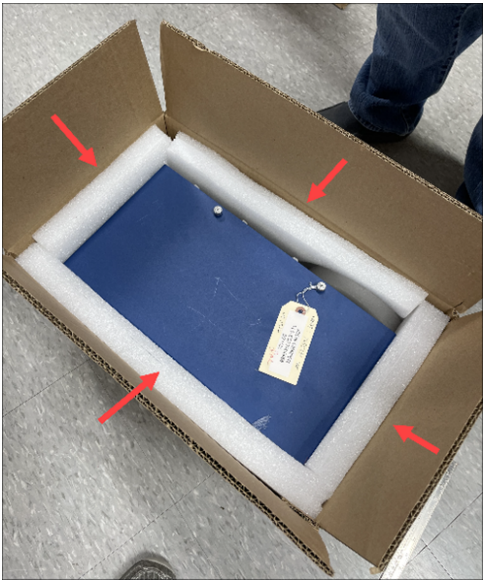
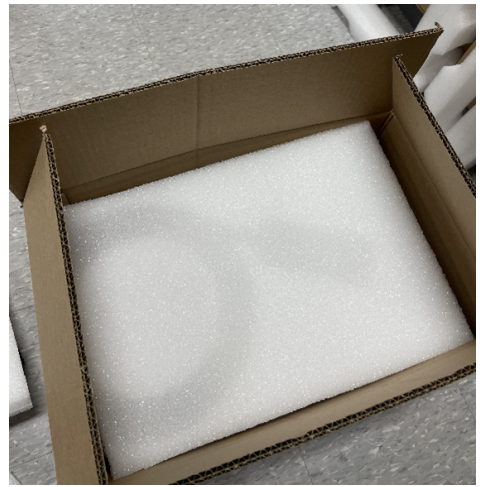
Part Number	Description	Quantity
-----	Packing tape dispenser	1
-----	Utility knife	1
-----	Packing foam sheets, 24" x 48" x 2"	1
-----	Bubble wrap roll, 24" x 100' x ½"	1
-----	Corrugated cardboard box, 20" x 12" x 13.5"	1 per TLS system
-----	Corrugated cardboard box, 25" x 17" x 18"	1 per TLS system
-----	Pallet	1
-----	Pallet wrap roll	1
-----	Pallet edge protectors	8
-----	½" poly strap sealer	1
-----	¾" poly strap tensioner	1
-----	Poly strap seals	4
-----	Poly strap	64'
-----	TLS-EQ-77 system	Up to 2






6.2.4 Procedure



**Warning:** Always wear clean gloves when handling components.

Step	Instructions	Visual Aid
1.	<p>a. Prepare inner corrugated cardboard box 20" x 12" x 13.5" in size.</p> <p>b. Close inner cardboard box seams using <b>packing tape</b>.</p> <p>c. Leave top of box open.</p>	
2.	<p>On bottom of inner cardboard box, place padding material.</p> <p>Energetiq recommends the following types of padding material:</p> <ul style="list-style-type: none"><li>• Packing foam sheets</li><li>• Bubble wrap</li></ul> <p>If necessary, cut padding material using a <b>utility knife</b>.</p>	<div></div>



3.	Place TLS-EQ-77 system on top of padding material in inner cardboard box.	
4.	<ul style="list-style-type: none"><li>a. Place padding material on all four sides of inner box to fill empty spaces.</li><li>b. If necessary, cut padding material using a <b>utility knife</b>.</li></ul>	
5.	<ul style="list-style-type: none"><li>a. Place padding material on top of TLS-EQ-77 system to fill empty space.</li><li>b. If necessary, cut padding material using a <b>utility knife</b>.</li></ul>	


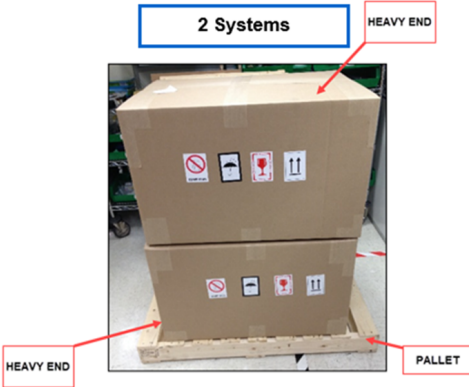

6.	<ol style="list-style-type: none"><li>Close inner cardboard box.</li><li>Tape inner cardboard box closed using <b>packing tape</b>.</li></ol>	
7.	<ol style="list-style-type: none"><li>Prepare outer corrugated cardboard box approximately 25" x 17" x 18" in size.</li><li>Tape outer box seams using <b>packing tape</b>.</li><li>Leave top of box open.</li></ol>	
8.	<ol style="list-style-type: none"><li>On bottom of outer cardboard box, place padding material.</li><li>If necessary, cut padding material using a <b>utility knife</b>.</li></ol>	








9.	<p><b>Note:</b> You <b>must</b> pack the TLS-EQ-77 system using 2 cardboard boxes. <b>Do not ship the system using only 1 cardboard box.</b></p> <p>Place sealed inner cardboard box on top of padding material in outer cardboard box.</p>	
10.	<p>a. Place padding material on all 4 sides of outer cardboard box to fill empty spaces.</p> <p>b. If necessary, cut padding material using a <b>utility knife</b>.</p>	



11.	<p>a. Place padding material on top of outer cardboard box to fill empty space.</p> <p>b. If necessary, cut padding material using a <b>utility knife</b>.</p>	
12.	<p>a. Close outer cardboard box.</p> <p>b. Tape outer cardboard box closed using <b>packing tape</b>.</p>	
13.	<p>If available, place the following labels on the side of the outer cardboard box:</p> <p>a. "Fragile" label</p> <p>b. "Keep Dry" label</p> <p>c. "Do Not Stack" label</p> <p>d. "This Side Up" label</p>	
14.	If packing 2 TLS-EQ-77 system systems, repeat steps 1-13.	N/A

15.	<p>a. Place <b>pallet</b> on floor.</p> <p>b. Place first TLS-EQ-77 system box on the pallet and center the system.</p> <p>c. If packing 2 systems, place second TLS-EQ-77 system box on top of the first TLS-EQ-77 system box and center the system as shown.</p> <p>Ensure the heavy end of the second system box is opposite the heavy end of the first system box.</p>	<p><b>1 System</b></p>  <p><b>2 Systems</b></p> 
16.	<p>If packing 2 systems, tape the seam between the TLS-EQ-77 system boxes using <b>packing tape</b>. Make several wraps around the boxes.</p>	<p><b>*If Packing 2 Systems*</b></p> 

17.	<p>a. Wrap the TLS-EQ-77 system boxes using <b>pallet wrap</b>. Wrap several times around the boxes.</p> <p>b. At the top of the boxes, overlap the pallet wrap.</p>	
18.	<p>a. Prepare 8 <b>pallet edge protectors</b>.</p> <p>b. Position pallet edge protectors evenly along the top cardboard box on the pallet.</p>	

19.	<p>a. Cut 4 pieces of <b>poly strap</b>.</p> <p>b. If packing 1 TLS-EQ-77 system, cut each piece of poly strap to 10'. If packing 2 systems, cut each piece of poly strap to 16'.</p> <p>c. Place 2 poly straps around the pallet in both directions as shown.</p>	
20.	<p>a. Use the poly strap tensioner tool.</p> <p>b. Tension each strap until it is tight on the pallet edge protectors using the <math>\frac{3}{4}</math>" <b>poly strap tensioner tool</b>.</p>	
21.	<p>a. On the overlapped part of the poly strap, place a <b>poly strap seal</b>.</p> <p>b. Crimp poly strap seal at both ends of the seal using the <b>poly strapping sealer</b>.</p> <p>c. Repeat this step for each poly strap.</p>	
22.	Ship the pallet of systems to Energetiq as air freight.	N/A



## Chapter 7. Troubleshooting

As shown in the figure [LDLS Controller LED Lights](#) below, there are five LED lights on the side of the LDLS controller that indicate the current status of the TLS-EQ-77 system.



**Figure 34. LDLS Controller 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-77 system and the potential steps to resolve those issues.

**Table 18. 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-77 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>	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> .	If the lamp bulb fails to ignite after several attempts, contact Energetiq.
LASER ON is <b>OFF</b>	There was a failure to ignite the plasma inside the lamp bulb.  This also causes the LAMP MODULE FAULT light to turn <b>ON</b> and LAMP ON light to turn <b>OFF</b> .	



## 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 EQ-77X lamp head is shipped with the laser power set to a factory default value of 100% of full scale power. Laser power can be increased or decreased in increments of 0.5% of full scale. The following describes the serial commands and their functions.

Commands consist of a single ASCII character, case-sensitive. This can be transmitted to the EQ-77X via a terminal emulation program, or the user's control system. Response from the EQ-77X will be a string of ASCII characters, format depending on the command issued.

The following table describes the serial commands and their functions.

**Table 19. Serial Commands and Functions**

Command Character	Function	Reply from EQ-77X
U	Increases the present laser power setpoint by 0.5% of full scale	Power = XX.X%
D	Decreases the present laser power setpoint by 0.5% of full scale	Power = XX.X%
Q	Queries the value of the present laser power setpoint (in % of full scale)	Power = XX.X%
F	Resets laser power setpoint to factory default value	Power = XX.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 EQ-77X is interrupted.	Calibration data copied to FLASH Memory.
H	Queries the bulb operating hours	XXXX.X hours
Z	Zeroes the bulb operating hours	Send 'z' within 10 sec. to confirm
z	(Confirm zero within 10 sec)	Bulb hours zeroed & flash saved

Command Character	Function	Reply from EQ-77X
?	Displays a help menu listing the available commands	U/D – Raise/lower laser power by 0.5% Q – Query present laser power F – Reset laser power to Factory default B – Burn present settings to non-volatile flash H – Query bulb operating hours Z – Zero bulb operating hours z – (Confirm zero within 10 sec) ? – This help menu

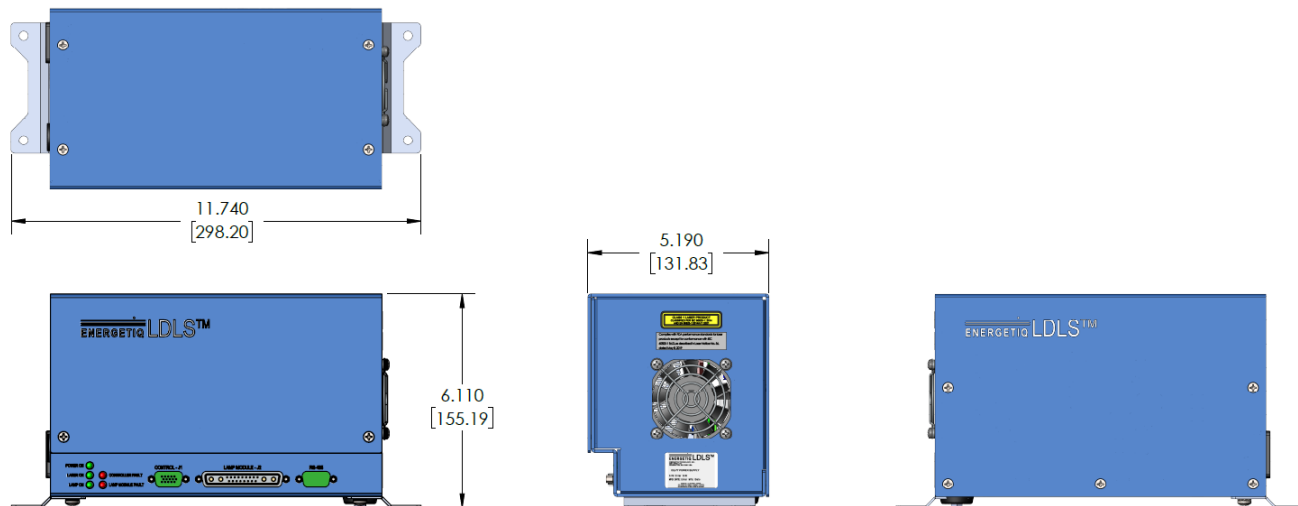
The following table details pin assignments for the RS-485 interface.

**Table 20. RS-485 Interface Pin Assignments**

Description	Pin #	Details
TRANSMIT A (–)	8	From TLS-EQ-77 system, connect to host RECEIVE A
TRANSMIT B (+)	3	From TLS-EQ-77 system, connect to host RECEIVE B
RECEIVE A (–)	7	To TLS-EQ-77 system, connect to host TRANSMIT A
RECEIVE B (+)	2	To TLS-EQ-77 system, connect to host TRANSMIT B
GROUND	5, 9	Galvanically isolated from system
RESERVED	1, 4, 6	Do not connect

## Appendix B. Dimensional Drawings

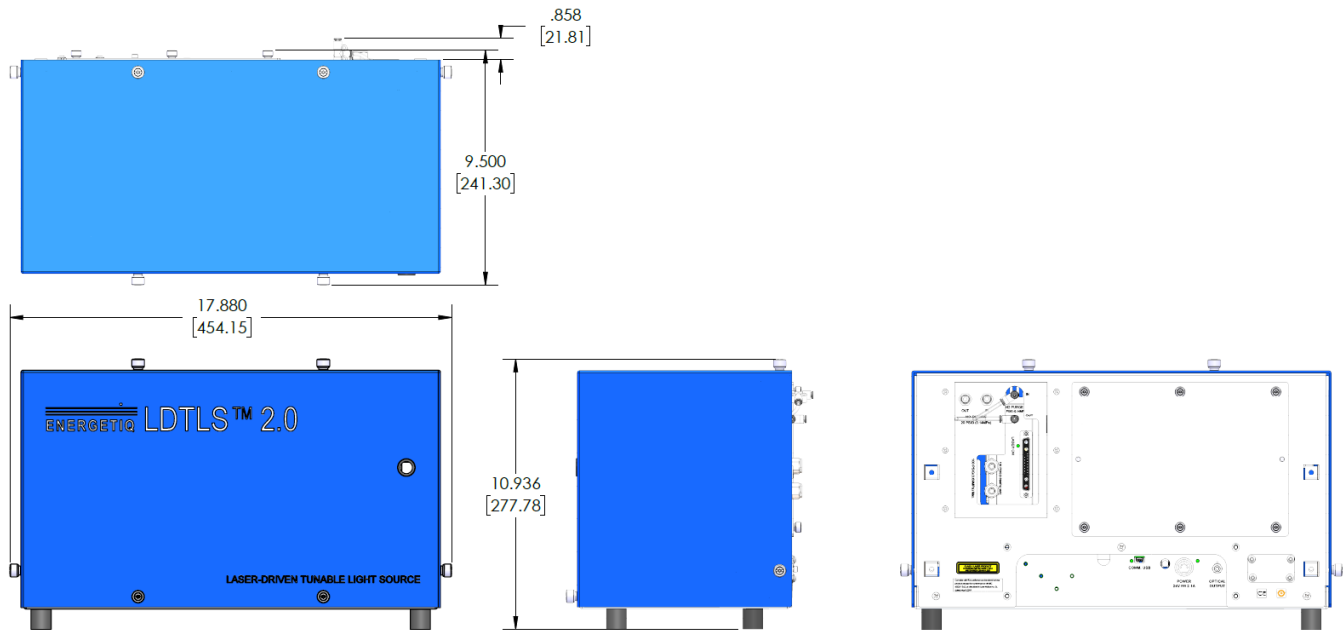
### LDLS Controller



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

**Figure 35. LDLS Controller Dimensional Drawing**

## TLS Housing



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

**Figure 36. TLS Housing Dimensional Drawing**

## Appendix C. Revision History

Version Number	Modified By	Modifications Made	Date Modified
Rev. 1	E. Burz	Initial release.	03/06/2023
Rev. 2	E. Burz	Compliance label updates. Updated Declaration of Conformity. Updated cooling fluid temperature range.	06/23/2023
Rev. 3	E. Burz	Updated Certification label description in "Labels and Safety Notifications" to conform to UL requirements.	09/05/2023
Rev. 4	E. Burz	Reformatted manual using new template and organization structure. Compliance updates. Updated the following sections: "Installing the Monochromator Software" and "Troubleshooting." Added the following sections: "Using the Monochromator Software." Minor edits.	01/20/2024
Rev. 5	E. Burz	Minor compliance updates.	04/05/2024
Rev. 6	E. Burz	Updated product dimensions and dimensional drawings. Added chiller operation instructions. Revised "Installation" chapter. Minor edits.	11/11/2024