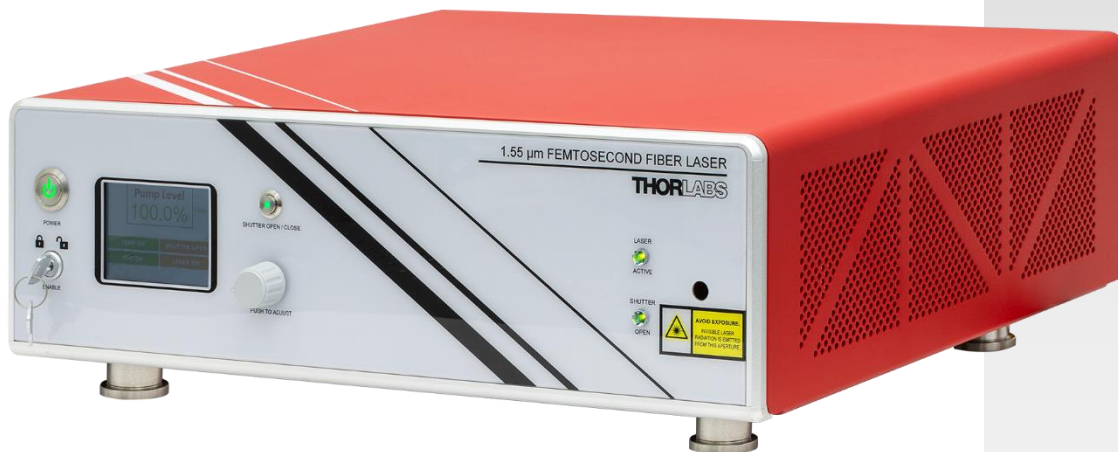




# **FSL1550**

## **1.55 $\mu\text{m}$ Femtosecond Fiber Laser**

### **User Guide**



# Table of Contents

















|           |   |    |
|-----------|---|----|
| Chapter 1 | Warning Symbol Definitions.....                 | 1  |
| Chapter 2 | Safety.....                                     | 2  |
| Chapter 3 | Description .....                               | 5  |
|           | 3.1. <i>Introduction</i> .....                  | 5  |
|           | 3.2. <i>Shipping List</i> .....                 | 5  |
| Chapter 4 | Setup and Operation .....                       | 6  |
|           | 4.1. <i>Environmental Requirements</i> .....    | 6  |
|           | 4.1.1. Temperature Range .....                  | 6  |
|           | 4.1.2. Humidity Range.....                      | 6  |
|           | 4.2. <i>Electrical Requirements</i> .....       | 6  |
|           | 4.3. <i>Setting the AC Line Voltage</i> .....   | 6  |
|           | 4.4. <i>Changing the Fuse</i> .....             | 6  |
|           | 4.5. <i>Setup</i> .....                         | 6  |
|           | 4.6. <i>Operating the Laser</i> .....           | 9  |
|           | 4.6.1. Starting the Laser.....                  | 9  |
|           | 4.6.2. Controlling the Laser Output Power ..... | 11 |
|           | 4.6.3. Turning Off the Laser .....              | 11 |
| Chapter 5 | Maintenance .....                               | 12 |
| Chapter 6 | Warranty.....                                   | 13 |
| Chapter 7 | Specifications.....                             | 14 |
|           | 7.1. <i>Optical Specifications</i> .....        | 14 |
|           | 7.2. <i>Electrical Requirements</i> .....       | 14 |
|           | 7.3. <i>Environmental Requirements</i> .....    | 14 |
| Chapter 8 | Regulatory .....                                | 17 |
| Chapter 9 | Thorlabs Worldwide Contacts.....                | 19 |

---



## Chapter 1 Warning Symbol Definitions

Below is a list of warning symbols you may encounter in this manual or on your device.

| Symbol  | Description                              |
|---|--|
|    | Direct Current                           |
|    | Alternating Current                      |
|    | Both Direct and Alternating Current      |
|    | Earth Ground Terminal                    |
|    | Protective Conductor Terminal            |
|    | Frame or Chassis Terminal                |
|    | Equipotentiality                         |
|  | On (Supply)                              |
|  | Off (Supply)                             |
|  | In Position of a Bi-Stable Push Control  |
|  | Out Position of a Bi-Stable Push Control |
|  | Caution: Risk of Electric Shock          |
|  | Caution: Hot Surface                     |
|  | Caution: Risk of Danger                  |
|  | Warning: Laser Radiation                 |
|  | Caution: Spinning Blades May Cause Harm  |

## Chapter 2 Safety

All statements regarding safety of operation and technical data in this instruction manual will only apply when the unit is operated correctly in accordance to this user manual.



### SHOCK WARNING



High voltage inside. To avoid electrical shock, before powering the unit on, make sure that the protective conductor of the 3-conductor power cord is correctly connected to the protective earth contact of the socket outlet. Improper grounding can cause electric shock resulting in severe injury or even death. Do not operate without cover installed.



### EXPLOSION WARNING



This instrument must not be operated in an explosion endangered environment.



### LASER WARNING



The FSL1550 is a Class IV laser. Avoid Eye or Skin Exposure to Direct or Scattered Radiation.



### LASER WARNING



Always wear appropriate laser safety eyewear during laser setup and operation.



### CAUTION



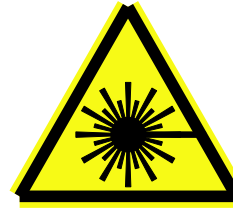
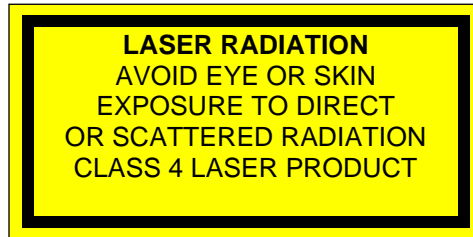
**Note:** This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures: Reorient or relocate the receiving antenna.—Increase the separation between the equipment and receiver.—Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.—Consult the dealer or an experienced radio/TV technician for help.



### CAUTION



This instrument should be kept clear of environments where liquid spills or condensing moisture are likely. It is not water resistant. To avoid damage to the instrument, do not expose it to spray, liquids, or solvents.



Class IV lasers such as the FSL1550 may cause damage to the skin, and also to the eye, even from the viewing of diffuse reflections. These hazards may also apply to indirect or non-specular reflections of the beam, even from apparently matte surfaces. Great care must be taken when handling these lasers. They also represent a fire risk, because they may ignite combustible material.

Safe practices and proper usage of safety equipment should be taken into consideration when operating lasers. The eye is susceptible to injury, even from very low levels of laser light. Laser emission in the visible and near infrared spectral ranges has the greatest potential for retinal injury, as the cornea and lens are transparent to those wavelengths, and the lens can focus the laser energy onto the retina.

1. Follow all safety precautions in the operator's manual.
2. Never aim the laser at a person's eye, skin, or clothes.
3. Always use proper laser safety eyewear.
4. Avoid wearing watches, jewelry, or other objects that may reflect or scatter the laser beam.
5. Keep the laser beam paths above or below eye level for both sitting and standing positions.
6. Ensure that individuals do not look directly into a laser beam.
7. Eliminate all unnecessary reflective surfaces from the vicinity of the laser beam path.
8. Ensure that all individuals who operate Class 4 lasers are trained in laser safety and authorized to operate a laser. Do not leave a running laser unattended if there is a chance that an unauthorized user may attempt to operate the laser. A key switch should be used if untrained persons may gain access to the laser. A warning light or buzzer should be used to indicate when the laser is operating.
9. Use low power settings, beam shutters, and laser output filters to reduce the beam power to less hazardous levels when the full output power is not required.
10. Make sure that spectators are not exposed to hazardous conditions.
11. Operate the laser only in a well-controlled area (for example, within a closed room with covered or filtered windows and controlled access).
12. Label the laser and the room with appropriate Class 4 laser warning signs.
13. Mount the laser on a firm support to ensure that the beam travels along the intended path.

The unit is supplied with a region-specific power cord. If using your own power cord, make sure it is IEC 320 compatible.

Make sure that the line voltage rating marked on the rear panel agrees with your local supply and that the appropriate fuses are installed. Changing of the mains fuse can be done by the user (see Section 4.4, Changing the Fuse). With the exception of the mains fuses, there are no user serviceable parts in this product.

Do not operate in wet or damp conditions. Do not obstruct the air ventilation slots in the housing!

This device can only be returned when packed into the complete original packaging, including all foam packing inserts. If necessary, ask for a replacement package.

Mobile telephones, cellular phones, or other radio transmitters should not be used within the range of three meters of this unit since the electromagnetic field intensity may exceed the maximum allowed disturbance values according to EN50082-1.

All statements regarding operational safety and technical data in this manual will only apply when the unit is operated correctly.

## Chapter 3 Description

### 3.1. Introduction

Thorlabs' FSL1550 Femtosecond Fiber Laser emits <50 fs pulses with a center wavelength of 1.55  $\mu\text{m}$  at a 100 MHz repetition rate. This fiber laser is based upon an oscillator-amplifier combination that uses only polarization-maintaining fiber, yielding reliable turn-key operation and exceptional long-term reliability. The FSL1550 has a collimated free-space output with a 2.2 mm beam diameter. The laser is used in applications where high peak power is required, such as supercontinuum and terahertz generation. The product is intended to be used in indoor laboratory environment.

The pump current of the amplifier stage in the FSL1550 is adjustable through the instrument's front panel, allowing the user to vary the output power of the laser. The display screen shows the pump level, as well as the temperature and emission status. An enable key-lock switch must be set to turn on the laser emission, and a green LED indicator displays the current state of the unit. There is a 3 second delay before the fiber amplifier turns on, and the user is warned by the rapidly blinking LED. An aperture shutter allows blocking the output beam even when the laser emission is on. The shutter can be opened and closed using a push button switch on the front panel. The shutter status is displayed on the front panel display and through an LED indicator next to the output aperture.

For added safety, there is an interlock connector located on the rear panel that must be shorted in order for the output to be enabled. This can easily be configured to be triggered by doors or an emergency push button to disable the fiber amplifier in unsafe conditions.

The amplifier includes a universal power supply allowing operation over 100 to 240 VAC without the need for selecting the line voltage. The fuse access is conveniently located on the rear panel

### 3.2. Shipping List

The FSL1550 consists of the following components:

- Benchtop Laser Unit
- IEC Power Cord
- Four CF175 Clamping Forks
- Interlock-Shorting BNC Connector (Installed)

## Chapter 4 Setup and Operation

### 4.1. Environmental Requirements

The FSL1550 should be operated under controlled conditions to achieve stable performance.

#### 4.1.1. Temperature Range

For any laser, the ambient temperature must be well controlled. The ambient temperature of the lab environment should be in the 17 °C - 25 °C range, and should not change by more than 3 °C over any 24 hour period.

#### 4.1.2. Humidity Range

Humidity control (<50%) is required to prevent condensation from forming on optical surfaces. Keep the system away from air conditioning vents, which can cause sudden humidity and temperature changes.

### 4.2. Electrical Requirements

The following table lists the electrical requirements of the FSL1550.

| Electrical Requirements |             |
|-------------------------|-------------|
| Input Voltage           | 100 - 240 V |
| Frequency               | 50 - 60 Hz  |
| Power Consumption       | 400 W (Max) |

A region-specific power cord is included with the laser, which is compatible with a standard wall outlet.

### 4.3. Setting the AC Line Voltage

The fiber laser has been shipped configured for 100 to 240 VAC operation. There is no end user adjustment of the line voltage for 110 or 220 VAC. The user needs to select the correct AC cord for their location.

### 4.4. Changing the Fuse

To change the power fuse, follow the following steps.

1. Remove the AC power cord if it is connected to the unit.
2. Locate the fuse tray directly adjacent to the AC power cord connection on the rear panel of the unit.
3. Carefully use a flat blade screwdriver to open the fuse tray.
4. Remove the existing fuses and install two fuses with the appropriate specifications. The replacement fuses must be ceramic 5 mm x 20 mm, 10 A, 250 VAC, slow-blow type.
5. Push the fuse tray back into place making sure that it snaps and sits correctly.
6. Connect the appropriate power cord into the AC receptacle and plug the unit in.

### 4.5. Setup

The laser system requires roughly 19" x 15" of optical table space. In addition, the laser has air intakes and outlets on both sides of the enclosure, which are perforated to permit airflow. Allow at least an additional 3" on each side for proper circulation. After choosing the location, secure the laser head's pedestal posts to the optical table using the supplied CF175 clamps.

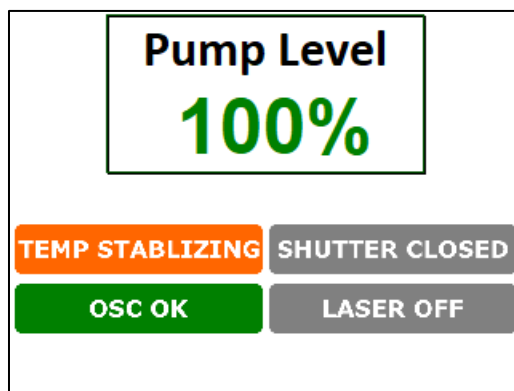
### 4.5.1 Powering the laser

Use this procedure to connect the laser to AC line power, and power the unit on and off. Always connect the laser to the AC power mains using the power cord that shipped with the laser. Always leave enough distance between the back panel and any walls or barriers such that the power cord can be disconnected when needed.

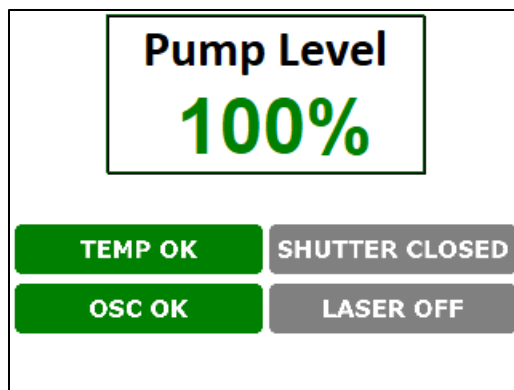
1. Connect the supplied power cord to the power connector on the rear panel.
2. Confirm that the rear panel AC power switch is in the “0” off position.
3. Connect the supplied power cord to an appropriate AC mains source.
4. Toggle the rear panel AC power switch to the “1” on position. Power is supplied to the internal power supply whenever the AC power cord is connected to a live mains circuit and the AC power switch is in the “1” on position. The laser will now be in the standby state.
5. Push the front panel power button to power the instrument on and off. The power button will illuminate Green to indicate that the unit is powered on.
6. To completely remove power from the unit, toggle the rear panel AC power switch to the “0” off position and disconnect the power cord.

### 4.5.2 Checking Status Indicators

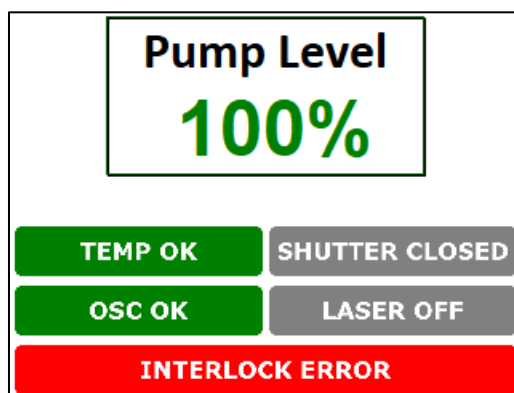
When the system is powered on, the temperature stability indicator on the front panel display shows a “Temp stabilizing” status while the system reaches a thermally stable condition, as shown in the screen shot below. The temperature stability indicator should show “Temp OK” status within 5-20 minutes from turning the system on, as shown in the screen shot on the following page (Figure 2). The amount of time to reach stable condition will depend on the environment temperature where the system is being operated. If the temperature status indicator does not show a stable condition for more than 20 minutes, or if a temperature error is displayed, please contact Technical Support ([techsupport@thorlabs.com](mailto:techsupport@thorlabs.com)) for assistance. Please note that the oscillator status should always show “OSC OK” status. If an oscillator error status is displayed, please contact Technical Support. The interlock circuit in the system should be closed by shorting the BNC connector on the back panel either through a BNC short plug-in connector or a remote interlock circuit. If the circuit is open, an interlock error status will be shown as seen in the screen shot on the following page (Figure 3).



**Figure 1** Screen shot of the laser display during the initial system warm-up.



**Figure 2** Screen shot of the laser display after temperature stabilization has been reached.



**Figure 3** Screen shot of the laser display when interlock circuit is open.

4.6. Operating the Laser



**WARNING**

Only qualified professionals should service the laser or perform optical alignment.





**WARNING**

While operating the laser, it is mandatory that the temperature status indicator is showing stable temperature. Failure to follow this instruction can cause severe damage to the laser.



4.6.1. Front and Back Panel Overview

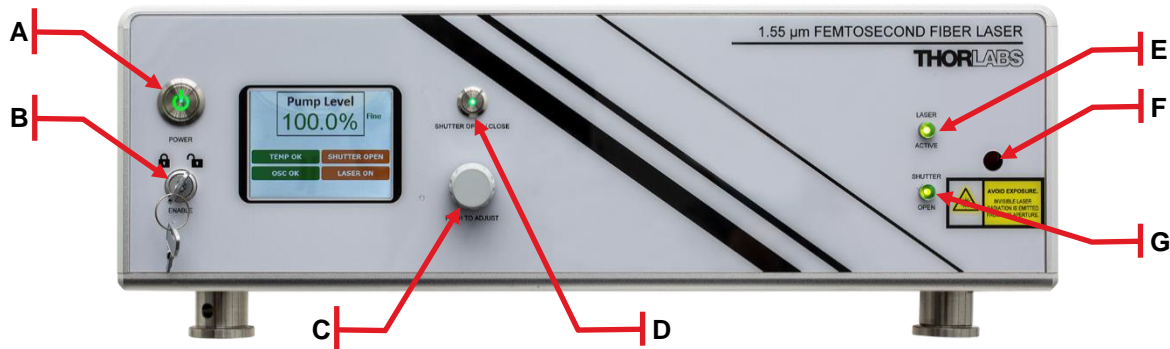
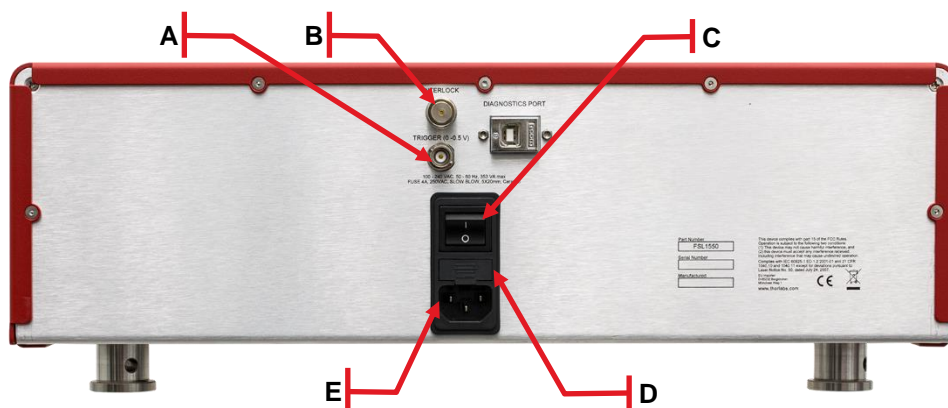


Figure 4 Front Panel of the FSL1550

| Callout | Description                      |
|---------|----------------------------------|
| A       | Push-Button Power Switch         |
| B       | Laser Enable Switch              |
| C       | Adjustment Knob (Push to Adjust) |
| D       | Shutter Open/Close Switch        |
| E       | Emission Indicator               |
| F       | Laser Output Aperture            |
| G       | Shutter Indicator                |



**Figure 5 Back Panel of the FSL1550**

| Callout | Description   |
|---------|---|
| A       | Trigger Signal Output (BNC)                         |
| B       | Remove Interlock Input (BNC)                        |
| C       | AC Power On/Off Switch                              |
| D       | Fuse Tray (See Section 4.4 for Replacement Details) |
| E       | AC Power Cord Connector                             |

#### 4.6.2. Starting the Laser

Before starting the laser, ensure that the interlock circuit is closed using a short-circuited connection on the interlock BNC connector on the laser's back panel. A BNC short connector is shipped with the laser to be used when a remote interlock circuit is not needed.

Before turning on the laser, ensure that the temperature is stable and no errors are displayed on the front panel display.

The output from the laser aperture is a collimated beam as specified in the specifications table in this manual. The output should be guided into the user's setup or measurement devices while observing all application laser safety precautions based on the classification of the laser system. Use the Laser On/Off key-lock switch on the front panel to enable laser emission. The Laser Emission indicator on the display and the LED indicator next to the laser aperture will blink for 3 seconds before the output is enabled.

A shutter blocks access to laser emission from the output aperture. The shutter status is by default "closed" when the laser is powered on. The shutter can be closed and opened using the push button on the front panel. An indicator on the display as well as an LED indicator next to the output aperture show the shutter status.

Please note the following when operating the laser:

- The laser has been tested, optimized, and specified for a particular output power level. To achieve the specified pulse width, the laser should be operated at the optimal pump current value in the test report included with the laser.
- In the event that the red interlock indicator is turned on, the laser emission cannot be enabled. Please ensure that the BNC interlock connector on the back panel of the laser has been shorted.
- Please note that the BNC connector labeled as "TRIGGER" and the USB connector labeled as "DIAGNOSTIC PORT" are intended for factory use during initial build, calibration, or service of the laser.

#### 4.6.3. Controlling the Laser Output Power

The pump current of the amplifier stage in the FSL1550 can be adjusted using the rotary knob on the front panel. There are two adjustment modes available: Coarse and Fine. Pushing the knob once will activate the coarse adjustment mode. Pressing the knob a second time will activate the fine adjustment mode. Pressing the knob a third time exits the adjustment mode. It is important to note that the pulse shape and duration are strongly dependent on the output power of the laser. The laser is shipped with a test report that shows the measured autocorrelation and spectrum at a few power levels, which can be used as a guideline for adjusting the output power. The laser performance specifications are only guaranteed at the factory-specified operating pump current set-point in the test report.

The laser system can be left on continuously for extended periods of time, as long as there are no error indicators displayed. It is recommended to turn off the laser emission whenever the system is not in use. While not required, it is also recommended to turn the power off when the system is not in use for long intervals, e.g. a few days. The system can be turned on immediately after being powered on, and emission can be switched on when the temperature indicator shows stable operation.

#### 4.6.4. Turning Off the Laser

Use the Laser On/Off key-lock switch to disable the laser emission. This disables the laser emission, but will leave the temperature control loops engaged. The oscillator also remains on when the laser emission has been turned off. Do not terminate the main power unless the laser will be disabled for more than a day before its next use.

## Chapter 5 Maintenance



### WARNING



**Always wear appropriate laser safety eyewear during laser setup and operation.**

Aside from the AC input fuse, the FSL1550 does not require regular maintenance. Please keep the shutter closed when laser is not being used in order to keep the optics inside the laser enclosure clean. If you suspect something has failed in the unit, please contact Thorlabs for advice on returning the unit for evaluation.

---

## Chapter 6    Warranty

Thorlabs warrants to the buyer of the laser system described in this manual that it conforms to the published specifications and is free from defects in materials and workmanship for a period of 12 months or 5,000 hours of operation, whichever occurs first. The warranty period begins at the date of shipment.

The buyer must provide the appropriate utilities and operating environment as outlined in Chapter 4 of this manual. Damage to the laser system caused by failure of the buyer's utilities is solely the responsibility of the buyer and is specifically excluded from any warranty.

The obligations of Thorlabs are limited to repairing or replacing, without charge, equipment which proves to be defective during the warranty period. Repaired or replaced parts are warranted for the duration of the original warranty period only. This warranty does not cover damage due to misuse, negligence, or damage due to installations, repairs or adjustments not specifically authorized by Thorlabs. All repairs for this product are performed at the factory.

The warranty terms are in accordance with and subject to the terms and conditions set forth in Thorlabs' General Terms and Conditions of Sale which can be found at:

**[https://www.thorlabs.com/Images/PDF/LG-PO-001\\_Thorlabs\\_terms\\_and\\_%20agreements.pdf](https://www.thorlabs.com/Images/PDF/LG-PO-001_Thorlabs_terms_and_%20agreements.pdf)**

## Chapter 7 Specifications

### 7.1. Optical Specifications

| Optical Specifications              |                                  |
|-------------------------------------|----------------------------------|
| Center Wavelength                   | 1560 nm $\pm$ 30 nm              |
| Pulse Width (FWHM)                  | <40 fs (Typical)<br><50 fs (Max) |
| Peak Power <sup>a</sup>             | >60 kW                           |
| Output Power <sup>b</sup>           | >500 mW (Average)                |
| Repetition Rate                     | 100 MHz (Nominal)                |
| Pulse Energy                        | >5 nJ                            |
| Polarization Extinction Ratio       | >15 dB                           |
| Beam Size                           | Ø2 mm (Nominal)                  |
| Output Power Stability <sup>c</sup> | <0.4% / °C                       |

- a. The peak power is an estimate based on the retrieved intensity profile of the pulse and the pulse energy.
- b. Maximum output average power is 1 W.
- c. The maximum change in power for every 1 degree change in the environment temperature.

### 7.2. Electrical Requirements

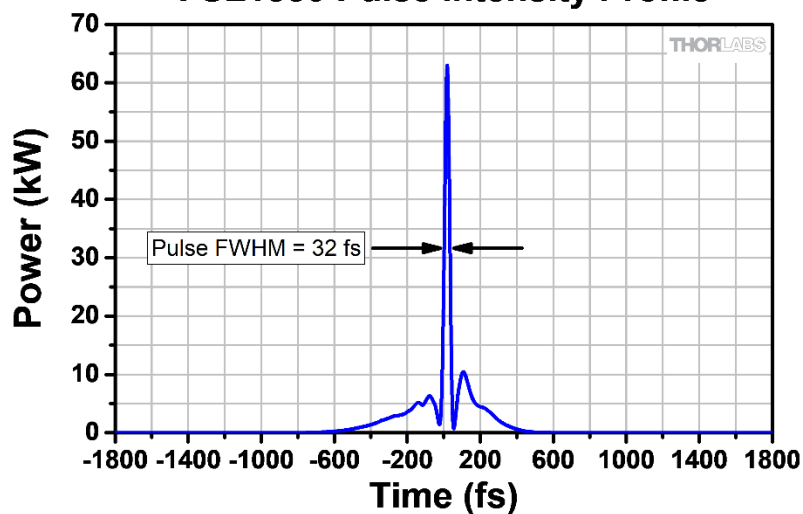
| Electrical Requirements |             |
|-------------------------|-------------|
| Input Voltage           | 100 - 240 V |
| Frequency               | 50 - 60 Hz  |
| Power Consumption       | 400 W (Max) |

### 7.3. Environmental Requirements

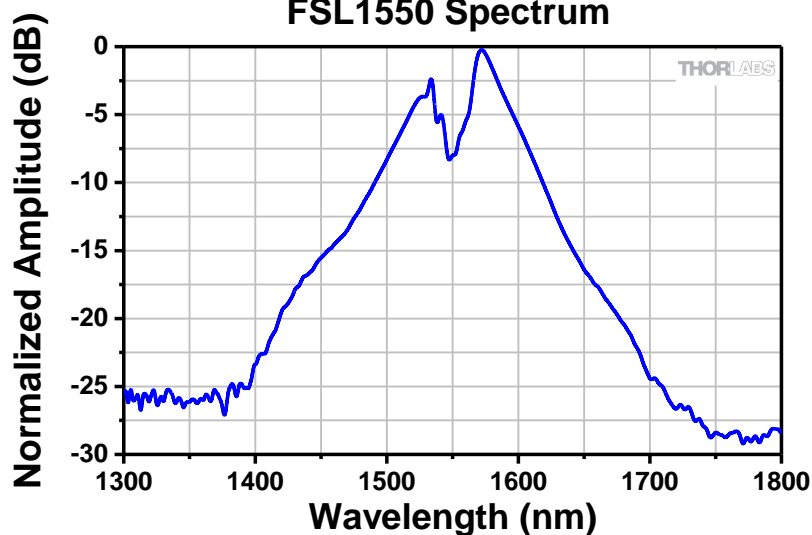
| Environmental Requirements |                     |
|----------------------------|---------------------|
| Room Temperature Range     | 17 °C to 25 °C      |
| Room Temperature Stability | <3 °C over 24 Hours |

#### 7.4. Typical Pulse Performance Plots

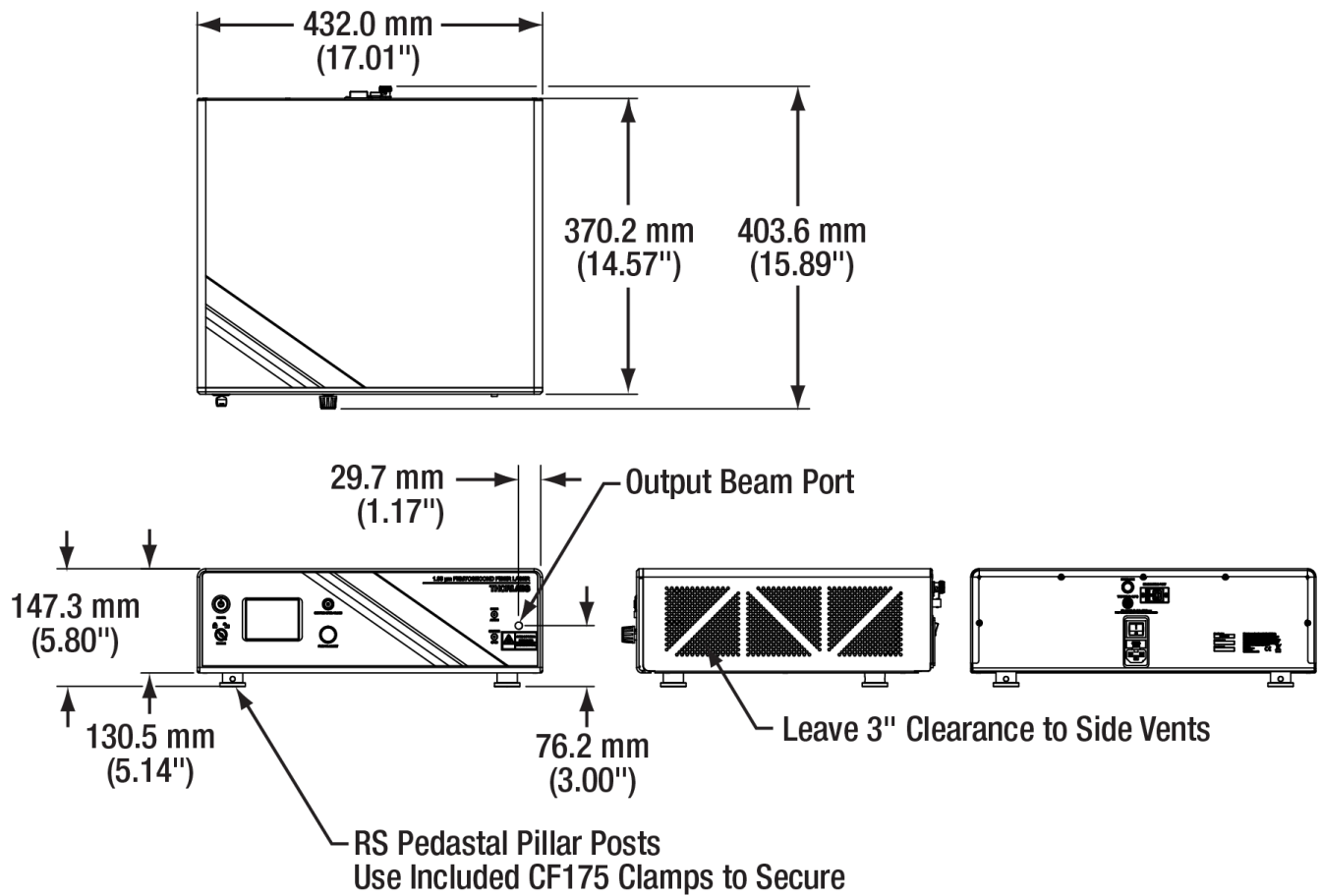
##### FSL1550 Pulse Intensity Profile



##### FSL1550 Spectrum



## Chapter 8 Mechanical Drawings



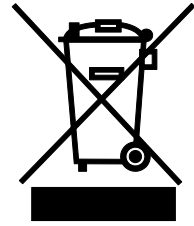
**Figure 6** FSL1550 Mechanical Drawing

## Chapter 9 Regulatory

As required by the WEEE (Waste Electrical and Electronic Equipment Directive) of the European Community and the corresponding national laws, Thorlabs offers all end users in the EC the possibility to return “end of life” units without incurring disposal charges.

This offer is valid for Thorlabs electrical and electronic equipment:

- Sold after August 13, 2005
- Marked correspondingly with the crossed out “wheelie bin” logo (see right)
- Sold to a company or institute within the EC
- Currently owned by a company or institute within the EC
- Still complete, not disassembled and not contaminated



**Wheelie Bin Logo**

As the WEEE directive applies to self-contained operational electrical and electronic products, this end of life take back service does not refer to other Thorlabs products, such as:

- Pure OEM products, that means assemblies to be built into a unit by the user (e. g. OEM laser driver cards)
- Components
- Mechanics and optics
- Left over parts of units disassembled by the user (PCB's, housings etc.).

If you wish to return a Thorlabs unit for waste recovery, please contact Thorlabs or your nearest dealer for further information.

### ***Waste Treatment is Your Own Responsibility***




If you do not return an “end of life” unit to Thorlabs, you must hand it to a company specialized in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.

### ***Ecological Background***

It is well known that WEEE pollutes the environment by releasing toxic products during decomposition. The aim of the European RoHS directive is to reduce the content of toxic substances in electronic products in the future.

The intent of the WEEE directive is to enforce the recycling of WEEE. A controlled recycling of end of life products will thereby avoid negative impacts on the environment.

## Chapter 10 Declaration of Conformity

|   |   |   |                            |
|---|---|---|----------------------------|
|    |   | <b>THORLABS</b><br><a href="http://www.thorlabs.com">www.thorlabs.com</a> |                            |
| <b>EU Declaration of Conformity</b><br><i>in accordance with EN ISO 17050-1:2010</i>  |   |   |                            |
| We:   | Thorlabs Inc.   |   |                            |
| Of:   | 56 Sparta Avenue, Newton, New Jersey, 07860, USA  |   |                            |
| in accordance with the following Directive(s):  |   |   |                            |
| 2014/35/EU  | Low Voltage Directive (LVD)   |   |                            |
| 2014/30/EU  | Electromagnetic Compatibility (EMC) Directive   |   |                            |
| 2011/65/EU  | Restriction of Use of Certain Hazardous Substances (RoHS)                                 |   |                            |
| hereby declare that:  |   |   |                            |
| Model:  | <b>FSL1550</b>  |   |                            |
| Equipment:  | <b>Femtosecond Fiber Laser</b>  |   |                            |
| is in conformity with the applicable requirements of the following documents:   |   |   |                            |
| EN 61010-1  | Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use. | 2010  |                            |
| EN 61326-1  | Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements       | 2013  |                            |
| EN 60825-1  | Safety of Laser Products  | 2014-05   |                            |
| and which, issued under the sole responsibility of Thorlabs, is in conformity with Directive 2011/65/EU of the European Parliament and of the Council of 8th June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment, for the reason stated below: |   |   |                            |
| does not contain substances in excess of the maximum concentration values tolerated by weight in homogenous materials as listed in Annex II of the Directive  |   |   |                            |
| I hereby declare that the equipment named has been designed to comply with the relevant sections of the above referenced specifications, and complies with all applicable Essential Requirements of the Directives.   |   |   |                            |
| Signed:   |        | On:   | 15 February 2021           |
| Name:   | Carmine Lencsak   |   |                            |
| Position:   | Chief Operating Officer   |   |                            |
|   |   |   | EDC - FSL1550 - 2021-02-15 |
|    |   |   |                            |

## Chapter 11 Thorlabs Worldwide Contacts

For technical support or sales inquiries, please visit us at [www.thorlabs.com/contact](http://www.thorlabs.com/contact) for our most up-to-date contact information.



### USA, Canada, and South America

Thorlabs, Inc.  
sales@thorlabs.com  
techsupport@thorlabs.com

### Europe

Thorlabs GmbH  
europe@thorlabs.com

### France

Thorlabs SAS  
sales.fr@thorlabs.com

### Japan

Thorlabs Japan, Inc.  
sales@thorlabs.jp

### UK and Ireland

Thorlabs Ltd.  
sales.uk@thorlabs.com  
techsupport.uk@thorlabs.com

### Scandinavia

Thorlabs Sweden AB  
scandinavia@thorlabs.com

### Brazil

Thorlabs Vendas de Fotônicos Ltda.  
brasil@thorlabs.com

### China

Thorlabs China  
chinasales@thorlabs.com





**THORLABS**  
[www.thorlabs.com](http://www.thorlabs.com)

