FSL1950(F)
2 µm Femtosecond Fiber Laser

User Guide

Table of Contents

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

WARNING

This unit must not be operated in explosive environments.

WARNING

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

WARNING

The FSL1950 and FSL1950F are Class IV lasers.

LASER RADIATION
AVOID EYE OR SKIN
EXPOSURE TO DIRECT
OR SCATTERED RADIATION
CLASS 4 LASER PRODUCT

Class IV lasers such as the FSL1950 and FSL1950F 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.

Chapter 3 Description

3.1. Introduction

Thorlabs' FSL1950(F) Femtosecond Fiber Lasers emit <80 fs pulses with a center wavelength of 1.95 µm at a 50 MHz repetition rate. They are based upon an oscillator-amplifier combination that uses only polarization-maintaining fiber, yielding reliable turn-key operation and exceptional long-term reliability.

The FSL1950 has a collimated free-space output with a 2.2 mm beam diameter. In contrast, the FSL1950F has a pigtailed delivery fiber with an FC/APC connector, allowing direct connections to fiber collimators (such as Thorlabs' FiberPort Collimators) or other free-space components.

3.2. Shipping List

The FSL1950(F) consists of the following components:

- Laser Head
- Controller
- One DB25 Cable
- One DB15 Cable
- One DB26 High Density Cable
- One USB Cable
- Controller Power Supply and IEC Power Cord
- Four CF175 Clamping Forks
- Control Software for Windows®

Chapter 4 Setup and Operation

4.1. Environmental Requirements

The FSL1950(F) 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 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 FSL1950(F).

Electrical Requirements	
Input Voltage	100 - 240 V
Frequency	50 - 60 Hz
Power Consumption	700 W (Max)

The FSL1950(F) laser head is powered through the connection to the included controller. A region-specific power cord is included with the controller which is compatible with a standard wall outlet.

4.3. Setup

The laser head requires roughly 17.5" x 16.0" (44.5 cm x 40.5 cm) of optical table space. In addition, the laser head has air intakes and outlets on both sides of the enclosure, which are perforated to permit airflow. Allow at least an additional 3" (7.5 cm) 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.

Use the supplied DB25, DB15, and DB26 high density cables to connect the laser head to the controller, and use the supplied USB cable to connect the controller to a Windows® computer.

If you are using the FSL1950F (which offers a fiber-coupled output), refer to Section 4.3.1 before continuing.

At this point, turn the controller on by holding down its Power On/Off push button for approximately 2 seconds. The controller will switch on after emitting a clicking sound, and the green indicator next to the Power button will illuminate. Observe the two status indicator LEDs on the controller front panel labeled "Temperature" and "Oscillator". The temperature indicator shows the status of the temperature control loops in the system. While the temperature status indicator is blinking, the temperature is stabilizing; once a stable temperature is achieved, the temperature status indicator will turn green. Depending on the laboratory temperature, this can take several minutes. The oscillator indicator should turn green within a few seconds of powering on the controller, which indicates a stable mode-locked condition. If the oscillator indicator is off, the oscillator can be reset using the GUI shown on page 8. If the temperature status indicator continues to blink for more than 10 minutes, please contact Technical Support (techsupport@thorlabs.com) for assistance.

4.3.1. Additional Setup for FSL1950F Only

These instructions should be followed before turning on the FSL1950F laser controller.

WARNING

When operating the FSL1950F, never use a fiber inspection scope to examine the FC/APC fiber connector while the laser is on! Looking into the fiber connector while the laser is on can cause severe eye damage.

Thoroughly clean the FC/APC output facet, using a fiber inspection scope to verify that the facet is free of dust. (We recommend Thorlabs' FCC-7020 Fiber Connector Cleaner and FS201 Fiber Inspection Scope for these tasks.) Then connect the FC/APC connector to your setup.

In order to minimize the risk of optical damage to the FSL1950F's FC/APC output facet, we strongly recommend that FSL1950F *not* be connected to another FC/APC patch cable. Aside from the risk of optical damage, the pulse shape and duration have been optimized for the specific delivery fiber that is pigtailed to the FSL1950F, so connecting the FSL1950F even to short (>5 cm) lengths of single mode fiber will significantly alter the pulse characteristics.

For these reasons, it is best to use a free-space coupling apparatus to couple the light out of the FC/APC connector into the desired setup. (Suitable collimators include Thorlabs' FiberPorts, Triplet Collimators, and Protected Silver Reflective Collimators.) If the use of an FC/APC patch cable is unavoidable, please ensure that its connector facets are also thoroughly cleaned.

4.4. Powering the Laser On and Off

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 on the controller box is solid green at all times. Failure to follow this instruction can cause severe damage to the laser.

4.4.1. Starting the Laser

Before starting the laser, ensure that the interlock circuits are defeated by:

a. Turning the key-lock switch on the front panel of the controller in the clockwise direction towards "Enable", and

b. Making sure that a short-circuited connection is established on the interlock BNC connector on the controller's back panel.

Before turning on the laser, ensure that the temperature and oscillator status indicators on the controller are both green.

Use the red Laser On/Off button on the front panel of the controller to enable laser emission. The Laser Emission indicators on the laser head and on the controller will blink for 5 seconds, then turn green once the laser output is enabled.

Please note the following when operating the laser:

a. 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. For additional details, see Section 4.5.2.

b. The laser should be switched on and off for normal operation only by using the Laser On/Off push button, as explained above. The keylock switch on the front panel of the controller should only be used to enable or limit access to the laser emission for laser safety purposes. This switch should not be used to turn the laser emission on and off during normal operation of the laser.

c. 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 controller has been shorted and that the keylock switch is in the unlocked position. At this point, press the Laser On/Off push button once to clear the interlock error. This should switch the red interlock indicator off and allow the laser to be switched on using the Laser On/Off push button.

4.4.2. Turning Off the Laser

Use the Laser On/Off button on the controller 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.

4.5. Operating the Laser with a Computer

The laser can be independently operated and controlled using the included Windows® GUI. The GUI also provides access to the oscillator reset button and a pump current control slider, neither of which are available through the controller hardware. The installation package and all the required drivers are provided with the laser.

A screenshot of the user control panel in the GUI is shown in Figure 1. The indicators for the temperature, oscillator, laser emission, and interlock function identically to the same indicators on the controller. The Laser On/Off button also functions identically to the same button on the controller. In the event that the interlock trips, the Laser On/Off button will change to read Clear. Clicking the Clear button will deactivate the error indicator, making the laserready to be turned on.

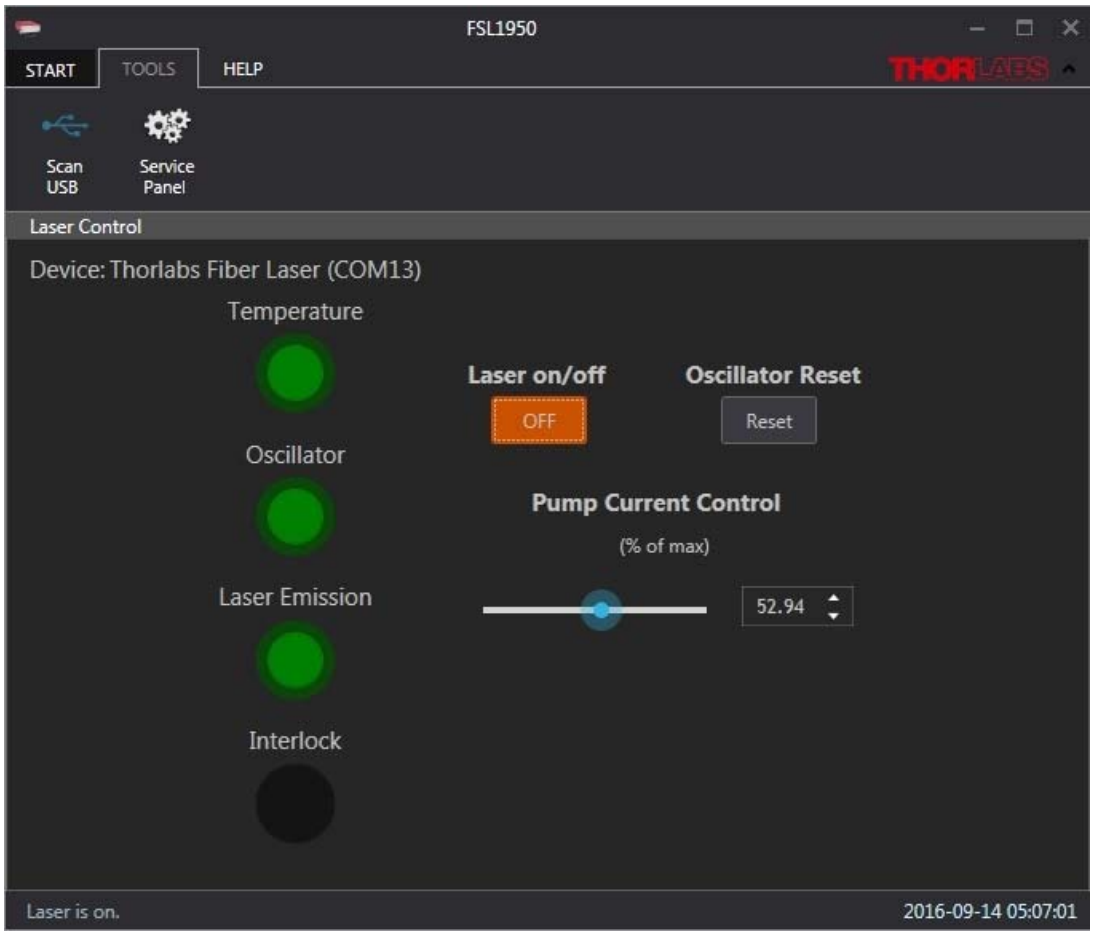


Figure 1 GUI for Laser Control

4.5.1. Resetting the Oscillator

If the oscillator status indicator is off, the oscillator is not mode-locked. Use the oscillator reset button in the GUI to reset the oscillator. If this operation does not result in the oscillator status indicator turning green, please contact technical support (techsupport@thorlabs.com) for assistance.

Do not reset the oscillator unless it will not mode-lock, as the operation reduces the lifetime of the system.

4.5.2. Controlling the Laser Output Power

The Pump Current Control slider adjusts the gain of the fiber amplifier in order to control the laser output power. It is important to note that the pulse shape and duration are strongly dependent on the output power of the laser. For this reason, the laser is shipped with the power adjusted to a preset value that provides optimal pulse compression. Please note that the laser specifications are only guaranteed at this specific power level.

If desired by the user, the laser output power can be adjusted by using the slider to set the pump current between 0% and 100% of the full-scale value. Changing the output power from the preset power will result in modifyingthe spectral and temporal shape and width of the output pulse.

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-preset power.

Chapter 5 Maintenance

WARNING

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

The FSL1950 and FSL1950F do not require regular maintenance. For the FSL1950F, ensure that the delivery fiber facet remains clean and free from scratches, capping the connector if the laser is to be stored. (Replacement fiber caps are available as Thorlabs Item # CAPF.)

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. The warranty period begins at installation or thirty days from shipment, whichever occurs first. For systems which do not include installation, this warranty begins at the date of shipment.

On-site warranty services are provided only at the installation point. In order to keep the warranty in effect the buyer needs to purchase additional installation or inspection services if the system is moved from the original installation point.

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.

Chapter 7 Specifications

7.1. Optical Specifications

Common Specifications	
Center Wavelength	1950 nm ± 30 nm
Pulse Width	<80 fs (FWHM)
Output Power	>500 mW (Average)
Repetition Rate	50 MHz (Nominal)
Pulse Energy	>10 nJ
Polarization Extinction Ratio	>15 dB
External Sync Output	SMA Connector

FSL1950 Specifications	
Beam Size	Ø2.2 mm
Divergence	<1.5 mrad

FSL1950F Fiber Specifications	
Connector	2.0 mm Narrow Key FC/APC
Numerical Aperture (NA)	0.13
Mode Field Diameter	~12 µm
Length	30 cm (Nominal)
Minimum Bend Radius	6 cm
Jacket	Ø3 mm Stainless Steel

7.2. Electrical Requirements

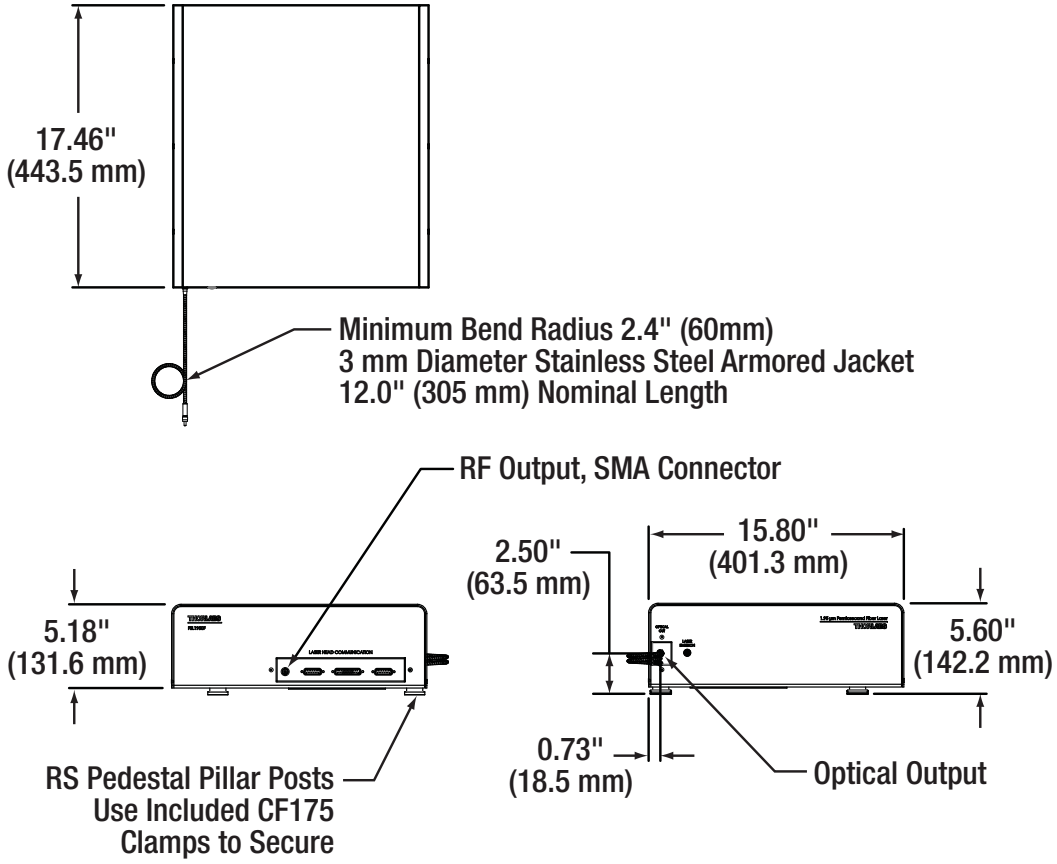
Electrical Requirements	
Input Voltage	100 - 240 V
Frequency	50 - 60 Hz
Power Consumption	700 W (Max)

7.3. Environmental Requirements

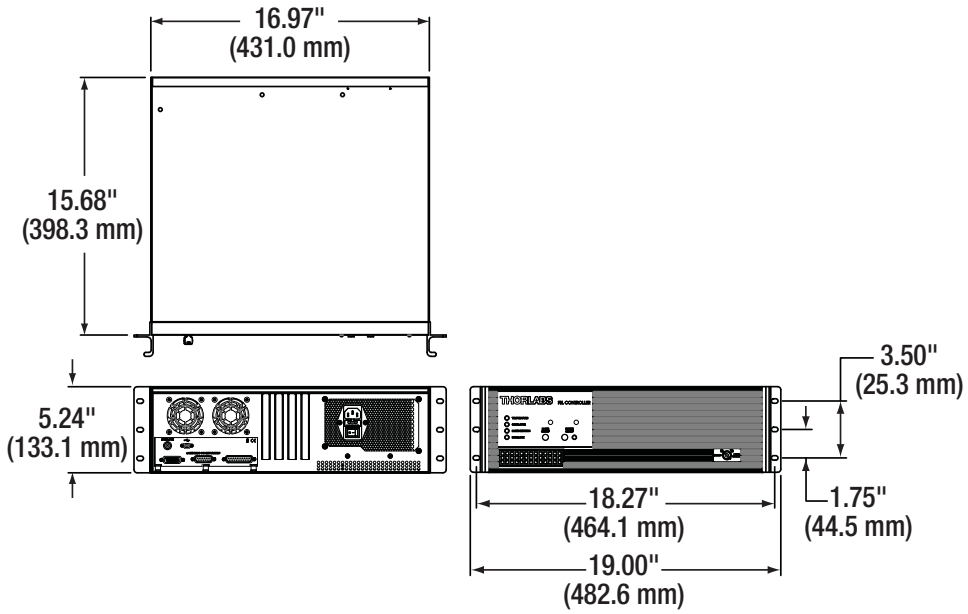
Environmental Requirements	
Room Temperature Range	17 °C to 25 °C
Room Temperature Stability	<3 °C over 24 Hours

7.4. Mechanical Drawings

7.4.1. Laser Head



7.4.2. Controller

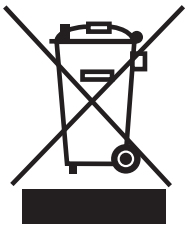


Chapter 8 Regulatory

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 9 Thorlabs Worldwide Contacts

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

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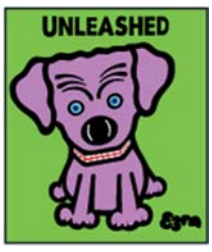
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