Swept Source Laser

Operating Manual

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Part 1. Introduction

1.1. Important Notices

ATTENTION USER!

Please read the instruction manual carefully before operating the Swept Source Laser.

All statements regarding safety and technical specifications will only apply when the unit is operated correctly.

WARRANTY WARNING

Do not open the unit under any circumstance.

There are no user serviceable parts in this product. Opening the device will void your warranty.

Any modification or servicing of this system by unqualified personnel renders Thorlabs free of any liability.

Attention

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

ATTENTION USER!

Check the supply voltage of the system before plugging in the Swept Source Laser.

Make sure the included power cord for the Swept Source Laser is connected to a properly grounded power outlet (100V – 240V AC; 50Hz – 60Hz).

Transportation and delivery may cause the Swept Source Laser to be warm or cool upon receipt. Please wait for the unit to reach room temperature before attempting to operate.

Use a flat, dry, and stable surface to set up the system.

1.2. Safety and Warnings

WARNING High Voltage!

Before applying power to your system, make sure that the protective conductor of the 3 conductor mains 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!

Make sure that the line voltage rating agrees with your local supply and that the appropriate fuses are installed. Fuses should only be changed by qualified service personnel. Contact Thorlabs for assistance.

Do not operate without cover installed. To avoid electrical shock the power cord protective grounding conductor must be connected to ground. Refer servicing to qualified personnel.

NOTE: Thorlabs provides the proper power input cable with each system for use in the United States. If using this unit anywhere else, the user will need to supply a properly grounded power cable to power the unit.

Attention!

Do not obstruct air-ventilation into the bottom of the swept source engine or out of the exhaust fan on the rear of the unit!

Mobile telephones, cellular phones or other radio transmitters are not to 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.

WARNING Electrostatic Discharge (ESD)

All types of electronic components, particularly integrated circuits, are sensitive to Electrostatic Discharge (ESD). ESD is a general reason for failure of electronic equipment. The total operating time can be reduced if precautions against ESD-damage are not taken.

ALWAYS wear an ESD wrist strap connected to the ESD terminal whenever handling the swept source. See Figure 2.

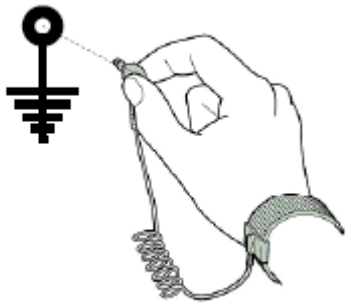

Figure 1: ESD wrist wrap. The wrist strap is connected to ground to ensure that no electrostatic field is built up.

WARNING

Do not, under any circumstances look into the optical output when the unit is operating. The laser radiation at 1050nm or 1325nm is not visible to the human eye, but it can seriously damage your eyesight.

VISIBLE AND INVISIBLE LASER RADIATION
DO NOT STARE INTO BEAM
OR VIEW DIRECTLY WITH
OPTICAL INSTRUMENTS.
CLASS 1M LASER PRODUCT

1.3. Care of the Swept Source Laser

Handle the system with care during transportation and unpacking. Banging or dropping the Swept Source Laser can damage the unit or lower system performance.

Attention

If the system is mishandled during shipment, the optical components may become misaligned, which could lead to a decrease in the image quality. If this happens, the system will need to be realigned by qualified personnel.

If the system is dropped from a height greater than 15", it will be necessary for qualified Thorlabs' personnel to perform an electrical security check.

Please contact Thorlabs for more information.

- Do not store or operate in a damp, closed environment.
- Do not store or operate on surfaces that are susceptible to vibrations.
- Do not expose to direct sunlight.
- Do not use solvents on or near the equipment.
- Keep away from dust, dirt, and air-borne pollutants (including cigarette smoke). The system is not designed for outdoor use. Protect the equipment from rain and snow and humidity.
- Do not expose to mechanical and thermal extremes. Protect the equipment from rapid variation in temperature.
- Handle all connectors, both electrical and optical, with care. Do not use unnecessary force as this may damage the connectors.
- Handle the optical fiber with care; mechanical stress can decrease the performance and potentially destroy the fiber. Continual bending of the optical fiber can cause damage, it is important to keep the optical fiber patch cable as straight as possible to minimize bending.

NOTE: The most common cause of low signal intensity is contamination of the fiber due to airborne pollutants. To minimize exposure avoid unnecessarily disconnecting the optical fiber patch cable. In addition, it is advisable to check the fiber before making other adjustments to the optical system such as changing the focus, or optical path length. Be sure to check the patch cord for a loose connection, and make sure that the fiber is kept as straight as possible.

Attention

All lasers, especially laser having resonator cavities defined by mechanical tolerances, are delicate precision instruments and they must be handled accordingly.

The swept source OCT system is designed to withstand normal transportation and normal operation conditions.

Do not move the system while it is connected and in operation.

Maintenance: Optical Cleaning

Before connecting any fiber to the Swept Source laser output, make sure the fiber is clean. A dirty fiber will lead to poor output power, reducing the performance of the laser. Whenever using the Thorlabs OCM system, the following rules of thumb for optical fiber connection should be followed.

1. ALWAYS inspect and clean the fiber end before plugging it into a receptacle.
2. ALWAYS cover the fiber end that is not in use with a fiber cap or dust protection cover.

Service

Only trained and approved Thorlabs' personnel should service the system. Please contact:
techsupport@thorlabs.com

Accessories and Customization

Though the system is easily adapted for custom interfaces, to achieve the listed specifications, this system should only be used with accessories provided by Thorlabs. Any modification or servicing by unqualified personnel renders the warranty null and void, leaving Thorlabs free of liability. Please contact Thorlabs for questions on customization.

Part 2. Laser Description

2.1. Technical Specifications

Unless otherwise stated, all specs are typical

SL1050-P16 Parameters	Minimum	Typical	Maximum	Units
Central Wavelength	1025	1040	1055	nm
Tuning Range (-3dB cut off point)	60	80	-	nm
Tuning Range (-10dB cut off point)	90	110	-	nm
Repetition Rate +/- 200 Hz	15.7	15.9	16.1	kHz
Coherence length	4	5	6	mm
Average Output Power	6	7.5	-	mW
Optical Power Stability	+/- 0.5 dB			dB
Optical Isolation(1)	N/A			dB
Linear Polarization(2)	>80:1			-
Storage/Operating Temperature	+ 10	+ 25	+ 40	°C
Humidity	>85%, non condensing environment			-
Supply Voltage(3)	100 – 240VAC 50/60 Hz			-
Laser Classification (per IEC 60825-1)	Class 1M			-
Physical Size	315 x 295 x 146			mm

(1)Does not have internal isolator (2)Measured at laser output facet.
(3) Swept source has universal AC input.

SL1325-P16 Parameters	Minimum	Typical	Maximum	Units
Central Wavelength	1310	1325	1340	nm
Tuning Range (-3dB cut off point)	110	125	-	nm
Tuning Range (-10dB cut off point)	120	140	-	nm
Repetition Rate +/- 200 Hz	15.7	15.9	16.1	kHz
Coherence length	5	6	7	mm
Average Output Power	10	15	-	mW
Optical Power Stability	+/- 0.5 dB			dB
Optical Isolation(1)	50			dB
Linear Polarization(2)	>80:1			-
Storage/Operating Temperature	+ 10	+ 25	+ 40	°C
Humidity	>85%, non condensing environment			-
Supply Voltage(3)	100 – 240VAC 50/60 Hz			-
Laser Classification (per IEC 60825-1)	Class 1M			-
Physical Size	315 x 295 x 146			mm

(1)Mean tuning speed around center wavelength. (2)Measured at laser output facet.
(3) Swept source has universal AC input.

2.2. Components

Packing List

The SLXXXX-P16 system is a self contained laser system, it does not need any additional equipment or instrument or controls to be connected in order to operate. Please refer to the packing list below to ensure that the system is complete. If any item is missing or damaged, contact Thorlabs for assistance.

Components	Quantity
Swept Source Laser Module	1
Power Cord[(1)]	1
Manual	1

(1) Power cord supplied for use in North America only.

2.3. Operating Principles

What is a tunable laser source (TLS)?

A Tunable Laser Source (TLS) is a laser whose output wavelength could be swept (continuous or random access) over a certain, and usually quite wide, wavelength range. The SLXXXX-P16 can be tuned over typically 85nm. TLS's are frequently used in various measurement applications where a recording of a certain measure versus wavelength is performed. Each application requires detailed knowledge on some or all parameters characterizing a TLS (*e.g.* wavelength range, side mode levels, spontaneous noise levels, line width, sweep characteristics).

Thorlabs' Frequency Swept Tunable Lasers are specifically designed for Swept Source Optical Coherence Tomography (SS-OCT) and Optical Frequency Domain Reflectometry (OFDR) applications. These applications provide real-time, high resolution, cross-sectional imaging of turbid media and require a specially designed laser source that can sweep a wide wavelength range at very high speeds. A wide spectral tuning range is required for high axial resolution OCT images, and a high sweep-speed is needed to obtain real-time 2D and 3D OCT imaging speeds. Thorlabs now offers a variety of frequency swept laser sources based on a tunable external cavity semiconductor laser, designed and optimized for SS-OCT and OFDR applications.

Basic operation

SLXXXX-P16 is based on external cavity laser geometry. This external cavity laser consists of a single gain element where one facet of the element serves as an end mirror for the cavity. The extended cavity is comprised of a single collimating lens and a Cat-Eye wavelength selection device. The intra-cavity side of the semiconductor gain element is AR coated, providing a residual reflectivity of less than 10-4 thus allowing for the efficient formation of an extended cavity. Wavelength selection is achieved using a diffraction grating mounted onto a scanner with a focusing lens, mirror, and slit assembly providing active wavelength selection. The focusing lens and slit/mirror assembly are separated by the focal length of the lens. This configuration is commonly referred to as a Cat-Eye and is highly insensitive to angular misalignment. Output from the laser cavity is coupled into a fiber using a lens system containing an isolator (SL1325-P16 only) that prevents optical feedback into the cavity. This design enables a robust alignment due to the cat's eye configuration of the back-reflector which provides superior long-term stability compared to designs with a quasi-collimated beam on the laser cavity back-reflector.

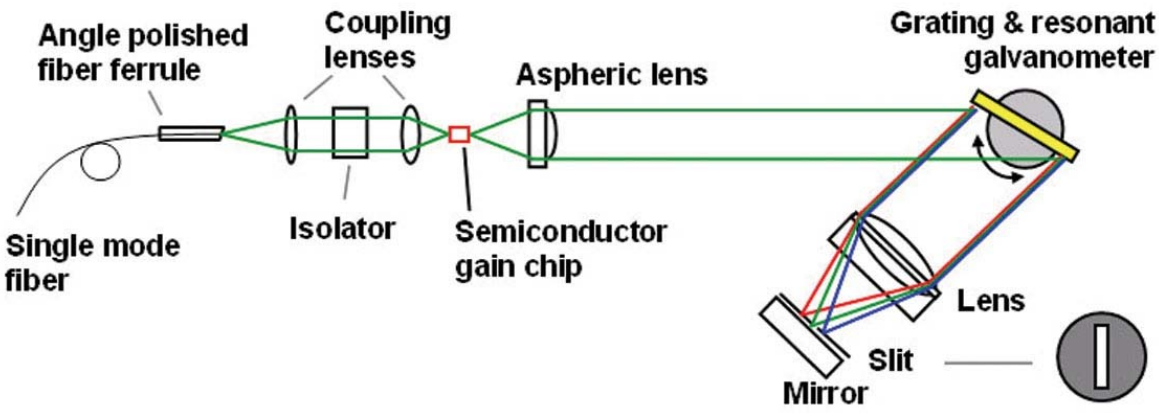

Figure 2: ***Schematic of the Swept Source Laser***

At fast frequency sweep speeds, the laser frequency varies sinusoidally in time. For OCT imaging, accurate and reliable recalibration of the interference output is required so that the samples are equidistant in frequency. Thorlabs' swept source laser is ideal for this application. The laser features a built-in Mach-Zehnder Interferometer (MZI) with balanced detector output, which can be used as a frequency clock because the zero crossings of the interference fringe signal are equally spaced in optical frequency (k-space). This 'clock', while useful for resampling OCT data sets, can also be used to synchronize other measurements.

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Figure 3: Oscilloscope view

2.4. Mechanical Interface

SS-OCT applications require a laser that can be swept over a broad wavelength range with very high speed. The broad wavelength tuning range is required for obtaining high image resolution while the high tuning speed is needed for video rate imaging speed higher than 20 fps.

Thorlabs' Swept Source Laser is specifically designed for SS-OCT applications. It sweeps across at least 100nm at a 16 kHz repetition rate, offers a coherence length of 6mm, and delivers more than 10mW of average optical power out of an SMF28 single mode fiber. The Swept Source Engine is based on a patented external cavity laser diode design.

Switches and Indicators

2.5. Switches and Indicators

The SLXXXX-P16 is easily controlled using the three switches located on the front panel. The Power switch applies AC power to the entire unit when set to the | position. The “POWER ON” indicator will illuminate when power is applied.

The “Tune Enable” keypad enables the resonant scanner housed in the swept source laser. The “Tune On” indicator will illuminate when the scanner is enabled. The scanner must always be enabled for the unit to function as a swept source laser; otherwise the output will be a fixed wavelength – typically 1050nm or 1325nm. Pressing the “Tune Enable” keypad when the scanner is already enabled will turn the scanner and indicator off.

The “Laser Enable” keypad enables the laser output. The “Laser On” indicator will illuminate whenever the laser is enabled. Pressing the “Laser Enable” keypad when the laser is already enabled will turn the laser and indicator off.

The “SYS OK” indicator will turn on when all necessary conditions are met for proper operation of the unit. The laser cannot be enabled until the “SYS OK” indicator turns on.

The “TEMP” indicator will turn on under the following conditions: The internal temperature of the enclosure exceeds approximately 60 degrees C, the heatsink temperature of the laser driver exceeds a maximum temperature, or the TEC system has not attained its set operating temperature – as would be the case when first turning on a cold unit.

If the laser is enabled and a temperature alarm causes the “TEMP” indicator to turn on, the laser will automatically shutdown, as will the scanner and internal TEC system. Once the unit returns to a normal operating temperature the TEC system will automatically restart. The scanner and laser must be manually re-enabled.

Figure 4: Swept Source OCT Engine

2.6. Electrical Interfaces

The SLXXXX-P16 should only be connected to an external electrical power source that has the proper value as stated on the backside of the unit, see Figure 5.

Figure 5: The AC input voltage must be 100-240 VAC and 50-60 Hz.

Electrical Outputs

Figure 6: Rear View of the Swept Source OCT System

The SLXXXX-P16 has the following electrical outputs at the back panel (see Figure 6):

- BNC output “TRIGGER” - generates a TTL signal for the tuning scan.
- BNC output ”MZI OUT” - Sinusoidal trigger pulse – see Figure 3 above. This is the interference signal from the MZI.

Part 3. Operation

3.1. Starting the System

System Components Start-up

Follow the steps for a proper initiation of the system:

1. Start the Swept Source laser by switching on the POWER to |, and check that the “POWER ON” indicator turns green. The “TEMP” indicator will remain green until the temperature of the system is stable (>60 seconds).
2. Wait until the “SYS OK” indicator turns green, the “TEMP” indicator should turn off.
3. Turn on the resonant scanner by pressing the “TUNE ENABLE” keypad.
4. Turn the laser ON using the “LASER ENABLE” keypad.

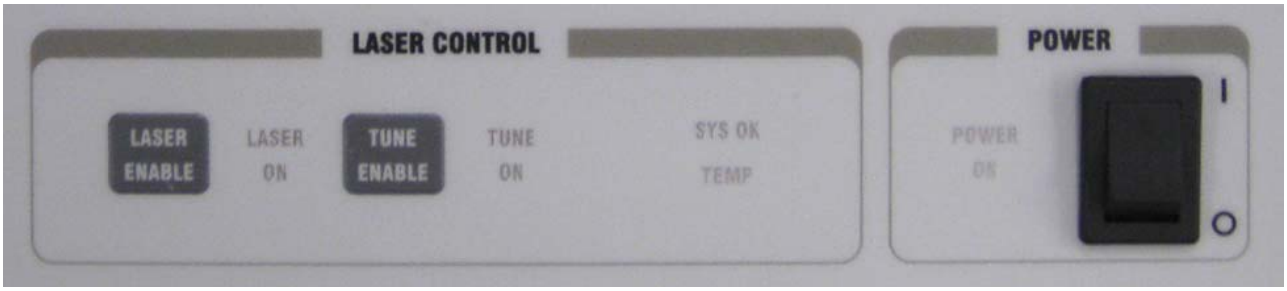

Figure 7: Swept Source front panel controls

3.2. Shutting Down the System

The following steps should be followed when shutting down the system:

1. Turn the laser off by pressing the Laser Enable switch. The “LASER ON” indicator will turn off.
2. Turn the power Switch to O.

3.3. Troubleshooting

Symptom	Possible Cause	Solution
System does not start	No power is supplied to the unit	Connect the power supply
	Power cord is broken	Change power cord
	Other reason	Call Thorlabs for assistance
Poor performance/No signal	Fiber not connected	Connect fiber patch cable
	Fiber tip is dirty	Clean fiber tip
	Other reason	Call Thorlabs for assistance
Laser turns off and Temp Indicator turns on	Exhaust fan is broken.	Stop system and call for service

Part 4. Warranty Information

General Product Warranty

Thorlabs warrants that all products sold will be free from defects in material and workmanship, and will conform to the published specifications under normal use, when correctly installed and maintained.

Optomechanics

Lifetime Warranty: Thorlabs offers a lifetime warranty on all optomechanical components. Thorlabs will repair or replace any optomechanical product which, after evaluation, has been shown to not meet specifications under the conditions listed above.

Optical Tables and Breadboards

Lifetime Warranty: Thorlabs provides a lifetime guarantee that all of our passively damped optical tables and breadboards will meet all originally stated performance specifications under normal use and proper handling. We additionally guarantee that all our table tops and breadboards, both active and passive, will be free from defects in workmanship, including delamination of the skins under normal use and handling.

Lasers and Imaging Systems

Thorlabs offers a one year warranty on all lasers and imaging systems, with the exceptions of laser diodes. Some products are warranted for the number of hours specified in the operating manual of each laser.

Opto-Electronics, Control Electronics, Optics, and Nano-Positioning Product Lines

Thorlabs offers a two year warranty on the above mentioned product lines, provided normal use and maintenance of the products and when properly handled and correctly installed.

Thorlabs shall repair or replace any defective or nonconforming product as detailed above. We ask that buyer contact Thorlabs for a Return Material Authorization number (RMA #) from our Customer Service/Returns department in order to most efficiently process the return and/or repair.

Non-Warranty Repairs

Products returned for repair that are not covered under warranty, will incur a standard repair charge, in addition to all shipping expenses. This repair charge will be quoted to the customer before the work is performed.

Warranty Exclusions

The stated warranty does not apply to Products which are (a) specials, modifications, or customized items (including custom patch cables) meeting the specifications you provide; (b) ESD sensitive items whose static protection packaging has been opened; (c) items repaired, modified or altered by any party other than Thorlabs; (d) items used in conjunction with equipment not provided by, or acknowledged as compatible by, Thorlabs; (e) subjected to unusual physical, thermal, or electrical stress; (f) damaged due to improper installation, misuse, abuse, or storage; (g) damaged due to accident or negligence in use, storage, transportation or handling.

Part 5. Certifications and Compliance

Konformitätserklärung
Declaration of Conformity
Déclaration de Conformité

Thorlabs Inc
435 Rt 206
Newton, NJ
USA

erklärt in alleiniger Verantwortung, dass das Produkt:
declares under it's own responsibility, that the product:
déclare sous notre seule responsabilité, que le produit:

OCM1300SS/OCP1300SS/OCMP1300SS
OCS1300SS/OCS1050SS

mit den Anforderungen der Normen
fulfills the requirements of the standard
satisfait aux exigences des normes

72/73/EEC	Low Voltage Directive 19.02.1973
93/68/EEC	Change of Low Voltage Directive
DIN EN 61010-1:2001	Safety of Test and Measurement Equipment
DIN EN 61326:97+A1:98+A2:01+A3:03	EMC of Test and Measurement Equipment
DIN EN 61000-3-2:2000	Harmonic Current Emission
DIN EN 61000-3-3:95 + A1:2001	Voltage Fluctuations and Flickers
DIN EN 61000-4-2	Electrostatic Discharge Immunity (Criterion C)
DIN EN 61000-4-3	Radiated RF Electromagnetic Field Immunity (Criterion B)
DIN EN 61000-4-4	Electrical Fast Transient/Burst Immunity (Criterion B)
DIN EN 61000-4-5	Power Line Surge Immunity
DIN EN 61000-4-6	Conducted RF Immunity
DIN EN 61000-4-11	Voltage Dips and Interruptions Immunity

übereinstimmt und damit den Bedingungen entspricht.
and therefore corresponds to the regulations of the directive.
et répond ainsi aux dispositions de la directive.

Dachau, 20. Mai 2009 ..... D. Jemetz .....

Ort und Datum der Ausstellung	Name und Unterschrift des Befugten
Place and date of issue	Name and signature of authorized person
Lieu et date d'établissement	Nom et signature de la personne autorisée

Note: The SL1050-P16 and SL1325-P16 were tested as components of the OCS1050SS and OCS1300SS.

Part 6. 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 13th 2005
- Marked correspondingly with the crossed out “wheelie bin” logo
- 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

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.

Environmental Impact

It is well known that WEEE directive was established because electronic products are known to pollute the environment by releasing toxins 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 live products will thereby avoid negative impacts on the environment.

Part 7. Appendix

7.1. Setting the Line Select Switch

The Swept Source will operate from AC line voltages ranging from 100-240 VAC at 50-60Hz. There is no need to configure the unit for specific line voltages.

7.2. Changing the Input Fuses

If for some reason you need to replace an open fuse in the Swept Laser Source, you must perform the following procedure:

- Remove the AC input cable that may be connected to the unit.
- Slide open the cover of the fuse holder located at the rear panel of the Swept Laser Source as shown in figure 48. Remove the existing fuse and install the appropriate replacement fuse for Swept Laser Source.
  Use only is 1A 250VAC Type T 5x20mm style fuse
  (IEC 60127-2/III, Low Breaking Capacity, slow blow)
- Slide the fuse cover closed.

Figure 10: Fuse cover located on the Swept Source rear panel

Part 8. 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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