THOR**LABS**

LS2000C Series
Broadband SLD Light Source

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

Precautions of a general nature should be gathered here. Wherever possible, however, safety warnings, cautions, and notes should only appear immediately before the instructions to which they apply (versus being listed in this section). All statements regarding safety of operation and technical data in this instruction manual will only apply when the unit is operated correctly.

⚡	**SHOCK WARNING**	⚡
	High voltage inside. To avoid electrical shock, before powering unit, 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.	

⚠	**WARNING**	⚠
	This unit must not be operated in explosive environments.	

☢	**WARNING**	☢
	Avoid Exposure – Laser Radiation Emitted from apertures.	

This unit is supplied with an 115 V parallel blade line cord for North American use only. For all other applications use an IEC 320 compatible line cord fitted with a plug appropriate for your particular AC wall socket.

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 Setting the AC Line Voltage and Installing Fuses). 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 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.

INVISIBLE LASER RADIATION
DO NOT VIEW DIRECTLY WITH
OPTICAL INSTRUMENTS
CLASS 1M LASER PRODUCT
1100 nm to 1500 nm   <50mW

Chapter 3   Description

The LS2000C extended broadband SLD light source can be used for many imaging applications such as optical coherence tomography, low coherence interferometry, and passive components test. The LS2000C combines broadband output spectrum and high-power, fiber-coupled output within a compact form factor ideal for bench-top applications or larger system integration.

In OCT imaging systems, the optical bandwidth of the light source is inversely proportional to the axial resolution. To provide higher axial resolution than currently possible with a single SLD, the LS2000C uses two SLDs with different center wavelengths. The SLDs are designed so that their emission spectra are offset yet, when combined (matched-pair), the difference in intensity from peak to valley based on that offset is minimized to less than 3 dB. The output of the two fiber pigtailed SLDs is fiber coupled to provide a single extended bandwidth (>200 nm, typical) light source. This extended light source can be used in OCT imaging systems to produce images with a resolution of ~3 µm in biological (n = 1.33) samples.

The LS2000C extended broadband SLD light source packages the matched-pair of SLDs into a single compact housing. Like our other 1325 nm SLDs for OCT, these SLDs have an integrated isolator, thermistor, and TEC element for optimal performance. The LS2000C front panel allows the user to control each channel independently, switch between each channel or a combined signal, set the output back to the factory settings, and enable/disable the system.

There are three FC/APC fiber connectors on the front panel of the LS2000C. Two connectors are for access to the output of each SLD. The other provides extended bandwidth output from the combined pair of SLDs. The combo-channel will have a bandwidth greater than 170 nm and output power greater than 10 mW.

The LS2000C can operate in two modes. Independent control allows each SLD to be directly output to front panel FC/APC connectors. Each SLD source operates from a high precision, low noise, constant current source and is independently temperature controlled. By selecting the "CH A+B" enable button, internal optical switches will route the two SLD's through a coupler to a single output. Thorlabs calibrates the temperature and current to give the best overall broadband performance. The user may adjust these settings at any time to better suit their needs. With one touch the system can be reset to its original factory settings.

An intuitive LCD interface allows the user to view and set the parameters for each SLD. Adjustments include SLD current and temperature control for each source. The display will indicate the channel selected, the center wavelength of the source or "CH A+B", the operating current, and the actual temperature the laser is stabilized to. This system includes a microcontroller to fully control the SLD's optical power, temperature, and monitor the system for fault conditions. Other features include a USB connection that allows remote adjustment of power, temperature, and enabling.

While most output sources fall within the class 3R laser rating, the system was fully designed to meet 3B laser class requirements. There is an interlock located on the rear panel that must be shorted in order for any SLD output to be enabled. This can easily be configured for use with lab doors to disable the lasers in unsafe conditions. The power switch is a key lock system to prevent accidental or unwanted use. Each source has its own enable button allowing the user to choose the light source or sources they wish to be active as well as a master enable which must also be set. Each includes an indicator to easily determine its state. There is a 3 second delay before the lasers will turn on, with the indicators rapidly blinking to warn the user. All of this is done to provide a safe operating environment for the user.

The LS2000C includes a universal power supply allowing operation over 100 to 240 VAC without the need for selecting the line voltage. Fusing is located on the rear panel for user convenience. This unit is supplied with a US line cord as well as a standard European line cord.

Chapter 4   Setup

4.1.   Setting the AC Line Voltage and Installing Fuses

Your LS2000C SLD Light Source has been shipped from Thorlabs configured for 100 to 240VAC operation. There is no line switch adjustment to be made. However it may be necessary to replace an open fuse. To do this you must perform the following procedure.

- Remove the AC power cord if it is connected to the unit.
- Locate the Fuse tray directly below the AC power cord connection on the rear panel of the unit.
- Carefully use a flat blade screwdriver to open the fuse tray.
- Remove the existing fuse and install the appropriate 500mA fuse. The replacement fuse must be a 5 mm x 20 mm 250 VAC Type T Fuses (IEC 60127-2/III, low breaking capacity, slow blow)
- Push the fuse tray back into place making sure that it snaps and seats correctly.
- Connect the appropriate power cord into the AC receptacle and plug the unit in.

4.2.   Initial Set-up

- Locate the unit on a dry, level working surface.
- Make sure the POWER key switch on the front of the unit is in the OFF position (key perpendicular to working surface).
- Plug the female end of the AC line cord provided into the AC Input Receptacle on the rear of the unit. Plug the male end into a properly grounded AC socket.
- Install the interlock "key" into the interlock connector located on the rear panel. See Section 5 for details.
- Connect a FC/APC Fiber Optic cable to the LASER APERTURE on the front panel of the unit and verify that the dust caps are installed onto all unused fiber connections.

Chapter 5   Operation

5.1.   Front and Back Panel Overview

CH A + B Switch
Selects extended spectral bandwidth mode.

Channel Select Switch
Selects the channel desired to be enabled.

Default Setup Switch
This configures the system to the optimal spectrum.

SLD Enable Switch
Press to activate selected lasers.

16x2 LCD Display with Backlight
Displays channel, output power, wavelength, and temperature. It is also used to adjust drive current and temperature.

SLD Output Port
FC/APC fiber optic connectors output .

Extended SLD Output Port
FC/APC fiber optic connector output the extended spectrum SLD source.

Indicator LEDs
Indicates the channel is selected, the default parameters are set and the systems enable condition.

Control Knob / Switch
Selects channel, adjusts current and adjusts temperature.

Keylock Power Switch
Turn on power to the unit. The key only removes when off.

Remote Interlock Input
(See section 5 for details)

AC Power Connector

Cooling Vent - Do Not Block
The temperature control system moves air from vent holes on the bottom, through a heat sink and out this vent. Periodically remove dust buildup from vents for best operation.

Fuse Tray
(See section 3.1 for replacement details)

USB Input Connector
Allows full operation through a PC interface (See section 6 for details)

Figure 1   Front and Rear Panels of Laser Source

5.2.   Turning On the Source

1. Turn the POWER key switch clockwise. The LCD display will scroll "Thorlabs LS2000C" across the screen, followed by the Ch A information.

2. Make sure the Interlock Input is short-circuited; see Section 5 for detailed instructions.

3. Select the desired output channels by pressing and releasing the ENABLE switch located above the desired fiber output sources. An indicator located next to the switch will light up. "CH A ENABLE" will enable the channel A light source and route it to the first FC/APC connector. "CH B ENABLE" will enable the channel B light source and route it to the second FC/APC connector. "CH A+B Enable" will select both light sources, route them through a combiner and to the third FC/APC connector. Note that only the first two or last FC/APC connectors can be utilized at any given time.

4. Press and release the SYSTEM ENABLE switch to activate the sources. There will be an approximately 3 second delay before the sources power up. During this time the SYSTEM ENABLE indicator will light up and the selected channel indicator lights will blink rapidly.

5. If the "CH A+B ENABLE" was chosen, the unit can be configured quickly to the recommended operating parameters by selecting the "DEFAULT SETUP" button. Thorlabs predetermines the best operating current and temperature for the matched pair SLD's to provided the optimal broadband source.

5.3.   Viewing Channel Information

The LS2000C uses a single LCD display to access the information for each output channel. At any time the display can be adjusted to view another channel by simply rotating the control knob located to the left of the display. The display will scroll between the channels until the desired channel is selected. The following information will be available:

- **Top left** – Indicates the channel selected. As an additional indicator, the channel enable indicator selected will periodically blink on if disabled and off if enabled.

- **Top Right** – Indicates the center wavelength of the selected channel or "CH A+B" if broadband operation is selected. This is set at the factory when the lasers are installed.

- **Bottom Left** – Indicates the operating current of the selected SLD.

- **Bottom Right** – Indicates the actual temperature the laser is stabilized to and is displayed in °C. The temperature control is always active and requires 5 to 10 minutes to properly stabilize. If the "CH A+B ENABLE" and "DEFAULT SETUP" buttons are selected, the default temperature settings will change to the precalibrated temperature settings.

5.4.   Adjusting the SLD Output Power and Temperature

1. Rotate the control knob to select the appropriate channel. The selected channel is indicated on the display as well as with a periodic blink of the channel indicator light.

Note: The adjustment knob utilizes an intelligent speed control. Adjusting the knob slowly will increment values at the maximum resolution while adjusting fast will make larger movements. This allows both a fine and course control.

2. When the appropriate channel is selected, press the control knob in. The bottom left location will start blinking and will change to current, ex: 500.0 mA. Adjust the control knob until the desired current is achieved. The power will adjust real-time. The first time default setting will be power full off. Adjusting the knob clockwise incrementally increase the operating current. Adjusting the knob counter clockwise will incrementally decrease the current. On power down, the current setting will be remembered.

Note that there is a timeout on the display, after which the display will revert back to the viewing mode. This is to prevent accidental adjustment of the power.

3. Press the knob again to switch to temperature adjustment. The set point temperature will be displayed and will be blinking; ex. 25.00°C. Adjust the control knob to increase or decrease the temperature set point. The temperature default is 25.00°C but can be adjusted over a range of 12.00°C to 30.00°C with a resolution of 0.01°C.

Note, as above there is a timeout where the display will revert to the viewing display and lock out adjustment to the temperature.

4. Pressing the control knob again will exit the adjustment mode and revert back to the viewing mode, locking in the selected parameters. This can also be achieved by allowing the display to time out at any point in the process. Depending on the magnitude of the change in temperature set point, it will take anywhere from a few seconds to a few minutes for the system to settle into the new operating temperature.

5.5.   Selecting the Operating Mode

Independent Operating Mode – While in independent operating mode the two SLD's will operate as standalone units and will be routed to the first and second optical FC/APC connectors. In this mode both SLDs will be fully and independently controllable through the front panel controls or through USB commands. Simply select the "CH A" and/or "CH B" buttons. Press the "SYSTEM ENABLE" button to turn the SLD's on. To adjust the current or temperature scroll the control knob until the desired channel is selected. Press the knob in to adjust the operating current and press again to adjust the set temperature.

Extended Broadband Mode – This mode will reroute the SLD outputs using MEM's optical switches into a fiber coupler and place the combined output on the third optical FC/APC connector. Note that the total output power of the two SLD's is evenly split between the two output connectors. Either or both may be used with the same resulting spectrum. To operate in this mode, press the "CH A+B" button. This will disable the "CH A" and "CH B" outputs and configure the output for extended bandwidth. Channel A and B may still be independently controlled to massage the full optical spectrum by adjusting the current and temperature. Thorlabs provides an optimal broadband spectrum. To use these settings simply press the "Default Setup" button. This will set the operating current and temperature to the optimal operating conditions. Press "SYSTEM ENABLE" to turn the SLD's on.

Power Down - When completely powering down an enabled unit, first press and release the SYSTEM ENABLE switch and then turn the POWER key switch counterclockwise, which will turn OFF the entire unit. Anytime the unit is turned OFF and then turned back ON, the Laser will be disabled until the SYSTEM ENABLE button is pressed and the desired channels are enabled. Previous settings will be remembered.

Chapter 6   Making the Safety Interlock Connections

The LS2000C series SLD source is equipped with a remote interlock connector located on the rear panel, see Figure 2. All units have this feature regardless of their FDA and IEC classifications. In order to enable the laser source, a short circuit must be applied across the terminals of the Remote Interlock connector. In practice this connection is made available to allow the user to connect a remote actuated switch to the connector (i.e. an open door indicator). The switch (which must be normally open) has to be closed in order for the unit to be enabled. Once the switch is in an open state the laser source will automatically shutdown. If the switch returns to a closed condition the laser source must be re-enabled at the unit by pressing the SYSTEM ENABLE switch.

All units shipped from Thorlabs are configured with a shorting device installed in the Interlock connector. If you are not going to use this feature then you can leave the shorting device installed and the unit will operate normally as described in the procedures above.

If you wish to make use of the Interlock feature you will need to acquire the appropriate connector mate and wire it to your remote interlock switch. Next, remove the shorting device by pulling it out with a pair of needle nose pliers and install the connector into the interlock input.

The interlock input only accepts a 2.5 mm mono phono jack. This connector is readily available at most electronics stores.

The electrical specifications for the interlock input are shown in the following table.

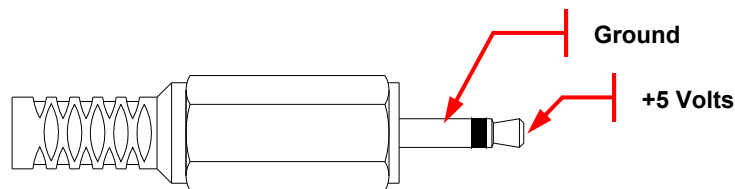| Specification	Value
Type of Mating Connector	2.5 mm Mono Phono Jack
Open Circuit Voltage	+5 VDC with Respect to Chassis Ground
Short Circuit Current	~8 mA DC
Connector Polarity	Tip is +5 V, Barrel is Ground
Interlock Switch Requirements	Must be N.O. Dry Contacts Under no circumstances should any external voltages be applied to the Interlock input

Figure 2   Remote Interlock Connector

Chapter 7   Remote Communications

7.1.   Installing the USB Drivers

Prior to running the command line interface, the USB drivers must be installed. The LS2000C must not be connected to the PC while installing the drivers. Insert the CD that was supplied with your unit into your PC. From the dialog box that is displayed, select the Install Drivers button. If the dialog box is not displayed, browse to the CD and run CD_Started.exe. Follow the onscreen prompts to install the driver. After the driver is installed, attach the LS2000C to the PC and power it on. Your PC will then detect the new hardware and will prompt you when the installation is complete.

7.2.   Command Line Interface

The LS2000C Series may also be controlled by a command line language through the USB port. This is offered to enable operation through a terminal interface or for those who may want to write their own program to control the system. The command language is described below. Prior to running the command line interface, the drivers should be installed, the unit should be powered and a USB cable should be connected between the MCLS and the host. The terminal emulator should be set as follows:

- Baud Rate = 115.2K Bits Per Second
- Data Bits = 8
- Parity = None
- Stop Bits = 1
- Flow Control = None

If the connection is correct you will see the following after pressing the "Enter" key.

> *Command error CMD_NOT_DEFINED*

Followed immediately by the prompt:

> >

The basic structure of the interface is a keyword followed by either an equals sign "=" or a question mark "?". The "=" or "?" will determine if the string is a command or a query. All strings (commands and queries) must be terminated by a carriage return (CR) or pressing the ENTER key on the computer.

The command structure is as follows:

> *Keyword = argument (CR)*

Where "keyword" defines the function and "argument" is a numerical value followed by a carriage return (CR). See listing below.

The query structure is a follows:

> *Keyword? (CR)*

The "keyword" defines the function and the question mark (?) indicates a query. The string is terminated with a carriage return (CR). See listing below.

There are a few exceptions to this which are noted below, also noted are unique shortcut keys.

The prompt symbol ">" will appear on power up and after a command is accepted by the system indicating it is ready to receive another command line.

7.3.   Keywords (Commands and Queries)

The following list shows all of the available commands and queries, and summarizes their functions:

Command	Syntax[1]	Description
Get Commands	?	List the available commands
Get ID	id?	Returns the model number and firmware version.
Get Channel	channel?	Returns the active channel.
Set Channel	channel=*n*	Select the channel specified by *n* where *n* is A or B.
Get Target	target?	Returns the target temperature for the active channel.
Set Target	target=*n*	Sets the target temperature (*n*) for the active channel.
Get Temp	temp?	Returns the actual temperature for the active channel.
Get Current	current?	Returns the current for the active channel.
Set Current	current=*n*	Sets the current (*n*) for the active channel.
Get Enable Ch A	enableA?	Returns the current state of the channel A Enable button.
Set Enable Ch A	enableA=*n*	Sets the state of the channel A Enable button (0: disabled, 1: enabled). This will disable Ch A+B if on.
Get Enable Ch B	enableB?	Returns the current state of the channel B Enable button.
Set Enable Ch B	enableB=*n*	Sets the state of the channel B Enable button (0: disabled, 1: enabled). This will disable Ch A+B if on.
Get Enable Ch A+B	enableAB?	Returns the current state of the channel A+B Enable button.
Set Enable Ch A+B	enableAB=*n*	Sets the state of the channel A+B Enable button (0: disabled, 1: enabled). This will disable Ch A and Ch B if on.
Get System	system?	Returns the current state of the System Enable button.
Set System	system=*n*	Sets the state of the System Enable button (0: disabled, 1: enabled).
Default Setup	defset	Sets the current and temperature for channel A and B to the default values.
Get Specs	specs?	Returns the specifications for the selected channel.
Get Step	step?	Returns the increment used to adjust the temperature and current when the arrow keys are pressed.
Set Step	step= *n*	Sets the increment used to adjust the temperature and current when the arrow keys are pressed.
Save Parameters	save	Saves all of the current settings.
*	*All commands and queries are case sensitive.*	

If the keyword, format, or argument is incorrect or out of range, the unit will return an error string. The function is determined by the value set with the mode command in the above table.

In addition to the above commands there is also special functionality added to the arrow keys of the computer's keyboard.

- Up Arrow Key – Increments the current for the active channel by *n*.
- Down Arrow Key – Decrements the current for the active channel by *n*.
- Right Arrow Key – Increments the temperature for the active channel by *n*.
- Left Arrow Key – Decrements the Temperature for the active channel by *n*.

Where *n* is set by the command "Set Step".

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[1] *All commands and queries are case sensitive.*

Chapter 8   General Maintenance

Aside from the AC Input fuse there are no user serviceable parts in this product. If you suspect something has failed on the unit, please contact Thorlabs for advice on returning the unit for evaluation. Always clean fiber optic connectors that will be inserted into the system and install the dust cap whenever the source is not being used. Allowing dust and dirt into the fiber ports will degrade coupling efficiency and possibly damage the fiber patch cords, both inside and outside. If you suspect this to be true, Thorlabs can clean and inspect the fiber connections, and repair if necessary.

8.1.   Cleaning

The unit can be cleaned using a soft, slightly damp cloth. Avoid using any solvents on or near the unit. Keep the vent holes located on the bottom of the unit and on the rear panel free of dust buildup. Restricted airflow will cause the temperature controls to operate inefficiently and in extreme cases, lose temperature control.

Always clean the ferrule end of your fiber patch cable prior to inserting it into the output FC/APC Adapter. Allowing dust and dirt into the fiber ports will degrade coupling efficiency and possibly damage the fiber patch cords, both inside and outside. If you suspect this to be true, Thorlabs can clean and inspect the fiber connections, and repair if necessary.

Chapter 9   Specifications

Optical Performance Specifications	
Center Wavelength	1300 nm
Bandwidth (FWHM)	200 nm Typical, >170 nm Min
Min Full Output Power	>10 mW
Fiber	SMF28
Noise	<0.2% Typical (Source Dependent)
Electrical Performance Specifications	
Current Set point Resolution	0.1 mA
Temperature Adjust Range	14.00 to 30.00 °C
Temp Set point Resolution	±0.01 °C
General Specifications	
AC Input	100 - 240 VAC, 50 - 60 Hz
Input Power	65 VA max.
Fuse Ratings	500 mA
Fuse Type	IEC60127-2/III (250V, Slow Blow Type 'T')
Fuse Size	5 x 20 mm
Dimensions (W x H x D)	12.6" x 2.5" x 10.6" (320 x 64 x 269mm)
Weight	7.3 lbs
Operating Temperature	10 to 30 °C
Storage Temperature	0 to 50 °C
Connections and Controls	
Interface Control	Optical Encoder with Pushbutton
Enable and Laser Select	Keypad Switch Enable with LED indication
Power On	Key Switch
Fiber Ports	FC/APC
Display	LCD, 16 x 2 alphanumeric characters
Input Power Connection	IEC Connector
Interlock	2.5 mm Mono Phono Jack
Communications	
Communications Port	USB 2.0
Com Connection	USB Type B connector
Cable, Included	2 m USB Type A to Type B Cable (Replacement Part Number USB-A-79)

Note: Handpicked, matched pair SLD's and configurations are available. Contact Thorlabs to request a quote.

9.1.   Typical Spectral Curves

Sample SLD Emission Spectrum

Channel A
Channel B

FWHM ~ 80 nm

FWHM ~ 110 nm

Sample SLD Emission Spectrum
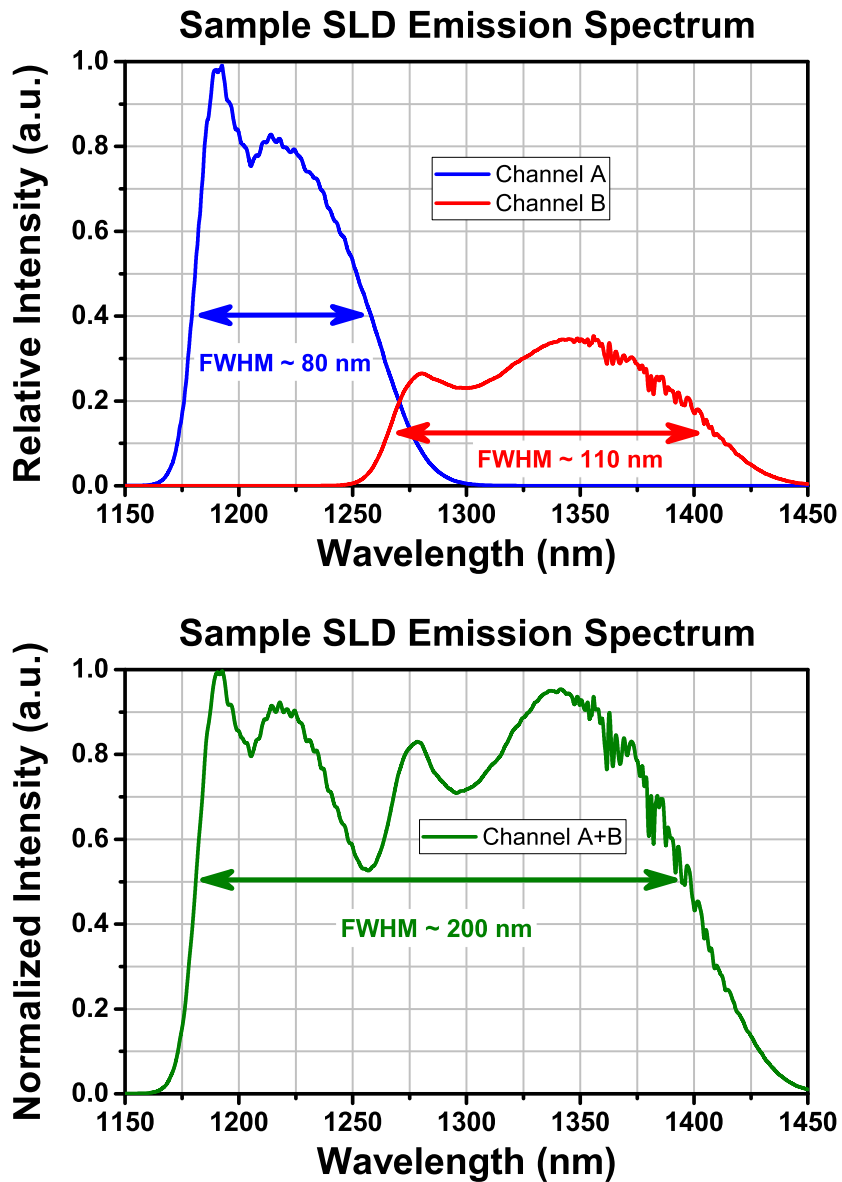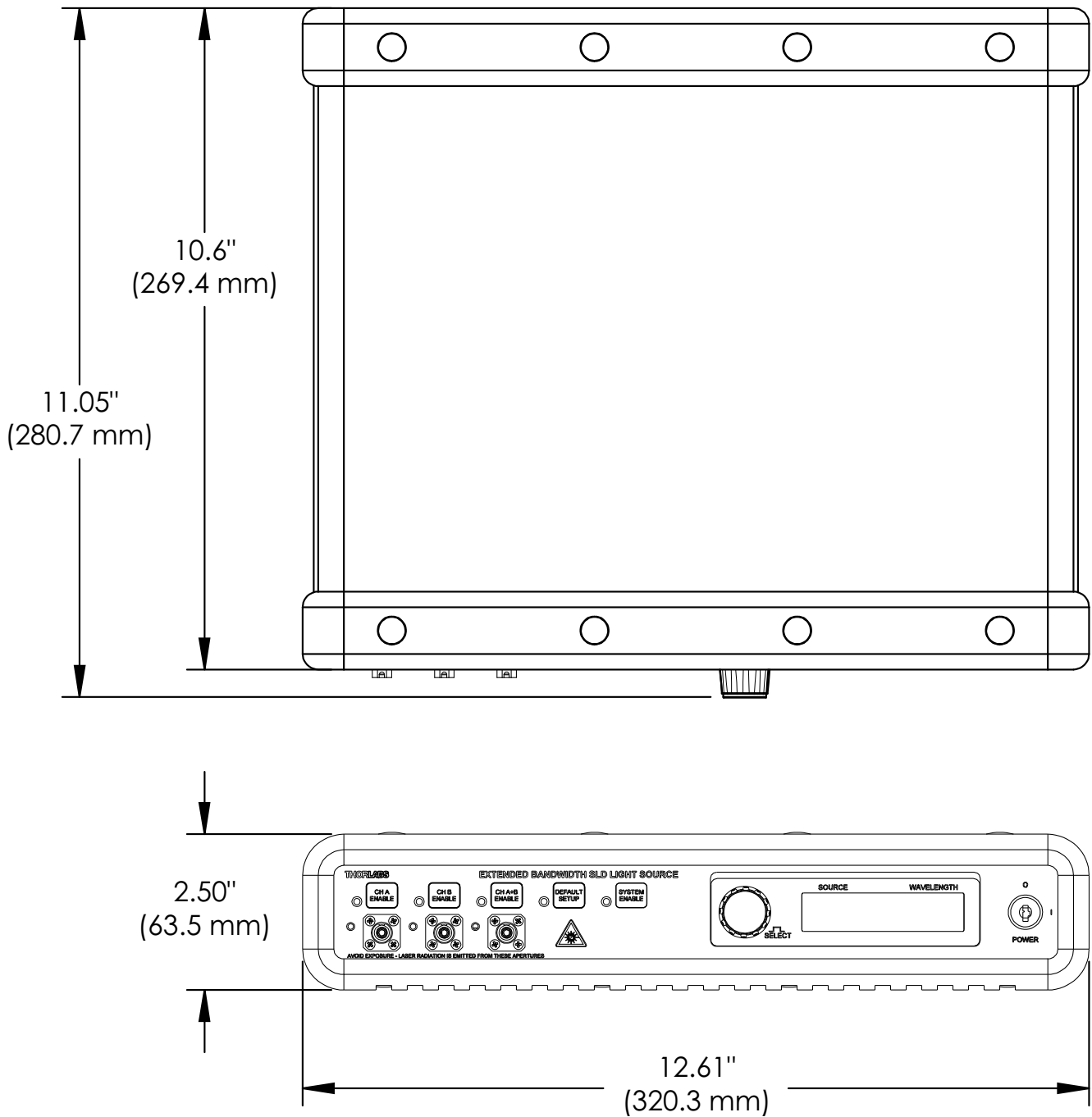
Channel A+B

FWHM ~ 200 nm

Figure 3   Typical Spectra

Note: The above graphs are a sample of one matched pair. Spectra will vary based on the available matched pairs.

Chapter 10   Mechanical Drawing

10.6"
(269.4 mm)

11.05"
(280.7 mm)

2.50"
(63.5 mm)

THORLABS   EXTENDED BANDWIDTH SLD LIGHT SOURCE

CH A ENABLE   CH B ENABLE   CH A+B ENABLE   DEFAULT SETUP   SYSTEM ENABLE   SOURCE   WAVELENGTH

SELECT   POWER

AVOID EXPOSURE - LASER RADIATION IS EMITTED FROM THESE APERTURES

12.61"
(320.3 mm)

Chapter 11 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.

11.1 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.

11.2 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 12   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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