New Focus TLB-6500-H-20

Swept-Wavelength Tunable Laser Source

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USER'S GUIDE

Swept-Wavelength Tunable Laser Source™

External-Cavity Tunable Diode Lasers
Model Series TLB 6500

U.S. Patent #5,319,668 & Other Patents Pending

Use of controls or adjustments, or performance of procedures other than those specified herein, may result in hazardous radiation exposure.

NEW FOCUS®

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Warranty

New Focus, Inc. guarantees its lasers to be free of material and workmanship defects for one year from the date of shipment. This warranty is in lieu of all other guarantees expressed or implied and does not cover incidental or consequential loss.

Document Number 650152 Rev. E

Contents

User Safety

Introduction

Your safe and effective use of this product is of utmost importance to us at New Focus. Please read the following laser safety information before attempting to operate the laser.

Laser Safety

The laser radiation emitted from this unit may be harmful. Always follow these precautions:

- Avoid direct exposure to the beam.
- Always wear protective goggles or eyeglasses appropriate for working with laser light.
- Avoid looking at the beam directly.
- Be aware of the warning and safety labels (examples are shown on page 10).
- To completely shut off electrical power to the unit, disconnect the power cord from the product.
- Do not open the laser system. There are no user-serviceable parts inside the unit.

Viewing the laser output with certain optical instruments (for example, eye loupes, magnifiers, and microscopes) within a distance of 100 mm may pose an eye hazard.

- Opening the laser cavity may cause exposure to wavelengths and power outside the specified range shown on page 95. The following table shows the maximum wavelength range and the maximum internal power accessible inside the laser cavity.

Model	Wavelength Range	Max. Power
TLB-6500-L-CL	1450-1650 nm	55 mW
TLB-6500-H-CL	1450–1650 nm	55 mW
TLB-6500-L-ES	1400-1540 nm	55 mW
TLB-6500-H-ES	1400-1540 nm	55 mW
TLB-6500-L-O	1150-1350 nm	55 mW
TLB-6500-H-O	1150-1350 nm	55 mW
TLB-6500-H-09	940-1050 nm	55 mW

Unauthorized opening of the laser will void the warranty and may result in burns, electric shock, misalignment of the laser cavity and/or irreparable damage to the internal components.

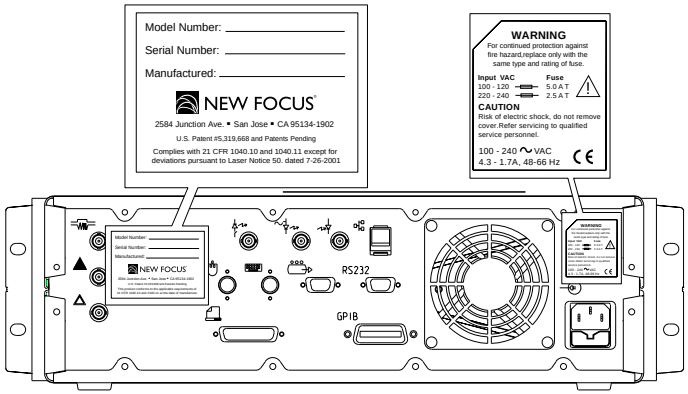
Label Identification

The following figures show the location of the warning label and certification label used with this product. Please be aware of them and use caution when working with the laser.

Figure 1: Aperature label on the front of the laser

Figure 2: Certification and warning labels on the back of the laser

CAUTION!	*Caution! Risk of electrical shock! Do not remove cover. Refer servicing to qualified service personnel.*
~	*Alternating Current*
⏚	*Protective Conductor Terminal*



Using the Safety Interlock

The safety interlock connector on the back of the controller is provided for external safety systems. The system is shipped with a jumper across the interlock terminals. Do not remove this jumper unless you are using the safety interlock feature; the laser will not emit light unless the interlock circuit is closed. The circuit carries 15-V DC. For the exact location of the safety interlock connector, see “Controller Back Panel and Tunable Laser Cavity Connections” on page 15.

Getting Started

Introduction

This section outlines the basic steps needed to start using your Swept-Wavelength Tunable Laser Source laser system, including information on unpacking the system and brief set-up and starting notes. For more detailed information on how to operate the instrument, refer to the "General Operation" chapter beginning on page 19.

Unpacking the System

Carefully unpack the laser system. Compare the contents against the packing slip and inspect them for any signs of damage. If parts are missing or you notice any signs of damage, such as dented or scratched covers, or broken knobs, please contact New Focus immediately. Save the shipping container and packing material for future shipping needs.

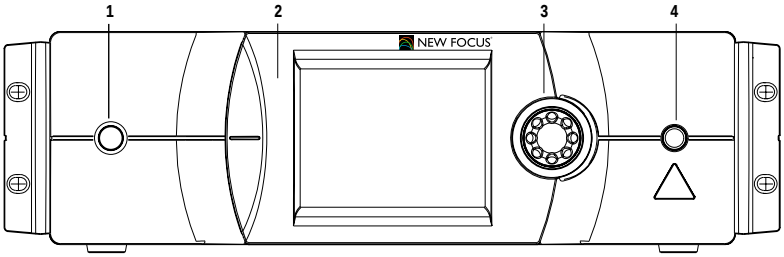
Familiarizing Yourself with the System

Controller Front Panel

The Swept-Wavelength Tunable Laser Source has two control options, local and remote. In local mode, the detatchable front screen located in the front panel of the laser provides control of the laser system using an icon-based interface. In remote mode, you control the laser over a computer interface (IEEE-488, RS-232, or Ethernet). Whenever the Swept-Wavelength Tunable Laser Source receives a command over the computer interface, it restricts most of the front-screen controls (the

Front Panel button to initialize system is always enabled). Select the Remote icon on the front screen to restore front-screen control. For information on using computer control, see page 43.

Figure 3: Controller front panel

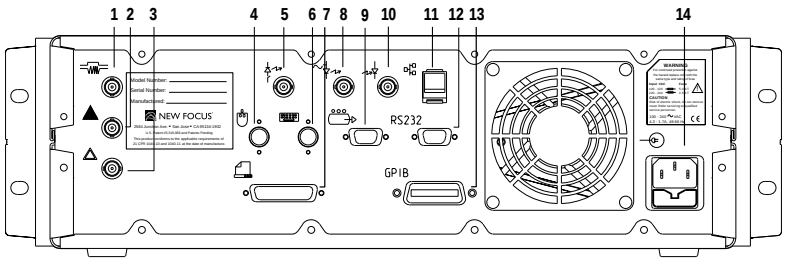


1. **Front Panel Button to Initialize System:** Controls AC power to the entire laser system, including the temperature-control circuit. Power is not supplied to the laser diode until the Laser Power button is activated.
2. **Front Screen:** Use this removable screen to control the laser using an icon-based interface.
3. **Selection Knob:** Use this knob on the front screen to navigate through numeric inputs on the screen.
4. **Laser Output:** Connector for FC/APC-connectorized fiber. The polarization is aligned parallel to the key on the FC connector.

   Note: *Make sure the laser output is blocked or attached to an optical fiber and the fiber is connected to an appropriate receptacle on the other end.*

Controller Back Panel and Tunable Laser Cavity Connections

Figure 4: Controller back panel



1. **Laser Sync Output:** The controller sends a signal out through this BNC connector when the laser is scanning from the start to the stop wavelength.
2. **Wavelength Trigger A Output:** The controller sends a pulse through this BNC connector when a scan hits the specified trigger wavelength.
3. **Wavelength Trigger B Output:** The controller sends a pulse through this BNC connector when a scan hits the specified trigger wavelength.
4. **Mouse port:** Port used to connect an external mouse to the laser for navigation through the user interface.
5. **Safety Interlock:** For use with external safety systems, the laser will not operate if the interlock circuit is open.
6. **Keyboard port:** Port used to connect an external keyboard to the laser for data entry.
7. **Printer port:** Port used to connect an external printer to the laser.
8. **Detector Input:** BNC connector for monitoring an external instrument through the laser controller's computer interface.
9. **Monitor port:** Use this port to connect an external monitor to the laser.
10. **Current Modulation Input:** BNC connector for modulating the laser current (amplitude).

11. **Ethernet:** Connector for controlling the laser over an Ethernet interface.
12. **RS232:** Connector for controlling the laser over an RS-232 interface.
13. **IEEE 488:** Connector for controlling the laser over an IEEE-488 (GPIB) interface.
14. **Power Module:** This module is universal and can accept all of the voltages and frequencies listed on page 21.

Setting Up the Laser

The laser is designed to operate in environments from 15–35 ˚C. It is intended for *indoor use only*. If the laser has been in storage at temperatures outside the range of 15–35 ˚C, allow the laser system at least 4 hours to equalize.

Note: *Do not store the laser outside the range of -20–70 ˚C.*

The laser is shipped with brackets for mounting the system in a rack and with rubber feet for using the system on a table top. Use a 1/8" Allen wrench to add or remove the feet or the brackets.

Connecting Fiber to the Laser

Use only FC/APC-connectorized fiber with the Swept-Wavelength Tunable Laser Source. This laser operates with polarization-maintaining (PM) fiber. The polarization is aligned parallel to the key on the FC connector. The laser output comes to the front panel through a fiber with an optical isolator of 30 dB, preventing optical feedback into the laser cavity.

Turning on the Power

The Swept-Wavelength Tunable Laser Source can operate at 100 – 120V (±10%) AC @ 50/60 (±10%) Hz or 200 – 240V (±10%) AC @ 50/60 (±10%) Hz, Pollution degree 2, Installation Category II. The input AC voltage is selected automatically by the universal AC power module.

1. **Make sure the laser aperture is blocked or attached to an optical fiber that is connected to an appropriate receptacle.** Only use fiber with FC/APC connectors See "Connecting Fiber to the Laser" on page 16.

Laser radiation emitted from this unit may be harmful. Avoid direct exposure to the beam.

2. **Turn On Power:** Connect the power cord to the laser power module and plug it into a wall outlet.
3. **Initialize the system:** Push the Front Panel button to initialize the system: the system ID will appear in the screen during initialization.Wait at least 45 minutes after turning on the Front Panel button to initialize system to allow the system to warm up.

It is recommended that you leave the system power on and turn the laser diode power off when you are not using the laser.

Once you turn on the power and the system initializes (about 30 seconds), you can operate the system remotely through the IEEE-488 (GPIB), RS-232, or Ethernet ports. Refer to the "Computer Control" chapter beginning on page 43 for details. The system will take another 2 minutes to start the Welcome screen.

Turning Off the Power

Before turning off the system, you should first turn off power to the laser diode. See page 27 for more information about turning off power to the laser using the front screen. See page 58 for more information about turning off power to the laser using the remote computer commands.

General Operation

Overview

The Swept-Wavelength Tunable Laser Source is a stable, narrow-linewidth source of tunable light. The laser operates in four modes: Sweep Mode, Step-Scan Mode, Track Mode and Program Mode. Use it in Track mode to operate it at a set wavelength. In Sweep Mode, it is capable of fast and extremely linear scans between the start and stop wavelengths that you specify. In Step-Scan Mode, the laser dwells at evenly spaced wavelengths as it scans. In Program Mode, it dwells at the wavelengths you specify in a stored list. The system can be operated manually, using the front-screen icons, or remotely, using one of the computer interfaces (see “Computer Control” on page 43).

What’s Inside

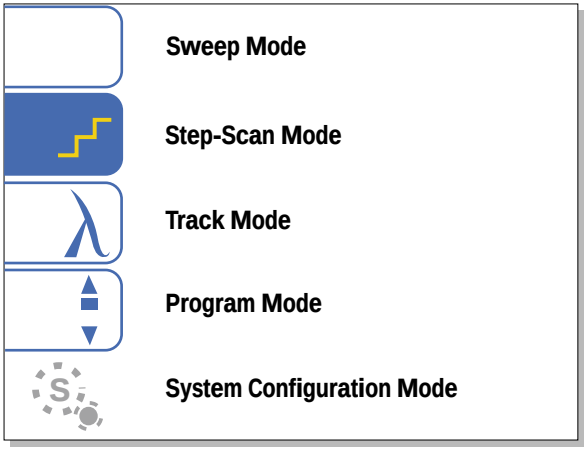
The Swept-Wavelength Tunable Laser Source is an external-cavity diode laser (ECDL) based on the Littman-Metcalf design (see “Principles of Operation” on page 83). The laser is designed to provide very accurate and linear wavelength scans. Smooth and fast tuning is achieved with a brushless DC motor. An optional wavelength ramp ensures linearity by adding 2 nm before and after the specified tuning range to compensates for the motor’s start-up and slow-down times; enable or disable the ramp using the computer interface (page 76) or the front screen interface (page 26).

The system also provides high resolution when stepping between wavelengths. An ultra-low-noise current source controls the laser’s output power. A temperature-control circuit actively stabilizes the laser-cavity temperature for optimal performance.

Understanding the Laser's Operating Modes

The Swept-Wavelength Tunable Laser Source has four scan modes and a system configuration mode. These modes are represented by the five icons on the left side of the screen:

Figure 5: The Mode icons



- **Sweep Mode:** Use Sweep Mode to perform a wavelength sweep across a wavelength range you specify.
- **Step-scan Mode:** Use Step-Scan Mode to perform a sweep across a wavelength range you specify, stopping at set intervals and dwelling at each wavelength for the time you specify.
- **Track Mode:** Use Track Mode to tune to a specific wavelength.
- **Program Mode:** Use Program Mode to perform a sweep across a list of wavelengths you specify.
- **System Configuration:** Use this mode to access the following system settings:
  - Display Laser Information
  - Wavelength Offset and Trim (calibration)
  - Set Preferences
  - Set Language
  - Select Port

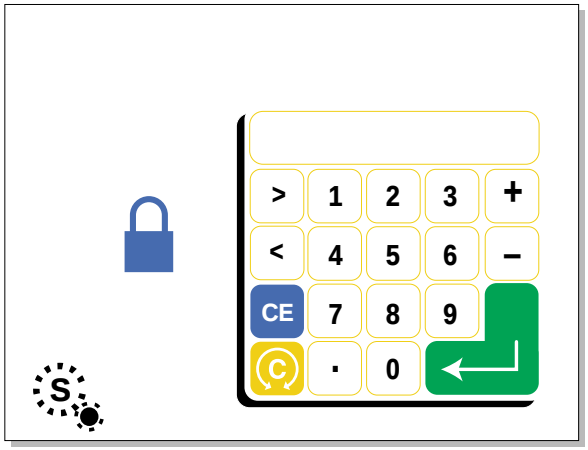
The System icon spins anytime the system is busy. When this icon stops spinning, the system is ready to process another request.

Logging Into the System

When you first power on the laser and the system initializes (about 30 seconds), the welcome screen appears with the spinning System icon in the lower left portion of the screen, indicating that the system is warming up.

Once the system has warmed up, the Password screen appears. If this is the first time you have powered up the system, enter the default password: 1234.

Figure 6: The Password screen



Enabling Local Control

The Swept-Wavelength Tunable Laser Source comes with a detachable touch-screen icon-based interface.

Commands sent over the IEEE (GPIB), RS-232, or Ethernet interface will switch the laser into remote mode and disable most of the front-screen controls. This remote-control mode is indicated by the Remote icon on the front panel. To return the controller to local (front-screen) control, select the Remote icon on the front screen.

Entering Data and Navigating in Local Mode

There are four methods for entering data and navigating while in Local Mode:

- Touch-screen
- Selection knob
- External keyboard
- External mouse

These methods are described in the following sections. Throughout this chapter, any steps calling for data entry or navigation can be performed using any one of these four interaction methods.

Using the Touch-Screen to Enter Data

Many functions on the Swept-Wavelength Tunable Laser Source require numeric inputs. When you select an icon on the front screen representing a function that requires numeric inputs, a keypad appears.

Enter values by touching the number pads on the screen. Use the CE pad to clear the value, use the C pad to exit from the keypad without changing or entering a new value, use the forward (>) and backward (<) pads to move forward or backward through the numbers you've entered. Use the large green Enter pad to accept the value you've entered.

Figure 7: The touch-screen keypad

Using the Selection Knob to Enter Data

You can enter or edit numeric data using the Selection knob, located on the right side of the front screen.

To use the Selection knob:

1. Turn the knob clockwise or counterclockwise to navigate through the screen.
2. When you have highlighted the value you want to enter or edit, push the Selection knob once. This will select the value.
3. Turn the knob to choose the numerals you'd like to change. Push again to edit that numeral.
4. Turn the knob clockwise to increase or counterclockwise to decrease value.
5. When you have finished, push the Selection knob once to accept the new value.
6. To exit Selection knob navigation, push the Selection knob twice.

Using an External Keyboard to Enter Data

You can enter or edit numeric data using a standard keyboard, attached to the laser through the back keyboard port. See "Controller Back Panel and Tunable Laser Cavity Connections" on page 15 for the location of the keyboard port.

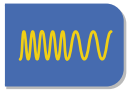
You can use the keyboard instead of the graphical keypad or front knob to enter numeric data. However, even with a keyboard attached, the graphical keypad and front knob are still available.

Using an External Mouse to Navigate

You can navigate through the user interface using a standard mouse, attached to the laser through the back mouse port. See "Controller Back Panel and Tunable Laser Cavity Connections" on page 15 for the location of the mouse port.

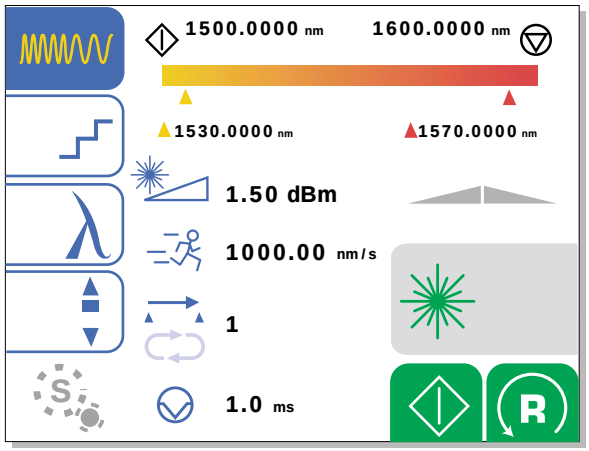
You can use the mouse to select icons on the screen instead of touching the screen itself. However, even with a mouse attached, the touch screen capabilities are still available.

Performing a Wavelength Sweep (Sweep Mode)



In Sweep Mode, the laser continuously tunes from one wavelength to another; you control the start and stop wavelengths, the scan speed, the number of scans, and the delay (pause) between each scan. You can also set the laser to send trigger signals at specified wavelengths (see “Setting Output Triggers A and B” on page 25). To perform a Wavelength Sweep in Sweep Mode, select the Sweep Mode icon. The Sweep Mode screen appears. From this screen, you can set the parameters for your wavelength sweep.

Figure 8: The Sweep Mode screen



Setting the Start Wavelength

To set the wavelength at which the sweep will begin:

1. Select the Start Wavelength icon. The keypad appears.
2. Enter the start wavelength value and choose Enter when you are finished..

Note: You cannot change the start or stop wavelengths during a sweep.

Setting the Stop Wavelength

To set the wavelength at which the sweep will end:

1. Select the Stop Wavelength icon. The keypad appears.
2. Enter the stop wavelength value and choose Enter when you are finished..

Note: You cannot change the start or stop wavelengths during a scan.

Setting the Scan Speed

Use the Set Speed icon to set the speed at which the laser will move through the sweep. Refer to Appendix C for tuning speed specifications. The speed will be expressed in (nm) or THz, depending on the preferences you selected during System Configuration. See “Setting Preferences” on page 38. for more information about changing from nm to THz.

1. Select the Set Speed icon. The keypad appears.
2. Enter the scan speed value and choose Enter when you are finished.

Note: You cannot change the scan speed during a sweep.

Setting Output Triggers A and B

As the laser sweeps, it is capable of sending trigger pulses to external measurement instruments. The signals are sent through two back-panel outputs, Output Trigger A and Output Trigger B. The rising edge of the output pulse corresponds with the trigger wavelength.

Output Trigger Specifications	
Connector Type	BNC
Output Voltage Range	3–4 V
Max. Load Impedance	50 Ω
Jitter (rising edge)	150 µs
Wavelength Repeatability	150 µs x (scan speed)

Output Trigger Specifications	
Pulse Width	> 660 µs

1. To set trigger A, select the trigger A position symbol on the main screen. The keypad appears.
2. Enter the trigger A wavelength value and choose Enter. The trigger A value should be greater than or equal to the start wavelength value.

3. To set trigger B, select the trigger B position symbol on the main screen. The keypad appears.
4. Enter the trigger B wavelength value and choose Enter. The trigger B value should be less than or equal to the stop wavelength value.

Note: *For the location of the Trigger A and Trigger B outputs on the back panel, see "Controller Back Panel and Tunable Laser Cavity Connections" on page 15.*

Note: *To ensure accurate triggers, either enable the wavelength ramp or set the triggers at least 2-nm away from the start wavelength.*

Setting the Laser Power

To set the constant power at which the laser will operate through the sweep:

1. Select the Set Power Level icon. The keypad appears.
2. Enter the laser power level value and choose Enter when you are finished.

Note: *When you reach maximum power for the current wavelength, the controller Displayed Power value will change to red. Maximum power is wavelength dependent. See page 95 for power specifications.*

Using the Wavelength Ramp

In order to obtain extremely linear tuning, the laser can add 2-nm "ramps" to the beginning and end of the scan range which allow the motor to get up to speed before the specified start wavelength and to

slow down after the specified stop wavelength. For example, if the ramp is enabled and you set a scan to run from 1500–1550 nm, the laser will actually start at 1498 nm and run through 1552 nm.

The laser ships with the ramp feature turned off.

To enable the wavelength ramp, select the Wavelength Ramp icon. The icon is black when wavelength ramp is enabled and grey when wavelength ramp is disabled. For information about using computer control to enable or disable the ramp, see page 76.

Choosing Single or Continuous Sweeping

To set the laser to run through a sweep routine for the specific number of times you set:

1. Select the Single Scan icon. This icon toggles between single and continuous scan. When you select the Single Scan icon, the keypad appears.
2. Enter the number of times you'd like the laser to run the sweep.
3. To set the laser to run continuously through a scan routine, select the Continuous Scan icon. The laser will run the sweep until you select the Reset icon. See page 77 for information about setting the specific number of sweeps using computer control.

Setting the Pause Time Between Sweeps

When the laser is in Sweep Mode, the Pause Time icon is used to set the amount of time the laser should pause between sweeps. To set the pause time:

1. Select the Pause Time icon. The keypad appears.
2. Enter the Pause Time value and choose Enter when you are finished.

Turning Laser Diode On or Off

To turn on the current to the laser diode, select the Laser Diode icon. When the current is off, this icon will display a grey star.

When the current is on, this icon will display a green star. The icon will flash during the five-second safety delay before the current is activated. The icon will remain green while current is flowing to the laser diode.

Starting a Sweep

Once you have set up the sweep parameters, you can begin the sweep by selecting the Start Test icon.

Stopping or Aborting a Sweep

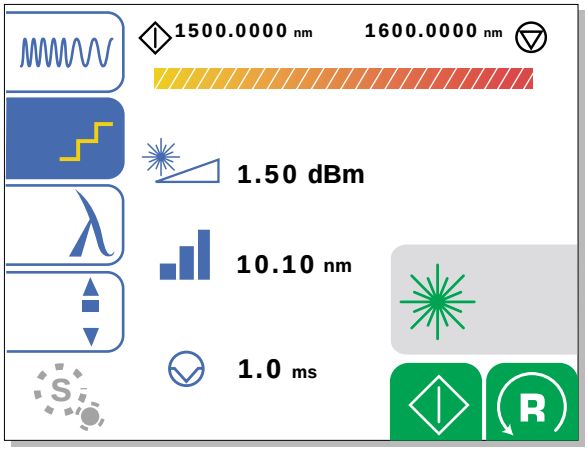
1. To stop an ongoing sweep, select the Reset icon. The laser will finish the current sweep and return to the Start wavelength.
2. To abort a sweep, select the Reset icon *twice*. The laser will immediately stop the current sweep and return to the Start wavelength.

Performing a Step-Scan

Step-scans allow you to dwell at evenly-spaced wavelengths through the range you specify. You control the start and stop wavelengths, the step size, and the dwell time.

To perform a step-scan, select the Step-Scan Mode icon. The Step-Scan Mode screen appears. From this screen, you can set the parameters for your step-scan.

Figure 9: The Step-Scan Mode screen



Setting the Start Wavelength

To set the wavelength at which the step-scan will begin:

1. Select the Start Wavelength icon. The keypad appears.
2. Enter the start wavelength value and choose Enter when you are finished.

Note: *You cannot change the start or stop wavelengths during a scan.*

Set the Stop Wavelength

To set the wavelength at which the step-scan will end:

1. Select the Stop Wavelength icon. The keypad appears.
2. Enter the stop wavelength value and choose Enter when you are finished.

Setting the Laser Power

To set the constant power at which the laser will operate through the step-scan:

1. Select the Set Power Level icon. The keypad appears.

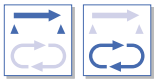
2. Enter the laser power level value and choose Enter when you are finished.

Note: When you reach maximum power for the current wavelength, the controller Displayed Power value will change to red. Maximum power is wavelength dependent. See page 95 for power specifications.

Setting the Step Size

To set the distance between wavelengths in the step scan:

1. Select the Step Size icon. They keypad appears.
2. Enter the value for the distance between wavelengths and choose Enter when you are finished.



Choosing Single or Continuous Scanning

To set the laser to run through a scan routine for the specific number of times you set:

1. Select the Single Scan icon. This icon toggles between single scan and continuous scan. When you select the Single Scan icon, the keypad appears.
2. Enter the number of times you'd like the laser to run the scan.
3. To set the laser to run continuously through a scan routine, select the Continuous Scan icon. The laser will run the scan until you select the Reset icon. See page 77 for information about setting the specific number of scans using computer control.

Setting the Pause Time

When the laser is in Step-Scan Mode, the Pause Time icon is used to set the amount of time the laser should dwell at each wavelength in the step scan. To set the dwell time:

1. Select the Pause Time icon. The keypad appears.
2. Enter the dwell time value and choose Enter when you are finished.

Turning Laser Diode On or Off

To turn on the current to the laser diode, select the Laser Diode icon. When the current is off, this icon will display a grey star.

When the current is on, this icon will display a green star. The icon will flash during the five-second safety delay before the current is activated. The icon will remain green while current is flowing to the laser diode.

Starting the Scan

Once you have set up the step-scan, begin the scan by selecting the Start Test icon.

Stopping or Aborting a Scan

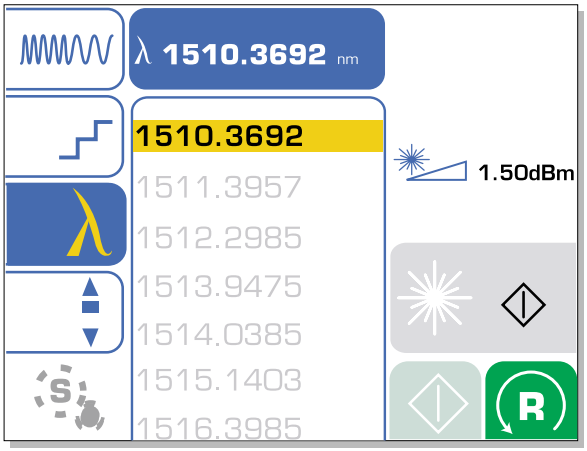
1. To stop an ongoing sweep, select the Reset icon. The laser will finish the current sweep and return to the Start wavelength.
2. To abort a sweep, select the Reset icon *twice*. The laser will immediately stop the current sweep and return to the Start wavelength.

Scanning Wavelengths in Track Mode

The Swept-Wavelength Tunable Laser Source can tune to a specific wavelength. This is called Track Mode.While in Track Mode, you can actively control the tuning motor to operate the laser at a set wavelength. The wavelengths you enter will be stored in a list, allowing you to quickly switch from one to the other.

To scan wavelengths in Track Mode, select the Track Mode icon. The Track Mode screen appears. From this screen, you can select the parameters for your scan.

Figure 10: The Track Mode screen



Setting the Wavelength

To set the wavelength value:

1. Select the Set Wavelength icon at the top of the screen. The keypad appears.
2. Enter the wavelength value and choose Enter when you are finished.
3. To scan a different wavelength, select the Set Wavelength icon again. The keypad appears.
4. Enter the next wavelength value and choose Enter when you are finished.
5. The system will store the wavelength values you enter in a list.
6. To switch between wavelengths, click the wavelength values in the list.

Setting the Laser Power

To set the power at which the laser should scan the given wavelength:

1. Select the Set Power Level icon. The keypad appears.
2. Enter the laser power level value and choose Enter when you are finished.

Turning Laser Diode On or Off

To turn on the current to the laser diode, select the Laser Diode icon. When the current is off, this icon will display a grey star.

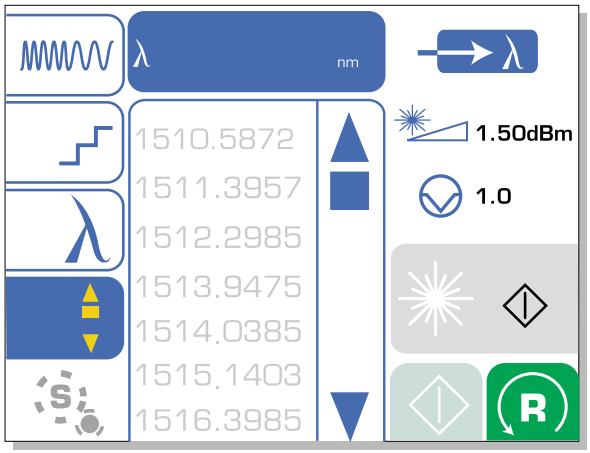
When the current is on, this icon will display a green star. The icon will flash during the five-second safety delay before the current is activated. The icon will remain green while current is flowing to the laser diode.

Scanning Wavelengths in Program Mode

In Program Mode, you can enter and store a list of wavelengths for the laser to step through. These wavelengths can be evenly or unevenly spaced. The wavelengths can also be in any order you choose. When you begin the sweep, the laser will scan each of the wavelengths in the order listed.

To scan wavelengths in Program Mode, select the Program Mode icon. The Program Mode screen appears. From this screen, you can enter the wavelengths you want to scan. You can also set the laser power and dwell time at each wavelength.

Figure 11: The Program Mode screen

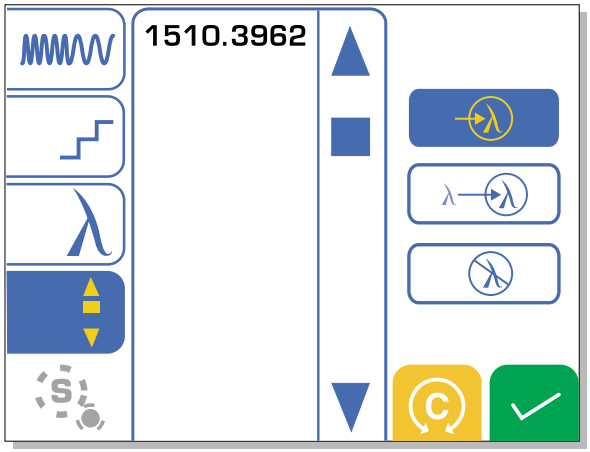


Creating the Wavelength List

To create a list of wavelengths to scan:

1. Select the Set Wavelength icon. The Wavelength List screen appears.
2. On this screen you can Add, Edit, or Delete Wavelength values from the Program List. When you have finished creating your wavelength list, select the CheckMark icon.

Figure 12:
The Wavelength List screen



Adding Wavelength Values to the List

Select the Add a Wavelength icon. The keypad appears. Enter the wavelength value and choose Enter when you are finished. The first wavelength value you enter will be the “start” wavelength in the list. Each wavelength that you add after that will be added sequentially in the list.

Editing Wavelength Values

If you need to change a wavelength value you have entered, select the wavelength value from the list and select the Edit a Wavelength icon. The keypad appears, displaying the wavelength value you selected. Change the value and choose Enter when you are finished.

Deleting Wavelength Values

To delete a wavelength value from the list, select the wavelength value from the list and select the Delete a Wavelength icon. The wavelength value will be removed from the list.

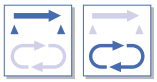
Setting the Laser Power

Select the Set Power Level icon. The keypad appears. Enter the laser power level value using the keypad and select Enter when you are finished.

Setting the Pause Time

When the laser is in Program Mode, the Pause Time icon is used to set the amount of time the laser should dwell at each wavelength in the Program List. To set the dwell time:

1. Select the Pause Time icon. The keypad appears.
2. Enter the dwell time value and choose Enter when you are finished.



Choosing Single or Continuous Sweeping

To set the laser to run through a sweep routine for the specific number of times you set:

1. Select the Single Scan icon. This icon toggles between single and continuous scan. When you select the Single Scan icon, the keypad appears.
2. Enter the number of times you'd like the laser to run the sweep.
3. To set the laser to run continuously through a scan routine, select the Continuous Scan icon. The laser will run the sweep until you select the Reset icon. See page 77 for information about setting the specific number of sweeps using computer control.

Turning Laser Diode On or Off

To turn on the current to the laser diode, select the Laser Diode icon. When the current is off, this icon will display a grey star.

When the current is on, this icon will display a green star. The icon will flash during the five-second safety delay before the current is activated. The icon will remain green while current is flowing to the laser diode.

Starting the Sweep

Once you have set up the Program List, begin the sweep by selecting the Start Test icon.

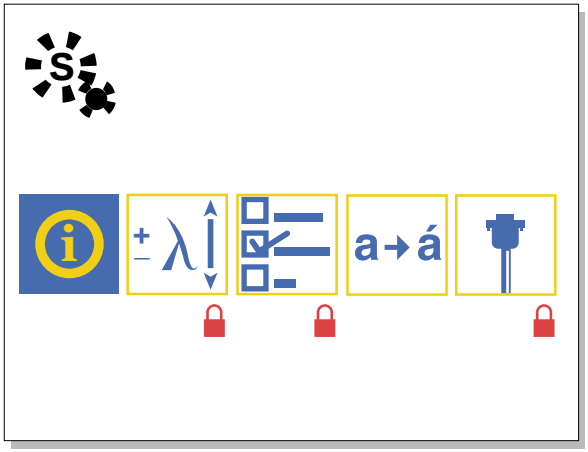
Stopping or Aborting a Sweep

1. To stop an ongoing sweep, select the Reset icon. The laser will finish the current sweep and return to the Start wavelength.
2. To abort a sweep, select the Reset icon *twice*. The laser will immediately stop the current sweep and return to the Start wavelength.

Configuring the System

To configure your system, select the System icon. The System screen appears. From this screen, you can Display Information, Set Offset and Trim (used for laser calibration), Set Preferences, Set Language preference, and select the Interface type for your ports.

Figure 13: The System Configuration screen



Display Laser Information

The Laser Information screen displays the following information about the laser:

- Model Number
- System Serial Number
- Motor Firmware Version
- Control Software Version
- Maximum Wavelength
- Minimum Wavelength
- Wavelength Offset
- Power Trim
- Total Scan Count

Set Wavelength Offset and Power Trim

The Set Wavelength Offset/Trim icon displays the Wavelength Offset and PowerTrim screen. From this screen, set the wavelength offset (2.500nm to -2.500nm) and Power Trim (0.50 dBm to -0.50 dBm)

This function is password protected.

Setting Preferences

The Set Preferences icon displays the Preferences screen. From this screen you can:

- Choose to set laser in Constant Power Mode or Constant Current Mode
- Choose to see power values in dBm or mW
- Choose to see wavelength values in nm or frequency values in Thz
- Change passwords

The laser can operate in either Constant Power Mode or Constant Current Mode. Constant Power Mode is the default mode for all TLB 6500 Extenal-Cavity Tunable Diode Lasers. All specifications in Appendix C are guaranteed for Constant Power Mode. Advance notification is required if Constant Current Mode is preferred.

From the Preference screen, select the Constant Power icon to set laser to Constant Power Mode. The keypad appears. Enter password and choose Enter when you are finished. Select the green CheckMark icon to finish.

Note: *Turn laser diode off before switching modes.*

Note: *Constant Power Mode will display value in dBm or mW.*

From the Preference screen, select the Constant Current icon to set laser to Constant Current Mode. The keypad appears. Enter password and choose Enter when you are finished. Select the green CheckMark icon to finish.

Note: *Turn laser diode off before switching modes.*

Note: *Constant Current Mode will display value in dBm or mW.*

To change your password, from the Preferences screen, select the lock icon. The keypad appears. Enter your new password and choose Enter when you are finished. Select the green CheckMark icon to finish.

Setting the Language

The Set Language icon displays the list of language choices for the Help file. English is the default language.

Selecting the Communication Interface (Select Port)

The Select Port icon displays the Select Port screen. From this screen, choose between communication interfaces GPIB, RS-232, or Ethernet for peripheral devices. This function is password protected. For more information about these three interfaces, see “Computer Control” on page 43.

Monitoring Swept Scans

The Laser Sync Output on the back panel generates a signal when the laser is scanning from the start to the stop wavelength during a swept scan. No signal is produced during the wavelength ramps or as the laser resets from the stop wavelength back to the start wavelength.

Laser Sync Output Specifications	
Connector Type	BNC
Voltage Range	3–4 V
Max. Load Impedance	50 Ω
Accuracy (rising edge)	2.5 ms

Note: *You should not use the Laser Sync Output as a trigger, since the error is usually greater than 1 ms.*

Modulating the Laser Output

Modulate the laser current (amplitude) using an externally generated low-level signal. Connect the line for the input signal to the Current Modulation connector on the back of the controller. Make sure the signal conforms to the following specifications:

Current Modulation Input Guidelines (DC-coupled)	
Connector Type	BNC
Max. Voltage	±10 V
Input Frequency Range	10 kHz–1 MHz
Impedance	1 kΩ
Modulation*	1 mA/V

* For models with a serial number ending below 02000, the impedance is 5 kΩ and the modulation is 0.2 mA/V.

The DC-coupled Current Modulation Input is NOT current limited. DO NOT modulate the current with input voltages above ±10 V.

Since changes in the current affect the laser frequency, modulating the current will also create some fine-frequency modulation due to changes in the index of refraction of the laser-gain medium. The degree to which this affects the laser is wavelength dependent, but it is in the range of 40–50 MHz/mA.

The front-panel current readout does not reflect the modulation input. You can calculate the actual current by adding the current shown on the front-panel display to the modulation input.

Reading an Input Signal

You can monitor an input signal using the DC-coupled Detector Input connector on the back of the laser controller. The input is connected to a 10-bit analog-to-digital converter. This general-purpose input allows you to collect data from another instrument, such as a photodetector, during a wavelength scan. The signal from this input can only be read using computer control (see page 57); it will not be displayed on the front screen.

Connect the line for the input signal to the BNC connector on the back of the laser controller. Make sure the signal conforms to the following specifications:

Detector Input Guidelines	
Connector Type	BNC
Voltage Range	0 V to +10 V
Input Frequency	DC–1 kHz
Impedance	51 kΩ

Computer Control

Introduction

The Swept-Wavelength Tunable Laser Source can be operated remotely through the parallel IEEE-488 (GPIB) interface, the serial RS-232 interface, or the Ethernet interface. Most computers have RS-232 interfaces built in. In order to use the IEEE-488 interface, a special card or interface box is necessary. In order to use the Ethernet interface, a network card is necessary. The IEEE-488 interface is many times faster than the RS-232 interface and can be used to communicate with up to 30 instruments at the same time. RS-232 is limited to communication with one instrument at a time. The Ethernet interface allows for communication over a network.

Upon receiving a command over the computer interface, the front-panel functions are locked out. Use the Local button on the front panel to re-enable the front panel. All front-panel operations are available through computer control. In addition, several functions are unique to computer control.

Before attempting to communicate with the instrument, you must set the device address (for IEEE-488), the baud rate (for RS-232) or the IP address (for Ethernet), via the front panel.

Using the IEEE-488 Interface

The IEEE interface, also known as the General-Purpose Interface Bus or GPIB, is a standard interface used for personal computers to communicate with laboratory instruments. Several manufacturers make printed circuit board “cards” that plug into the computer,

allowing it to communicate over the IEEE interface. The card's manufacturer can provide information for configuration with your computer. Proper configuration is required to communicate to an instrument at a given address, and to issue commands to it from the programming language.

The IEEE connector on the back of the laser controller allows for remote operation through a standard IEEE-488 (GPIB) cable. The connector is a standard, female, 24-pin IEEE-488 connector for use with a standard shielded IEEE-488 cable.

Before you can operate the laser through the IEEE interface, you must assign a device address to the laser controller that is unique from all the other IEEE-488 components attached to your computer.

See “Programming for this Laser” on page 48 for more information on using the IEEE interface.

Setting the Device Address

1. On the main screen, choose the System icon. The System screen appears.
2. On the System screen, choose the Select Port icon. The keypad appears.
3. Enter your password using the keypad. The Select Port screen appears.
4. Choose the GPIB icon. The device address icon appears to the right of the GPIB icon.
5. Choose the device address field. The keypad appears. Enter a new device address using the keypad and choose the green Enter button. On the Select Port screen, choose the green CheckMark icon.

Using the RS-232 Interface

The RS-232 9-pin connector on the back of the controller allows remote operation through an RS-232 serial connection. To use the RS-232 interface, attach a 3-wire, straight-through RS-232 cable with a male D-sub 9 connector to the RS-232 port on the back of the laser. The cable should be less than 50-feet long. For extremely noisy environments, you may need to use a shielded cable.

Note: *The laser controller receives data on pin 3 and transmits data on pin 2 (see page 94). If you have trouble communicating with the laser over the RS-232 port, you may need to use a null-modem adapter or cable.*

The controller can support baud rates up to 57,600 bps. Set your computer to 8-data bit, no parity checking, 1-stop bit, no hardware handshake. Use the following steps to set the controller's baud rate.

See "Programming for this Laser" on page 48 for more information on using the RS-232 interface.

Setting the Baud Rate for RS-232

The RS-232 interface works at baud rates of 300, 1200, 2400, 4800, 9600, 19200, 38400, or 57600.

1. On the main screen, choose the System icon. The System screen appears.
2. On the System screen, choose the Select Port icon. The keypad appears.
3. Enter your password using the keypad. The Select Port screen appears.
4. Choose the RS 232 icon. The Baud Rate list appears to the right of the RS 232 icon.
5. Select a baud rate from the list and then choose the green CheckMark icon.

Using the Ethernet Interface

The Ethernet interface is a standard interface used for personal computers and other devices to communicate over a network. In order for a device to communicate over the Ethernet interface, it must have a network card. The card's manufacturer can provide information for configuration with your computer. Proper configuration is required to communicate to a device at a given address and to issue commands to it from the program language.

Before you can operate the laser through the Ethernet interface, you must configure it. The Dynamic Host Configuration Protocol (DHCP) allows you to automatically configure the controller. You can also manually configure the controller. Use the following steps to configure the controller to use the Ethernet interface.

The Ethernet connector on the back of the laser controller allows for remote communication with the laser through a standard network cable. The connector is 10 base-T. The port is 1034 on the TCP/IP protocol.

See “Programming for this Laser” on page 48 for more information on using the Ethernet interface.

Configuring the Ethernet Interface

1. On the main screen, choose the System icon. The System screen appears.
2. On the System screen, choose the Select Port icon. The keypad appears.
3. Enter your password using the keypad. The Select Port screen appears.
4. Choose the Ethernet icon. The Ethernet screen appears.
5. By choosing the Obtain IP Address Via DHCP button at the bottom of the Ethernet screen, you can automatically configure the IP Address, SubnetMask, and Gateway Address.The Obtain IP Address Via DHCP button is red when it is enabled.

6. You must reset the laser once the Ethernet setting has been changed.

Manually Configuring the Ethernet Interface

1. To Manually configure, disable DHCP lookup. Select the Obtain IP Address Via DHCP button. This button is grey when it is disabled.
2. Enter the IP Address, SubnetMask, and Gateway Address in their respective fields:
   - Select the IP Address field. The keypad appears. Enter a unique IP address using the keypad and choose the green Enter button.
   - Select the SubnetMask field. The keypad appears. Enter a unique SubnetMask using the keypad and choose the green Enter button.
   - Select the Gateway Address field. The keypad appears. Enter a unique Gateway Address using the keypad and choose the green Enter button.
3. When you have finished, choose the green CheckMark icon.
4. You must reset the laser once the Ethernet setting has been changed.

Note: *In order to manually configure the controller, you must have valid inputs for each of these fields.*

Restoring Local Control

Commands sent over the IEEE (GPIB), RS-232, or Ethernet interface will switch the laser into remote mode and disable most of the front-screen controls This remote-control mode is indicated by the Remote icon on the front screen of the laser.

To return the controller to local control, select the Remote icon on the front screen.

Understanding the Command Types

There are three types of commands understood by the laser controller: *Set* commands, *Query* commands, and *Sense* commands.

- Use Set commands to set or change a value. Examples would be commands that turn on the laser or set the operating power.
- Use Query commands to check the user- or factory-set values of the laser. Examples include checking the set value for the power and checking the start wavelength for scans.
- Use Sense commands to determine the actual values for the laser properties at any given time. For example, you would use a Sense command to check the actual operating current or the voltage from the Detector Input.

Programming for this Laser

When programming for the laser, keep the following rules in mind.

- For IEEE-488, issue all commands using the IBWRT function call. To read the controller's response, use the IBRD function call.
- For IEEE-488, a command is not parsed until a hardware EOI is detected (IEEE-488).
- For RS-232 operation, end each command with a carriage return (0x0c).
- Numbers may contain at most 15 characters. The number 1550 will be read correctly, but the number 00000000000001550 will be read as 15.
- Commands that expect integer values will truncate after any decimal point in the input. For example, if a command is issued to run "11.76" scans, the laser will run 11 scans.
- Only one command can be issued per line. For example, if the controller receives `WAVE 1550;*IDN?`, it will change the wavelength to 1550, but the Identification Query will be ignored.

Laser-Controller Responses

All commands evoke a response from the driver (set commands return an “OK” when executed). If you are using RS-232, the response is sent immediately; with IEEE-488 and Ethernet, the response is loaded into the output buffer (a first-in, first-out buffer with a capacity of 5 messages).

- Laser-controller responses are sent differently depending on the interface you are using.

  IEEE-488: responses are written into the output buffer — a first-in first-out (FIFO) buffer with a capacity for 5 outgoing messages. You will need to send a separate command to read the response from the buffer.

  RS-232: responses are sent immediately and can be processed or ignored. Responses are terminated with the <CR> character (0x0c).

  Ethernet: responses are written into the output buffer — a first-in first-out (FIFO) buffer with a capacity for 5 outgoing messages. You will need to send a separate command to read the response from the buffer.

- The controller does not echo commands.
- When the controller is first turned on, all computer-control commands other than OPC? will receive the response “Initializing.”
- The controller returns “OK” for properly executed set commands.
- If unable to carry out a command, the controller will use one of the following responses:
  - “Out of Range” if sent a value outside the allowed range.
  - “Unknown Command” if the command is not recognized.
  - “Initializing” if the system is booting up.
  - “Operation not complete” if the laser is performing a long-term operation (e.g. turning on the diode or scanning).
  - “Can’t scan in TRACK mode” if you try to initiate a scan while the laser is in track mode.
  - “Not in interactive step mode” if you try to initiate a step while not in interactive step mode.

- "Offset out of Range: -2.5nm to 2.5nm" if you enter a wavelength-offset value outside of this range.
- "Trim Out of Range: -0.50 to 0.50dBm" if you enter a power-trim value outside of this range.

Conventions

These typographical conventions are used in the following "Command Summary" and "Command Definitions" sections.

- The part of the command shown in uppercase represents the short form of the command. The commands are case insensitive.

  If the syntax shown is ":SOURce:CURRent?", then the controller will accept any of the following: ":SOUR:CURR?", ":sour:curr?", or ":sour:current?". It will not accept commands such as ":SOURC:CURR?" or ":sour:curre?".

- Optional values and portions of syntax are indicated by square brackets ([ ]).
- Values to be input are indicated by angle brackets (< >) and are separated from the command either by a space or by a colon, as shown in the command syntax.
- Commands all begin with an asterisk character, "*",or a colon, ":". These characters are not optional.

Command Summary

System Status and Maintenance

Syntax	Command	Page
*IDN?	Identification Query	55
*OPC?	Operation Complete Query	55
:SYST:MCON <INT|EXT>	Set Control Mode (Remote/Local)	56
:SYST:MCON?	Query Control Mode	57
:SENS:VOLT:AUX	Sense Voltage from Detector Input	57
:OUTP:SCAN:MAIN	Starts a Maintenance Cycle	58
:SYST:PASS	Set Instrument Password	58

Power Commands

Syntax	Command	Page
:OUTP <on/off>	Turn Laser Power On/Off	58
:OUTP?	Query Laser Power (On/Off)	59
:POW <value>	Set Laser Output Power (dBm)(1)	59
:POW?	Query Laser Power Setpoint(1)	60
:POW:TRIM <value>	Set Power Trim(1)	60
:POW:TRIM?	Read Power Trim(1)	61
:POW:UNIT <dBm|mW>	Set Power Unit Type(1)	61
:POW:UNIT?	Query Power Unit Type(1)	61

Wavelength Commands

Syntax	Command	Page
:WAVE <value|MIN|MAX>	Set Wavelength (nm)	62
:OUTP:WAVE <value>	Activate Track Mode and Move to Wavelength	63
:WAVE:UNIT <nm|THz>	Set Wavelength Unit Type(1)	64
:WAVE:UNIT?	Query Wavelength Unit Type(1)	64
:WAVE:RES <HI|LOW>	Set Wavelength Resolution(1)	64
:WAVE:RES?	Query Wavelength Resolution(1)	65
:WAVE[<MIN|MAX>]?	Query Wavelength	65
:WAVE:OFFS <value>	Set Wavelength Offset (nm)(1)	66
:WAVE:OFFS?	Query Wavelength Offset(1)	66

Scan Commands

Syntax	Command	Page
:OUTP:TRAC OFF	Switch to Scan Mode	67
:OUTP:SCAN:STAT?	Query Scan State	67
:WAVE:SLEW <value|MIN|MAX>	Set Scan Speed (nm/sec)	68
:WAVE:SLEW[<MIN|MAX>]?	Query Scan Speed	68
:PAUS <value>	Set Pause (ms): Set delay between consecutive scans	69
:PAUS?	Query Pause	69
:WAVE:DWEL <value>	Set Dwell Time(ms): Set delay between steps of a step scan	70
:WAVE:DWEL?	Query Dwell Time	70
:WAVE:STAR <value>	Set Starting Wavelength (nm)	71
:WAVE:STAR?	Query Starting Wavelength	71

Syntax	Command	Page
:WAVE:STOP <value>	Set Stopping Wavelength (nm)	72
:WAVE:STOP?	Query Stopping Wavelength	72
:WAVE:STEP <value>	Set Step Size for Step Scans (nm)	73
:WAVE:STEP?	Query Step Size for Step Scans	73
:WAVE:TRIG:A <value>	Set Trigger A (nm)	74
:WAVE:TRIG:A?	Query Trigger A	74
:WAVE:TRIG:B <value>	Set Trigger B (nm)	75
:WAVE:TRIG:B?	Query Trigger B	75
:WAVE:RAMP <ON|OFF|0|1>	Enable/Disable Wavelength Ramp	76
:WAVE:RAMP?	Query Wavelength-Ramp Status	76
:OUTP:SCAN:STAR <value>	Start Scanning	77
:OUTP:SCAN:STEP	Next Step in Interactive Step Scan	77
:OUTP:SCAN:RESE	Reset Scan (finish scan and reset)	78
:OUTP:SCAN:ABOR	Abort Scan (cancel scan and reset)	78
:OUTP:SCAN:TRIG	Set Trigger Mode to Software Enabled	79
:SCAN:TRIG?	Query Trigger Mode State	79

Current Commands

Syntax	Command	Page
:CURR <MIN|MAX|val>	Set Diode Current	79
:CURR?	Query Diode Current	80
:SYST:LCON <1|0>	Switch Laser Mode	80
:SYST:LCON?	Read Laser Mode	80

System Status and Maintenance

Syntax	Command	Page
:SYST:ERR?	Read, Reset and Clear Latest Error Flag	81
:SYST:ERR:LOG?	List Errors	81

(1) These commands are password protected. In order to access or set any parameter of these commands., you must send the system password before sending these commands.

Command Definitions

System Status Commands

Identification Query

Syntax	`*IDN?`
Description	Returns the system identification string containing the manufacturer, model number, serial number, and firmware revision numbers for the laser cavity and controller.
Example	`*IDN?` ⇒ `New Focus Inc., 6528, 02149, H1.67, C1.00` (Manufacturer = New Focus, Model= 6528, Serial Number=02149, Motor Firmware Rev. 1.67, Controller Firmware Rev. 1.00)

Operation Complete Query

Syntax	`*OPC?`
Description	The laser has five long-term operations: • Turning on the system (system initialization) • Turning on the diode (:OUTPut ON) • Scanning (:OUTPut:SCAN:START) • Resetting (:OUTPut:SCAN:RESEt) • Set Wavelength ([:SOURce]:WAVElength) Starting any of these operations clears the OPC status bit. When the laser returns to the start wavelength or reaches the target wavelength, the OPC status bit is set to 1. The bit is also set to 1 if the movement is interrupted, either with OUTPutSCAN:ABORt, which interrupts a scan or reset, or OUTPut:TRACk OFF, which interrupts a wavelength set.
Argument/Response	Returns 0 if performing a long-term operation. Returns 1 if system is available.

Set Control Mode (Local/Remote)

Syntax	`:SYSTem:MCONtrol <INT|EXT>`
Description	Puts controller into Remote mode (using the internal DACs) or Local Mode (using the external front-screen controls).
Argument	`INT` or `EXT` INT sets the laser to use the internal DACs and gives you remote control via the computer interface. The laser will use the current power setpoint when it switches to remote control. The front-panel displays will change as sensed. Target values can differ by up to 3% due to component variations. EXT returns control to the external front-panel controls. The laser power will return to the last level set from the front panel.
Example	`:SYST:MCON INT` ⇒ `OK` (The laser switches to remote mode and the front screen displays the Remote icon.)

Query Control Mode

Syntax	`:SYSTem:MCONtrol ?`
Description	Reads the Control Mode.
Response	"0" for remote mode and "1" for local mode
Example	Determine if the laser is in local or remote control mode: `:SYST:MCON ?` ⇒ `1` (The laser is in local control mode.)

Sense Voltage from Detector Input

Syntax	`:SENSe:VOLTage[:LEVel]:AUXiliary`
Description	Returns the voltage detected at the Detector Input on the back panel of the laser controller. *Note: This is the only way this value can be read; it cannot be read on the front panel.* The resolution for the Detector Input is 10 bits, so the step size is 5 V/2^{10} = 4.88 mV. The response will be rounded to the nearest mV.
Response	`"x.xxx"` Range: 0 to 5. Units: volts (V).
Example	`:SENS:VOLT:AUX` ⇒ `1.200` (The Detector Input sees 1.2 volts.)

Begin a Maintenance Scan

Syntax	`:OUTPut:SCAN:MAINtenance`
Description	Starts a maintenance scan cycle on the laser.
Example	`:OUT:SCAN:MAIN` ⇒ `OK`

Set the Instrument Password

Syntax	`:SYSTem:PASSword <value>`
Description	Sets a numeric password for the laser controller.
Argument	`xxxx` Minimum password length=4 characters. Maximum password length= 10 characters. Default password=1234.
Example	Change the password to 5678: `:SYST:PASS 5678` ⇒ `OK` (sets the laser controller password to `5678`)

Power Commands

Turn Laser Power On/Off

Command Syntax	`:OUTPut[:STATe] <ON|OFF|1|0>`
Description	Turns the laser on or off. When turning the laser on, the light in the front panel's Laser Power switch will flash for five seconds before the power is turned on.
Argument	`OFF`, `ON`, `0`, or `1`. `0` or `OFF` turns the laser off, `1` or `ON` turns the laser on.
Example	Turn off power to the laser: `:OUTP 0` ⇒ `OK`

Query Laser Power (On/Off)

Syntax	`:OUTPut ?`
Description	Reads whether or not the laser power is on.
Response	"0" for laser current off and "1" for laser current on
Example	Determine if the laser current is on or off: `:OUTP ?` ⇒ `1` (The laser is turned on.)

Set Laser Output Power

Syntax	`[:SOURce]:POWer[:LEVel] <value>`
Description	Sets the power level. This command will not turn on power to the laser. Changes mad1e during a scan will not affect the scan.
Argument	`x.x` Range: *See "Appendix C: Specifications" on page 95.* Units: dBm or mW, depending on the power unit setting chosen. *See Set Power Unit Type on page 61* *Note: Power is wavelength dependent. You may not be able to achieve the set power at all wavelengths. See "Appendix C: Specifications" on page 95.*
Example	Set the laser power to 2.5 dBm: `:POW 2.5` ⇒ `OK`

Query Laser Power Setpoint

Syntax	`[:SOURce]:POWer[:LEVel] ?`
Description	Queries the laser-power setpoint.
Response	`"x.x"` Range: *See "Appendix C: Specifications" on page 95.* Returns the value in dBm or mW, depending on the power unit type chosen. *See "Set Power Unit Type" on page 61.*
Example	`:POW ?` ⇒ `2.8` (Laser output is set to 2.8 dBm.)

Set Power Trim

Syntax	`[:SOURce]:POWer:TRIM <value>`
Description	Allows you to calibrate the output power to an external power meter. *Note: The laser power must be off to change the trim.*
Argument	`x.xx` Range: ±0.5 dBm
Example	The power level shown on the front panel is off when measured by an external power meter, so you want to increase the output power to 0.40: `:POW:TRIM 0.40` ⇒ `OK`

Query Power Trim

Syntax	`[:SOURce]:POWer:TRIM ?`
Description	Checks the trim applied the laser output power. The trim is used to calibrate the laser to an external power meter.
Response	`“x.xx”`
Example	`:POW:TRIM ?` ⇒ `0.40`

Set Power Unit Type

Syntax	`[:SOURce]:POWer:UNIT <dBm|mW>`
Description	Sets the Power Unit type to dBm or mW. This command is password protected. The system password must be set before sending this command.
Argument	`dBm or mW`
Example	`:POW:UNIT mW` ⇒ `mW` (The power unit type has been set to milliwatts)

Query Power Unit Type

Syntax	`[:SOURce]:POWer:UNIT?`
Description	Reads the Power Unit type. This command is password protected. The system password must be set before sending this command.
Response	`“dBm” or “mW”`
Example	`:POW:UNIT?` ⇒ `mW` (The power unit type is milliwatts)

Wavelength Commands

Set Wavelength

Syntax	`[:SOURce]:WAVElength <val|MIN|MAX>`
Description	Switches the laser to track mode and drives the laser to the specified wavelength, the laser's minimum wavelength, or the laser's maximum wavelength. If the value is out of range, the laser returns an out of range error and no other action is taken.
Argument	`x.xxx`, `MIN`, or `MAX` Range: Within the laser's minimum and maximum wavelength range. (These values are laser dependent; use the Query Wavelength command to determine your laser's range.) Units: nanometers (nm).
Example	Set the wavelength to 1525 nm. `:WAVE 1525` ⇒ `OK` (The wavelength starts changing at the maximum rate until it reaches 1525 nm.)

Activate Track Mode

Syntax	`:OUTPut:WAVElength <value>`
Description	Switches the laser to track mode and drives the laser to the specified wavelength. If the value is out of range, the laser returns an out of range error and no other action is taken. Note: see also `[:SOURce]:WAVElength <val|MIN|MAX>`
Argument	`x.xxx` Range: Within the laser's minimum and maximum wavelength range. (These values are laser dependent; use the Query Wavelength command to determine your laser's range.) Units: nanometers (nm).
Example	Activate Track Mode and set the wavelength to 1525 nm. `:OUTP:WAVE 1525` ⇒ `OK`

Set Wavelength Unit Type

Syntax	[:SOURce]:WAVElength:UNIT <nm|THz>
Description	Sets the Wavelength unit type to nm or THz. When the Wavelength unit is set to nm, the laser will display and accept wavelength in nm. When the wavelength unit is set to THz, the laser will display and accept wavelength in THz.
Argument	`nm or THz`
Example	Set the Wavelength unit type to nanometers: `:WAVE:UNIT nm` ⇒ `OK`

Query Wavelength Unit Type

Syntax	`[:SOURce]:WAVElength:UNIT ?`
Description	Reads the wavelength unit type, nm or THz.
Example	Set the Wavelength unit type to nanometers: `:WAVE:UNIT ?` ⇒ `nm`

Set Wavelength Resolution

Syntax	`[:SOURce]:WAVElength:RESolution <HI|LOWW>`
Description	Sets the Wavelength resolution to HI or LOW. If the resolution is set to HI, the laser will display 0.0001 nm. If the resolution is set to LOW, the laser will display 0.001nm.
Argument	`HI or LOW`
Example	Set the wavelength resolution to high: `:WAVE:RES HI` ⇒ `OK`

Query Wavelength Resolution

Syntax	`[:SOURce]:WAVElength:RESolution ?`
Description	Reads the Wavelength resolution, HI or LOW. If the resolution is set to HI, the laser will display 0.0001 nm. If the resolution is set to LOW, the laser will display 0.001nm.
Example	`:WAVE:RES ?` ⇒ `HI` (the wavelength resolution is set to high.)

Query Wavelength

Syntax	`[:SOURce]:WAVElength[MIN|MAX] ?`
Description	Queries the wavelength setpoint for track mode, or the minimum or maximum available wavelengths.
Response	`"x.xxxx"` Units: nanometers (nm).

Example	`:WAVE ?`
	⇒ `1525.2552`
	(The wavelength is set to 1525.2552 nm)
	`:WAVE MIN?`
	⇒ `1500.0000`
	(The minimum wavelength is 1500.0000 nm.)

Set Wavelength Offset

Syntax	`[:SOURce]:WAVElength:OFFSet <val>`
Description	Allows you to recalibrate the laser to an external wavelength meter.
Argument	`x.xxx` Range: ±2.5. Units: nanometers (nm).
Example	Using an external wavelength meter, you notice that the wavelength display on the laser's front panel is 0.2-nm more than the reading on the meter. `:WAVE:OFFS -0.2` ⇒ `OK` (You will not notice a difference without using an external wavelength meter.)

Query Wavelength Offset

Syntax	`[:SOURce]:WAVElength:OFFSet ?`
Description	Checks the value of the wavelength offset. The units are in nanometers.
Response	`"x.xxxxx"` Units: nanometers (nm).
Example	`:WAVE:OFFS ?` ⇒ `−0.03000` (The wavelength has been offset by -0.030 nm from the factory-calibrated setting.)

Scan Commands

Switch to Scan Mode

Syntax	`:OUTPut:TRACk OFF`
Description	Switches the laser into scan mode and sets the wavelength to the start wavelength so it is ready to start a scan. *Note: If the wavelength ramp is enabled, the laser will be set to the start wavelength minus the 2-nm ramp. See page 26 for more on the ramp, or page 76 for information on enabling or disabling the ramp.*
Example	Turn off track mode and set the laser to the start wavelength in scan mode. `:OUTP:TRAC OFF` ⇒ `OK`

Query Scan State

Syntax	`:OUTPut:SCAN:STATe ?`
Description	Reads the scan state of the laser.
Response	"x" x>0: The laser is in the process of performing that number of scans. x=0: The laser is in scan mode, waiting at the start wavelength. x=-1: The laser is repeatedly running swept scans. x=-2: The laser is in track mode. x=-3: The laser is in automated step-scan mode. x=-4: The laser is in interactive step-scan mode.
Example	`:OUTP:SCAN:STAT ?` ⇒ `0` (The laser is at the start wavelength and ready to scan.)

Set Scan Speed

Syntax	`[:SOURce]:WAVElength:SLEWrate <val|MIN|MAX>`
Description	Sets the slew rate, the speed at which the laser tunes between the start and stop wavelengths, for swept scans. This value only affects the speed at which the motor tunes from the start to stop wavelength. When resetting to the start wavelength or tuning to a specific wavelength in track mode, the motor moves at the maximum rate. Changes made during a scan will not take effect until the current scan finishes or is cancelled and a new scan is started.
Argument	x, `MIN`, or `MAX` Range: 1–100 Units: nanometers per second (nm/s).
Example	Set the scan speed to 15 nm/s. `:WAVE:SLEW 15` ⇒ `OK`

Query Scan Speed

Syntax	`[:SOURce]:WAVElength:SLEWrate[ <MIN|MAX>] ?`
Description	Checks the set value of the scan speed.
Response	"x.xx" Units: nanometers per second (nm/s).
Example	`:WAVE:SLEW ?` ⇒ `22.00` (The laser is set to scan at 22 nm/s.)

Set Pause

Syntax	`[:SOURce][:WAVElength]:PAUSe <val>`
Description	Sets a delay between consecutive swept scans. The laser scans from the start to the stop wavelength at the set scan rate, resets to the start wavelength, and then pauses before performing the next scan.
Argument	`x.x` (will round to nearest integer) Units: milliseconds (ms). Range: 0 to $4x10^9$
Example	Set a 1.5-second pause between consecutive scans. `:PAUS 1500` ⇒ `OK`

Query Pause

Syntax	`[:SOURce][:WAVElength]:PAUSe ?`
Description	Checks the delay between consecutive scans.
Response	"x" Units: milliseconds (ms).
Example	`:PAUS ?` ⇒ `800` (The laser is set to pause for 800 ms between scans.)

Set Dwell Time

Syntax	`[:SOURce]:WAVElength:DWELl <val>`
Description	Sets a delay between steps during an automated step scan.
Argument	`x.x` (will round to nearest integer) Units: milliseconds (ms). Range: 0 to $8x10^6$
Example	Set a 3-second pause between steps of a step scan. `:WAVE:DWEL 3000` ⇒ `OK`

Query Dwell time

Syntax	`[:SOURce]:WAVElength:DWELl ?`
Description	Checks the delay between steps of an automated step scan.
Response	"x" Units: milliseconds (ms).
Example	`:WAVE:DWEL ?` ⇒ `3000` (The laser is set to pause for 3000 ms between steps.)

Set Starting Wavelength for Wavelength Scans

Syntax

`[:SOURce]:WAVElength:STARt <val>`

Description

Sets the starting wavelength for wavelength scans.

Note: If the wavelength ramp is enabled, the laser will reset to 2 nm before the start wavelength. See page 26 for more on the ramp, or page 76 for information on enabling or disabling the ramp.

Argument

`x.xxx`

Range: The value must be less than the stop wavelength and must be within the laser's operating range. (The minimum and maximum values are laser dependent. See "Query Wavelength" on page 65.)

Units: nanometers (nm).

Example

Set scans to start at 1530 nm.

```
:WAVE:STAR 1530
⇒ OK
```

Query Starting Wavelength

Syntax

`[:SOURce]:WAVElength:STARt ?`

Description

Queries the starting wavelength for scans.

Note: If the wavelength ramp is enabled, scans will start 2 nm before this wavelength. See page 26 for more on the ramp, or page 76 for information on enabling or disabling the ramp.

Response

"x.xxxx"

Units: nanometers (nm).

Example

```
:WAVE:STAR ?
⇒ 1530.0000
```

(Scans will start at 1530 nm, or at 1528 nm if the ramp is enabled.)

Set Stop Wavelength for Wavelength Scans

Syntax	`[:SOURce]:WAVElength:STOP <val>`
Description	Sets the ending wavelength for wavelength scans. *Note: If the wavelength ramp is enabled, the laser will stop scanning 2 nm after the stop wavelength. See page 26 for more on the ramp, or page 76 for information on enabling or disabling the ramp.*
Argument	`x.xxx` Range: The value must be greater than the start wavelength and must be within the laser's operating range. (The minimum and maximum values are laser dependent. See Query Wavelength, above.) Units: nanometers (nm).
Example	Set scans to stop at 1560 nm. `:WAVE:STOP 1560` ⇒ `OK`

Query Stopping Wavelength

Syntax	`[:SOURce]:WAVElength:STOP ?`
Description	Queries the ending wavelength for scans. *Note: If the wavelength ramp is enabled, the laser will stop scanning 2 nm after the stop wavelength. See page 26 for more on the ramp, or page 76 for information on enabling or disabling the ramp.*
Response	"x.xxxx" Units: nanometers (nm).
Example	`:WAVE:STOP ?` ⇒ `1560.0000` (Scans will end at 1560 nm, or at 1562 if the ramp is enabled.)

Set Step Size

Syntax	`[:SOURce]:WAVElength:STEP <value>`
Description	Sets the change in wavelength for each step of a step scan.
Argument	x.xxx Range: The value should be less than the difference between the scan's start and stop wavelengths. The maximum value is the difference between the laser's minimum and maximum wavelengths. Units: nanometers (nm).
Example	Set the laser to tune in 25-nm steps (this only applies to step-scan mode). `:WAVE:STEP 25` ⇒ `OK`

Query Step Size

Syntax	`[:SOURce]:WAVElength:STEP ?`
Description	Queries the step size.
Response	"x.xxxx" Units: nanometers (nm).
Example	`:WAVE:STEP ?` ⇒ `25.0000` (In step-scan mode, the laser will tune in 25-nm increments.)

Set Trigger A

Syntax	`[:SOURce]:WAVElength:TRIGger:A <value>`
Description	Sets a wavelength that will send an output pulse to the controller's Trigger A output during a wavelength scan. The rising edge of the pulse corresponds with the trigger wavelength. See page 25 for trigger specifications.
Argument	x.xxx Range: The value should be between the laser's start and stop wavelengths. *To ensure accurate triggers, either enable the wavelength ramp or set the triggers at least 2-nm away from the start wavelength.* Units: nanometers (nm).
Example	Send a trigger pulse when the scan crosses 1552.655 nm. `:WAVE:TRIG:A 1552.655` ⇒ `OK`

Query Trigger A

Syntax	`[:SOURce]:WAVElength:TRIGger:A ?`
Description	Queries the trigger A wavelength.
Response	"x.xxxx" Units: nanometers (nm).
Example	`:WAVE:TRIG:A ?` ⇒ `1552.6550` (Scans will trigger a pulse at 1552.655 nm.)

Set Trigger B

Syntax	`[:SOURce]:WAVElength:TRIGger:B <value>`
Description	Sets a wavelength that will send an output pulse to the controller's Trigger B output during a wavelength scan. The rising edge of the pulse corresponds with the trigger wavelength. See page 25 for trigger specifications.
Argument	x.xxx Range: The value should be between the laser's start and stop wavelengths. *To ensure accurate triggers, either enable the wavelength ramp or set the triggers at least 2-nm away from the start wavelength.* Units: nanometers (nm).
Example	Send a trigger pulse when the scan crosses 1559.25 nm. `:WAVE:TRIG:B 1559.25` ⇒ `OK`

Query Trigger B

Syntax	`[:SOURce]:WAVElength:TRIGger:B ?`
Description	Queries the trigger B wavelength.
Response	"x.xxxx" Units: nanometers (nm).
Example	`:WAVE:TRIG:B ?` ⇒ `1559.2500` (Scans will trigger a pulse at 1559.25 nm.)

Enable/Disable Wavelength Ramp

Syntax	`[:SOURce]:WAVElength:RAMPenable <ON|OFF|0|1>`
Description	Enables or disables a 2-nm wavelength "ramp" at the beginning and end of a scan. The ramp enables the laser to scan at a constant rate between the specified start and stop wavelengths. The ramp is used at the beginning of a scan to accelerate the tuning motor to the desired scan speed. The laser then tunes at a constant rate through the stop wavelength, and uses the ramp to decelerate to a stop. The default setting for the ramp is disabled.
Argument	`0`, `1`, `ON`, or `OFF` `1` or `ON` enables the ramp, `0` or `OFF` disables it.
Example	Enable the wavelength ramp: `:WAVE:RAMP 1` ⇒ `OK`

Query Wavelength-Ramp Status

Syntax	`[:SOURce]:WAVElength:RAMPenable ?`
Description	Checks the status of the 2-nm wavelength "ramp" at the beginning and end of a scan.
Response	"`1`" for enabled, "`0`" for disabled.
Example	`:WAVE:RAMP ?` ⇒ `1` (The ramp is enabled.)

Start Scanning

Syntax	`:OUTPut:SCAN:STARt[ <value>]`
Description	Begins a wavelength scan. The argument to this command determines the type of scan and, for continuous mode, the number of scans. The *OPC? command will return 0 until the stop wavelength is reached on the last scan.
Argument	x (or no argument) Range: -4 to 10,000,000. no value: Scan once and remain tuned to the ending wavelength (plus 2-nm, if the ramp is enabled). Use Reset command to return to start wavelength. x>0: Run that number of continuous scans. x=-1: Repeatedly run swept scans until scanning is cancelled or aborted. x=-3: Run one automated step scan. x=-4: Run one interactive step scan.
Example	Run 25 swept scans: `:OUTP:SCAN:STAR 25` ⇒ OK

Next Step

Syntax	`:OUTPut:SCAN:STEP`
Description	In interactive step-scan mode, tunes the laser to the next step, as defined by the step size (page 73). If the next step is past the stop wavelength, this command will reset the laser to the start wavelength (minus the ramp, if it is enabled).
Example	Advance to the next step (an interactive step scan has already been initiated): `:OUTP:SCAN:STEP` ⇒ OK

Reset Scan

Syntax	`:OUTPut:SCAN:RESEt`
Description	Resets the laser to ready mode. If a scan is in progress, it will be allowed to finish the current scan before the laser is reset. If the laser is in track mode, it will change to scan mode. The Operation Complete Query will return 0 until the start wavelength is reached.
Example	Complete the current scan and return to ready mode at the start wavelength. `:OUTP:SCAN:RESE` ⇒ OK

Abort Scan

Syntax	`:OUTPut:SCAN:ABORt`
Description	Immediately cancels the current scan and sets the laser to the start wavelength. This is similar to the Reset Scan command, except that the current scan is not completed. If the laser is in track mode, it will switch to scan mode.
Example	Cancel the current scan and reset immediately to the start wavelength: `:OUTP:SCAN:ABOR` ⇒ OK

Set Trigger Mode to Software Enabled

Syntax	`:OUTPut:SCAN:TRIGger`
Description	Enable trigger mode and begin a scan using external software. See also SCAN:TRIG[1].
Example	Begin a scan in trigger mode using external software: `:OUTP:SCAN:TRIG` ⇒ `OK`

Query Trigger Mode State

Syntax	`[:SOURce]:SCAN:TRIGger ?`
Description	Reads the state of trigger mode.
Response	"-1" if Trigger Mode is hardware enabled. "0" if Trigger Mode is disabled. "1" if Trigger Mode is software enabled.
Example	`:SCAN:TRIG ?` ⇒ `0` (Trigger Mode is disabled.)

Set Diode Current

Syntax	`[SOURce]:CURRent[:LEVel]` `[:DIODe] <MIN|MAX|val>`
Description	Sets laser to the specified minimum diode current, maximum diode current, or the specified diode current. This command will only work in Constant Current Mode.
Argument	`MIN, or MAX, x.xxx` Range: Within the laser's minimum and maximum diode current range.
Example	`:CURR x.xxx` ⇒ `OK` (The diode current is set to x.xxx mA.)

Query Diode Current

Syntax	`[:SOURce]:CURRent:` `[LEVel][:DIODe][:MIN|:MAX]?`
Description	Reads the set value of the diode current.
Response	`x.xxx` Units: mA and dBm
Example	`:CURR?` ⇒ `x.xxx` (The diode current has been set to x.xxx mA.)

Switch Laser Mode

Syntax	`:SYSTem:LCONstpwr <1|0>`
Description	Reads laser mode
Argument	0: Constant Power Mode; 1: Constant Current Mode
Example	`:SYST:LCON 0` ⇒ `OK`

Read Laser Mode

Syntax	`:SYSTem:LCONstpwr?`
Description	Reads laser mode
Argument	0: Constant Power Mode; 1: Constant Current Mode
Example	`:SYST:LCON?` ⇒ `1` (Laser was set to Constant Current Mode.)

Read, Reset and Clear Latest Error Flag

Syntax	`:SYSTem:ERRor?`
Description	Reads latest error, resets the error and clears the error flag.
Example	`:SYST:ERR?` ⇒ `0` (No error found.)

List Errors

Syntax	`:SYSTem:ERRor:LOG?`
Description	Lists the last 16 errors from the latest to the oldest.
Example	`:SYST:ERR:LOG?` ⇒ List of last 16 Errors [latest on TOP] ⇒ Error #30 ⇒ Error #10 ⇒ : ⇒ Error #15

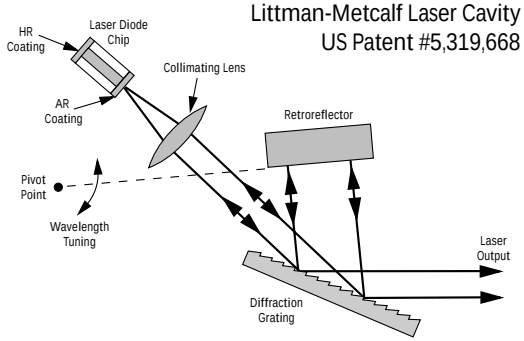
Principles of Operation

Overview

Traditional diode-laser technology provides high reliability, high electrical efficiency, and a wide range of available wavelengths in a compact package. By using an external cavity built around a diode laser, the Swept-Wavelength Tunable Laser Source provides enhanced performance compared to an off-the-shelf diode laser, guaranteeing single-mode operation with narrow linewidth and precise wavelength tuning.

General Theory

Littman-Metcalf Laser Cavity
US Patent #5,319,668



The Swept-Wavelength Tunable Laser Source is based on the Littman-Metcalf design (see “References” on page 85), which uses a diffraction grating at grazing incidence to provide wavelength selectivity. Essential to the performance of tunable external-cavity diode lasers (ECDLs) is a high-quality anti-reflection (AR) coating on the front facet of the diode. The AR coating turns the diode into purely a gain element. A collimating lens directs the output of the diode across a diffraction grating at grazing incidence. The retroreflector in the laser cavity reflects the first-order diffraction off the grating to provide feedback. Dispersion

provided by the grating allows only one cavity mode to lase, resulting in a very narrow linewidth. The specular reflection or zero-order diffraction off the grating serves as the output beam of the laser.

The angle between the grating and the end mirror determines the lasing wavelength. Tuning is achieved by varying the angle using a brushless DC motor to rotate the end reflector. Continuous (mode-hop free) tuning requires selecting an appropriate rotation point. Discontinuous tuning, characterized by periodic "mode-hops" results from two competing wavelength-selection constraints, the mirror-grating angle and the laser-cavity length. The laser-cavity length, L, defines a discrete set of possible wavelengths or *modes*, λ_N, that can lase, given by the equation $L = N\lambda_N/2$, (N = integer). The grating equation insists that $\lambda = \Lambda(\sin\theta_i + \sin\theta_d)$, where Λ refers to the groove spacing of the grating while θ_i and θ_d refer to the incident and diffracted angles of the laser beam. Rotation of the end mirror causes parameters in both equations to change. An appropriately selected point of rotation synchronizes the two, such that the cavity length remains the same number of half-wavelengths long as the mirror is being rotated. Thus mode-hop free tuning is achieved. When this condition is not met, the lasing wavelength will periodically hop from one mode to the next (e.g. from N to $N+1$) as the laser is tuned. The mechanical design of the Swept-Wavelength Tunable Laser Source provides truly mode-hop free tuning.

The laser controller provides current and temperature controls to the laser cavity, as well as manual and computer controlled input/output interfaces. The low-noise current supply drives the diode in the laser, controlling the output power. The temperature control regulates the laser-cavity temperature, providing a stable-output wavelength.

The laser wavelength is also affected by the current through the diode. Changing the diode current affects the refractive index of the diode lasers and therefore, the laser cavity length. The magnitude of the effect is diode dependent, but is typically 25–150 MHz/mA.

References

T. Day, F. Luecke, and M. Brownell, “Continuously tunable diode lasers,” *Lasers and Optronics*, pages 15–17, June 1993.

K. C. Harvey and C. J. Myatt, “External-cavity diode laser using a grazing-incidence diffraction grating,” *Optics Letters*, vol. 16, pages 910–912, 1991.

M. G. Littman and H. J. Metcalf, “Spectrally narrow pulsed dye laser without beam expander,” *Applied Optics*, vol. 17, pages 2224–2227, 1978.

M. G. Littman, “Single-mode operation of grazing-incidence pulsed dye laser,” *Optics Letters*, vol. 3, pages 138–140, 1978.

M. G. Littman, “Single-mode pulsed tunable dye laser,” *Applied Optics*, vol. 23, pages 4465–4468, 1984.

K. Liu and M. G. Littman, “Novel geometry for single mode scanning of tunable lasers,” *Optics Letters*, vol. 6, pages 117–118, 1981.

Troubleshooting

Front-Screen Controls Won't Work

If the front-screen controls aren't working, the laser may be in remote (computer-control) mode. Select the Remote icon on the front screen to restore local control. If this does not restore control, cycle the power off and then on.

Can't Access Some Commands or Screen Controls

Some of the functions of this laser are password protected. If you have not entered the system password, either by sending it before other remote computer commands or by entering it on the front screen, you cannot access password-protected functions. See "Command Summary" on page 51 for the list of commands that are password protected. Screen controls that are password protected will require password entry before allowing access.

Computer Control Doesn't Work

If you are using the IEEE (GPIB) interface, make sure the laser is set to the same device address as your software is requesting (see page 44).

If you are using the RS-232 interface, make sure the laser system is set to the correct baud rate for your system (see page 45). If the baud rate is correct, then it may be that the serial connector on the laser and on your computer are both set to transmit on pin 2 (see page 94). If this is the case, then using a null-modem adapter or a null-modem cable will solve this problem.

If you are using the Ethernet interface, make sure the laser is configured with a valid IP Address, SubnetMask and Gateway Address (see page 46).

Wavelength Not Set to the Start Wavelength

If the laser is in track mode, it will not tune to the start-scan wavelength. Press the Sweep Mode icon to switch the laser to Sweep mode.

If the laser is in Sweep mode and the wavelength display does not show that the laser is at the start wavelength, it may be because the wavelength ramp is enabled. The wavelength ramp is a 2-nm offset from the start wavelength that allows the motor enough time to get to the specified scan speed before it starts tuning across the designated tuning range. Using the ramp results in extremely linear tuning between the start and stop wavelengths. (Another 2-nm ramp after the stop wavelength is used to slow down the motor). See page 76 for information about using the computer interface to enable or disable the ramp. See page 26 for information about using the front screen controls to enable or disable the ramp.

If the wavelength display does not match the wavelength measured by an external wavelength meter, you can recalibrate the laser by adding a wavelength offset. See page 66 for information about using the computer interface to add a wavelength offset. See page 38 for information about using the front screen controls to add a wavelength offset.

Scans Won't Start

You cannot start a swept-scan if the laser is in Track mode. Select the Sweep Mode icon to switch to sweep mode.

Power Display Flashes

In track mode, a flashing power display indicates that the set power is out of range for the current wavelength.

In scan mode, a flashing power display indicates that the set power is out of range for at least some wavelengths in the scan range.

Temperature Display Flashes

A flashing temperature display indicates that the laser cavity temperature is outside allowable operating limits. If this occurs, the system will automatically shut off current to the laser diode. This may occur if the environmental temperature is outside the specified operating range, 15–35 ºC. If this is the case, shut off power to the system until the environmental temperature returns to this range.

This may also occur if the laser has recently been moved from an environment outside this range. Shut off power to the system and allow the laser time to adjust to the new climate (time will vary depending on the temperature of the previous environment).

If this problem persists, contact New Focus technical support.

Triggers are Inconsistent

The normal timing jitter of the triggers is within 150 µs. Due to timing issues relating to the start wavelength, the trigger wavelengths, and the scan speed, you may encounter trigger instability greater than the jitter. To make the triggers stable, shift either the start wavelength or the affected trigger in 1-pm increments in either direction. The trigger should stabilize within a few picometers. Triggers should also be set at least 2 nm away from the start wavelength.

Error Codes

The wavelength display will indicate an error code if the controller is unable to perform its proper functions.

The following list describes the error codes. Switching the laser controller off and then back on can clear some of these errors. If the error persists, contact New Focus for assistance.

Error	Description
E 1	Key Jam.
E 9	Motor temperature too high.
E 10	Laser cavity temperature too high.
E 20	Over-current protection
E 21	Interlock error or over-power protection. If you are not using the safety interlock feature (page 12), check to make sure the jumper on the back of the controller is securely in place.
E 30	Motor-controller error.
E31	Printing error: Paper Out
E32	Printing error: Printer Offline
E33	System BIOS Check Error
E34	Flash Ram Check Error
E35	Communication Error

Calibrating the Laser

You can calibrate the laser power or wavelength to an external meter using the computer interface. To calibrate the power, see page 60; to add an offset to the wavelength, see page 66.

Customer Service

Service and Maintenance

We designed the Swept-Wavelength Laser to be maintenance free; no scheduled service actions are required.

If your laser does require service, repair, or calibration, please call for a Return Authorization Number before shipping the unit to New Focus.

There are no user-serviceable parts inside the laser. Unauthorized opening of the laser will void the warranty and may result in burns, electric shock, misalignment of the laser cavity, and/or irreparable damage to the internal components.

Technical Support

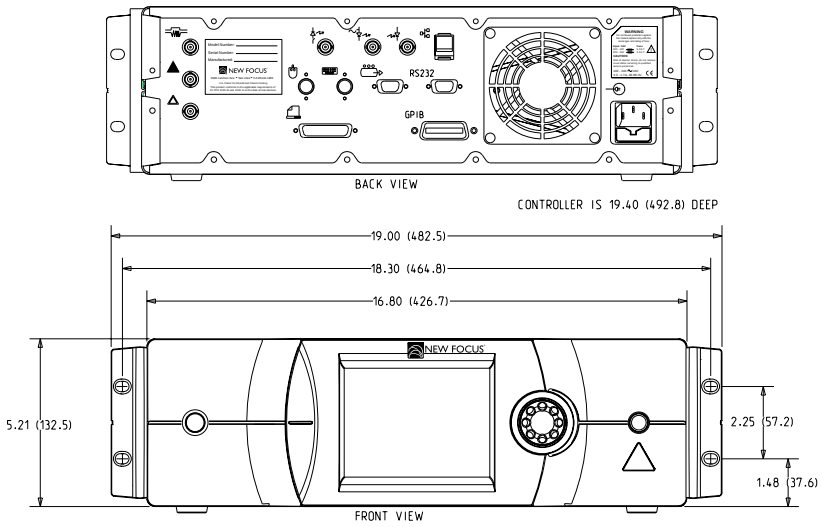
Engineers are on duty from 8:00–5:00 PST Monday through Friday (excluding holidays) to answer questions about the performance or operation of your laser. Call us at 408-919-1500 or, from the USA or Canada, use our toll-free number, 1-866-NUFOCUS (1-866-683-6287). For quickest response ask for "Technical Support" and have your model and serial number available. The model and serial number can be read from the certification label on the back panel of the laser.

You can also send technical questions by email directly to our Technical Support department at techsupport@newfocus.com. We will typically respond to email within one business day.

Appendices

Appendix A: Physical Specifications

Figure 14: Front view and back view of the laser



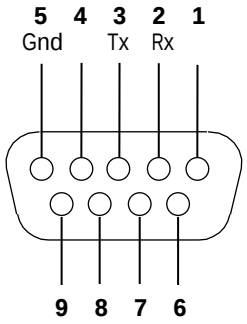
The Controller is 19.40 inches (492.8 centimeters) deep.

Controller Weight: 34 lbs (15.4 kg)

Appendix B: RS-232 Connector Wiring

The RS-232 connector on the back of the laser controller is a standard female 9-pin D-connector. The laser controller transmits data on pin 2 and receives data on pin 3 (see below). If you have trouble communicating with the laser over the RS-232 port, you may need to use a null-modem adapter or cable.

Figure 15: RS-232 Female 9-Pin D-Connector



Pin	Name	Description
1		Not Connected
2	Rx	Data Received by laser
3	Tx	Data Transmitted from laser
4		Not Connected
5	Ground	Digital Ground Line
6–9		Not Connected

Appendix C: Specifications

Specification	TLB-6500-H-CL	TLB-6500-L-CL
Tuning Range	1520–1620 nm	1520–1620 nm
Absolute Wavelength Accuracy[1]	30 pm	30 pm
Mode-Hop Performance	Mode-Hop Free	Mode-Hop Free
Wavelength Resolution[2]	0.1 pm	0.1 pm
Wavelength Repeatability	<±2.5 pm	<±2.5 pm
Wavelength Stability[3,7]	< 5 pm	< 5 pm
Tuning Speed (slow scan option available)	1–100 nm/s (0.01–100 nm/s)	1–100 nm/s (0.01–100 nm/s)
Output Power	>+8 dBm	>+ 3 dBm (1560–1620 nm) >0 dBm (1520–1620 nm)
Power Repeatability[7]	±0.01 dB	±0.01 dB
Power Stability[3]	±0.01 dB	±0.01 dB
Amplified Spontaneous Emission (ASE)[8]	>40 dB[4] >45 dB[4] (1460-1525 nm)	>70 dB[4] >90 dB[5]
Integrated Dynamic Range[8]		>55 dB[6] >60 dB[6,7] (1540-1620 nm)
Side-Mode Suppression Ratio[7]	> 50 dB	> 50 dB
Control Pad	Icon-Based Touch Screen	Icon-Based Touch Screen
Control Pad Cord Length	4 feet	4 feet
Fiber Connector	FC/APC	FC/APC
Fiber Type	Polarization Maintaining (PM)	Polarization Maintaining (PM)
TTL Triggers	2 Settable Triggers	2 Settable Triggers
Computer Interface	IEEE, RS232C, Ethernet, Keyboard, and Mouse	IEEE, RS232C, Ethernet, Keyboard, and Mouse

Specification	TLB-6500-H-CL	TLB-6500-L-CL
Operating Temperature	15 to 35 ºC	15 to 35 ºC
Storage Temperature	-20 ºC to 70 ºC	-20 ºC to 70 ºC
Shock/Vibration	ISTB Procedure 2B	ISTB Procedure 2B
Operating Humidity	80% RH (non-condensing)	80% RH (non-condensing)
Warm-Up Time	45 minutes	45 minutes
Size	19" Rack Mount, 3U high	19" Rack Mount, 3U high

PRELIMINARY SPECIFICATIONS

(1) After wavelength recalibration (user-performed function)

(2)1 pm in step mode.

(3)1 hour, temperature .±2 ºC

(4)0.1-nm bandwidth, signal to max ASE, 1-3 nm from carrier.

(5)0.2-nm bandwidth, signal to max ASE, >5 nm from carrier.

(6)Signal to total ASE >0.5 nm from carrier.

(7)Typical.

(8)Measurement taken at maximum rated power.

Viewing the laser output with certain optical instruments (for example, eye loupes, magnifiers, and microscopes) within a distance of 100 mm may pose an eye hazard.

E+S Band Laser

Specification	TLB-6500-H-ES	TLB-6500-L-ES
Tuning Range	1425–1525 nm	1425–1525 nm
Absolute Wavelength Accuracy[1]	30 pm	30 pm
Mode-Hop Performance	Mode-Hop Free	Mode-Hop Free
Wavelength Resolution[2]	0.1 pm	0.1 pm
Wavelength Repeatability	<±2.5 pm	<±2.5 pm
Wavelength Stability[3,7]	< 5 pm	< 5 pm
Tuning Speed (slow scan option available)	1–100 nm/s (0.01–100 nm/s)	1–100 nm/s (0.01–100 nm/s)
Output Power	>+6 dBm	>+ 1 dBm (1460–1525 nm) >-1 dBm (1425–1525 nm)
Power Repeatability[7]	±0.01 dB	±0.01 dB
Power Stability[3]	±0.01 dB	±0.01 dB
Amplified Spontaneous Emission (ASE)[8]	>40 dB[4] >45 dB[4] (1460-1525 nm)	>70 dB[4] >90 dB[5]
Integrated Dynamic Range[8]		>55 dB[6] >60 dB[6,7] (1460-1525 nm)
Side-Mode Suppression Ratio[7]	> 50 dB	> 50 dB
Control Pad	Icon-Based Touch Screen	Icon-Based Touch Screen
Control Pad Cord Length	4 feet	4 feet
Fiber Connector	FC/APC	FC/APC
Fiber Type	Polarization Maintaining (PM)	Polarization Maintaining (PM)
TTL Triggers	2 Settable Triggers	2 Settable Triggers
Computer Interface	IEEE, RS232C, Ethernet, Keyboard, and Mouse	IEEE, RS232C, Ethernet, Keyboard, and Mouse
Operating Temperature	15 to 35 ºC	15 to 35 ºC

Specification	TLB-6500-H-ES	TLB-6500-L-ES
Storage Temperature	-20 ºC to 70 ºC	-20 ºC to 70 ºC
Shock/Vibration	ISTB Procedure 2B	ISTB Procedure 2B
Operating Humidity	80% RH (non-condensing)	80% RH (non-condensing)
Warm-Up Time	45 minutes	45 minutes
Size	19" Rack Mount, 3U high	19" Rack Mount, 3U high

PRELIMINARY SPECIFICATIONS

(1) After wavelength recalibration (user-performed function)

(2)1 pm in step mode.

(3)1 hour, temperature ±2 ºC

(4)0.1-nm bandwidth, signal to max ASE, 1-3 nm from carrier.

(5)0.2-nm bandwidth, signal to max ASE, >5 nm from carrier.

(6)Signal to total ASE >0.5 nm from carrier.

(7)Typical.

(8)Measurement taken at maximum rated power.

Viewing the laser output with certain optical instruments (for example, eye loupes, magnifiers, and microscopes) within a distance of 100 mm may pose an eye hazard.

O Band Laser

Specification	TLB-6500-H-O	TLB-6500-L-O
Tuning Range	1260–1340 nm	1260–1340 nm
Absolute Wavelength Accuracy(1)	30 pm	30 pm
Mode-Hop Performance	Mode-Hop Free	Mode-Hop Free
Wavelength Resolution(2)	0.1 pm	0.1 pm
Wavelength Repeatability	<±2.5 pm	<±2.5 pm
Wavelength Stability(3,7)	< 5 pm	< 5 pm
Tuning Speed (slow scan option available)	1–100 nm/s (0.01–100 nm/s)	1–100 nm/s (0.01–100 nm/s)
Output Power	>+6 dBm	>+ 1 dBm (1290–1340 nm) >-1 dBm (1260–1340 nm)
Power Repeatability(7)	±0.01 dB	±0.01 dB
Power Stability(3)	±0.01 dB	±0.01 dB
Amplified Spontaneous Emission (ASE)(8)	>40 dB(4) >45 dB(4) (1290-1340 nm)	>70 dB(4) >90 dB(5)
Integrated Dynamic Range(8)		>55 dB(6) >60 dB(6,7) (1290-1340 nm)
Side-Mode Suppression Ratio(7)	> 50 dB	> 50 dB
Control Pad	Icon-Based Touch Screen	Icon-Based Touch Screen
Control Pad Cord Length	4 feet	4 feet
Fiber Connector	FC/APC	FC/APC
Fiber Type	Polarization Maintaining (PM)	Polarization Maintaining (PM)
TTL Triggers	2 Settable Triggers	2 Settable Triggers

Specification	TLB-6500-H-O	TLB-6500-L-O
Computer Interface	IEEE, RS232C, Ethernet, Keyboard, and Mouse	IEEE, RS232C, Ethernet, Keyboard, and Mouse
Operating Temperature	15 to 35 ºC	15 to 35 ºC
Storage Temperature	-20 ºC to 70 ºC	-20 ºC to 70 ºC
Shock/Vibration	ISTB Procedure 2B	ISTB Procedure 2B
Operating Humidity	80% RH (non-condensing)	80% RH (non-condensing)
Warm-Up Time	45 minutes	45 minutes
Size	19" Rack Mount, 3U high	19" Rack Mount, 3U high

PRELIMINARY SPECIFICATIONS

(1) After wavelength recalibration (user-performed function)

(2)1 pm in step mode.

(3)1 hour, temperature .±2 ºC

(4)0.1-nm bandwidth, signal to max ASE, 1-3 nm from carrier.

(5)0.2-nm bandwidth, signal to max ASE, >5 nm from carrier.

(6)Signal to total ASE >0.5 nm from carrier.

(7)Typical.

(8)Measurement taken at maximum rated power.

Viewing the laser output with certain optical instruments (for example, eye loupes, magnifiers, and microscopes) within a distance of 100 mm may pose an eye hazard.

980 nm Band Laser

Specification	TLB-6500-H-09
Tuning Range	960–995 nm
Absolute Wavelength Accuracy(1)	30 pm
Mode-Hop Performance	Mode-Hop Free
Wavelength Resolution(2)	0.1 pm
Wavelength Repeatability	<±2.5 pm
Wavelength Stability(3,7)	< 5 pm
Tuning Speed (slow scan option available)	1–100 nm/s (0.01–100 nm/s)
Output Power	>+6 dBm
Power Repeatability(7)	±0.01 dB
Power Stability(3)	±0.01 dB
Amplified Spontaneous Emission (ASE)(8)	>35 dB(4) >45 dB(4) (965-990 nm)
Integrated Dynamic Range(8)	
Side-Mode Suppression Ratio(7)	> 50 dB
Control Pad	Icon-Based Touch Screen
Control Pad Cord Length	4 feet
Fiber Connector	FC/APC
Fiber Type	Polarization Maintaining (PM)
TTL Triggers	2 Settable Triggers
Computer Interface	IEEE, RS232C, Ethernet, Keyboard, and Mouse
Operating Temperature	15 to 35 ºC
Storage Temperature	-20 ºC to 70 ºC

Specification	TLB-6500-H-09
Shock/Vibration	ISTB Procedure 2B
Operating Humidity	80% RH (non-condensing)
Warm-Up Time	45 minutes
Size	19" Rack Mount, 3U high

PRELIMINARY SPECIFICATIONS

(1) After wavelength recalibration (user-performed function)

(2)1 pm in step mode.

(3)1 hour, temperature .±2 ºC

(4)0.1-nm bandwidth, signal to max ASE, 1-3 nm from carrier.

(5)0.2-nm bandwidth, signal to max ASE, >5 nm from carrier.

(6)Signal to total ASE >0.5 nm from carrier.

(7)Typical.

(8)Measurement taken at maximum rated power.

Viewing the laser output with certain optical instruments (for example, eye loupes, magnifiers, and microscopes) within a distance of 100 mm may pose an eye hazard.

Appendix D: Cleaning Procedures

Cleaning the Chassis Exterior

Never open the Swept-Wavelength Tunable Laser Source to clean it. Doing so runs the risks of electric shock and damage to sensitive components from electrostatic discharge. It also voids your warranty! Clean the chassis' exterior only, using an alcohol-dampened cloth. (Avoid using harsh or abrasive cleaning agents.)

Cleaning the Front Screen

Use a lint-free, non-abrasive cloth to clean the Tunable Laser Source's LCD front screen. If necessary, use a cloth sprayed lightly with a cleaning solution made specifically for LCD screens. (Alcohol- or ammonia-based products can damage the surface.) Never spray the LCD front screen with cleaning solution directly.

Cleaning the Back Panel Connectors

To clean the Back Panel connectors (see Figure 4),

1. Remove the AC power cord from Power Module.
2. Scrub the connectors with a small brush dipped in isopropyl alcohol (91%).
3. Allow 30 minutes for the alcohol to dry completely before reconnecting the AC power cord and operating the Tunable Laser Source again.

Cleaning the Laser Output Connector

To clean the Laser Output connector (see Figure 3),

1. Make sure that laser output power is disabled.
2. Remove the Laser Output FC Adapter Protective Cap.
3. Remove the Laser FC Adapter by turning it counterclockwise. The fiber output ceramic ferrule is now visible.

4. Blow compressed air directly through the FC Adapter from a distance of 5 inches and at a 45º angle. (Ultra Jet, Chemtronics Compressed Air, p/n ES1020R, with a precision or flexible trigger valve is recommended.)
5. Reinstall the Laser FC Adapter. (Make sure the FC Adapter key mates with its corresponding key slot in the connector.)
6. Measure Laser Output by using any type of power measurement device.
7. The laser output power should meet the maximum output power specification (see Appendix C). If it does not, repeat steps 1 - 4 , and continue with step 8.
8. Dip a lint-free, absorbent-tipped applicator into cleanroom-grade alcohol, and swipe the tip of the output ferrule with a circular motion.
9. Apply compressed air directly to the output ferrule and the uninstalled Laser FC Adapter.
10. Reinstall the Laser FC Adapter. (Make sure the FC Adapter key mates with its corresponding key slot in the connector.)
11. Measure Laser Output by using any type of power measurement device.
12. The laser output power should meet the maximum output power specification (see Appendix C). If it does not, continue with step 13.
13. Disable laser output power.
14. Reinstall the Laser Output FC Adapter Protective Cap.
15. Shut down the Tunable Laser Source.
16. Contact New Focus, Inc. Technical Support for additional help.