USER'S GUIDE

Vidia-Swept™

External-Cavity Tunable Diode Lasers

Model Series 64X8 & 64X8-SM

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®
Smart Optics for Networks™

5215 Hellyer Ave. • San Jose, CA 95138-1001 • USA
phone: (408) 284–6808 • fax: (408) 284–4824
e-mail: contact@newfocus.com • www.newfocus.com

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.

Products described in this document are covered by U.S. Patent #5,319,668 and patents pending.

Document Number 640046 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 and follow the warnings on the safety labels (examples are shown on page 6).
- To completely shut off electrical power to the unit, turn off the keyswitch. The **Power** button on the front panel only controls power to the laser diode; even when power to the diode is off, power is still supplied to other system components.
- Do not open the laser system. There are no user-serviceable parts inside the unit.
- Opening the laser cavity may cause exposure to wavelengths and power outside the specified range shown on page 71. The

following table shows the maximum wavelength range and the maximum internal power accessible inside the laser cavity.

Model	Wavelength Range	Max. Power
6428, 6428-SM	1450–1650 nm	55 mW
6438, 6438-SM	1450–1650 nm	55 mW

WARNING

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 locations of the various warning labels used with this product. Please be aware of them and use caution when working with the laser.

Figure 1: Safety labels on the front of the laser

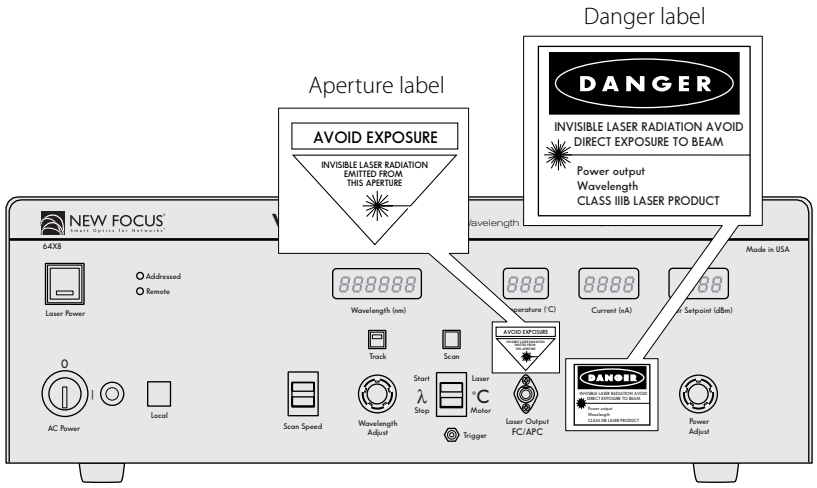
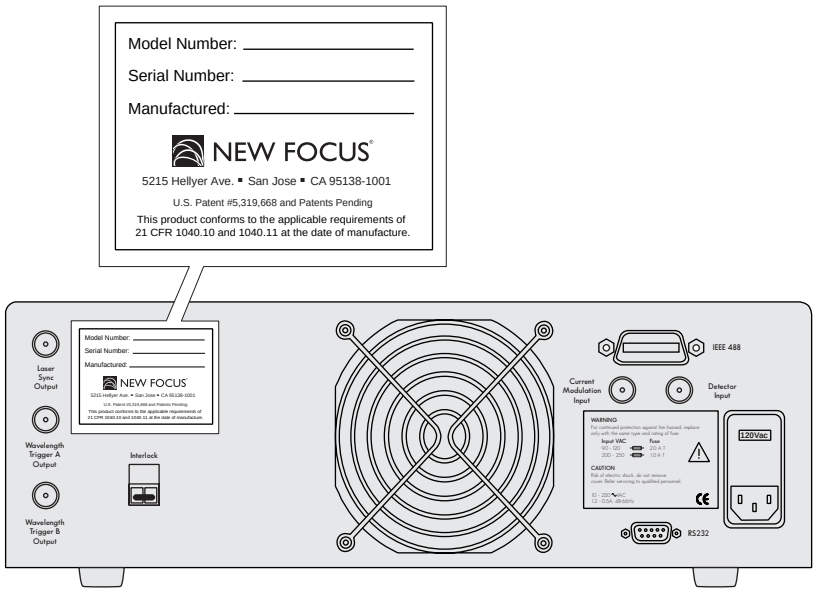


Figure 2: Certification label on the back of the laser



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.

Getting Started

Introduction

This section outlines the basic steps needed to start using your Vidia-Swept™ 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 13.

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.

Check that the power module on the back of the controller is set to the AC line voltage appropriate for your work station (see page 59 for information on checking and changing the voltage).

Setting Up the Laser

The laser is designed to operate in environments from 15–35 ˚C. If the laser has been in storage at temperatures outside the range of 10–40 ˚C, allow the laser system at least 4 hours to equalize.

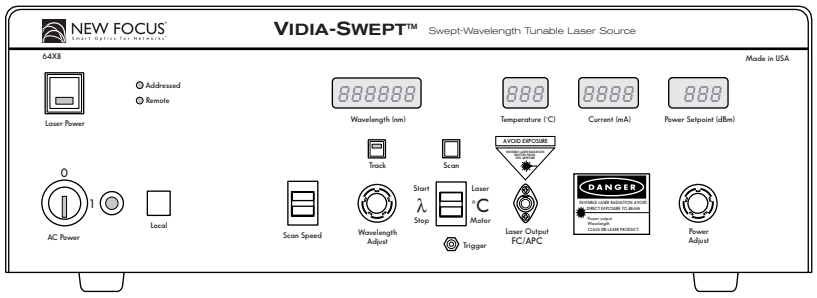
When connecting fiber to the laser, use only FC/APC-connectorized fiber.

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.

Starting the Laser for the First Time

The following section takes you through the basic steps of starting up and shutting down the laser. The controls and functions are described in more detail in the following chapter.

Figure 3: Front Panel



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.
2. **Check the voltage setting:** Check that the power module on the back of the laser is set for the proper AC line voltage (see page 59 for information on checking and changing the voltage).
3. **Connect the power cord:** Attach the power cord to the laser and plug it into a wall outlet.
4. **Turn on the system:** Turn on the **AC Power** keyswitch (position "**1**") to initialize the system: the system ID will appear in the wavelength display during initialization.

   Note: *After turning the keyswitch, allow the system a minimum of 45 minutes to warm up before turning on the laser diode (step 6.) to ensure the system meets its operating specifications.*

   Once you turn on the keyswitch and the system initializes (about 30 seconds), you can operate the system remotely through the

IEEE-488 (GPIB) or RS-232 ports. Refer to the "Computer Control" chapter beginning on page 27 for details.

5. **Set the power to minimum:** For safety, turn the **Power Adjust** knob counter-clockwise until it stops to set it to minimum power.
6. **Activate the laser:** Push the **Laser Power** button. The button will flash for approximately 5 seconds before current flows through the diode and the laser begins to emit light.

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

7. **Set the operating power:** Turn the **Power Adjust** knob clockwise to set the laser's output power (the units are dBm).

To prevent damage to the laser diode, the factory has limited the maximum current to the laser diode (the maximum is wavelength dependent). When you reach maximum power for the current wavelength, the controller will engage the current limiter and the power display will start to flash.

8. **Set the system to track mode:** To manually set the wavelength, the system needs to be in track mode. A light in the **Track** button indicates when the system is in track mode. If it is not lit, press the **Track** button to turn it on.
9. **Set the Wavelength:** Turn the **Wavelength Adjust** knob to set the wavelength. This will allow you to tune the laser with a resolution of 0.01 nm. For 0.001-nm resolution, press the **Scan** button and then turn the knob. (Scanning is discussed on page 20.)
10. **Turn the laser off:** To minimize the risk of power surges damaging the laser diode, push the **Power** button to turn off the laser when it is not in use (the LED on the button will turn off) and before shutting down the system. Turn the keyswitch off (position "**0**") to shut down the entire system.

To avoid the warm-up period, you may want to leave on the system power.

General Operation

Overview

The Vidia-Swept laser is a stable, narrow-linewidth source of tunable light. The laser operates in four modes: track mode, swept-scan mode, automated step-scan mode, and interactive step-scan mode. Use it in track mode to operate it at a set wavelength. In swept-scan mode, it is capable of fast and extremely linear scans between the start and stop wavelengths that you specify. In the step-scan modes, the laser dwells at evenly spaced wavelengths as it scans. The system can be operated manually, using the front-panel controls, or remotely, using one of the computer interfaces (see "Computer Control" on page 27).

What's Inside

The 64X8 Series Vidia-Swept laser is an external-cavity diode laser (ECDL) based on the Littman-Metcalf design (see "Principles of Operation" on page 55). 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 (page 21); enable or disable the ramp using the computer interface (page 52).

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 (the temperature is displayed on the front panel but cannot be adjusted).

Connecting Fiber to the Laser

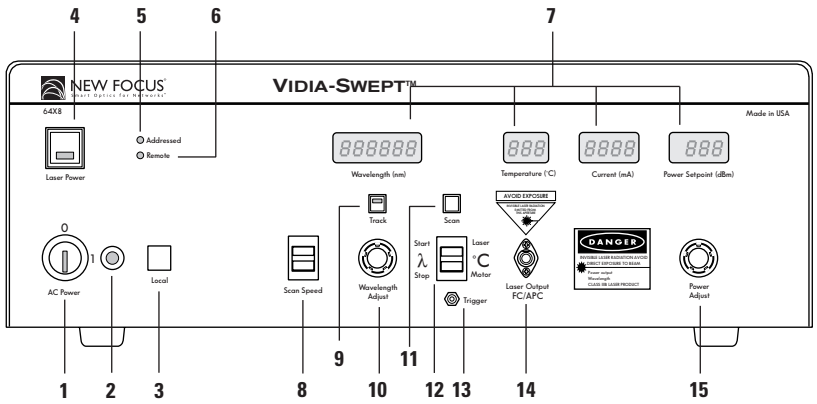
Use only FC/APC-connectorized fiber with the Vidia-Swept. This laser can be ordered with polarization-maintaining (PM) fiber (Models 64X8) or with single-mode fiber (Models 64X8-SM). For PM versions, the polarization is aligned parallel to the key on the FC connector. The laser output comes to the front panel through a fiber with an optical isolator of 30 dB, preventing optical feedback into the laser cavity.

Using the Front-Panel Controls

The Vidia-Swept has two control options, local and remote. In local mode, the front panel provides control of the laser system. In remote mode, you control the laser over the computer interface (IEEE-488 or RS-232). Whenever the Vidia-Swept receives a command over the computer interface, it restricts most of the front-panel controls (the **Laser Power** and keyswitch control are always enabled). Press the **Local** button on the front panel to restore front-panel control. For information on using computer control, see page 27.

The controls on the front panel (Figure 4) allow you to read and set the laser power, wavelength, start and stop wavelengths for scans, scanning speed, and computer-interface parameters.

Figure 4: Controller front panel



1. **AC Power Keyswitch:** 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. **Power Indicator:** This indicator is lit when the system power is on. To check if power is being supplied to the laser diode, check the indicator light in the Laser Power button.
3. **Local Button:** Returns the controller to local (front-panel) control when the driver is in remote (computer-control) mode.
4. **Laser Power Button:** Turns on and off current to the laser diode. When the laser power is on, this button will remain lit.
5. **Addressed Indicator:** This indicator is lit whenever the controller is communicating over the computer interface (see the "Computer Control" chapter beginning on page 27).
6. **Remote Indicator:** This indicator is lit whenever the controller is under computer control, via either the IEEE-488 (GPIB) or the RS-232 interface. (See "Computer Control" on page 27.)
7. **Wavelength, Temperature, Current, and Power Displays:** Show the status of the different laser parameters, as well as errors and system-identification information. Units are nm, ° C, mA, and dBm, respectively.

   The Temperature display indicates the laser-cavity temperature. The laser controller actively stabilizes the cavity temperature for optimal performance. The system is designed to operate in environments from 15– 35 °C; if the system is exposed to temperatures outside this range and is unable to maintain the cavity temperature, the temperature display will flash and the controller will shut off current to the diode. If this occurs, shut down the unit until the environmental temperature returns to the operating range.

   The current changes with the power and wavelength; it is not adjustable. You can modulate the current through a back-panel BNC input (see page 24). The display does not reflect any current modulation.

   The power display shows the power setpoint. It will display this value even if the laser-diode power is off.

8. **Scan Speed Switch**: Hold this switch up to view the scan speed in the wavelength display. Units are nm/s. With the switch held up, turn the **Wavelength Adjust** knob to adjust the scan speed.
9. **Track Button:** Switches the laser between track mode, where you can specify a set operating wavelength, and scan mode.
10. **Wavelength Adjust Knob:** Adjusts the wavelength while in track mode. Sets other parameters when other buttons or switches are depressed (see "Control Combinations" on page 17).
11. **Scan Button:** Starts and stops a wavelength scan. For continuous scanning, hold up the **Start/Stop λ** switch before releasing **Scan**. Pressing the button twice aborts a scan. (For more on scanning, see page 20.)

    For high-resolution tuning, pressing the **Scan** button while in Track mode will shift the wavelength display by two decimal places and allow you to set the wavelength with 0.001-nm accuracy.
12. **Start/Stop λ Switch**: Display or set the start and stop wavelengths for wavelength scans. In the down position, it will also change the temperature display to show the motor temperature.
13. **Trigger:** SMB connector for TTL input pulses. Each input pulse has the same effect as pressing and releasing the **Scan** button. The falling edge of the pulse initiates the action.
14. **Laser Output:** Connector for FC/APC-connectorized fiber. For models with polarization-maintaining fiber (Models 64X8), the polarization is aligned parallel to the key on the FC connector.

    CAUTION!

    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.
15. **Power Adjust Knob:** Adjusts the laser-power setpoint.

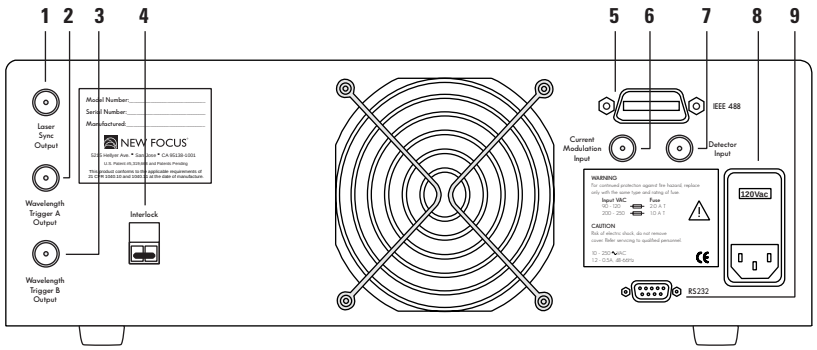
Control Combinations

To access many of the laser's features from the front panel, you will need to use several controls at the same time. The following table summarizes these combinations.

	Local Button	Track Button	Scan Button	Scan Speed Switch	Wave-length Switch	Wave-length Knob
View/Set start wavelength for scans						
View/Set stop wavelength for scans						
View/Set scanning speed						
Start continuous scan (release Scan before releasing wavelength switch)						
View/Set wavelength for Trigger A output						
View/Set wavelength for Trigger B output						
Set GPIB address						
Set RS-232 baud rate						

Back Panel and Tunable Laser Cavity Connections.

Figure 5: 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. **Interlock:** For use with external safety systems, the laser will not operate if the interlock circuit is open.
5. **IEEE 488:** Connector for controlling the laser over an IEEE-488 (GPIB) interface.
6. **Current Modulation Input:** BNC connector for modulating the laser current (amplitude).
7. **Detector Input:** BNC connector for monitoring an external instrument through the laser controller's computer interface.
8. **Power Module:** The operating voltage is displayed on the power module. The module also contains the fuses for the unit.
9. **RS232:** Connector for controlling the laser over an RS-232 interface.

Turning on the Power

1. Make sure the laser aperture is blocked or attached to an optical fiber that is connected to an appropriate receptacle. Use only FC/APC-connectorized fiber.
2. Before turning on the system for the first time, check that the AC line voltage indicator on the back of the controller matches the voltage you are using (see page 59).
3. Turn on the **AC Power** keyswitch on the front panel.

   The keyswitch turns on AC power for the entire laser system, including the temperature circuit for the laser diode. It does not turn on the power to the laser diode.
4. Wait at least 45 minutes after turning on the keyswitch to allow the system to warm up.
5. Press the **Laser Power** button on the controller front panel to allow current to flow to the diode. The button will flash during the five-second safety delay before the current is activated. The button will remain lit while current is flowing to the laser diode.
6. Turn the **Power Adjust** knob to control the output power. Turning the knob clockwise increases power: counter-clockwise decreases power. If the Power Display begins to flash, the power is already at maximum for the selected wavelength. See page 71 for power specifications.

Before turning off the system, you should first turn off power to the laser diode by pressing the **Laser Power** button.

Note: *You can avoid the 45-minute warm-up period by leaving the system power (keyswitch) on when you are not using the laser.*

Enabling Local (Front-Panel) Control

When the laser receives a command from the computer interface, it deactivates all of the front-panel controls except the **Laser Power** and **Local** buttons. This remote-control mode is indicated by the **Remote** LED on the front panel. To return the controller to local (front-panel) control, press the **Local** button on the front panel.

Setting the Laser Power

Turn the **Power Adjust** knob to set the power.

To prevent damage to the laser diode, the factory has limited the maximum current to the laser diode. When you reach maximum power, the controller will engage the current limiter and the power display will start to flash.

Note: *Maximum power is wavelength dependent. See page 71 for power specifications.*

Setting the Laser Wavelength (Track Mode)

The Vidia-Swept has two modes, track mode and scan mode. While in track mode, you can actively control the tuning motor to operate the laser at a set wavelength.

1. If the laser is in scan mode (the LED in the **Track** button is off), switch to track mode by pressing the **Track** button.

   Note: *You cannot switch to track mode during a scan. Press the* **Scan** *button to cancel a scan (press it once to finish the current scan; press twice to abort the scan immediately).*

2. Standard tuning resolution is 0.01 nm. For 0.001-nm resolution, press the **Scan** button while in track mode. The wavelength display will shift two decimal places.
3. Turn the **Wavelength Adjust** knob to set the wavelength. Turn the knob clockwise to increase the wavelength: counter-clockwise to decrease the wavelength.

Performing Wavelength Scans

The Vidia-Swept has three scan modes: swept-scan mode, automated step-scan mode, and interactive step-scan mode. In swept-scan 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" on page 22).

The two step-scan modes are only available via computer control. Step scans allow you to dwell at evenly spaced wavelengths during a scan. You control the start and stop wavelengths, the step size, and the dwell time. In automated mode, you program a set dwell time, in interactive mode the laser waits for you to trigger each step.

The system always scans from shorter to longer wavelengths.

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. Use computer control to enable or disable the ramp (see page 52).

Setting the Start and Stop Wavelengths

1. Push *up* the **Start/Stop** λ switch to display the set start wavelength.
2. While still holding the switch up, turn the **Wavelength Adjust** knob to change the start wavelength.
3. Push the **Start/Stop** λ switch *down* to display the current stop wavelength.
4. While still holding the switch down, turn the **Wavelength Adjust** knob to change the stop wavelength. The stop wavelength must be larger than the start wavelength.
5. Release the switch.
6. If the laser is in track mode, switch to scan mode by pressing the **Track** button. The laser will then tune to the start wavelength (minus the 2-nm ramp, if it is enabled).

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

Setting the Scan Speed

1. Display the current scan speed by pushing *up* the **Scan Speed** switch. The Wavelength display will change to show the current scan speed in nanometers per second (nm/s).
2. While still holding the switch up, turn the **Wavelength Adjust** knob to change the scan speed. Displayed units are nm/s. The speed can be set between 1 and 100 nm/s in 1-nm/s increments.
3. Release the switch.

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

Setting Output Triggers

As the laser scans, it is capable of sending trigger pulses. 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 • (scan speed)
Pulse Width	> 660 µs

1. To set trigger A, hold *down* the **Scan Speed** switch and push *up* the **Start/Stop** λ switch while turning the **Wavelength Adjust** knob.
2. To set trigger B, hold *down both* the **Scan Speed** switch *and* the **Start/Stop** λ switch while turning the **Wavelength Adjust** knob.
3. Release the switches.

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

Starting a Scan

From the front panel, you can set the laser to perform a single scan or to continuously scan.

1. If the laser is in track mode, press the **Track** button to switch the laser to scan mode (the light in the **Track** button should be off).
2. To run a single scan, press the **Scan** button once. To continuously run scans, push *up* the **Start/Stop** λ switch, press and release the **Scan** button to start scanning, and release the switch.
3. After the laser finishes a scan, it returns to the start wavelength minus the ramp (see "Using the Wavelength Ramp" on page 21).

Note: *You can set the laser to run a specific number of scans using computer control (see page 53).*

Using a Trigger to Begin a Scan

There is a **Trigger** input jack with an SMB-type connector under the **Start/Stop** λ switch. A TTL signal sent to the laser through this connector is equivalent to depressing and releasing the **Scan** button. The actual trigger happens on the falling edge of the input signal.

Cancelling a Scan

To stop an ongoing scan, press the **Scan** button. The laser will finish the current scan and return to the Start wavelength.

To abort a scan, press the **Scan** button twice. The laser will immediately stop the current scan and return to the Start wavelength.

Using a Trigger to End a Scan

There is a **Trigger** input jack with an SMB-type connector under the **Start/Stop** λ switch. A TTL signal sent to the laser through this connector is equivalent to depressing and releasing the Scan button. The actual trigger happens on the falling edge of the input signal.

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.

WARNING

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

Note: *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 25–40 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 37); it will not be displayed on the front panel.

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 +5 V
Input Frequency	DC–10 kHz
Impedance	51 kΩ

Computer Control

Introduction

The Vidia-Swept can be operated remotely through either the parallel IEEE-488 (GPIB) interface or the serial RS-232 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. 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.

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) or the baud rate (for RS-232) 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. Configuration is required to talk 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 the Vidia-Swept" on page 30 for more information on using the IEEE interface.

Setting the Device Address

1. On the front panel, press and hold the **Local** button and hold *up* the **Scan Speed** switch.
2. Turn the **Wavelength Adjust** knob until the desired address number appears in the Wavelength display. The address can be from 1 to 31.
3. Release the **Local** button and the **Scan Speed** switch.

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 70). 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 19,200 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 the Vidia-Swept" on page 30 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, or 19200.

1. On the front panel, press and hold the **Local** button and hold *down* the **Scan Speed** switch.
2. Turn the **Wavelength Adjust** knob to change the baud-rate setting.
3. Release the **Local** button and the **Scan Speed** switch.

Restoring Local (Front-Panel) Control

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

To return the controller to local (front-panel) control, press the **Local** button on the front panel.

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, to check the actual operating current or the voltage from the **Detector Input**.

Programming for the Vidia-Swept

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 0000000000001550 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, 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).

- 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: 0.85 to 1.15” 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	34
*OPC?	Operation Complete Query	34
:SYST:MCON <INT|EXT>	Set Control Mode (Remote/Local)	35
:SENS:WAVE	Sense Wavelength (nm)	36
:SENS:CURR:DIOD	Sense Level of Current (mA)	36
:SENS:TEMP:LASE	Sense Temperature (° C)	37
:SENS:VOLT:AUX	Sense Voltage from Detector Input	37

Power Commands

Syntax	Command	Page
:OUTP <on/off>	Turn Laser Power On/Off	38
:OUTP?	Query Laser Power (On/Off)	38
:POW <value>	Set Laser Output Power (dBm)	39
:POW?	Query Laser Power Setpoint	39
:POW:TRIM <value>	Set Power Trim	40
:POW:TRIM?	Read Power Trim	40

Wavelength Commands

Syntax	Command	Page
:WAVE <value|MIN|MAX>	Set Wavelength (nm)	41
:WAVE[<MIN|MAX>]?	Query Wavelength	41
:WAVE:OFFS <value>	Set Wavelength Offset (nm)	42
:WAVE:OFFS?	Query Wavelength Offset	42

Scan Commands

Syntax	Command	Page
:OUTP:TRAC OFF	Switch to Scan Mode:	43
:OUTP:SCAN:STAT?	Query Scan State	43
:WAVE:SLEW <value|MIN|MAX>	Set Scan Speed (nm/sec)	44
:WAVE:SLEW[<MIN|MAX>]?	Query Scan Speed	44
:PAUS <value>	Set Pause (ms): Set delay between consecutive scans	45
:PAUS?	Query Pause	45
:WAVE:DWEL <value>	Set Dwell Time(ms): Set delay between steps of a step scan	46
:WAVE:DWEL?	Query Dwell Time	46
:WAVE:STAR <value>	Set Starting Wavelength (nm)	47
:WAVE:STAR?	Query Starting Wavelength	47
:WAVE:STOP <value>	Set Stopping Wavelength (nm)	48
:WAVE:STOP?	Query Stopping Wavelength	48
:WAVE:STEP <value>	Set Step Size for Step Scans (nm)	48
:WAVE:STEP?	Query Step Size for Step Scans	48
:WAVE:TRIG:A <value>	Set Trigger A (nm)	49
:WAVE:TRIG:A?	Query Trigger A	49
:WAVE:TRIG:B <value>	Set Trigger B (nm)	50
:WAVE:TRIG:B?	Query Trigger B	50
:WAVE:RAMP <ON|OFF|0|1>	Enable/Disable Wavelength Ramp	52
:WAVE:RAMP?	Query Wavelength-Ramp Status	52
:OUTP:SCAN:STAR <value>	Start scanning	53
:OUTP:SCAN:STEP	Next Step in Interactive Step Scan	53
:OUTP:SCAN:RESE	Reset Scan (finish scan and reset)	54
:OUTP:SCAN:ABOR	Abort Scan (cancel scan and reset)	54

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., 6428, 02149, H1.67, C1.00` (Manufacturer = New Focus, Model= 6428, 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-panel 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.

Note: In Remote Mode, the front-panel knobs are ignored but they are still active. If a knob is turned and the controller is then switched back to external (front-panel) control, the corresponding parameter will move to the new setting.

Example

```
:SYST:MCON INT
⇒ OK
```

(The laser switches to remote mode and the front panel's remote light turns on.)

Sense Wavelength

Syntax	`:SENSe:WAVElength`
Description	Returns the current wavelength of the laser. Each laser is calibrated with respect to wavelength at the factory and a calibration table loaded into the Tunable Laser Cavity.
Response	`"x.xxxx"` Units: nanometers (nm).
Example	`:SENS:WAVE` ⇒ `1550.0250` (The wavelength is 1550.025 nm.)

Sense Level of Current to Diode

Syntax	`SENSe:CURRent[:LEVel]:DIODe`
Description	Returns the magnitude of the laser-diode current in milliamperes. The value returned is the same as that seen on the front panel of the controller at the time the command is executed.
Response	`"x.x"` Units: milliamperes (mA).
Example	`:SENS:CURR:DIOD` ⇒ `59.2`

Sense Temperature

Syntax `:SENSe:TEMPerature[:LEVel]:LASEr`

Description Returns the temperature of the laser cavity.

Note: The laser controller actively stabilizes the temperature for optimal performance. If the system is exposed to environments outside the operating temperature of 15–35 ˚C and is unable to maintain the cavity temperature, the temperature display will flash. If this occurs, shut down the system until the environmental temperature returns to this range.

Response `"x.x"`

Units: ˚ C

Example `:SENS:TEMP:LASE`
⇒ `31.1`
(The laser temperature is 31.1 °C.)

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.)

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 made during a scan will not affect the scan.

Argument
`x.x`

Range: *See specifications on page 71.*

Units: dBm

Note: Power is wavelength dependent. You may not be able to achieve the set power at all wavelengths. See specifications on page 71.

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 specifications on page 71.*

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. You can alter the output power by ±15% from factory settings. *Note: The laser power must be off to change the trim.*
Argument	`x.xx` Range: 0.85–1.15 This value is a multiplier to the photodetector signal. Values greater than 1 will decrease the output power; values less than 1 will result in increased power. The value 0.85 corresponds to -0.7 dB and 1.15 corresponds to +0.6 dB. To calculate a value based on a desired dB correction, use $value=10^{(dB\ correction)/10}$.
Example	The power level shown on the front panel is off by 10% when measured by an external power meter, so you want to increase the output power by 10%: `:POW:TRIM 0.90` ⇒ `OK` (With the power display on the laser showing the same power as before, the external power meter will show that the power level has increased by 10%.)

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?` ⇒ `1.12` (The laser has been adjusted to decrease the output power by 12%. [10log(1.12)=0.5 dB])

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.)

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 21 for more on the ramp, or page 52 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 21 for more on the ramp, or page 52 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, page 41.)

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 21 for more on the ramp, or page 52 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 21 for more on the ramp, or page 52 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 21 for more on the ramp, or page 52 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 22 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 22 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 49). 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`

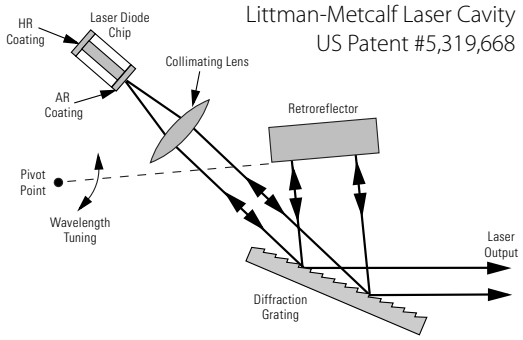
Principles of Operation

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 Vidia-Swept 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 Vidia-Swept laser cavity is based on the Littman-Metcalf design (see refs. on page 57), 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 Vidia-Swept 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.

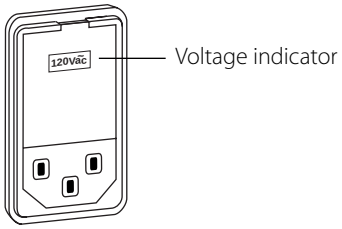
K. Liu and M. G. Littman, "Novel geometry for single mode scanning of tunable lasers," *Optics Letters,* vol. 6, pages 117–118, 1981.

Changing the AC-Voltage Selection

The laser controller can operate at 100, 120, 220, or 240 V AC, at AC frequencies of 47–63 Hz. The unit is configured at the factory for the standard AC voltage of the purchaser's country.

To check the voltage setting, look at the voltage indicator on the back of the laser controller.

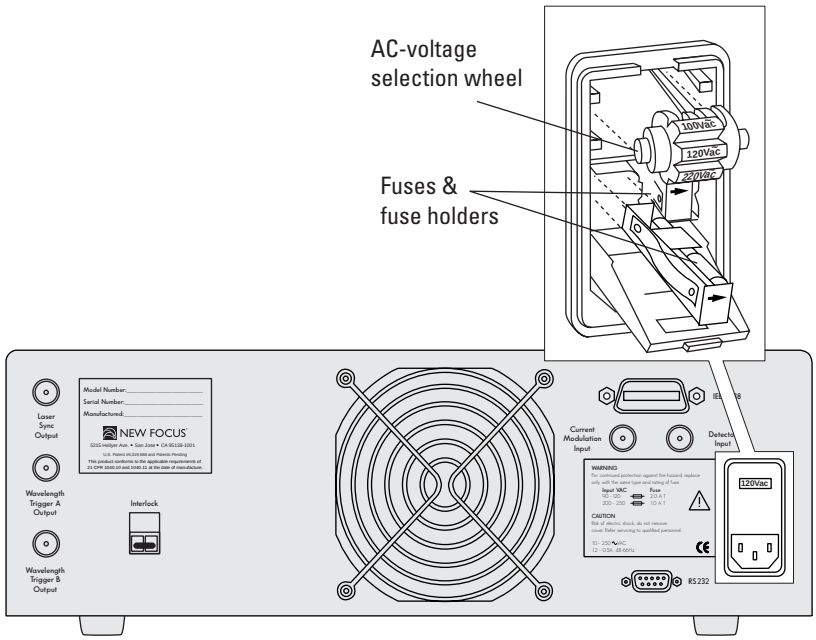
Figure 6: AC power module & voltage indicator



To change the operating voltage:

1. Make sure the laser power is off and the power keyswitch is in the off position.
2. Disconnect the AC power cord.
3. Open the cover of the power module on the rear panel with a small blade screwdriver or similar tool.

Figure 7: Power Module with the cover open



4. Remove the AC-voltage selection wheel from the unit.

   Do not attempt to rotate the wheel while it is still in the power module; the wheel must be removed, turned, and then reinserted for proper operation.

5. Re-insert the wheel into the module so the desired AC voltage can be viewed in the power-module window.

6. Ensure the proper fuses are installed in your system.

   The power entry module requires two 5x20-mm slow-blow fuses, such as Littelfuse's® Slo-Blo® 239 series: one for the hot line and the other for the neutral line. Replacement fuses should be as follows:

Figure 8: AC Voltages and their recommended fuses

AC Voltage	Fuse Rating	Slo-Blo Fuse #
100 V AC	2.0 A	239 002
120 V AC	2.0 A	239 002
220 V AC	1.0 A	239 001
240 V AC	1.0 A	239 001

7. Close the power-module cover.
8. Verify the proper voltage is showing through the module window.
9. Reconnect the AC-power cord.

Troubleshooting

Front-Panel Controls Won't Work

If the front-panel controls aren't working, the laser may be in remote (computer-control) mode. Press the **Local** button on the front panel to restore local control. If this does not restore control, cycle the power off and then on.

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 28).

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 29). 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 70). If this is the case, then using a null-modem adapter or a null-modem cable will solve this problem.

Wavelength Not Set to the Start Wavelength

If the laser is in track mode (the **Track** button should be lit), it will not tune to the start-scan wavelength. Press the **Track** button to switch the laser to Scan mode.

If the laser is in scan 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). Use the computer interface to enable or disable the ramp. See page 52.

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 using the computer interface. See page 42.

Scans Won't Start

You cannot start a scan if the laser is in track mode. Press the **Track** button to switch to scan 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 °C. 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.

The Laser is Mode Hopping

Mode hops may occur if a scan begins or ends outside the specified mode-hop-free range (see page 71 for specified range). Note that the mode hop may even occur within the mode-hop-free range.

Make sure the scan begins and ends completely within the mode-hop-free range. (If the ramp is enabled, the ramp must also be within this range.)

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	**Laser Power** button depressed during power up.
E 4	**Start/Stop** switch depressed during power up.
E 5	**Scan Speed** switch depressed during power up.
E 6	**Local** button depressed during power up.
E 7	Multiple stuck buttons during power up.
E 8	Internal data-cable connection error.

Error	Description
E 9	Motor temperature too high.
E 10	Laser diode temperature too high.
E 11	Microprocessor RAM error.
E 12	Microprocessor firmware revisions do not match.
E 14	Temperature board revision wrong.
E 15	Can't read laser EEPROM, or there is a conflict between the controller and the tunable laser cavity.
E 20	Over-current protection
E 21	Interlock error or over-power protection. If you are not using the safety interlock feature (page 7), check to make sure the jumper on the back of the controller is securely in place.
E 30	Motor-controller 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 40; to add an offset to the wavelength, see page 42.

Customer Service

Service

We designed the Vidia-Swept 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

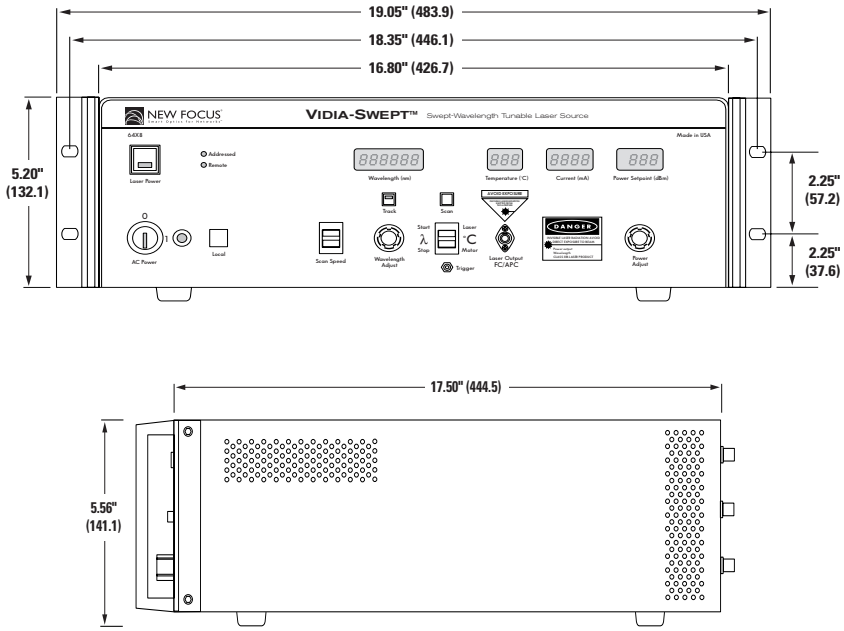
Engineers are on duty from 8:00–5:00 PST Monday through Friday (excluding holidays) to answer questions about the performance or operation of your laser. Call us at 408-284-6808 or, from the USA or Canada, use our toll-free number, 1-866-NUFOCUS (1-866-683-6287). For quickest response ask for "Technical 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 9: Front view and side view of the Vidia-Swept laser

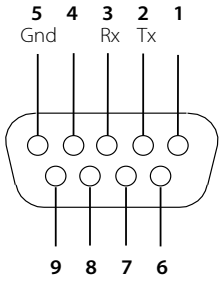


Controller Weight: 34 lbs (15.4 kg)

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 10: RS-232 Female 9-Pin D-Connector



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

Appendix C: Specifications

Specification	Model 6428	Model 6428-SM
Tuning Range	1500–1575 nm	1520–1570 nm
Mode-Hop-Free Tuning Range *	1520–1570 nm	1520–1570 nm
Maximum Output Power	> 0 dBm (1500–1575 nm) > 6 dBm (1520–1570 nm)	> 6 dBm (1520–1570 nm)
Side-Mode Suppression Ratio (relative to central mode)	> 45 dBc > 50 dBc typical	> 45 dBc > 50 dBc typical
Tuning Speed	0.01–100 nm/s	0.01–100 nm/s
Wavelength Resolution	1 pm	1 pm
Absolute Wavelength Accuracy**	±30 pm	±30 pm
Fiber Type	Polarization Maintaining (PM)	Single Mode (SM)
PM-Fiber Output Extinction Ratio	15 dB (typical)	-NA-
Environmental Operating Conditions	15 to 35 ºC	15 to 35 ºC
Environmental Storage Conditions	-20 to 70 ºC	-20 to 70 ºC
Laser Linewidth Jitter	15 MHz/s	15 MHz/s
Power Flatness While Scanning	±0.25 dB (typical)	±0.25 dB (typical)
Power Repeatability While Scanning	0.08 dB (typical)	0.08 dB (typical)
Relative Intensity Noise (RIN)	< -130 dB/Hz (typical)	< -130 dB/Hz (typical)
Signal-to-Noise Ratio (ASE, SSE)***	> 50 dB	> 50 dB
Warm-Up Time	> 45 minutes	> 45 minutes
Wavelength Stability	< 5 pm over 1 hour	< 5 pm over 1 hour
Computer Interface	GPIB (IEEE-488) and RS-232	GPIB (IEEE-488) and RS-232

* To ensure a mode-hop-free scan, the entire scan must fall in this range. Scans that begin or end outside this range could result in a mode hop, which may occur within the mode-hop-free range.

** After one-point recalibration (see "Set Wavelength Offset" on page 42).

*** Measured in a 0.1-nm bandwidth.

Specification	Model 6438*	Model 6438-SM*
Tuning Range	1565–1625 nm	1565–1625 nm
Mode-Hop-Free Tuning Range **	1565–1625 nm	1565–1625 nm
Maximum Output Power	> 6 dBm	> 6 dBm
Side-Mode Suppression Ratio (relative to central mode)	> 45 dBc > 50 dBc typical	> 45 dBc > 50 dBc typical
Tuning Speed	0.01–100 nm/s	0.01–100 nm/s
Wavelength Resolution	1 pm	1 pm
Absolute Wavelength Accuracy***	±30 pm	±30 pm
Fiber Type	Polarization Maintaining (PM)	Single Mode (SM)
PM-Fiber Output Extinction Ratio	15 dB (typical)	-NA-
Environmental Operating Conditions	15 to 35 °C	15 to 35 °C
Environmental Storage Conditions	-20 to 70 °C	-20 to 70 °C
Laser Linewidth Jitter	15 MHz/s	15 MHz/s
Power Flatness While Scanning	±0.25 dB (typical)	±0.25 dB (typical)
Power Repeatability While Scanning	0.08 dB (typical)	0.08 dB (typical)
Relative Intensity Noise (RIN)	< -130 dB/Hz (typical)	< -130 dB/Hz (typical)
Signal-to-Noise Ratio (ASE, SSE)****	> 50 dB	> 50 dB
Warm-Up Time	> 45 minutes	> 45 minutes
Wavelength Stability	< 5 pm over 1 hour	< 5 pm over 1 hour
Computer Interface	GPIB (IEEE-488) and RS-232	GPIB (IEEE-488) and RS-232

* These are preliminary specifications and are all subject to change. Call for critical specifications.

** To ensure a mode-hop-free scan, the entire scan must fall in this range. Scans that begin or end outside this range could result in a mode hop, which may occur within the mode-hop-free range.

*** After one-point recalibration (see "Set Wavelength Offset" on page 42).

****Measured in a 0.1-nm bandwidth.