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USER'S GUIDE

Model 6300-LN

The Velocity® Tunable Diode Laser

U.S. Patent #5,319,668
European Patent #EP 0 693 231 B1



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

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Warranty

New Focus, a division of Bookham, guarantees its lasers to be free of 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 European Patent #EP 0 693 231 B1.

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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 warnings on the safety labels (examples are shown on page 8).
- To completely shut off 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.
- The user will NEVER need to open the laser head. Unauthorized opening of the laser head will void the warranty and may result in misalignment of the laser cavity and/or irreparable damage to the internal components.



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

The following table shows the maximum possible wavelengths and powers accessible inside the laser head, listed by model number. The actual wavelength range and output power of your laser will be a fraction of the values shown here.

Model Number	Wavelength Range (nm)	Max. Power (mW)
6304	632.5–637	15
6304-H	635–637	21
6305	652–660	10
6308	668–678	15
6309	680–690	20
6312	765–781	45
6312-H	776–781	75
6314	794–804	25
6315	815–825	30
6316	838–853	30
6316-H	848–853	70
6318	890–910	15
6319	930–945	30
6320	960–995	30
6320-H	975–985	45
6321	1050–1075	20
6321-H	1055–1070	60
6323	1220–1250	25
6324	1270–1330	25
6326	1470–1545	45
6327	1415–1480	25
6328	1520–1570	75
6330	1550–1630	30
6330-H	1570–1630	55
6331	1650–1680	10
6332	1760–1790	10
6334	1940–1970	10
6335	1970–2000	10

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 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.

Safety Warning Labels

Figure 1: Aperture and certification label placement

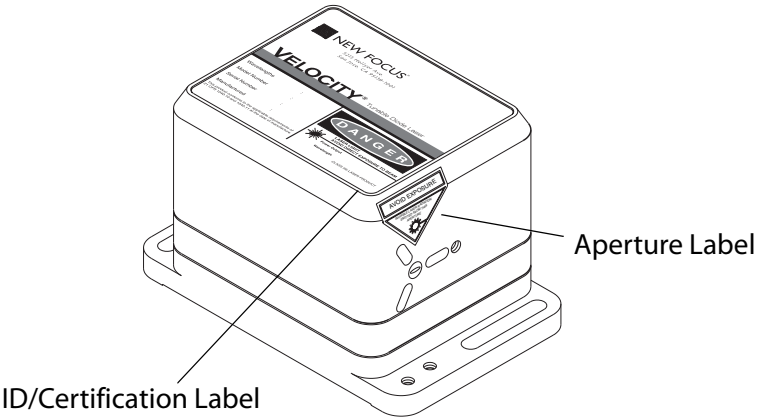
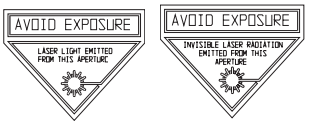


Figure 2: Certification and warning labels on the back of the laser



Warning—hazard



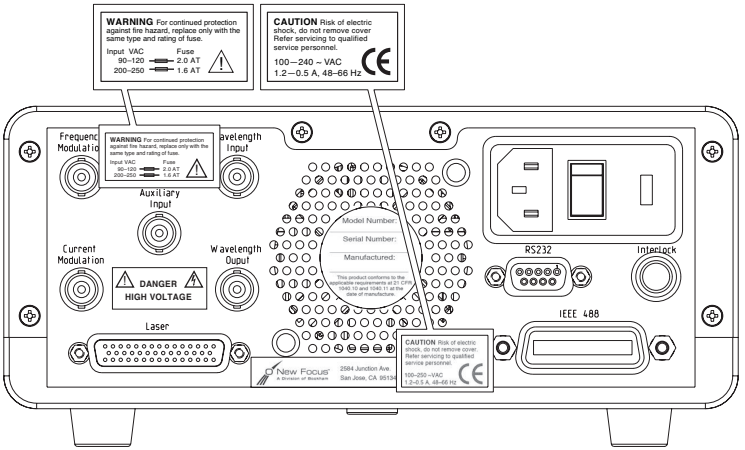
Caution!
(Refer to accompanying documentation)



Alternating Current



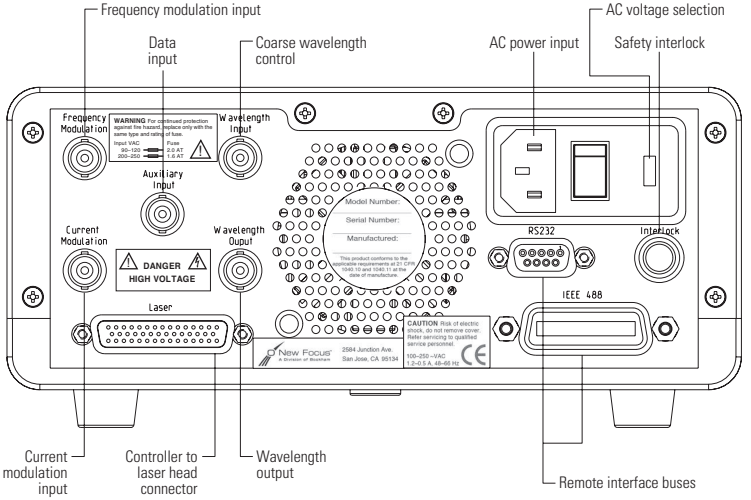
Protective Conductor Terminal



Using the Safety Interlock

The safety interlock connector on the back of the controller is provided for external safety systems. The laser is shipped with a 50-ohm terminator. Do not remove this terminator 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 Figure 3.

Figure 3: Back panel



Quick Start

This section outlines the basic steps needed to start using your 63XX Series External Cavity Tunable Diode Laser, including information on unpacking the system and a brief setup and getting started guide. For more detailed information on how to operate the instrument, refer to "Manual Operation" on page 27.

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.

Setting Up

The laser is configured at the factory for the line voltage and frequency appropriate for your country. If you are unsure how your unit is configured, check "AC Operating Voltages" on page 85 for more details.

Place the laser head on a stable surface with good heat conduction capability. Point the laser in a safe direction.

Connect the bidirectional cable to the laser head and the controlling unit.

Turn on AC power with the backpanel switch. The LED display will show the model number, head software revision number, and controller software revision number. After a few seconds, the display will become active. Allow 30 minutes for warmup.

Operation

Turn lockout keyswitch to "1" position. Press Laser Power button. The LED in the button will flash for 5 seconds and then stay on. Press Display pushbutton until the current, mA LED is ON. Press Set pushbutton to enable Adjust knob.

Now you can increase laser current to reach the power you want by turning the Current Adjust knob clockwise. The laser current has a factory-set maximum value to ensure no damage occurs to the diode due to over-driving. Before reaching the maximum current, the current display will start to flash at some current to indicate that the laser may enter the multimode operation regime.

For fine frequency control, adjust Piezo Voltage.

Press Track button and the LED in the button will light up. The laser is now in Track mode. You can adjust the wavelength by turning the wavelength adjust knob.

For other functions, such as setting scanning speed and wavelength range, enable Wavelength Input mode and Enable Constant Power mode, refer to "Manual Operation" on page 27.

Turning the Laser OFF

To minimize the risk of power surges damaging the laser diode, push the Laser 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 backpanel AC switch off to shut down the entire system.

Introduction

The New Focus 63XX series External Cavity Tunable Diode Laser is a stable, narrow-linewidth source of tunable light. The 63XX series laser can be operated manually from the front panel of the controller or remotely using computer control.

In this section we'll describe the key features of the 63XX series and explain some of the theory of external cavity diode laser design.

Features

The 63XX series laser incorporates a simple, stable mechanical design with a minimal number of optical components. Low-noise analog circuits precisely set critical operating parameters, such as diode temperature and current. Digital control facilitates remote operation and computer interfacing.

The 63XX is a modular system. The same control unit will work with any 63XX series laser head. The control units work in both manual and remotely programmed modes and are compatible with RS-232 and GPIB addressing.

Microprocessor-based motion control allows you hands-free wavelength-scanning capability. You set the start and stop wavelengths and scanning speed and the microprocessor-controlled DC motor takes care of the rest. The unique cavity design assures continuous tuning with continuous mode hop-free tuning.

Two LED digital readouts display important operating parameters including wavelength and diode temperature. Inputs are available for low-speed (1 MHz) and high-speed (up to 100 MHz) diode current modulation.

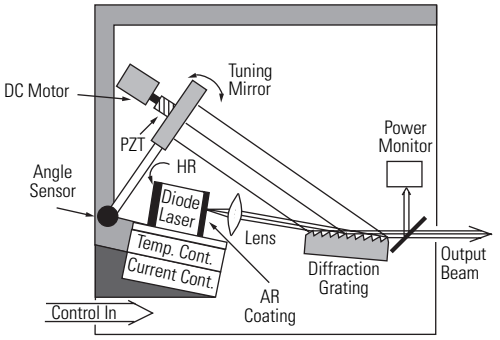
Theory of Design

The New Focus 63XX series tunable lasers take advantage of the broad gain bandwidths available in semiconductor diode lasers. Most tunable lasers use liquid organic dyes for gain. These dyes are notoriously messy, toxic, and difficult to use. The all solid-state diode laser design, by comparison, is compact, clean, and efficient.

In addition to being widely tunable, the 63XX series lasers offer narrow linewidths. This is accomplished by using a laser cavity design that began at the Massachusetts Institute of Technology [see refs. 1-6]. The original resonators were an adaptation of dye laser designs. New Focus has made key design modifications to adapt the cavity to the diode laser gain medium.

Our modified Littman-Metcalf laser cavity is shown in Figure 4. A high-reflection coating on one end of the diode laser forms one end of the cavity and a highly reflective tuning mirror forms the other. Starting from the diode, the beam in the cavity passes through a collimating lens and then strikes a diffraction grating at near grazing incidence. The beam is diffracted toward the tuning mirror which reflects the light back on itself for the reverse path. Part of the light from the diode is reflected, not diffracted, by the grating. This portion forms the output beam.

Figure 4: New Focus laser cavity



The grating functions as a narrow spectral filter. Its passband is only a few gigahertz wide. The high wavelength selectivity results because many lines of the grating are illuminated by the grazing incidence beam and because the beam is diffracted by the grating twice in each round trip through the cavity. The grating spectral filter is narrow enough to force the laser to operate on only a single longitudinal mode.

Different wavelengths diffract off the grating at different angles. However, only one wavelength leaves the grating in a direction that is exactly perpendicular to the surface of the tuning mirror closing the resonant laser cavity. It follows that we can tune the laser by changing the angle of the tuning mirror. There is one very important innovation that allows the New Focus ECDL to tune continuously without mode hops. In order to maintain resonance on the same mode as we tune the laser, the number of waves in the cavity must be kept constant (even though the wavelength of the light in the cavity is changing).

The number of waves in the cavity is maintained by having the tuning mirror rotate around a specific pivot point. The pivot point creates a relationship between the cavity length and the laser wavelength. The laser wavelength is set by the standard law for diffraction of light off a grating:

$$\lambda = \Lambda\left(\sin\theta_i + \sin\theta_d\right)$$

where Λ is the spacing between grooves in the grating while θ_i and θ_d refer to the incident and diffracted angles of the laser beam measured from a line normal to the surface of the grating.

The length, D, of the cavity can be broken into two parts l_1 and l_2. (See Figure 5.) If we call the distance from the pivot point to the place where the beam strikes the grating L, we can see from the figure that:

$$l_1 = L\sin\theta_i \text{ and, } l_2 = L\sin\theta_d.$$

Therefore, the total cavity length is $L\left(\sin\theta_i + \sin\theta_d\right)$. Dividing the total cavity length by the wavelength, shows that the total number of waves in the cavity is L/Λ which is a constant. By designing a mechanical system where this condition is maintained over the tuning range of the laser, the cavity can tune mode hop free over extended wavelength ranges. In the next section we'll show how the theory is put into practice by describing the components of the New Focus 63XX series laser system.

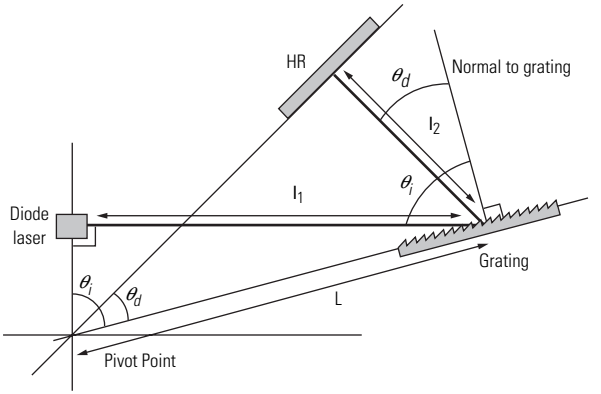


Figure 5: Drawing of important angles and optimum pivot point.

References

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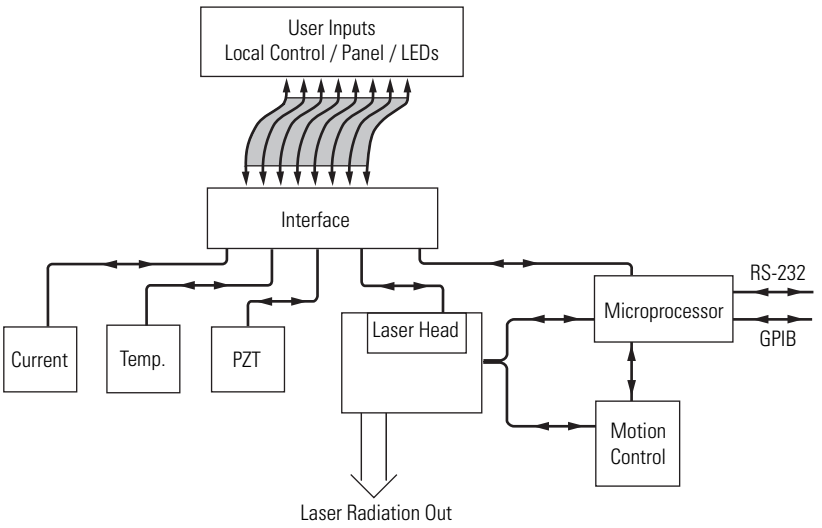
[6] T. Day, F. Luecke, and M. Brownell, "Continuously tunable diode lasers," *Lasers and Optronics*, p. 15–17, June 1993.

Description of Laser System

Controller

The job of the controller is to provide a stable, low-noise power source for the diode laser, set the temperature in the laser head, control wavelength scanning, and provide readouts of all relevant laser parameters. Conceptually, the circuitry inside the controller is built in two layers: analog and digital. The analog layer incorporates low-noise design for temperature, current, and wavelength fine tuning. The digital layer includes all the readouts and circuits to set operating points and scan parameters. This layer acts as an interface between the user (or the user's computer) and the analog layer.

Figure 6: Block diagram



The analog layer consists of four modules: current control, temperature control, piezoelectric transducer (PZT) driver (which controls wavelength fine tuning) and the motion control for coarse wavelength tuning.

The digital layer includes the microprocessor and interface. There is another digital circuit board in the laser head that contains information specific to each laser head such as the wavelength calibration table and the laser head serial number.

The current driver is a low-noise, analog, DC-current supply which provides up to 150 mA of current of either positive or negative polarity to the laser diode. The AC ripple in the output is less than 0.4 μA RMS. If desired, the current supply can be modulated at up to 1 MHz through a BNC connector on the rear panel of the controller. For proper operation, use only with a cable shorter than three meters.

The temperature driver controls the laser temperature by supplying current to thermoelectric (Peltier) elements in the laser head. Precise temperature control is achieved through the use of a two-stage system. One thermoelectric element maintains the overall temperature of the laser cavity while another is specifically dedicated to the diode temperature within the cavity. In this way the laser temperature is stabilized to within plus or minus one millikelvin, while the temperature of the surrounding environment stays constant to within plus or minus 10 millikelvin.

The PZT driver supplies 0–120 Volts DC to a piezoelectric fine-tuning element in the laser head. By using the PZT system you can tune the wavelength smoothly with sub-angstrom precision.

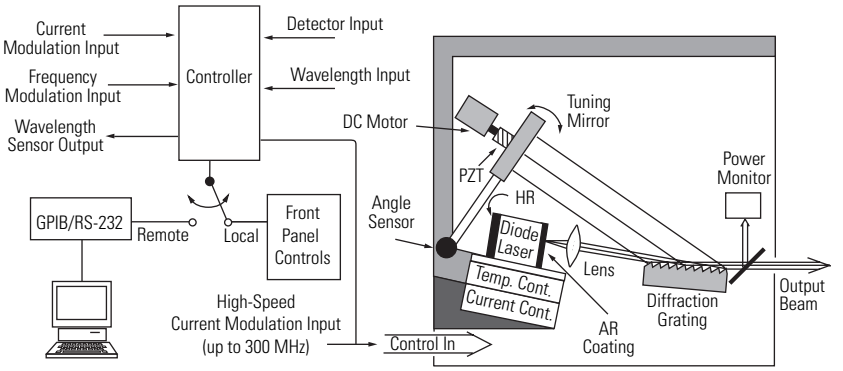
The Motion Control actuates the DC motor which provides coarse wavelength control and scanning. A dedicated motion control microprocessor provides a PID feedback control loop for smooth tuning.

The microprocessor board controls all of the other modules, runs the digital displays, and provides RS-232 and GPIB interfacing capability. It also communicates with the circuit board in the laser head to determine what kind of laser head it is and to upload the wavelength calibration table.

Laser Head

The laser head embodies a simple, ultra-stable design which is shown in Figure 7. Everything is mounted on a solid metal base and enclosed in a sealed package. You will never need to open the laser head to operate the laser. Unauthorized opening of the laser head will void the warranty.

Figure 7: Laser head mechanical schematic



In this design, a diode laser is used as the gain medium. One end of the diode laser has a high reflectivity coating which acts as an end mirror of the external-cavity. The other end of the diode has an antireflection coating.

The diode laser is bonded to a temperature sensor and a thermoelectric cooling block which maintains a constant diode temperature to within 1 millikelvin.

The laser beam radiating from the diode is collimated by a lens before striking a high-quality diffraction grating. The diffraction grating is precisely aligned at New Focus and its position is fixed with respect to the diode. From the diffraction grating, a fraction of the beam is directed to the tuning mirror. The position of this mirror determines the operating wavelength of the laser.

The tuning mirror is mounted on a stiff arm. An angle sensor near the pivot point of the arm provides data for wavelength readout. The other end of the arm is moved by a DC motor driven screw and a piezoelectric transducer (PZT). The DC motor makes coarse

wavelength changes while the PZT is used for micron scale movements which corresponds to sub-angstrom wavelength tuning precision.

The laser cavity is carefully adjusted to give the best tuning performance when tuned from short to long wavelength. Therefore, when scanning the laser, it is best to approach the desired wavelength from shorter wavelengths.

A small fraction of the output beam is directed to a power monitor. The reading from this monitor is displayed on the front panel of the controller.

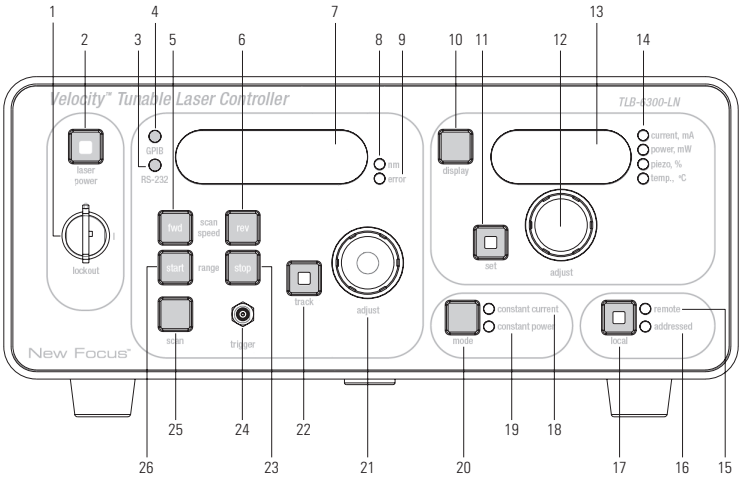
An SMA connector is available on the outside of the head enclosure for high-speed current modulation. The use of this feature is described in "Back Panel and Laser Head Connections" on page 31.

Finally, there is a monitor strip that indicates how many hours the diode laser has operated. A new laser head will typically show 100-150 hours due to factory burn-in. The red monitor bar will slowly move across the window. Full scale is 5,000 hours.

Using the Front-Panel Controls

Turn on the AC power with the back panel power switch. The calibration table, GPIB address, baud rate, laser-head serial numbers, and other pertinent operating information stored in an EEPROM in the laser head are uploaded to the controller. The LED displays will show the model number, head software revision number, and controller software revision number. After a few seconds the display will become active. About 30 minutes of warm-up time is recommended for best performance.

Figure 8: Controller front panel



1. Lockout Keyswitch: Enables current to the laser diode.
2. Laser Power Button: Turns on and off current to the laser diode.
3. RS-232 Button: When pressed, displays the RS-232 baud-rate setting in wavelength display.
4. GPIB Button: When pressed, displays the GPIB (IEEE) address setting in wavelength display.
5. Forward Scan Speed Button: Displays/sets start to stop scanning speed.
6. Reverse Scan Speed Button: Displays/sets stop to start scanning speed.
7. Wavelength Display: The display shows wavelength, error codes, and system identification information. When displaying wavelength, the nm LED is on.
8. Wavelength Indicator: When lit, display to left is reading the nominal wavelength of the laser.

9. Error Indicator: The controller will indicate an error code in the Wavelength Display if it is unable to perform its functions properly. (See "Error Codes" on page 83 for more information.)
10. Display Button: Changes the parameter display to show laser current, laser power, piezo %, or laser temperature.
11. Set Button: Activates/deactivates the parameter adjustment knob so you can adjust the displayed laser parameter. (The properties that can be controlled depend on the operating mode.)
12. Parameter Adjustment Knob: When activated by the Set button, this knob can be used to adjust the diode temperature, the drive current, the laser power, and the piezo voltage, which fine tunes the output wavelength.
13. Parameter Display: The display shows the various laser parameters. Each parameter has its own LED indicator.
14. Parameter Indicator LEDs: Indicates the information being displayed in the Parameter Display window.
15. Remote Indicator: This indicator is lit whenever the controller is under computer control via either the GPIB (IEEE-488) or the RS- 232 interface.
16. Addressed Indicator: This indicator is lit whenever the controller is communicating over the computer interface.
17. Local Button: Returns the controller to local (front-panel) control when it is in Remote (computer) Control mode.
18. Constant Current Indicator: This indicator is lit when the laser is set for Constant Current mode.
19. Constant Power Indicator: This indicator is lit when the laser is set for Constant Power mode.
20. Mode Button: Switches the laser between Constant Current and Constant Power modes.
21. Wavelength Adjustment Knob: Adjust various wavelength parameters, GPIB address, or RS-232 baud-rate.

22. Track Button: Sets the laser in Track mode.
23. Stop Range Button: Displays/sets end of scan wavelength.
24. Trigger SMB Connector: Triggers scan with external pulse.
25. Scan Button: Initiates a scan.
26. Start Range Button: Displays/sets start of scan wavelength.

Manual Operation

Using the Front Panel

Make sure the controller is plugged into a wall socket and your laser head cable is plugged into the back of the controller. Point the laser head in a safe direction, and check that the AC power input connector is configured for the correct line voltage. (See "AC Operating Voltages" on page 85 for information about the AC power input to the controller.)

Turn on the AC power with the power switch on the left-hand side of the back panel. The calibration table, GPIB address, baud rate, laser-head serial numbers, and other pertinent operating information stored in an EEPROM in the laser head are uploaded to the controller. The LED displays will show the model number, head software revision number, and controller software revision number. After a few seconds the display will become active. About 30 minutes of warm-up time is recommended for best performance.

The top half of the front panel contains all the indicators and readouts while the lower half has control knobs to adjust operating parameters.

The AC Power switch is the "on-off" for the whole unit including the laser head. The Laser Power button controls the laser output. When you push the Laser Power button, it flashes for a 5-second safety delay and then lights up to indicate that current is flowing through the diode laser in the laser head unit. This allows you to set up all the desired operating parameters with the AC Power on but while the laser is not generating light.

The Addressed and Remote indicator LEDs are status indicators. Addressed lets you know if your computer has established contact with

the laser via GPIB or RS-232, while Remote indicates that the laser is actually in Remote mode with temperature, piezo voltage, and laser current set by the computer. If you need to cancel at any time, pushing the Local button will restore Local mode with full front panel control.

Fine Frequency Control

The Piezo Voltage is used for fine (sub-angstrom) wavelength tuning. A piezoelectric transducer (PZT) is used to make adjustments in the tuning mirror angle that are too small to be made the by DC motor. The readout is in percent of the maximum PZT voltage from 0 to 100%.

The Piezo Voltage control can change the wavelength over a several angstrom range, which is easily seen on a wavemeter of sufficient accuracy. (If, however, the laser is in Track mode, the DC servo motor will counteract the piezo and the wavelength will change relatively little.)

Wavelength Display

The Wavelength readout can display operating wavelength, scan speed, scan start and stop wavelengths, GPIB address, and serial baud rate.

Wavelength Track Mode and Ready Mode

When the Track light is on, the laser is in the Track mode, and you can use the Wavelength Adjust knob to change the wavelength. When the Track light is off, the Wavelength Adjust knob is disabled and the laser is in the Ready mode. Push the Track button to switch between Track and Ready Modes. In Track mode the laser wavelength is actively controlled using the tuning motor that rotates the end mirror. In Ready mode the laser runs open loop without active wavelength control. **Because of the nature of the wavelength control scheme however, note that the wavelength of the laser is significantly more stable in Ready mode than it is in Track mode.**

With the laser in Track mode you can set the wavelength by rotating the Wavelength Adjust knob. Note that the display shows 0.01 nm

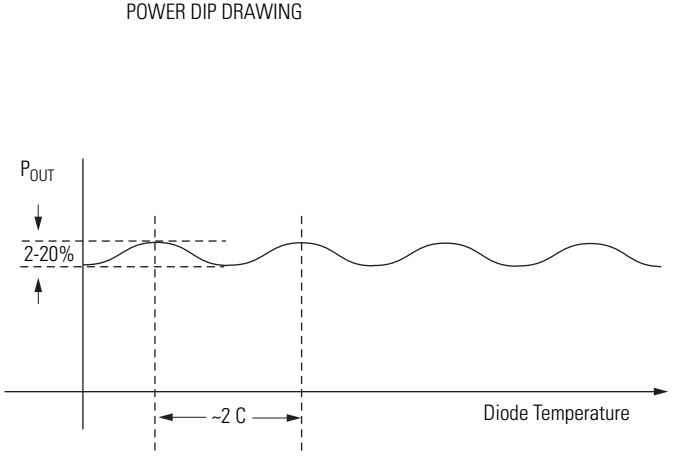
resolution for setting the wavelength but only 0.1 nm resolution once the operating wavelength is established. This is because the precision with which you can set the wavelength is greater than the accuracy of the wavelength readout.

When you select a new wavelength with the Wavelength Adjust knob, the DC motor moves the end mirror until the new wavelength is reached.

Setting the Temperature

Normally you will leave the temperature at the recommended operating temperature shown on the Acceptance Test Data Sheet. There may be certain wavelengths near the limits of your laser's tuning range where the light output power will drop significantly. This can happen because of residual étalon effects caused by small reflections at the antireflection coated facet of the diode laser. In this case, it is possible to change the diode temperature to shift the gain curve and increase the gain at the desired wavelength. (See Figure 9.) It is also possible to operate the laser in Constant Power mode, which will help to eliminate this problem. (See "Constant Power Mode" on page 35.)

Figure 9: Changing temperature to avoid power dips



Set the parameter display to Temperature, °C by pressing the Display button until the Temperature LED is on. Enable temperature adjustment by pressing the Set button. (Set LED will be on.) Turn the

Adjustment Knob to set the desired temperature. Press the Set button again to return the parameter display to Ready mode. However, be aware that if either the diode temperature or the cavity temperature rises as high as 35°C, the instrument will shut down.

Setting Current/Power

The New Focus ECDL is designed to run on a single longitudinal mode. The system is typically set so that the drive current is below the threshold of multimode operation. Under these conditions, the current display is continuously on. However, it is possible to increase the drive current in order to increase the output power. The trade-off is that there is increased risk of multimode operation. When the drive current is sufficiently high that mode hops are a risk, the current display will flash. The current settings for multimode operation may be wavelength dependent. Please refer to the included Acceptance Test Data Sheet for actual settings.

Scanning

The laser cavity is carefully adjusted to give the best tuning performance when tuned from short to long wavelength. Therefore, when scanning the laser, it is best to approach the desired wavelength from the short wavelength side.

Setting the Start and Stop Wavelengths

Press the Start button and hold it there. The Wavelength readout changes when you do this to display the starting wavelength for scanning. While holding the Start button, you can change the start-of-scan wavelength by turning the Wavelength Adjust knob.

Setting the end-of-scan wavelength is just as easy as setting the starting wavelength. This time you hold the Stop button while you use the Wavelength Adjust knob. The laser will scan in whichever direction you set it. The stop wavelength can be larger or smaller than the start wavelength, but it is recommended to scan from short to long wavelengths.

Setting the Scan Speed

The next step is to set the scanning speed. If you press down the Fwd Scan Speed button, the Wavelength readout will display the forward scan speed. To set the scan speed, turn the Wavelength Adjust knob. (It is possible to adjust the scan speed in 0.01 nm/s increments.) The return scan (stop to start) speed can also be set by pressing down the Rev Scan Speed button.

Performing a Scan

To start a scan, push the Scan button. If the laser was in Track mode, the Track LED will turn off. If the laser is at the start wavelength, it will begin scanning at the scan speed. Otherwise it will go to the Start wavelength at the return scan speed and wait. Push the Scan button again and the laser will begin scanning. When the laser arrives at the Stop wavelength it will stop and wait there. If you push the Scan button again, the laser will reset to the Start wavelength.

There is a Trigger (SMB-type connector) input (an SMB to BNC adapter is supplied with the laser) under the Scan Start/Stop switch. Applying a voltage which rises above 3 V and returns to zero to this input is equivalent to depressing and releasing the Scan button.

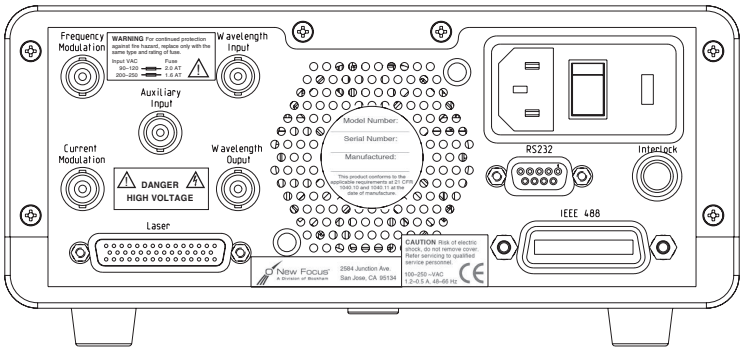
Stopping a Scan

If you push the Scan button in the middle of a scan or a reset, it will stop, leaving you in Ready mode. If you push the Track button in the middle of a scan or a reset, the scan will be halted, and the controller will be in Track mode.

Back Panel and Laser Head Connections

There are several input and output connectors on the back panel of the controller. They allow you to operate your laser with external analog or digital signals.

Figure 10: Back panel of laser controller



An Interlock connector is provided for external safety systems. The laser will not emit light unless the Interlock terminals are shorted.

Five BNC inputs are provided for external analog control. GPIB (IEEE-488) and RS-232 are available for computer interfacing. For information on computer control, see "Computer Control" on page 37. Analog BNC inputs and outputs are available for Frequency Modulation, Current Modulation, Wavelength Output, Wavelength Input, and Detector Input. In addition there is an SMA connector on the laser head for high-speed current modulation.

Frequency Modulation Input

The Frequency Modulation input is for external analog control of the wavelength through the voltage applied to the PZT on the tuning arm. It is useful for making fine-frequency adjustments and for FM spectroscopy. Sweeping the Frequency Modulation input from -3 V to +3 V corresponds to changing the laser frequency by an amount on the order of -30 GHz to +30 GHz for the Model 6316. The actual modulation you will observe depends on the wavelength range of the laser head (see the Acceptance Test Data Sheet of your particular laser) and on the rate and amplitude of the incoming signal (for example, full 30-GHz modulation is only available at rates up to 200 Hz). The Frequency Modulation input will accept signals from DC to 2 kHz (3-dB rolloff point).

Increasing voltage at the Frequency Modulation input corresponds to a decrease in piezo voltage and an increase in laser frequency (or a decrease in laser wavelength). This decrease in piezo voltage is effectively subtracted from the front-panel knob setting, and the front-panel display reads the result.

Current Modulation Input

The Current Modulation input allows you to modulate the diode current at rates up to 1 MHz. This input accepts -10 to +10 V into a DC-coupled 5 k Ω resistive load and provides 0.2 mA/V modulation. This input is summed with the front-panel setting. Note that the front panel current readout does not reflect the modulation input.

High-Speed Current Modulation

For high-speed current modulation up to 100 MHz, an SMA connector on the laser head is provided. This input is AC coupled; the low- and high-frequency roll off points are 50 kHz and about 100 MHz, depending on the model. The current modulation provided by this input is approximately 20 mA/V. To prevent damage to the diode laser, the voltage swing on this input must be less than 1 $V_{p\text{-}p}$.



This is a direct RF connection to the laser diode. Improper use could destroy the diode. Do not exceed 1 V peak-to-peak input. Avoid static discharge.

Since this is a direct connection to the diode laser, there is no current limiter that prevents too much current from passing through the diode. Thus, there is a danger of destroying the diode if the maximum current is exceeded. Be sure that the current modulation applied to the laser diode will not result in driving the diode above its maximum current. (See included Acceptance Test Data Sheet.)

The high-speed input has a protective shorting cap which should remain in place during normal operation. When removing the shorting cap to connect a high-frequency driver, be sure to wear a ground strap to prevent static discharge. Please contact New Focus if you have any questions on how to use the high-speed modulation input. Make sure

to turn off power to the diode before connecting any device to the high-speed input.

Wavelength Output

The Wavelength Output BNC connector provides a signal from 0 to 10 V that corresponds linearly to the laser output wavelength. This connection has 3 k Ω output impedance. Zero volts are output at the minimum operating wavelength for the laser head connected to the controller. The voltage increases with wavelength according to the equation:

$$V = f \cdot \Delta\lambda,$$

where Δλ is in nanometers and the parameter f depends on the particular laser center wavelength. Typically, f is between 0.2 and 1 V/nm. See the Acceptance Test Data Sheet for the particular Wavelength Output characteristics of your laser.

Wavelength Input

The Wavelength Input connector is for coarse analog control of the wavelength. For example, you could use it for your own analog wavelength scanning control. The DC signal that you apply to the Wavelength Input is digitized and sent to the motion control board for wavelength control. You can scan it as fast as the fastest internally controlled scan. If your analog control signal is not too noisy you should be able to control the wavelength in angstrom or even sub-angstrom increments. Note however, that if you don't have a quiet analog control voltage, this mode of operation has less wavelength stability than Track mode.

If you want to use the Wavelength Input connector, you must first place the laser in Wavelength Input mode. To do this you must first be in Track mode. Then push the Fwd Scan Speed and Start Range buttons at the same time. The wavelength display will show all ones (111111) and the Track light will begin to flash on and off. The laser will immediately begin changing to the wavelength which corresponds to the voltage at the input. The Wavelength Input connector accepts a DC signal between 0 and 10 V that corresponds linearly to the laser output

wavelength in the same way as the Wavelength Output jack does. The input impedance of this control is 51 k Ω. Note that an unconnected wavelength input corresponds to zero volts and the minimum wavelength. If the maximum voltage is exceeded, the diode laser will tune to its maximum wavelength and stop. In this case, the wavelength readout will flash, indicating you have exceeded the maximum input voltage. The laser will then be kicked out of Wavelength Input mode into Track mode. The same thing happens if you input a voltage less than the voltage corresponding to the minimum wavelength. To stop the flashing, either press the Local button or use the Wavelength Control knob to shift the wavelength a few angstroms off the edge.

To exit Wavelength Input mode, push the Rev Scan Speed and Stop Range buttons at the same time. The LED will stop flashing, the wavelength will remain where it is, and the controller will return to Track mode. Note that the wavelength control knob is disabled while the laser is in Wavelength Input mode. Also, if you exit Track mode and then re-enter, the laser will still be in Wavelength Input mode.

Detector Input

The Detector Input is a 10-bit analog-to-digital converter input to the microprocessor. Analog signals that you connect here can be read out by your computer when you use remote control. This is a general-purpose input that allows you to collect data from a photodetector during a wavelength scan or for example, to create your own Constant-Power mode with an external detector. The Detector Input will accept signals from 0 to +5 volts and presents a 51 k Ω load.

Constant Power Mode

Constant Power mode provides an easy way to remove the power modulation due to the étalon effect caused by the residual facet reflectivity when scanning the wavelength, or to stabilize the laser power to minimize long -term power drift. A digital feedback loop is implemented in the firmware to keep the laser power at a set level by controlling the laser current. Because of the relatively long loop time (~ 20 ms), we recommend using this mode with a scan speed under 1% of the maximum speed.

To enable Constant Power mode, press the Mode button. The Constant Power LED should be on. Note that the controller is set to Remote mode when Constant Power mode is enabled. This means that in Constant Power mode you can only adjust the diode temperature and the PZT voltage through either GPIB or RS-232 commands. There are two ways to disable Constant Power mode. You can press the Mode button again. This will leave the controller in Remote mode. Or, you can press the Local button. This disables both Remote and Constant Power modes. After leaving this mode, the power setting is stored in memory.

Computer Control

Introduction

Anything you can adjust from the front panel, you can also adjust by computer control. The 63XX Series system gives you an unprecedented level of external control over a high-precision, narrow-bandwidth laser source. Computer control lets your computer communicate with the laser controller to set or read a variety of operating parameters and perform actions.

The controller is always in one of two operating modes, Local mode or Remote mode. The operating mode is independent of computer control or manual control. The wavelength can be set or scanned in either operating mode. The piezo voltage, the diode temperature, and the diode current, on the other hand, are all either controlled at the front panel (Local mode) as discussed earlier, or all by internal digital-to-analog converters (DACs) that can be set remotely (Remote mode). When any one of these DACs is set by computer control, all three are then forced into Remote mode. The unspecified values default to their front-panel settings at the moment of the switch to Remote mode. Pressing the Local button returns the laser to Local mode. Back panel inputs and outputs are still active in Remote mode. Note that the controller will allow communication over the computer interface without switching to Remote mode. Only commands which alter the state of the instrument will switch it into Remote mode. For example, you can use a computer to monitor all laser operating parameters while manually changing the wavelength from the front panel.

GPIB

GPIB is a standard protocol for personal computers to communicate with laboratory instruments, and several manufacturers make plug-in cards for this purpose. Consult the user's manual of the GPIB card for specifics in configuring and addressing the card in your chosen programming language. In QuickBasic, commands are sent to the laser controller through, for example, the GPIB instructions IBWRT and IBRD. IBWRT sends an instruction to the controller; IBRD reads the controller's response to the command. Examples of controller responses are "OK" or "772.3".

Setting the GPIB Address

To set the GPIB address of the laser controller, the controller must be in Ready mode. Press (and hold) the GBIP button, then turn the Wavelength Adjust knob until the number of the address you want appears in the Wavelength readout display. You can set the address to be anything from 1 to 31. In the examples that follow we assume that you set your laser controller to address 1. Note also that the GPIB address is stored in the laser head, so that if you switch heads, you should check to make sure that the second head has the same GPIB address as the first.

RS-232

RS-232 is a widely available standard for communication via your computer's serial port. Almost every computer has an RS-232 interface. The one drawback is you can only communicate with one instrument at a time with serial communication. You will need to know how to send commands to your computer's RS-232 serial port. Any terminal emulation program will let you send and receive via the serial port interactively.

RS-232 ports can be configured for operation in DTE or DCE mode. The laser controller is configured as a DCE port. This means that the laser controller receives data on pin 2 and transmits data on pin 3.

Each RS-232 command begins with an @ sign and ends with a carriage return (<cr>). The @ sign indicates to the addressed device that a command is following. In other respects, RS-232 commands are identical to the GPIB commands. RS-232 commands are sent as a continuous string. For example: "@WAVE 671.84 <cr>".

The controller does not echo the command. If you send an action command (such as change the current or tune the wavelength), the controller will return one of the following responses: "OK" if the command was properly executed, "Out of Range" if a source value is outside the allowed range, or "Unknown Command" if the command was not recognized. If the command is a Source Query or a Sense Command, the controller will return a value or "Unknown Command" if the command was not recognized. For example: if you send "@WAVELENGTH? <cr>", you might get back "671.8".

Setting the RS-232 Communications

RS-232 communications may be performed at 300, 1200, 2400, 4800, 9600, or 19200 baud. The data format is 8 bits, no parity with 1 stop bit. The laser must be in Ready mode to change the controller's baud rate. Press the RS-232 button. Turning the Wavelength Control knob changes the baud rate.

Programming Examples

Next, we present three elementary programs written in QuickBasic. These example programs demonstrate the basics of communicating with your controller through GPIB or RS-232.

The section that follows these programming examples details the entire command set and describes the use and syntax of all the commands.

Example 1

This simple QuickBasic program asks the user for a wavelength and then tells the laser to tune to that wavelength. If you are using a National Instruments GPIB card in your computer, be sure to read the file GPIBPC\QBASIC\README.QB for instructions on using the QuickBasic interactive environment with GPIB. Cards made by other manufacturers will have similar instructions.

```
'The next line must be included for QuickBasic to work with
a National Instruments GPIB card:

'$INCLUDE:'qbdecl.bas'

'Clear screen; allocate 32 spaces to the string variable
buff$

CLS

buff$ = SPACE$(32)

'Find the laser controller at GPIB address #1

CALL IBDEV(0, 1, 0, T10s, 1, 0, nflaser%)
'           |  |  |   |    |   |  |
'           |  |  |   |    |   |  used to specify device in IB
'           |  |  |   |    |   |  function calls
'           |  |  |   |    |   EOS character and modes
'           |  |  |   |    EOI mode of the device
'           |  |  |   I/O timeout value (10 s)
'           |  |  secondary GPIB address
'           |  primary GPIB address, change if laser is at a
'           |  different address
'           GPIB board number
```


New Focus A Division of Bookham

```
'Clear the controller's GPIB port. nflaser% is an integer
that 'identifies the laser. It was set by IBDEV above; we
never need 'to know its value, except that it is set to -1
if IBDEV fails 'to find the device.
CALL IBCLR(nflaser%)
'Ask user for a wavelength in nanometers. wavelength! is a
'single precision, floating point number; 775.1, for
example.
INPUT "What wavelength would you like [nm] ? ",
wavelength!
'Use IBWRT to send the :WAVELENGTH command to the
controller. 'Example: IBWRT(nflaser%, ":WAVELENGTH 772.0")
'The STR$() function converts numbers to strings
CALL IBWRT(nflaser%, ":WAVELENGTH " + STR$(wavelength!))
'Read the output buffer
CALL IBRD(nflaser%, buff$)
'Print the contents of the output buffer: "OK" if the
operation was successful, "Out of Range" if wavelength is
not valid, etc.
PRINT
PRINT buff$
'Return to local control
CALL IBONL(nflaser%, 0)
END
```

Example 2

This is the same as the last program except that this time we use RS-232 communications instead of GPIB.

```
'Ask user for a wavelength in nanometers. wavelength! is a
'single precision, floating point number; 775.1, for
example.
INPUT "What wavelength would you like [nm] ? ",
wavelength!
'RS-232 commands should be preceded by "@"
MESSAGE$ = "@:WAVE ?" + STR$(wavelength!)
'Open the serial communications (RS-232) port (with baud
rate '9600, 8 data bits, no parity, and 1 stop bit).
OPEN
"COM2:9600,N,8,1,ASC,CD0,CS0,DS0,OP500,RS,TB512,RB512" FOR
RANDOM AS #1
'Send the message to the controller
PRINT #1, MESSAGE$
'Read and print the response from the controller
LINE INPUT #1, RESPONSE$
PRINT RESPONSE$
'Close the port
CLOSE #1
END
```

Example 3

This program sets up and executes a wavelength scan using GPIB. Be sure to look at Example 1 before reading this program.

```
'$INCLUDE: 'qbdecl.bas'

CLS

buff$ = SPACE$(32)

'Find the laser controller at GPIB address #1

CALL IBDEV(0, 1, 0, T10s, 1, 0, nflaser%)

CALL IBCLR(nflaser%)

'Set up start and stop wavelengths

INPUT "What start wavelength would you like [nm] ? ",
wavelength!

CALL IBWRT(nflaser%, ":WAVELENGTH:START " +
STR$(wavelength!))

INPUT "What stop wavelength would you like [nm] ? ",
wavelength!

CALL IBWRT(nflaser%, ":WAVELENGTH:STOP " +
STR$(wavelength!))

'Set forward and return scan speeds to their maximum
values

CALL IBWRT(nflaser%, ":WAVELENGTH:SLEW:FORW 100")

CALL IBWRT(nflaser%, ":WAVELENGTH:SLEW:RET 100")

'Get ready to scan

CALL IBWRT(nflaser%, "OUTPUT:SCAN:RESET")

PRINT "Tuning to the start wavelength...."

'Wait until laser gets to start wavelength. Here we use the
'*OPC? (operation complete ?) query to see if
:OUTPUT:SCAN:RESET 'has finished

ready% = 0

WHILE ready% = 0
    CALL IBWRT(nflaser%, "*OPC?")
    CALL IBRD(nflaser%, buff$)
    ready% = VAL(buff$)
```

```
WEND
'Start scan
PRINT "Push any key to begin the scan."
WHILE INKEY$ = "": WEND
CALL IBWRT(nflaser%, ":OUTPUT:SCAN:START")
END
```

Command Summary

Conventions

With GPIB and for programs written in QuickBasic, all commands are issued using the IBWRT function call in a program. To read the controller's response to a command, use the IBRD function call.

For RS-232 operation, use @ to get the attention of the controller before starting command entry, and end each command with a carriage return (<cr>). The controller's response is automatically sent.

The portions of the commands in square brackets [ ] are optional and can be omitted without affecting the command. Also, the lower case portion of the commands may be omitted.

- <wsp> means white space; either a tab or a space
- <value> is a floating point number
- OFF|ON|0|1 means OFF or ON; 0 or 1 are also accepted

Multiple commands on a line are not allowed. For instance, if the controller receives: "WAVE 670.22;*IDN?", it will change the wavelength to 670.22, but the Identification Query will be ignored.

Numbers may contain at most 15 characters. In most cases, however, this constraint will not be an issue. The number 670.22 will be read correctly, but the number 0000000000000670.22 will be read as 67.

The examples given on the following pages show the text to be included in the command and the response from the controller. With RS-232 serial communications the response is sent immediately and the user may process or ignore the data. With GPIB communications, the response is loaded into the output buffer, and the user may read it with

a GPIB read or else ignore it. For instance, the example for *IDN? appears as follows:

```
*IDN?

—> NEW FOCUS 6304 H2.04 C2.01
```

The *IDN? is the command that is sent to the controller either over GPIB or RS-232. The arrow symbol (—>) indicates the response from the controller, which in this example is NEW FOCUS 6304 H2.04 C2.01.

Types of Commands

There are six general types of commands: Standard Commands, Output Commands, Sense Commands, Source Controls, Source Queries, and System Commands.

Standard Commands allow you to get information about the laser head and to query whether an operation has been completed. Output Commands tell the laser to start some action such as starting or stopping a scan or reset. System Commands set the operating mode of the controller.

Source Controls set laser operating parameters. These parameters fall into two categories. Those that use the internal digital-to-analog converters (DACs) and those that do not. The piezo voltage, the diode temperature and the laser diode current can be controlled either from the front panel with potentiometers or from voltages generated by internal DACs. The other parameters, wavelength, scan speeds, and scan start and stop wavelengths, are independent of whether the potentiometers or the DACs have control.

When the front panel has control, the laser is considered to be in Local mode. When the internal DACs have control, the laser is considered to be in Remote mode. Setting any one of the three DAC parameters forces the other two under DAC control as well, and the controller will be placed into Remote mode.

Each Source Control has an accompanying Query. Source Queries return the value of various controller set points. A Source Query of diode current, diode temperature, or piezo voltage is only meaningful if

the laser is in Remote mode. For this reason, if any of those three parameters are queried while the laser is in Local mode, the laser is placed in Remote mode with the current, temperature set point, and piezo voltage taking on the last front-panel values they had before the switch.

Sense Commands return the value of various laser operating conditions. Note that there is an important difference between Sense Commands and Source Queries. Sense Commands read actual voltages, currents, temperatures, or wavelengths; the value returned is the same as that seen on the controller front panel at the time the command is executed. In contrast, Source Queries read set points (values that are theoretical goals). These values may not necessarily match the values displayed on the front panel. For instance, the queried diode current and piezo voltages can differ from the actual values by up to 3% due to component variations such as resistor tolerances. However, in the case of wavelength queries, the wavelength set by a Source Command will match the wavelength returned by a Source Query because each laser is factory calibrated and has its specific wavelength-calibration table loaded into the laser head.

The next section has an index of all the possible computer control commands. Then, the pages that follow the index of commands give detailed information about each command, including a description of the command and examples of how the command is used.

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Command Definitions

System Status

Identification Query

Syntax *IDN?

Description Returns the system identification string containing the manufacturer, model number of the laser, and the head revision and controller revision numbers of the software.

Example

```
*IDN?
—> NEW FOCUS 6304 H2.04 C2.01
```

(Manufacturer = New Focus, Model= 6304, Head Revision = 2.04, Controller Revision = 2.01)

Operation Complete Query

Syntax

```
*OPC?
```

Description

The laser has three long-term operations:

- Scanning (see `:OUTPut:SCAN:STARt`)
- Resetting (see `:OUTPut:SCAN:RESEt`)
- Set Wavelength (see `[:SOURce]:WAVElength`)

Starting any of the above three operations clears the OPC status bit. When the laser 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 `SCAN:STOP`, which interrupts a `SCAN` or `RESEt`, or `OUTPut:TRACk OFF`, which interrupts a Wavelength Set.

Response

Returns `0` if performing a long-term operation. Returns `1` if system is available.

Example

During a wavelength scan:

```
*OPC?
—> 0
```

Set Control Mode (Remote/Local)

Syntax

`:SYSTem:MCONtrol<wsp><INT|EXT>`

Description

Puts controller into Local mode (external) or Remote mode (internal).

Forces the laser to use internal DACs or front-panel potentiometers for control of piezo voltage, diode temperature set point, and diode current.

Response

`EXT` or `INT`

`EXT` returns control of diode-temperature set point, diode current and piezo voltage to the front-panel potentiometers.

- If the laser is already in Local mode, the command has no effect.
- If the laser is not in Local mode, Constant Power mode is disabled.
- *Note: The pots are absolute, not relative, so if they have changed the values will reflect that change.*

`INT`

If the laser is not in Remote mode:

- Diode temperature set point, diode current and piezo voltage are sensed and used as targets for the DACs.
- Front-panel displays will change as sensed and target values can differ by up to 3% due to component variations (such as resistor tolerances).

  Note: In Remote mode the front-panel potentiometers are ignored, but they are still active. If a potentiometer is changed to an extreme setting and the controller is then switched back to external control, the corresponding parameter will then move to the extreme setting.

If the laser is already in Remote mode:

- Command has no effect.

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.

Works the same whether the laser is in Remote mode or Local mode.

Argument `OFF, ON, 0,` or `1.`

`0` or `OFF` turns the laser off,
`1` or `ON` turns the laser on.

Example

```
:OUTP 0
—>OK
```

(Turns off power to the laser.)

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

```
:OUTP?
—>1
```

(The laser is turned on.)

Sense Commands

Sense Diode Current

Syntax `SENSe:CURRent[:LEVel]:DIODe`

Description Returns the magnitude of the laser-diode current. 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
```

(Front-panel current reading is -59.2.)

Sense Front-Facet Power

Syntax `:SENSe:POWer[:LEVel]:FRONt`

Description Returns the laser-output power in milliwatts. The value returned is exactly the same as that seen on the front panel of the controller at the time the command is executed.

Note: There are two power readings. One is derived from a front-facet measurement and the other from a back-facet measurement. The front-facet power measurement looks at light sampled with a beam splitter at the laser head output. The back-facet measurement is merely proportional to the optical power emitted from the rear facet of the laser-gain element. It is provided for backward compatibility with 6100 series laser heads or as a diagnostic.

Response "x.x"

Units: milliwatts (mW).

Example

```
SENS:POW:FRON
—> 2.6
```

(The output power indicator on the front panel reads 2.6 mW.)

Sense Rear-Facet Power

Syntax

```
:SENSe:POWer[:LEVel]:REAR
```

Description

Returns a number proportional to the power emitted from the rear facet of the laser-gain element. This is provided for backward compatibility with 6100 series laser heads or as a diagnostic. Use the front-facet power measurement to determine the actual optical power output from the laser.

Response

"x.x"

Units: milliwatts (mW).

Example

```
SENS:POW:REAR
—> 2.9
```

Sense Diode Temperature

Syntax

```
:SENSe:TEMPerature:LEVel:DIODe
```

Description

Returns the temperature of the laser-diode gain element. This value is exactly the same as that which appears on the front panel of the laser.

Note: The diode temperature is actively controlled. If the room temperature ever gets so high that the coolers have insufficient capacity to reduce the temperature, the control loop can become unstable and destroy the cooling elements. To prevent damage, the laser is automatically shut down if the laser-diode gain element temperature exceeds 35 °C.

Response

"x.x"

Units: °C.

Example

```
SENS:TEMP:LEV:DIOD
—> 21.1
```

(The diode temperature is 21.1 °C.)

Sense Cavity Temperature

Syntax

`:SENSe:TEMPerature:LEVel:CAVity`

Description

Returns the temperature of the laser cavity. This value is exactly the same as that which appears on the front panel of the laser.

Note: The laser-cavity temperature is actively maintained by the controller at about 30 °C. There is no command to set or change the cavity temperature set point. If the room temperature gets high enough that the coolers have insufficient capacity to reduce the temperature, the control loop can become unstable and destroy the cooling elements. To prevent damage, the laser is automatically shut down if the laser-diode gain element temperature exceeds 35 °C

Response

"x.x"

Units: °C.

Example

```
SENS:TEMP:LEV:CAV
—> 30.0
```

(The diode temperature is 30.0 °C.)

Sense Diode-Temperature Set Point

Syntax

`:SENSe:TEMPerature:SETPoint:DIODe`

Description

Returns the current temperature set point for the laser-diode gain element. This value is exactly the same as the set point that appears on the front panel of the laser. The diode temperature is maintained by an analog control loop. This command returns the measured set point of the control loop. This value can be changed either from the front panel or with the `SOURce:TEMPerature` command.

Response

"x.x"

Units: ° C.

Example

```
SENS:TEMP:SETP:DIOD
—> 21.1
```

(The diode-temperature set point is 21.1 °C.)

Sense Cavity-Temperature Set Point

Syntax

```
:SENSe:TEMPerature:SETPoint:CAVity
```

Description

Returns the current temperature set point for the laser cavity in degrees Celsius. This is the only way this value can be read; it cannot be read from the front panel.

This command returns the set point for the control loop inside the controller. This quantity is set at the factory and cannot be changed by the user.

Response

"x.x"

Units: ° C.

Example

```
SENS:TEMP:SETP:CAV
—> 30.0
```

(The cavity-temperature set point is 30.0 °C.)

Sense Piezoelectric Voltage

Syntax

`:SENSe:VOLTage[:LEVel]:PIEZo`

Description

Returns the current piezo voltage setting. This value is the same as that which appears on the front panel of the laser.

Note: As the piezo voltage increases, the lasing frequency increases and the wavelength decreases.

Response

"x.x"

Units: % of maximum from 0 to 100%

Example

```
SENS:VOLT:PIEZ
–> 66.8
```

(The piezo voltage setting is 66.8% of maximum.)

Sense Voltage from Detector Input

Syntax

`:SENSe:VOLTage[:LEVel]:AUXiliary`

Description

Returns the voltage at the auxiliary Detector Input on 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 5/1024 = 4.88 mV.

Response

"x.xxx"

Range: 0 to 5

Units: volts (V)

Example

```
SENS:VOLT:LEV:AUX
–> 1.22
```

(The Detector Input sees 1.22 V.)

Sense Output Wavelength

Syntax `:SENSe:WAVElength`

Description Returns the current wavelength of the laser. This value will match the front-panel display exactly. Each laser is calibrated with respect to wavelength at the factory and a calibration table loaded into the laser head.

The wavelength set by a Source Command will match the sensed wavelength to the number of decimal points returned. The number of decimal points depends on the accuracy of the angle-measurement technique used to measure the wavelength. Currently, the accuracy of this measurement is 0.1 nm.

Response "x.x"

Units: nanometers (nm).

Example `SENS:WAVE`

`—> 679.6`

(The wavelength is 679.6 nm.)

Scan Commands

Stop and Return to Start Wavelength

Command Syntax `:OUTPut:SCAN:RESEt`

Description The wavelength is reset to the start wavelength at the return slew rate. If a scan is in progress it will be interrupted and the wavelength reset to the start wavelength.

This function works the same whether the laser is in Remote mode or Local mode.

The `*OPC?` command will return `0` until the start wavelength is reached.

Example

The current wavelength is 672 nm, the Start Wavelength is 670.0 nm, and the Return Slew Rate is 6 nm/s.

```
OUTP:SCAN:RESET
—> OK
```

(The laser wavelength is changed at 6 nm/s until the wavelength 670.0 nm is reached.)

Start/Restart Scan

Syntax

`:OUTPut:SCAN:STARt`

Description

Begins scanning from the current wavelength to the stop wavelength at the forward slew rate.

Works the same whether the laser is in Remote mode or Local mode.

The `*OPC?` command will return `0` until the stop wavelength is reached.

Example

The current wavelength is 670.0 nm, the Stop Wavelength is 672.0 nm, and the Forward Slew Rate is set at 5 nm/s.

```
OUTP:SCAN:START
—> OK
```

(The laser wavelength is tuned at 5 nm/s until 672.0 nm is reached.)

Stop/Pause Scan

Syntax

`:OUTPut:SCAN:STOP`

Description

Stops a scan or reset (if one is going on), leaving the laser in Ready mode. Works the same whether the laser is in Remote mode or Local mode.

The OPC flag is set to 1 showing that the `SCAN` or `RESET` is stopped.

Example

The laser is performing a scan, and then the following commands are issued to the controller:

```
*OPC?
—> 0
OUTP:SCAN:STOP
—> OK
*OPC?
—> 1
```

(The scan is stopped, the controller is in Ready mode, and the wavelength is set to the wavelength the laser was at when the command was issued.)

Switch from Track Mode to Ready Mode

Syntax

```
:OUTPut:TRACk OFF
```

Description

Takes the laser out of Track mode and places it in Ready mode (the quiet mode of operation).

Note: Issuing a SOURce:WAVElength command, for instance, will place the laser in Track mode, and OUTPut:TRACk OFF is the way to get back into Ready mode.

Works the same whether the laser is under front panel or DAC control.

Example

The laser wavelength has been set to 672.4 nm with a WAVE 672.4 nm command. The Track LED is on.

```
:OUTP:TRAC OFF
—>OK
```

(The laser is still at 672.4 nm but is now in Ready mode. The Track LED is off.)

Set Forward Slew-Rate

Syntax

`[:SOURce]:WAVElength:SLEWrate:FORWard <value|MAX>`

Description

Write the forward slew rate for a wavelength scan.

This command does not affect and is not affected by whether the laser is in Local mode or Remote mode.

If the value is out of range:

- Returns Out of Range.
- No other action is taken.

If the value is in range:

- Returns OK.
- Forward wavelength slew rate is set to the desired value.
- The slew rate only affects scanning. The slew rate during a wavelength change from a `SOURCE:WAVELENGTH` command is always at the maximum value.

Argument

"x.xx"

`MAX` sets the laser to its maximum scan rate. MAX is laser dependent.

Range: 0.01 ≤ VALUE ≤ MAX

Units: nm/s

Example

```
WAVE:SLEW:FORW MAX
—> OK
```

(The wavelength now changes at its maximum rate.)

```
WAVE:SLEW:FORW 0.05
—> OK
```

(The wavelength now changes slowly at 0.05 nm/s.)

Query Forward Slew-Rate

Syntax

`[:SOURce]:WAVElength:SLEWrate:FORWard?`

Description

Returns the current forward slew rate.

Response

"x.xx"

Units: nm/s

Example

```
WAVE:SLEW:FORW?
—> 0.05
```

(The current forward slew rate is 0.05 nm/s.)

Set Return Slew-Rate

Syntax

`[:SOURce]:WAVElength:SLEWrate:RETurn <value|MAX>`

Description

Write the return slew rate for a wavelength scan.

This command does not affect and is not affected by whether the laser is in Local mode or Remote mode.

If the value is out of range:

- Returns Out of Range.
- No other action is taken.

If the value is in range:

- Returns OK.
- Return slew rate is set to the desired value.

The slew rate only affects scanning. The slew rate during a wavelength change from a `SOURCE:WAVELENGTH` command is always at the maximum value.

Argument

"x.xx"

`MAX` sets the laser to its maximum scan rate. MAX is laser dependent.

Range: 00.1 ≤ VALUE ≤ MAX

Units: nm/s

Example

```
WAVE:SLEW:RET 0.05
—> OK
```

(The wavelength now changes at 0.05 nm/s.)

Query Return Slew-Rate

Syntax	`[:SOURce]:WAVElength:SLEWrate:RETurn?`
Description	Returns the current return slew rate.
Response	"x.xx" Units: nm/s

Example	`WAVE:SLEW:RET`
	`–> 0.05`
	(The current return slew rate is 0.05 nm/s.)

Query Maximum Slew-Rate

Syntax	`[:SOURce]:WAVElength:SLEWrate:MAX?`
Description	Returns the maximum slew rate.
Response	"x.xx" Units: nm/s

Example	`WAVE:SLEW:MAX?`
	`–> 3.05`
	(The maximum return slew rate is 3.05 nm/s.)

Set Starting Wavelength

Syntax

```
[:SOURce]:WAVElength:STARt
<value>[NM|ANG]
```

Description

Write the start wavelength for a scan.

This command does not affect and is not affected by whether the laser is in Local mode or Remote mode.

If the value is out of range:

- Returns Out of Range.
- No other action is taken.

If the value is in range:

- Returns OK.
- Start wavelength is given a new value.

Argument

"x.x"

Range: MIN ≤ VALUE ≤ MAX
MIN and MAX are laser dependent.

Units: nm is the default; `ANG` indicates angstroms

Example

```
WAVE:START 770
—> OK
```

(The start wavelength is now 770 nm.)

Query Starting Wavelength

Syntax

```
[:SOURce]:WAVElength:STARt?
```

Description

Returns the current start wavelength.

Response

"x.x"

Units: nm is the default.

Example

```
WAVE:START?
—> 770.0
```

(The start wavelength is 770.0 nm.)

Set Stopping Wavelength

Syntax

`[:SOURce]:WAVElength:STOP <value>[NM|ANG]`

Description

Sets the ending wavelength for wavelength scans.

This command does not affect and is not affected by whether the laser is in Local mode or Remote mode.

If the value is out of range:

- Returns Out of Range.
- No other action is taken.

If the value is in range:

- Returns OK.
- Stop wavelength is set to the new value.

Argument

"x.x"

Range: MIN ≤ VALUE ≤ MAX
MIN and MAX are laser dependent.

Units: nm is the default; `ANG` indicates angstroms

Example

```
WAVE:STOP 774
–> OK
```

(The stop wavelength is now 774 nm.)

Query Stopping Wavelength

Syntax

`[:SOURce]:WAVElength:STOP?`

Description

Returns the current stopping wavelength.

Response

"x.x"

Units: nm is the default.

Example

```
WAVE:STOP?
–> 774.0
```

(The stop wavelength is 774.0 nm.)

Wavelength Commands

Set Piezoelectric Voltage

Syntax

```
[:SOURce]:VOLTage[:LEVel][:PIEZo]
<value>
```

Description

Sets the voltage level of the piezoelectric transducer.

This command always puts the laser into Remote mode.

If the value is out of range:

- Returns Out of Range.
- No other action is taken.

If the value is in range:

- Returns OK.
- Piezo voltage is changed.

If the laser was in Remote mode:

- Remote LED is already on.
- The piezo control DAC is driven to a voltage producing the requested percentage to within 3%.
- The diode current and temperature are unaffected.

If the laser was in Local mode:

- Remote LED comes on.
- Control of the laser is given to the DACs.
- The piezo control DAC is driven to a voltage producing the requested percentage to within 3%.
- The diode current and temperature control DACs are driven to voltages within 3% of the value they had under front-panel potentiometer control.
- The laser is now in Remote mode.

Argument

"x.x"

Range: $0 \leq \text{value} \leq 100$

Units: % of full scale.

Example

Front panel shows the following:

- Remote LED off (Local mode).
- Piezo voltage reads 30.1.
- Diode temperature set point reads 20.0.
- Diode current reads -59.2.

```
VOLT 66.8
—> OK
```

Front panel now shows:

- Remote LED on (Remote mode).
- Piezo Voltage reads 64.9.
- Diode Temperature set point reads 19.7.
- Diode Current reads -58.1.

Query Piezoelectric-Voltage Set Point

Syntax

`[:SOURce]:VOLTage[:LEVel][:PIEZo]?`

Description

Returns the piezo voltage set point

If the laser was in Remote mode:

- Remote LED is already on.
- The current, piezo voltage and diode temperature are unaffected.
- Returns the last piezo control percentage sourced.

If the laser was in Local mode:

- Remote LED comes on.
- Control of the laser is given to the DACs.
- The Piezo control DAC is driven to a voltage within 3% of the value it had under front panel control.
- The current and temperature control DACs are driven to voltages within 3% of the value they had under front panel potentiometer control. The laser is now in Remote mode.
- Returns the target piezo control percentage which is the front panel percentage at the moment the query occurred.

Response

"x.x"

Units: % of full scale

Example

```
SENSE:VOLT:PIEZO
—> 64.9
```

(returns the actual percentage)

```
VOLT?
—> 66.8
```

(returns the target percentage)

Set Output Wavelength

Syntax

`[:SOURce]:WAVElength <value|MIN|MAX>[NM|ANG]`

Description

Drives the laser to the specified wavelength.

This command does not affect and is not affected by whether the laser is in Local mode or Remote mode.

If the value is out of range:

- Returns Out of Range.
- No other action is taken.

If the value is in range:

- Returns OK.
- Wavelength is set to the desired wavelength.

*Note: You can use *OPC? to determine when the wavelength change has been completed.*

Argument

"x.xx" is the target wavelength.

`MIN` sets the laser to its minimum wavelength.

`MAX` sets the laser to its maximum wavelength.

Range: MIN ≤ VALUE ≤ MAX
MIN and MAX are laser dependent and may be queried.

Units: nm is the default; `ANG` indicates angstroms

Example

Front panel displays wavelength 679.6 nm.

```
WAVE 670.25
—> OK
```

(The wavelength starts changing at the maximum rate until it reaches 670.25 nm. The wavelength display will probably flicker between 670.2 and 670.3, as this is the round off point.)

Query Wavelength-Output Set Point

Syntax

`[:SOURce]:WAVElength?[<MIN|MAX>]`

Description

Returns the latest target wavelength. The actual wavelength may be changing due to a newly sourced value or because the laser is in the midst of a reset or a scan.

`? MIN` returns the Minimum wavelength achievable with the laser.

`? MAX` returns the Maximum wavelength achievable with the laser.

Response

"x.xx"

Units: nm is the default.

Example

```
WAVE?
—> 670.25
```

(The target wavelength is 670.25 nm.)

Source Controls

Set Diode Current

Syntax

```
[:SOURce]:CURRent[:LEVel][:DIODe]
<value>
```

Description

This command sets the diode laser current. This command always forces the laser into Remote mode.

If the value sent is out of range:

- The controller returns Out of Range.
- No other action is taken.

If the value is in range:

- The diode laser current is changed.
- The controller returns OK.

If the laser was in Remote mode:

- The Remote LED is already on.
- The current control DAC is driven to a voltage which produces the requested current within 3%.
- The piezo voltage and the diode temperature are unaffected.

If the laser was in Local mode:

- The Remote LED comes on.
- Control of the laser is given to the DACs.
- The current control DAC is driven to a voltage which produces the requested current within 3%.
- The temperature and piezo control DACs are driven to voltages which produce values within 3% of the value they had under front-panel potentiometer control. The laser is now in Remote mode.

Argument

"x.x"

Range: $0 \leq \text{value} \leq 152$

Units: mA

Example

Front panel shows the following:

- Remote LED off (Local mode).
- Piezo Voltage reads 30.1.
- Diode temperature set point reads 20.0.
- Diode current reads -59.2.

```
CURR 26.4
—> OK
```

Front panel now shows:

- Remote LED on (Remote mode).
- Piezo voltage reads 29.6.
- Diode temperature set point reads 19.7.
- Diode current reads -26.1.

Query Diode-Current Set Point

Syntax

`[:SOURce]:CURRent[:LEVel][:DIODe]?`

Description

Returns the diode current setpoint.

If the laser was in Remote mode:

- Remote LED is already on.
- The current, piezo voltage and diode temperature are unaffected.
- Returns the last current value.

If the laser was in Local mode:

- Remote LED comes on.
- Control of the laser is given to the DACs.
- The current control DAC is driven to a voltage which produces a current within 3% of the value it had under front panel control.
- The temperature control DAC and the piezo control DAC are driven to voltages which produce values within 3% of the value they had under front panel potentiometer control. The laser is now in Remote mode.
- Returns the target current which is the front panel current at the moment the query occurred.

Response "x.x"

Units: mA.

Example

```
SENSE:CURR:DIODE
—> 26.1
```

(returns the actual current)

```
CURR?
—> 26.4
```

(returns the target current)

Set Diode Temperature

Syntax

```
[:SOURce]:TEMPerature[:LEVel][:DIODe]
<value>
```

Description

This command sets the diode-temperature set point.

This command always forces the laser into Remote mode.

If the value is out of range:

- Returns Out of Range.
- No other action is taken.

If the value is in range:

- Returns OK.

If the laser was in Remote mode:

- Remote LED is already on.
- The diode temperature set point control DAC is driven to a voltage which produces the requested set point within 3%.
- The piezo voltage and the diode current are unaffected.

If the laser was in Local mode:

- Remote LED comes on.
- Control of the laser is given to the DACs.
- The diode temperature set point control DAC is driven to a voltage which produces the requested set point within 3%.
- The current control DAC and the piezo control DAC are driven to voltages which produce values within 3% of the value they had under front panel potentiometer control.
- The laser is now in Remote mode.

Argument

"x.x"

Range: 16 ≤ VALUE ≤ 26

Units: °C.

Example

Front panel shows the following:

- Remote LED off (Local mode).
- Piezo voltage reads 30.1.
- Diode temperature set point reads 20.0.
- Diode current reads -59.2.

```
TEMP 22.1
—> OK
```

Front panel now shows:

- Remote LED on (Remote mode).
- Piezo Voltage reads 29.6.
- Diode Temperature set point reads 21.8.
- Diode Current reads -58.4.

Query Diode-Temperature Set Point

Syntax

```
[:SOURce]:TEMPerature[:LEVel][:DIODe]?
```

Description

Returns the current temperature set point for the diode.

If the laser was in Remote mode:

- Remote LED is already on.
- The current, piezo voltage and diode temperature are unaffected.
- Returns the last diode temperature set point Sourced.

If the laser was in Local mode:

- Remote LED comes on.
- Control of the laser is given to the DACs.
- The diode temperature set point control DAC is driven to a voltage which produces a current within 3% of the value it had under front-panel control.
- The current control DAC and the piezo control DAC are driven to voltages which produce values within 3% of the value they had under front panel potentiometer control. The laser is now in Remote mode.
- Returns the target diode temperature set point, which is the front panel temperature set point at the moment the query occurred.

Response

"x.x"

Units: °C.

Example

```
SENSE:TEMP:SETP:DIOD
—> 21.8
```

(returns the actual temperature set point)

```
TEMP?
—> 22.1
```

(returns the target set point)

Turn Constant Power Mode On/Off

Syntax

`[:SOURce]:CPOWer <0|1|OFF|ON>`

Description

Enables and disables Constant Power mode.

This command has no affect if the laser power is not ON.

This command will force the laser to Remote mode if it was previously in Local mode.

Argument

`OFF`, `ON`, `0`, or `1`.

`ON` or `1` turns on Constant Power mode.

- If the laser is already in Constant Power mode, this command has no effect.
- If the laser is in Local mode, it is forced to Remote mode.
- If the laser has not been in this mode after power up, the constant power level is set to the power reading at the time this command is executed. If it has, the constant power level is set to the previous setting.

`OFF` or `0` disables Constant Power mode and leaves the laser in Remote mode. If the laser is not in Constant Power mode, this command has no effect.

Example

The laser has not been in Constant Power mode after power up, and it is in Local mode with the front panel power display reading 1.5 mW:

```
:SOUR:CPOW ON
—> OK
```

- The remote LED is ON.
- 'C' appears in power display.
- The Constant Power mode is enabled and the laser power is kept at 1.5mW.

```
:SOUR:CPOW OFF
—> OK
```

- The Constant Power mode is disabled and 'C' disappears in power display.
- The remote LED remains On.
- The laser is in Remote mode

Set Constant Power Level

Syntax

```
[:SOURce]:POWer[:LEVel] <value>
```

Description

Set the constant power level.

This command has no affect if the laser power is not ON. This command will force the laser to Remote mode if it was previously in Local mode.

If the laser is not in Constant Power mode, this command enables Constant Power mode and sets power level to the specified value or the internal maximum limit, whichever is lower.

Argument

"x.x"

Range: 0 ≤ Value ≤ 99.9

Units: mW

Note: Although this command accepts a value up to 99.9 mW, the actual set level is limited by an internal maximum value which is system dependent. See the Acceptance Test Data Sheet for this number. If the laser is already in Constant Power mode, this command sets the constant power level to the specified value or internal maximum limit, whichever is lower.

Example

The laser is in Local mode with the front panel power display reading 1.5 mW:

```
:SOUR:CPOW 2.5
—> OK
```

(The laser power is set to 2.5mW.)

Turn Wavelength Input Mode On/Off

Syntax

`:SYSTem:WINPut <0|1|OFF|ON>`

Description

Enables and disables Wavelength Input mode.

Response

`ON` or `1`

- All wavelength activity such as scanning or even moving to a newly sourced wavelength is halted.
- The laser will immediately begin moving to the wavelength corresponding to the voltage at the Wavelength Input connector.
- The controller does not have to be in Track mode to execute this command, but Track mode is entered on execution of this command.
- The Track LED will flash on and off signifying that the Wavelength Input is active.
- Encoder and Scan button are disabled.

`OFF` or `0`

- The laser remains in Track mode with the encoder active.
- Wavelength motion stops.
- Track LED stops flashing and remains on, signifying Track mode.
- Encoder can now change wavelength.
- The Scan button is active again.

Example

```
:SYST:WINP ON
—> OK
```

- Track LED flashes.
- Wavelength changes to voltage specified by value at Wavelength Input connector on back of controller.
- Encoder and Scan buttons are disabled.

Error Codes

The laser controller will indicate an error code in the wavelength display if it is unable to perform its proper functions. Some of these errors can be cleared by switching the laser controller off and then back on. If the errors persist, please contact New Focus for assistance.

Errors 1 through 7 could indicate a broken or stuck switch. Check the appropriate switch, and if the errors persist, contact New Focus.

Error 1	Laser Power switch depressed during power up.
Error 2	Scan button depressed during power up.
Error 3	Track button depressed during power up.
Error 4	Multifunction switch depressed during power up.
Error 5	Scan Speed switch depressed during power up.
Error 6	Local button depressed during power up.
Error 7	Multiple stuck buttons during power up.
Error 8	No head is connected to the controller.
Error 9	Cavity temperature at or greater than 35 °C. Make sure the laser head is heat sinked.
Error 10	Diode temperature at or greater than 35 °C. Make sure the laser head is heat sinked.

These errors indicate a hardware problem. If these errors persist, contact New Focus:

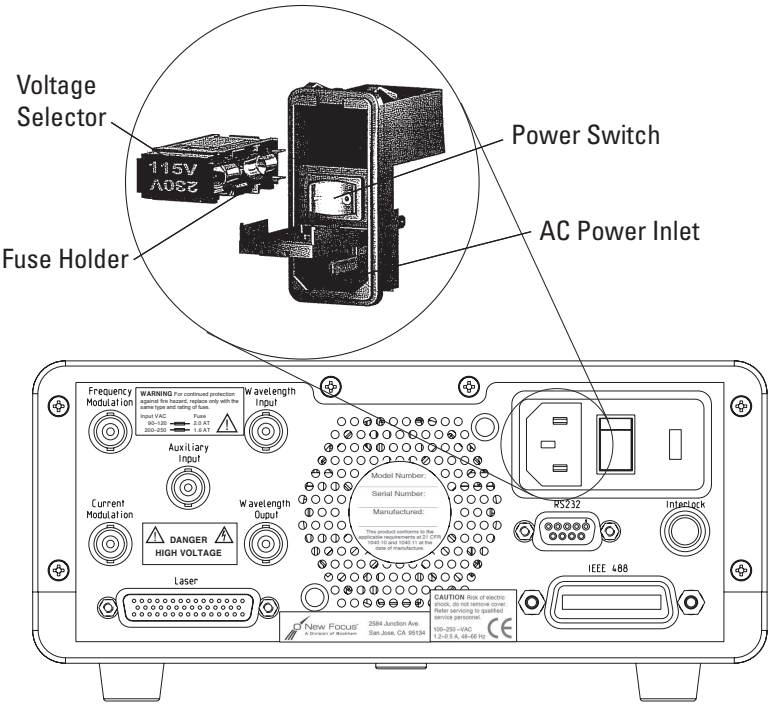
Error 11	Microprocessor RAM error.
Error 12	EPROM revision number mismatch.
Error 13	Current board revision wrong.
Error 14	Temperature board revision wrong.
Error 15	Laser head EEPROM stability error, or there is a compatibility conflict between controller and laser head.
Error 16	Motion control board is not functioning.
Error 17	Communication error between microprocessor board and motion control board.

AC Operating Voltages

The Model 6300-LN Controller can operate on approximately 115 or 230 V AC at AC frequencies of 47-63 Hz. The unit is configured at the factory for the standard AC voltage in the owner's country. To select a different operating voltage, please refer to Figure 11 and follow the directions below:

1. Disconnect the power cord.
2. Open the cover of the power module on the rear panel using a small-blade screwdriver or similar tool.
3. Remove voltage selector/fuse holder from the unit.

Figure 11: AC-line power connector



4. Rotate voltage selector to desired input voltage and change fuses.
5. Close the cover.
6. Verify the proper voltage is showing through the module's window.

The power entry module requires two 5x20-mm, slow-blow fuses, such as Littelfuse's® Slo-Blo® 218 series. Replacement fuses should be as follows:

AC Voltage	Fuse Rating	Littelfuse
115 V AC	2.0 A	0218002.HXP
230 V AC	1.6 A	021801.6HXP

Service and Support

Warranty

New Focus, a division of Bookham, guarantees its lasers to be free of defects for one year from the date of shipment or for 3000 hours of operation, whichever comes first. This is in lieu of all other guarantees, expressed or implied, and does not cover incidental or consequential loss.

Service

Your 63XX series laser has been designed to provide years of trouble-free operation. Virtually no maintenance is required except for ensuring that the unit is not damaged, contaminated, or used in an unsafe manner. To ensure <0.1-nm accuracy in wavelength readout, the system should be recalibrated every 6 months.

Technical Support

Information and advice about the operation of any New Focus product is available from our applications engineers. For the quickest response, ask for "Technical Support" and know the model and serial numbers of your product.

Hours: 8:00 am to 5:00 pm, Monday through Friday (excluding holidays).

Toll Free: 1-866-NUFOCUS (1-866-683-6287)
(from the USA & Canada only)
Phone: (408) 919-1500

Support is also available by fax and email:

Fax: (408) 980-6083
Email: techsupport@newfocus.com or
techsupport@bookham.com

We typically respond to faxes and email within one business day.

Specifications

	TLB-6304	TLB-6304-H	TLB-6305	TLB-6308	TLB-6309	TLB-6312	TLB-6312-H
Tuning Range (mode-hop free)	632.5–637 nm	635–637 nm	652–660 nm	668–678 nm	680–690 nm	765–781 nm	776–781 nm
Typical Maximum Power	5 mW	7 mW	3 mW	4 mW	6 mW	15 mW	24 mW
Minimum Power	2 mW	5 mW	2 mW	2 mW	2 mW	7 mW	20 mW
Fine Frequency Tuning Range	80 GHz (0.11 nm)	80 GHz (0.11 nm)	70 GHz (0.10 nm)	70 GHz (0.11 nm)	70 GHz (0.11 nm)	75 GHz (0.15 nm)	75 GHz (0.15 nm)
Linewidth	<300 KHz	<300 KHz	<300 KHz	<300 KHz	<300 KHz	<300 KHz	<300 KHz
Maximum Course Tuning Speed	6 nm/s	6 nm/s	6 nm/s	6 nm/s	6 nm/s	8 nm/s	8 nm/s
Coarse Tuning Resolution	0.02 nm	0.02 nm	0.02 nm	0.02 nm	0.02 nm	0.02 nm	0.02 nm
Typical Wavelength Repeatability	0.1 nm	0.1 nm	0.1 nm	0.1 nm	0.1 nm	0.1 nm	0.1 nm
Fine-Frequency Modulation BW	2 kHz	2 kHz	2 kHz	2 kHz	2 kHz	2 kHz	2 kHz
Current Modulation Bandwidth	100 MHz	100 MHz	100 MHz	100 MHz	100 MHz	100 MHz	100 MHz

Stated specifications are without fiber-couplingpigtail.

	TLB-6314	TLB-6315	TLB-6316	TLB-6316-H	TLB-6318	TLB-6319	TLB-6320
Tuning Range (mode-hop free)	794–804 nm	815–825 nm	838–853 nm	848–853 nm	890–910 nm	930–945 nm	960–995 nm
Typical Maximum Power	8 mW	10 mW	10 mW	22 mW	10 mW	10 mW	10 mW
Minimum Power	4 mW	8 mW	5 mW	20 mW	5 mW	5 mW	6 mW
Fine Frequency Tuning Range	75 GHz (0.16 nm)	60 GHz (0.14 nm)	60 GHz (0.15 nm)	60 GHz (0.15 nm)	50 GHz (0.15 nm)	50 GHz (0.15 nm)	50 GHz (0.16 nm)
Linewidth	<300 KHz	<300 KHz	<300 KHz	<300 KHz	<300 KHz	<300 KHz	<300 KHz
Maximum Course Tuning Speed	8 nm/s	8 nm/s	8 nm/s	8 nm/s	10 nm/s	12 nm/s	12 nm/s
Coarse Tuning Resolution	0.02 nm	0.02 nm	0.02 nm	0.02 nm	0.02 nm	0.02 nm	0.02 nm
Typical Wavelength Repeatability	0.1 nm	0.1 nm	0.1 nm	0.1 nm	0.1 nm	0.1 nm	0.1 nm
Fine-Frequency Modulation BW	2 kHz	2 kHz	2 kHz	2 kHz	2 kHz	2 kHz	2 kHz
Current Modulation Bandwidth	100 MHz	100 MHz	100 MHz	100 MHz	100 MHz	100 MHz	100 MHz

Stated specifications are without pigtail.

	TLB-6320-H	TLB-6321	TLB-6321-H	TLB-6323	TLB-6324	TLB-6327	TLB-6326
Tuning Range (mode-hop free)	975–985 nm	1050–1075 nm	1055–1070 nm	1220–1250 nm	1270–1330 nm	1415–1480 nm	1470–1545 nm
Typical Maximum Power	14 mW	6 mW	20 mW	7 mW	7 mW	8 mW	15 mW
Minimum Power	12 mW	4 mW	15 mW	5 mW	5 mW	3 mW	8 mW
Fine Frequency Tuning Range	50 GHz (0.16 nm)	50 GHz (0.19 nm)	50 GHz (0.19 nm)	45 GHz (0.23 nm)	50 GHz (0.29 nm)	30 GHz (0.21 nm)	50 GHz (0.38 nm)
Linewidth	<300 KHz	<300 KHz	<300 KHz	<300 KHz	<300 KHz	<300 KHz	<300 KHz
Maximum Course Tuning Speed	12 nm/s	12 nm/s	12 nm/s	20 nm/s	15 nm/s	20 nm/s	20 nm/s
Coarse Tuning Resolution	0.02 nm	0.02 nm	0.02 nm	0.02 nm	0.02 nm	0.02 nm	0.02 nm
Typical Wavelength Repeatability	0.1 nm	0.1 nm	0.1 nm	0.1 nm	0.1 nm	0.1 nm	0.1 nm
Fine-Frequency Modulation BW	2 kHz	2 kHz	2 kHz	2 kHz	2 kHz	2 kHz	2 kHz
Current Modulation Bandwidth	100 MHz	100 MHz	100 MHz	100 MHz	100 MHz	100 MHz	100 MHz

Stated specifications are without fiber-coupling pigtail.

	TLB-6328	TLB-6330	TLB-6330-H	TLB-6331	TLB-6332	TLB-6334	TLB-6335
Tuning Range (mode-hop free)	1520–1570 nm	1550–1630 nm	1570–1630 nm	1650–1680 nm	1760–1790 nm	1940–1970 nm	1970–2000 nm
Typical Maximum Power	24 mW	10 mW	18 mW	3 mW	2.5 mW	2.5 mW	2.5 mW
Minimum Power	20 mW	6 mW	15 mW	2 mW	1.5 mW	1.5 mW	1.3 mW
Fine Frequency Tuning Range	30 GHz (0.24 nm)	30 GHz (0.26 nm)	30 GHz (0.26 nm)	30 GHz (0.28 nm)	20 GHz (0.21 nm)	20 GHz (0.26 nm)	20 GHz (0.26 nm)
Linewidth	<300 KHz	<300 KHz	<300 KHz	<300 KHz	<300 KHz	<300 KHz	<300 KHz
Maximum Course Tuning Speed	20 nm/s	25 nm/s	25 nm/s	20 nm/s	20 nm/s	20 nm/s	25 nm/s
Coarse Tuning Resolution	0.02 nm	0.02 nm	0.02 nm	0.02 nm	0.02 nm	0.02 nm	0.02 nm
Typical Wavelength Repeatability	0.1 nm	0.1 nm	0.1 nm	0.1 nm	0.1 nm	0.1 nm	0.1 nm
Fine-Frequency Modulation BW	2 kHz	2 kHz	2 kHz	2 kHz	2 kHz	2 kHz	2 kHz
Current Modulation Bandwidth	100 MHz	100 MHz	100 MHz	100 MHz	100 MHz	100 MHz	100 MHz

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