

# Model TLB 6700-LN TLB 6700-XP

## Tunable Diode Laser



## User's Manual





# EU Declaration of Conformity

We declare that the accompanying product, identified with the **CE** mark, complies with requirements of the Electromagnetic Compatibility Directive, 2004/108/EC and the Low Voltage Directive 2006/95/EC.

**Model Numbers:** TLB 6700-LN, TLB 6700-XP

**Year **CE** mark affixed:** 2010

**Type of Equipment:** Electrical equipment for measurement, control and laboratory use in industrial locations.

**Manufacturer:** Newport Corporation

1791 Deere Avenue  
Irvine, CA 92606

## **Standards Applied:**

Compliance was demonstrated to the following standards to the extent applicable:

BS EN61326-1: 2006 “Electrical equipment for measurement, control and laboratory use – EMC requirements” for use in a controlled electromagnetic environment.

This equipment meets the CISPR 11:2009+A1 Class A Group 1 radiated and conducted emission limits.

BS EN 61010-1:2001, 2<sup>nd</sup> Edition “Safety requirements for electrical equipment for measurement, control and laboratory use”.



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Sr. Director, Instruments Business  
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## Warranty

New Focus warrants that this product will be free from defects in material and workmanship and will comply with Newport's published specifications at the time of sale for a period of one year from date of shipment. If found to be defective during the warranty period, the product will either be repaired or replaced at Newport's option.

To exercise this warranty, write or call your local Newport office or representative, or contact Newport headquarters in Irvine, California. You will be given prompt assistance and return instructions. Send the product, freight prepaid, to the indicated service facility. Repairs will be made and the instrument returned freight prepaid. Repaired products are warranted for the remainder of the original warranty period or 90 days, whichever occurs first.

### Limitation of Warranty

The above warranties do not apply to products, which have been repaired or modified without Newport's written approval, or products subjected to unusual physical, thermal or electrical stress, improper installation, misuse, abuse, accident or negligence in use, storage, transportation or handling. This warranty also does not apply to fuses, batteries, or damage from battery leakage.

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Part No. 90038357 Rev C

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## Newport Corporation Calling Procedure

If there are any defects in material or workmanship or a failure to meet specifications, promptly notify Newport's Returns Department by calling 1-800-222-6440 or by visiting our website at [www.newport.com/returns](http://www.newport.com/returns) within the warranty period to obtain a **Return Material Authorization Number (RMA#)**. Return the product to Newport Corporation, freight prepaid, clearly marked with the RMA# and we will either repair or replace it at our discretion. Newport is not responsible for damage occurring in transit and is not obligated to accept products returned without an RMA#.

E-mail: [rma.service@newport.com](mailto:rma.service@newport.com)

When calling Newport Corporation, please provide the customer care representative with the following information:

- Your Contact Information
- Serial number or original order number
- Description of problem (i.e., hardware or software)

To help our Technical Support Representatives diagnose your problem, please note the following conditions:

- Is the system used for manufacturing or research and development?
- What was the state of the system right before the problem?
- Have you seen this problem before? If so, how often?
- Can the system continue to operate with this problem? Or is the system non-operational?
- Can you identify anything that was different before this problem occurred?

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# 1 Safety Precautions

## 1.1 Definitions and Symbols

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The following terms and symbols are used in this documentation and appear on the Model 6700 Tunable Diode Laser where safety-related issues occur.

### 1.1.1 General Warning or Caution



*Figure 1 General Warning or Caution Symbol*

The Exclamation Symbol in the figure above appears on the product and in Warning and Caution tables throughout this document. This symbol designates that documentation needs to be consulted to determine the nature of a potential hazard, and any actions that have to be taken.

### 1.1.2 Electric Shock



*Figure 2 Electrical Shock Symbol*

The Electrical Shock Symbol in the figure above appears throughout this manual. This symbol indicates a hazard arising from dangerous voltage. Any mishandling could result in irreparable damage to the equipment, and personal injury or death.

### 1.1.3 European Union CE Mark



*Figure 3 CE Mark*

The presence of the CE Mark on Newport Corporation equipment means that this instrument has been designed, tested and certified compliant to all applicable European Union (CE) regulations and recommendations.

#### 1.1.4 Alternating Voltage Symbol



*Figure 4 Alternating Voltage Symbol*

This international symbol implies an alternating voltage or current.

#### 1.1.5 On



*Figure 5 On Symbol*

The symbol in the figure above represents a power switch position on the Model 6700 Tunable Diode Laser. This symbol represents a Power On condition.

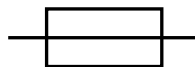
#### 1.1.6 Off



*Figure 6 Off Symbol*

The symbol in the figure above represents a power switch position on the Model 6700 Tunable Diode Laser. This symbol represents a Power Off condition.

#### 1.1.7 Fuses



*Figure 7 Fuse Symbol*

The symbol in the figure above identifies the fuse location on the Model 6700 Tunable Diode Laser.

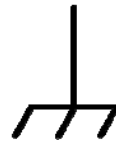
### 1.1.8 USB



*Figure 8 USB Symbol*

The symbol in the figure above identifies the USB connector location on the Model 6700 Tunable Diode Laser.

### 1.1.9 Frame or Chassis



*Figure 9 Frame or Chassis Terminal Symbol*

The symbol in the figure above appears on the Model 6700 Tunable Diode Laser. This symbol identifies the frame or chassis terminal

### 1.1.10 Waste Electrical and Electronic Equipment (WEEE)



*Figure 10 WEEE Directive Symbol*

This symbol on the product or on its packaging indicates that this product must not be disposed with regular waste. Instead, it is the user responsibility to dispose of waste equipment according to the local laws. The separate collection and recycling of the waste equipment at the time of disposal will help to conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment. For information about where the user can drop off the waste equipment for recycling, please contact your local Newport Corporation representative.

### 1.1.11 Control of Hazardous Substances

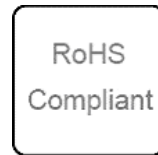


Figure 11 RoHS Compliant Symbol

This label indicates the products comply with the EU Directive 2002/95/EC that restricts the content of six hazardous chemicals.

## 1.2 Warnings and Cautions

The following are definitions of the Warnings, Cautions and Notes that are used throughout this manual to call your attention to important information regarding your safety, the safety and preservation of your equipment or an important tip.

	<p style="text-align: center;"><b>WARNING</b></p> <p>Situation has the potential to cause bodily harm or death.</p>
--	---

	<p style="text-align: center;"><b>CAUTION</b></p> <p>Situation has the potential to cause damage to property or equipment.</p>
--	--

### NOTE

Additional information the user or operator should consider.

### 1.2.1 General Warnings

Observe these general warnings when operating or servicing this equipment:

- Heed all warnings on the unit and in the operating instructions.
- Do not use this equipment in or near water.
- This equipment is grounded through the grounding conductor of the power cord.



- Route power cords and other cables so that they are not likely to be damaged.
- Disconnect power before cleaning the equipment. Do not use liquid or aerosol cleaners; use only a damp lint-free cloth.
- Lockout all electrical power sources before servicing the equipment.
- To avoid fire hazard, use only the specified fuse(s) with the correct type number, voltage and current ratings as referenced in the appropriate locations in the service instructions or on the equipment. Only qualified service personnel should replace fuses.
- To avoid explosion, do not operate this equipment in an explosive atmosphere.
- Qualified service personnel should perform safety checks after any service.

### 1.2.2 General Cautions

Observe these cautions when operating this equipment:

- If this equipment is used in a manner not specified in this manual, the protection provided by this equipment may be impaired.
- To prevent damage to equipment when replacing fuses, locate and correct the problem that caused the fuse to blow before re-applying power.
- Do not block ventilation openings.
- Do not position this product in such a manner that would make it difficult to disconnect the power cord.
- Position the equipment so that access to the mains disconnect On/Off switch is readily available.
- Use only the specified replacement parts.
- Follow precautions for static sensitive devices when handling this equipment.
- This product should only be powered as described in the manual.
- There are no user-serviceable parts inside the Model 6700 Tunable Diode Laser.
- Adhere to good laser safety practices when using this equipment.

### 1.2.3 Summary of Warnings and Cautions

The following general warning and cautions are applicable to this instrument:



#### **WARNING**

Before operating the Model 6700 Tunable Diode Laser, please read and understand all of Section 1.



#### **WARNING**

Do not attempt to operate this equipment if there is evidence of shipping damage or you suspect the unit is damaged. Damaged equipment may present additional hazards to you. Contact Newport technical support for advice before attempting to plug in and operate damaged equipment.



#### **WARNING**

To avoid electric shock, connect the instrument to properly earth-grounded, 3-prong receptacles only. Failure to observe this precaution can result in severe injury.



#### **WARNING**

Before cleaning the enclosure of the Model 6700 Tunable Diode Laser, the AC power cord must be disconnected from the wall socket.



#### **CAUTION**

There are no user serviceable parts inside the Model 6700 Tunable Diode Laser. Work performed by persons not authorized by Newport Corporation will void the warranty. For instructions on obtaining warranty repair or service, please refer to Section 8.



#### **WARNING**

If this equipment is used in a manner not specified in this manual, the protection provided by this equipment may be impaired.

**WARNING**

While the Model TLB-6700 Controller's rear panel switch turns power OFF to the internal electronics, it should not be depended upon to fully disconnect the unit from MAINS power. Disconnect the power cord to fully isolate the Model 6700 from MAINS power.

**WARNING**

The rear panel LASER CONTROL connector may have voltages as high as 150 VDC between various connector pins. Do not power up the Model 6700 without a laser head connected.

**WARNING**

Do not attempt to power up the controller if the cable between the controller and the laser head is damaged.

**WARNING**

Use only New Focus Model Number TLB-6700-01 cable, or New Focus approved alternative, to connect the TLB-6700 controller to the 6700 series laser head.

**WARNING**

Do not disconnect the cable between the Model 6700 and the laser head from the Model 6700 while the Model 6700 is powered up.

**WARNING**

Do not disconnect the cable between the Model 6700 and the laser head from the laser head while the Model 6700 is powered up.

**WARNING**

Secure the connector screwlocks at both ends of the cable between the Model 6700 and the laser head.



The Model TLB-6700 Controller is intended for use in an industrial environment. Use of this product in other environments, such as residential, may result in electromagnetic compatibility difficulties due to conducted as well as radiated disturbances.

## 1.3 Location of Labels and Warnings

### 1.3.1 Rear Panel

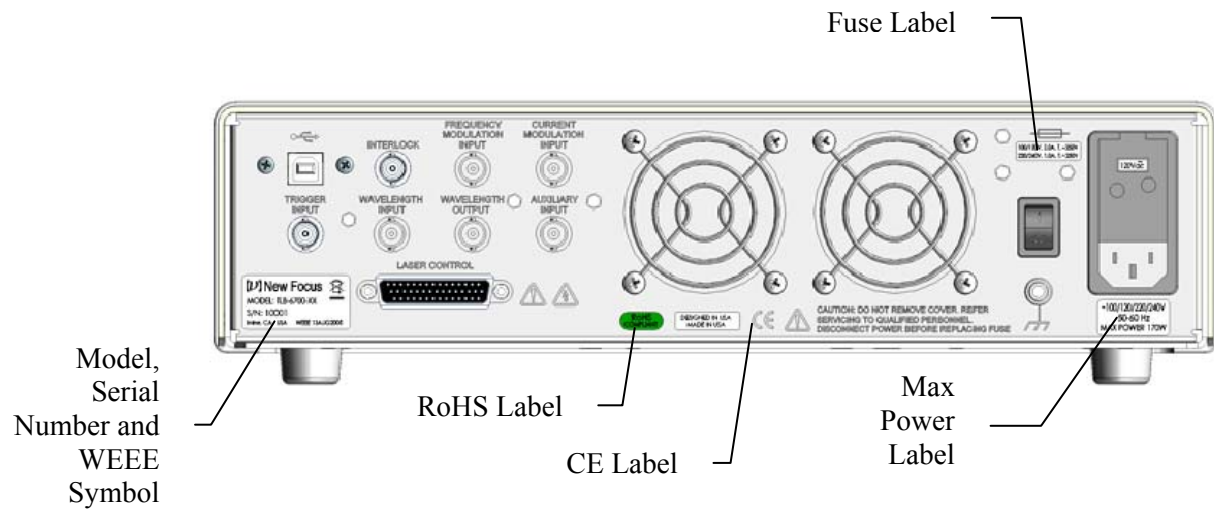


Figure 12 Rear Panel Labels and Warnings

## 2 General Information

### 2.1 Introduction

---

The New Focus 6700 series External Cavity Tunable Diode Laser is a stable, narrow-linewidth source of tunable light. The 6700 series laser can be operated manually from the front panel of the controller or remotely using computer control.

The 6700 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 6700 is a modular system. The same control unit will work with any 6700 series laser head. The control units work in both manual and remotely programmed modes and are compatible with USB interfaces.

Digital Signal Processor (DSP)-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 enables continuous mode hop-free tuning.

Two seven segment LED digital readouts and a multi-line LCD display show important operating parameters including wavelength and laser power. Inputs are available for low-speed and high-speed diode current modulation.

#### **Key Product Features:**

##### **Versatile tuning performance**

- Sweep, step, and fine-tuning modes
- Fine-tuning with the PZT at 0.1-GHz resolution
- Coarse-tuning with the DC motor for up to 80-nm mode hop-free tuning
- Smooth, linear, mode hop-free sweeps

**Low noise & narrow linewidths**

- <200-kHz linewidths
- >40-dB side-mode suppression ratios

**Flexible configurations**

- Wavelengths from 630 nm to 2  $\mu$ m
- Fiber-coupled and free-space outputs
- Current modulation, wavelength control and FM modulation
- Constant power and constant current modes

**Plug & play**

- Automated wavelength scans with wavelength and power readouts
- USB remote interface
- No beam walking

## **2.1.1 Instrument Features**

**Intuitive Controls and LCD Display**

Improved data presentation and system control are achieved using a combination of LCD and 7-segment LED displays. The LCD display shows the entire system configuration and status. The 7-segment LED displays visibly show diode laser wavelength and output power. “Menu Keys” guide you through initial system setup routines and operation. Real-time control of an output is accomplished either by entering the set point via the cursor keys or control knob. SETUP/ENTER and ARROW keys access saved system configurations and repetitive procedures. All controls are clearly marked and instructions easily understood for simple operation.

## **2.2 Input Power**

---

The Model 6700 can be configured to operate on 100, 120, 220, or 240 volt AC power. See Section 3.6 for information on how to configure the Model 6700 for operation on your country-specific AC voltage.

## 2.3 Specifications

### 2.3.1 Tunable Diode Laser

Model Number	Tuning Range [nm]		Maximum Power [mW]
	Min	Max	
6701	350	400	450
6702	390	440	450
6703	440	500	450
6704	630	640	450
6705	640	650	450
6706	650	680	450
6707	680	700	450
6708	650	750	450
6709	715	750	450
6710	700	800	450
6711	700	800	450
6712	760	800	450
6713	750	850	450
6714	750	850	450
6715	750	900	450
6716	800	950	450
6717	800	950	450
6718	850	1000	450
6719	900	1100	450
6720	900	1100	450
6721	900	1100	450
6722	1000	1200	450
6723	1100	1300	450
6724	1200	1400	450
6725	1300	1500	450
6726	1400	1600	450
6727	1350	1600	450
6728	1400	1700	450
6729	1400	1700	450
6730	1400	1700	450
6731	1550	1750	450
6732	1600	1900	450
6733	1700	2200	450
6734	1900	2300	450
6735	1900	2500	450

### 2.3.2 General Specifications

Environmental Specifications	
Voltage Requirements	100/120/220/240 VAC, 50/60Hz
Power Requirements	MAX POWER = 170 Watts
Chassis Ground	4 mm banana jack
Size (H x W x D) [in. (mm)]	3.48 (88.4) x 14.0 (355.6) x 16.51 (419.4)
Mainframe Weight [lb (kg)]	17.9 (8.1)
Operating Temperature	10°C to 40°C (<90% humidity non-condensing)
Storage Temperature	0°C to + 50°C (<90% humidity non-condensing)
Relative Humidity, Storage	<90% humidity non-condensing
Altitude	<3000 meters (10000 feet)
Installation Category	II
Pollution Degree	2
Use Location	Indoor use only

The Model 6700 Tunable Diode Laser is designed to operate in a controlled electromagnetic environment. While it will not be damaged by operation in an industrial electromagnetic environment, as defined in EN61316-1:2006, such operation may not yield optimal performance. For this reason, New Focus does not recommend operation of the Model 6700 in close proximity to mobile telephones, hand-held radio transmitters, and similar devices.



## 3 Getting Started

### 3.1 Unpacking and Handling

---

It is recommended that the Model 6700 Tunable Diode Laser be unpacked in a lab environment or work site. Unpack the system carefully; small parts are included with the instrument. Inspect the box carefully for loose parts. You are advised to save the packaging material in case you need to ship your equipment in the future.

### 3.2 Inspection for Damage

---

The Model 6700 Tunable Diode Laser is carefully packaged at the factory to minimize the possibility of damage during shipping. Inspect the box for external signs of damage or mishandling. Inspect the contents for damage. If there is visible damage to the instrument upon receipt, inform the shipping company and New Focus immediately. Carefully open the box and save the shipping material for later use.



#### **WARNING**

**Do not attempt to operate this equipment if there is evidence of shipping damage or you suspect the unit is damaged. Damaged equipment may present additional hazards to you. Contact New Focus technical support for advice before attempting to plug in and operate damaged equipment.**



#### **CAUTION**

**The user is advised to save the packaging material in case the unit has to be shipped to a different location. The packaging material is specially designed to protect the unit during shipping.**

### 3.3 Parts List

---

The following is a list of parts included with the Model 6700 Tunable Diode Laser:

1. CD with Software Drivers and Utilities, User's Manual, Start Up Guide.
2. IEC320 AC line cord with a NEMA 5-15P, or country-specific connector.
3. Cable for controlling unit and laser head connection, TLB-6700-01.
4. USB Cable for connecting the controller to a computer.
5. Spare fuses for 220 VAC, 230 VAC, and 240 VAC mains power.

If you are missing any parts or have questions about the parts you have received, please contact New Focus.

### 3.4 Choosing and Preparing a Suitable Work Surface

---

The Model 6700 Tunable Diode Laser may be placed on any reasonably firm table or bench during operation.

### 3.5 Electrical Requirements

---

Before attempting to power up the unit for the first time, the following precautions must be followed:



#### **WARNING**

**To avoid electric shock, connect the instrument to properly earth-grounded, 3-prong receptacles only. Failure to observe this precaution can result in severe injury.**

- Have a qualified electrician verify the wall socket that will be used is properly polarized and properly grounded.
- Provide adequate distance between the Models 6700 Tunable Diode Laser and adjacent walls for ventilation purposes. Do not let any other equipment blow hot air towards the Tunable Diode Laser. Verify the correct rated fuses are installed according to the fuse marking on the rear panel. The unit has temperature sensors. If the unit overheats it will generate an error message and stop operation to protect itself, until the user takes the necessary steps to lower the temperature.

## 3.6 Power Supplies



### WARNING

To avoid electric shock, the Model 6700 must be configured for operation on your specific AC line voltage **PRIOR TO CONNECTING THE POWER CORD TO THE AC MAINS**. See the instructions above for information

AC power is supplied through the rear panel power entry module connector that provides in-line transient protection and RF filtering. The power entry module also contains the instrument's fuses and the voltage selection switch.

Prior to plugging in the AC line cord, the user **MUST** configure the Model 6700 for operation on the available AC power. This is accomplished by setting the voltage selector switch on the AC power entry module **AND** verifying that the correct fuses are installed into the power entry module. Failure to do this can result in degraded instrument performance, damage to the Model 6700, and / or injury to the operator.

The voltage selector switch and the fuses are accessed by opening the power entry module using a flat-bladed screwdriver. Note that the AC line cord must be removed from the power entry module prior to attempting to open it. With the power entry module open, the voltage selector switch setting can be changed by removing the drum, rotating it to the desired setting, and reinstalling the drum. Do not attempt to rotate the drum, while it is inserted in the power entry module. You risk bending the power contacts and render the unit inoperable.


After correctly setting the voltage selection switch, the fuses installed in the power entry module should be checked for the correct value and, if not correct, changed.


Table 1, below, identifies the correct voltage selector switch setting and fuse ratings for several common AC power.

Input Power	Voltage Switch Setting	Fuses
100 VAC, 50 Hz	100	2A, 250VAC, Slo-Blo
120 VAC, 60 Hz	120	2A, 250VAC, Slo-Blo
220 VAC, 50 Hz	230	1A, 250VAC, Slo-Blo
230 VAC, 50 Hz	230	1A, 250VAC, Slo-Blo
240 VAC, 60 Hz	240	1A, 250VAC, Slo-Blo

Table 1 Voltage Selector Switch Settings and Fuse Ratings

	<p style="text-align: center;"><b>WARNING</b></p> <p>With the power entry module open, the voltage selector switch setting can be changed by removing the drum, rotating it to the desired setting, and reinstalling the drum. Do not attempt to rotate the drum, while it is inserted in the power entry module. Failure to observe this procedure will result in equipment damage.</p>
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	<p style="text-align: center;"><b>WARNING</b></p> <p>To avoid electric shock, connect the instrument to properly earth-grounded receptacles only. Failure to observe these precautions can result in fire, severe injury or death.</p>
---	--


	<p style="text-align: center;"><b>WARNING</b></p> <p>To avoid electric shock, the appropriate fuses for the AC input power voltage must be installed in the instrument. Only qualified service personnel should replace fuses. Failure to observe these precautions can result in fire, severe injury or death.</p>
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## 3.7 Quick Start

This section outlines the basic steps needed to start using your 6700 Series External Cavity Tunable Diode Laser, including a brief setup and getting started guide. It assumes that earlier sections regarding safety and AC input power settings have been read. For more detailed information on how to operate the instrument, refer to Chapter 4 System Operation.

### 3.7.1 Connecting the Laser Components

Connect the Model TLB-6700 Controller to the 6700 series laser head using the TLB-6700-01 or other approved New Focus Cable. Secure the screw locks on the connectors at both ends of the cable.

	<p style="text-align: center;"><b>WARNING</b></p> <p>Use only New Focus Model Number TLB-6700-01 cable, or New Focus approved alternative, to connect the TLB-6700 controller to the 6700 series laser head.</p>
---	--

**WARNING**

Do not disconnect the cable between the Model 6700 Controller and the laser head while the Model 6700 Controller is powered up.

**WARNING**

Secure the connector screwlocks at both ends of the cable between the Model 6700 and the laser head.

**3.7.2****Grounding and Powering the Laser System**

Verify that the line voltage setting on the rear of the Model TLB-6700 Controller matches your MAINS power. Verify that the proper fuses are installed. See Section 3.6, above, for details.

Connect the binding post on the rear of the chassis to earth ground. While the protective ground wire within the MAINS power cord, when connected to a properly earth-grounded receptacle using the supplied power cord, will provide adequate safety protection, the system noise performance may be improved if this additional connection is made.

**WARNING**

To avoid electric shock, connect the instrument to properly earth-grounded receptacles only. Failure to observe these precautions can result in fire, severe injury or death.

**WARNING**

To avoid electric shock, the appropriate fuses for the AC input power voltage must be installed in the instrument. Only qualified service personnel should replace fuses. Failure to observe these precautions can result in fire, severe injury or death.

**3.7.3****Turning the Laser ON**

Press Mode button to select desired laser diode mode of operation—constant current or constant power. Use the UP/DOWN navigation keys to select Current/Power field in the main Menu display. Turn the knob control to set the desired Current/Power setpoint.

Turn lockout keyswitch to “ON” position. Press Laser Power button. The LED in the button will flash for 3 seconds and then stay ON. The actual laser diode current/power will quickly ramp up to the specified setpoint.

For other functions, such as adjusting wavelength, fine frequency control, setting scanning parameters, enabling Wavelength Input mode etc., refer to “System Operation.”

#### **3.7.4 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 back panel AC switch off to shut down the entire system.

#### **3.7.5 Software Installation**

For instructions on how to install the software provided with the controller, please refer to TLB-6700 CD ReadMe.pdf file available on the CD. You need to have a PDF reader to view its content.

# 4 System Operation

## 4.1 Description of Laser System

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### 4.1.1 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.

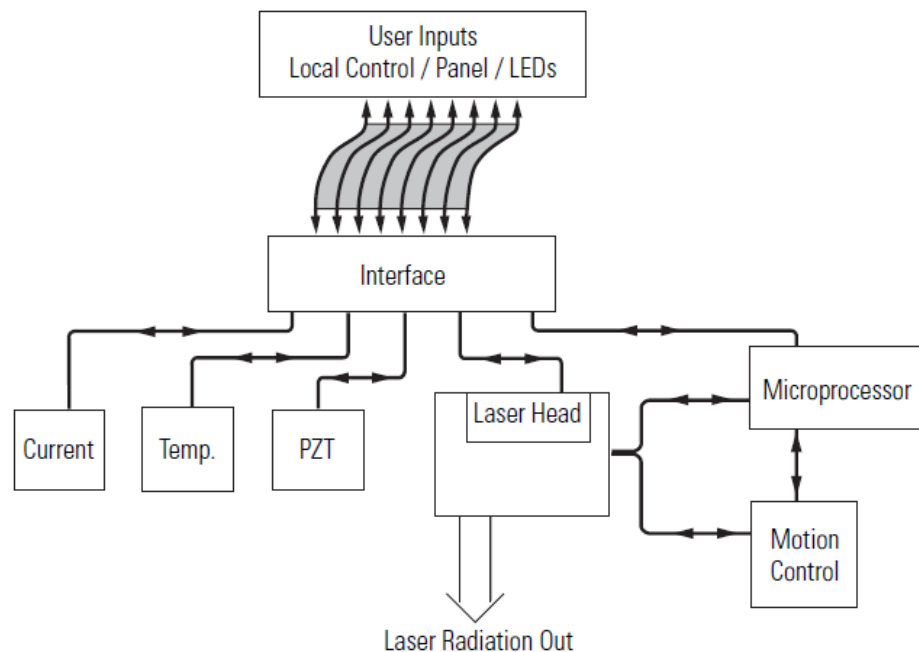


Figure 13 Controller Block Diagram

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 a Digital Signal Processor (DSP) and user interface circuitry. There is a 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 hundreds of mA of current to the laser diode. The AC ripple in the output is sub  $\mu$ A 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. A DSP is used to perform PID feedback control for each element. In this way, the laser temperature and the surrounding environment are stabilized 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 module actuates the DC motor, which provides coarse wavelength control and scanning. For smooth tuning, a DSP is used to generate desired motion trajectory and to perform PID feedback control of the DC motor.

The DSP based digital board controls all of the other modules, runs the digital displays, and provides USB 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.

#### **4.1.2 Laser Head**

The laser head embodies a simple, ultra-stable design which is shown below. 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.



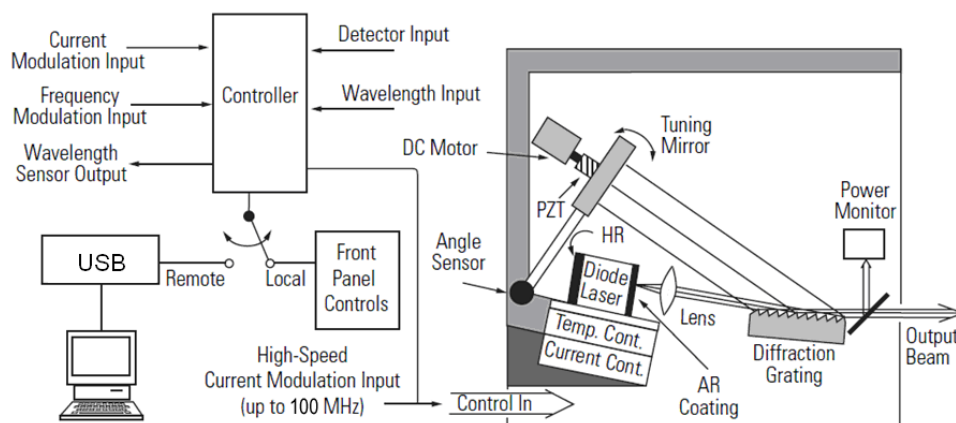


Figure 14 Laser Head Mechanical Schematic for TLB-6700 series laser

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 highly stable diode temperature.

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 correspond 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 Section 4.11 Rear Panel.

Finally, the laser head records how many hours the diode laser has operated. A new laser head will typically show 100-150 hours due to factory burn-in.

	<p style="text-align: center;"><b>WARNING</b></p> <p>Before operating the Model 6700 Tunable Diode Laser, please read and understand all of Section 1.</p>
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## 4.2 Using the Front Panel

The front panel of the Model 6700 Tunable Diode Laser is designed for easy operation. It has various distinct areas, each with a specific set of related functions, and a control knob, as shown in Figure 15 below.

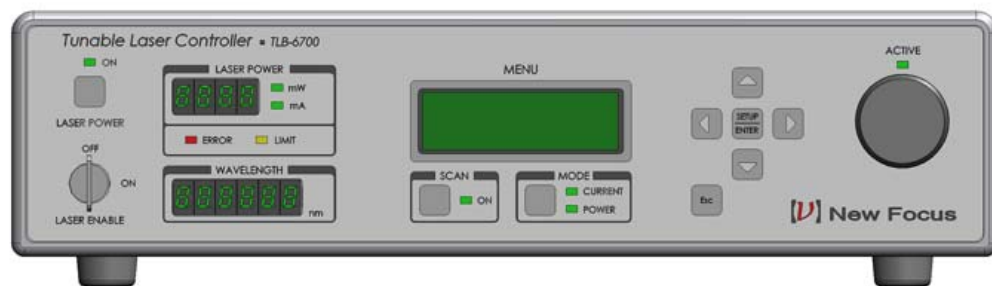


Figure 15 Front Panel Layout

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.

Turn on the AC power with the power switch on the left-hand side of the back panel. The calibration table, laser-head serial numbers, and other pertinent operating information stored in an EEPROM in the laser head are uploaded to the controller. The alphanumeric display will show the model number, and the 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 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 3-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.

Parameters can be modified by either turning the control knob, or by using the navigation keys. You can set the desired parameter by pushing the RIGHT navigation key until the cursor arrives under the digit you need to change.

Push the up/down key to change the digit value. After setting all the digits to the desired values push the Setup/Enter button to accept the desired parameter.

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### 4.3 Setting Current / Power

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The New Focus Velocity Tunable Diode Laser 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. The current settings for multimode operation may be wavelength dependent. Please refer to the included Acceptance Test Data Sheet for actual settings.

To set the desired Current/Power level press Mode button to select desired laser diode mode of operation—constant current or constant power. Use the UP/DOWN navigation keys to select Current/Power field in the main Menu display. Turn the knob control to set the desired Current/Power setpoint.

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### 4.4 Setting Wavelength

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The desired wavelength can be adjusted by first navigating to the “Lambda” field in the main Menu using the UP/DOWN navigation keys, and changing the value by turning the knob control. The maximum and minimum wavelengths that can be set depend upon the head rating.

If the wavelength Track Mode is ON, changing the wavelength setpoint will automatically cause the DC motor to move the end mirror until the new wavelength is reached.

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### 4.5 Fine Wavelength Control

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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 by the 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.)

To change the Piezo voltage setting, first navigate to the “Piezo” field in the main Menu using the UP/DOWN navigation keys, and changing the value by turning the knob control.

## 4.6 Wavelength Track Mode

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The wavelength track mode can be turned ON or OFF by navigating to the “Lambda Track” field in the main Menu using the UP/DOWN navigation keys, and changing the value by turning the knob control.

When the track mode is turned ON, the laser wavelength is actively controlled using the tuning motor that rotates the end mirror. When the tracking is turned OFF, 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, usually by 1 or 2 orders of magnitude, than it is in Track mode.**

## 4.7 Setting Wavelength Scan Parameters

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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. All wavelength scan related parameters are accessible from Scan Parameters menu. To view this menu, first press the menu Setup/Enter key and select “Set Scan Params” field using the UP/DOWN navigation keys. With this field selected, press the Setup/Enter key again (or the RIGHT navigation key) to enter the Scan Parameters menu.

### 4.7.1 Setting the Start and Stop Wavelengths

The start-of-scan wavelength can be changed by selecting the “Start  $\lambda$ ” field and turning the control knob, or using the navigation keys. Setting the end-of-scan wavelength is just as easy as setting the starting wavelength. This time select “Stop  $\lambda$ ” in the menu and then use the control knob to set the wavelength. 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.

### 4.7.2 Setting the Scan Velocity

To set the forward scan velocity, select the “Fwd Vel” field using the UP/DOWN navigation keys and turn the control knob. The reverse (Stop  $\lambda$  to Start  $\lambda$ ) scan velocity can be set by selecting the “Rev Vel” field and turning the control knob, or with the navigation keys. It is possible to adjust the forward and reverse scan velocities in 0.01 nm/s increments.

### 4.7.3 Performing a Scan

To start a scan, push the Scan button. If the laser is at the start wavelength, it will begin scanning at the forward scan velocity. Otherwise, it will go to the Start wavelength at the reverse scan speed and begin the scan process. When the laser arrives at the Stop wavelength it will stop briefly and return to Start wavelength at reverse scan velocity.

There is a Trigger input on the rear-panel of the controller. Applying a voltage which rises above 3 V and returns to zero (falling edge) to this input is equivalent to depressing and releasing the Scan button.

#### **4.7.4 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.

### **4.8 Laser Power Display**

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There is a 4-digit 7-segment display on the controller's front panel that is dedicated for displaying the actual laser current or power. This displayed value depends upon the mode of operation. Actual laser current is displayed, and "mA" LED is turned ON when the controller is in Constant Current mode. The display can also show the laser power. The "mW" LED is turned ON when the controller is in Constant Power mode. The ERROR LED located below this display will be turned ON (solid RED) if the laser output has been turned OFF by the controller due to any safety violation. If the laser output current reaches the programmed limit, the LIMIT LED will be turned ON (blinking YELLOW) to indicate that any further Set Current increase will be limited.

### **4.9 Wavelength Display**

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The actual laser wavelength is shown in the 6-digit 7-segment display on the controller's front panel.

### **4.10 Menu Section**

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In addition to displaying status parameters on the two 7-segment LED displays of the instrument, the Menu section of front panel enables users to view/change many more parameters.

#### **4.10.1 Control Knob**

The control knob on the right side of the front panel is used to set the value of all parameters. Users can select the parameter whose value needs to be modified using the Setup/Enter and Cursor Arrow keys, and then modify the values with the knob.

The knob has an acceleration algorithm that causes the rate of change of value to increase as the knob is turned faster. Turning slowly allows for fine adjustment at the smallest displayed decimal place.

#### **4.10.2 Setup / Enter**

The Setup/Enter key is used to (a) invoke the Setup screen, (b) accept parameter change, or (c) enter a lower menu level, depending on the screen displayed.

### 4.10.3 Esc

The Esc key is used to (a) cancel a parameter change or (b) back up one menu level.

### 4.10.4 Cursor Arrow Keys

Moves cursor UP or DOWN or between editable data fields. The DOWN arrow decrements values in numerical entry fields, or selects a previous choice in a multi-choice entry field. The UP arrow increments values in numerical entry fields, or selects a next choice in multi-choice entry fields. The RIGHT and LEFT arrow keys are used to move the cursor position in numerical entry fields.

### 4.10.5 Display Elements

The Model 6700 uses a character display to depict information about the current state of the system. The display screens shown by the instrument can be classified as follows: title screen, laser head information screen, main Setup screen, parameter setup screen and error message screen.

### 4.10.6 Menu Selection

All information displayed in various 6700 screens, with the exception of title screen, laser head information screen and error message screen, can be in one of two states: *selected* or *unselected*. A selected item can be in one of two states: *idle* or *active*.

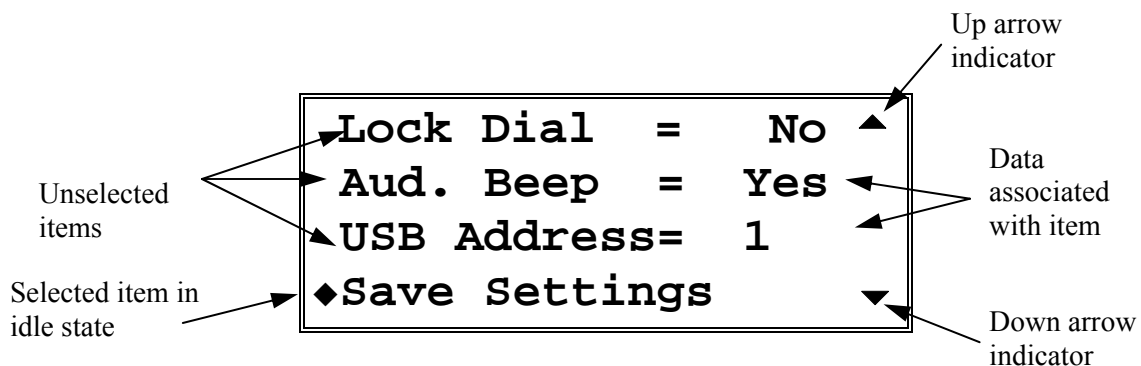


Figure 16 A Sample Setup Screen

A *selected* item in *idle* state is indicated by a diamond symbol (◆) placed to the left of the item. The idle state is the default state for a selected item. In this state, the present value of the item may be displayed next to the label depending upon the type of item. Pressing the SETUP/ENTER key will cause the instrument to display a sub-menu for that item, should one be available. Otherwise, it will change the display state for that item from *idle* to *active*.

A *selected* item in *active* state is indicated by flashing data associated with that item. The cursor arrow keys can be used to modify the data (numerical or non-numerical). Once the data has been modified, pressing SETUP/ENTER key will cause the instrument to accept the new data and return the item to idle

state. Pressing the Esc key will cause the display to ignore any changes made, and return to the previous menu.

An *unselected* item simply displays the item name. Depending upon the item, it may also display data associated with that item.

The Setup screens also have up (▲) and down (▼) indicators to show that more items can be accessed by pressing UP and DOWN arrow keys respectively.

#### 4.10.7 Title Screen

The Title screen is displayed for a few seconds every time the instrument is powered ON. This screen is used to display the present firmware version of the instrument. A sample Title screen is shown in Figure 17.

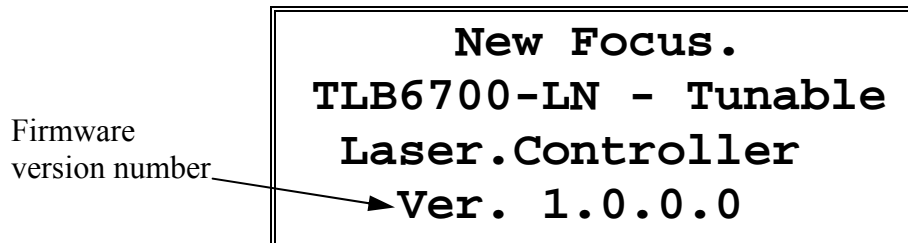


Figure 17 A Sample Title Screen

#### 4.10.8 Laser Head Information Screen

The Laser Head Information screen is displayed for a few seconds after the Title screen every time the instrument is powered ON. This screen is used to display the model number, serial number, revision number and calibration date of the laser head connected to the controller. A sample screen is shown in Figure 18.

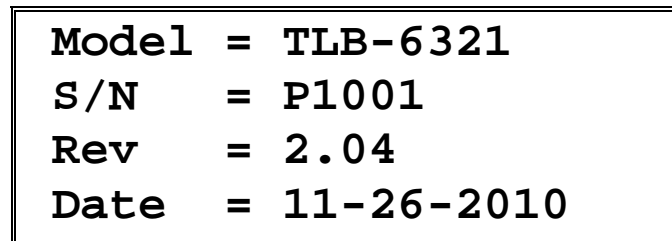


Figure 18 A Sample Laser Head Information Screen

#### 4.10.9 Main Setup Screen

The Main Setup screen is displayed after the controller has been powered ON for a few seconds. This is the topmost level display during normal operation, and it is used to change the laser current/power, wavelength, and piezo voltage setpoints, besides turning the wavelength track mode ON/OFF.

A sample Main Setup screen is shown in Figure 19.

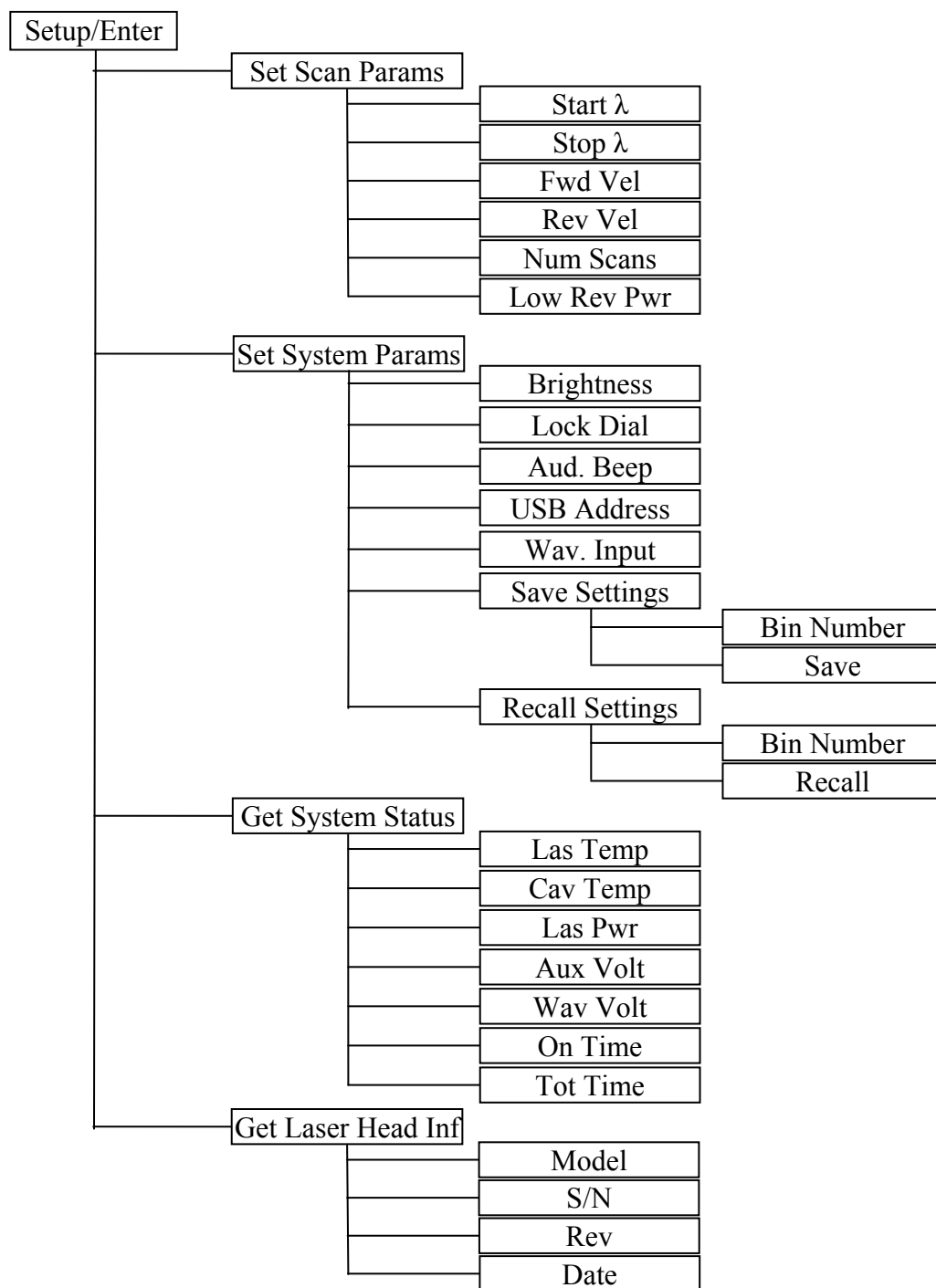
◆Current	=	150.00mA
Lambda	=	780.00nm
Piezo	=	75.00 %
Lambda Track	=	Off

*Figure 19 A Sample LDD and TEC Params Measurement Screen*

#### 4.10.10 Parameter Setup Screens

The setup screens are used to view and modify scan and system settings. These screens can be accessed from the Main Setup screen by pressing the Setup/Enter key.

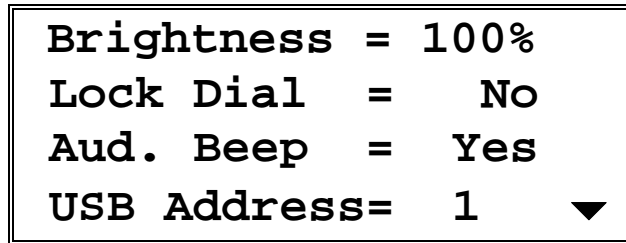


*Figure 20 Model 6700 Menu Structure*

#### 4.10.10.1 Set System Params Menu

The Set System Params menu item is used to change display brightness, lock the dial on the front panel, turn beeper ON/OFF, USB address, and to save/recall system settings

To modify these constants, use the UP and DOWN arrow keys to select this menu item. Press the SETUP/ENTER key to enter a sub-menu for this item. A sample sub-menu for setting the system parameters is shown in the figure below.



*Figure 21 A Sample System Parameters Sub-menu*

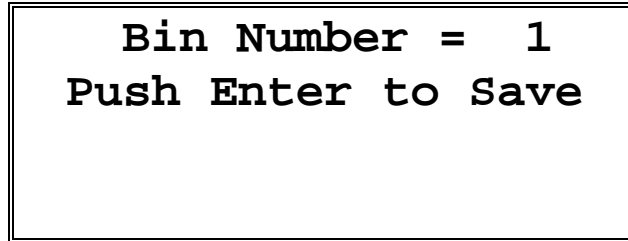
Use the UP and DOWN arrow keys to select the parameter that needs to be modified. Once the desired item has been selected, press the SETUP/ENTER key to change the item's state from idle to active. Once the item is in active state, use the cursor keys to specify a desired value. Once the desired value has been selected, press SETUP/ENTER key to accept the new value. The new parameters will take effect immediately, and the menu item will be returned to idle state. Press Esc key to cancel any changes or to return to Set System Params main menu.

#### 4.10.10.2 Save Settings Menu

The Save Settings menu item is used to store the instrument's setup configurations for future use. For example, a specific test setup may be saved for later use, and then another setup may be used presently. When the user desires to perform the specific test, its setup is simply recalled.

Non-volatile flash memory is used for saving the instrument's parameters. When a save operation is performed, all of the parameters which are currently in effect on the instrument are stored. The user selects a "bin" number for saving the parameters, up to the maximum available in the instrument. Then, when that "bin" number is recalled, the instrument is reconfigured to the previously stored values. A special "bin 0" is reserved for the reset state. Recalling bin 0 will reset the unit to factory defaults.

To perform the save operation, use the UP and DOWN arrow keys to select this menu item. Press the SETUP/ENTER key to enter a sub-menu for this item. A sample sub-menu for setting the system parameters is shown in figure below.



*Figure 22 A Sample Save Parameters Sub-menu*

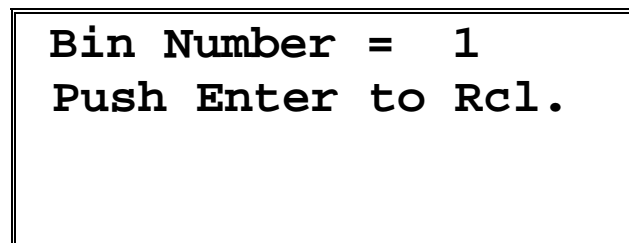
Use the UP arrow key to select the Bin Number. Press the SETUP/ENTER key to change the Bin Number menu state from idle to active. Once the item is in active state, use the cursor keys to select the desired bin number. Press SETUP/ENTER key to accept the desired bin.

Now, use the DOWN arrow key to select the menu item that states “Press Enter to Save”. Press SETUP/ENTER key with this menu item selected to save the system settings to the bin number selected earlier. The instrument will automatically return to the Measurement screen once the saving process has completed.

#### **4.10.10.3 Recall Settings Menu**

The Recall Settings menu item is used to recall previously saved instrument's setup configurations. Recalling bin 0 will reset the unit to factory defaults.

To perform the recall operation, use the UP and DOWN arrow keys to select this menu item. Press the SETUP/ENTER key to enter a sub-menu for this item. A sample sub-menu for recalling the system parameters is shown in figure below.



*Figure 23 A Sample Recall Parameters Sub-menu*

Use the UP arrow key to select the Bin Number. Press the SETUP/ENTER key to change the Bin Number menu state from idle to active. Once the item

is in active state, use the cursor keys to select the desired bin number. Press SETUP/ENTER key to accept the desired bin.

Now, use the DOWN arrow key to select the menu item that states “Press Enter to Rcl”. Press SETUP/ENTER key with this menu item selected to recall the system settings from the bin number selected earlier. The instrument will automatically return to the Measurement screen once the recalling process has completed.

#### 4.10.10.4 Error Message Screen

Whenever the instrument generates an error message, a flashing “E” symbol is shown on the left-top corner of the Measurement screen as shown in figure below. Users can retrieve this error message from the instrument from the Error Message screen. To retrieve error messages, press the SETUP/ENTER key to view the setup menu. The first menu item will be “GET ERRORS” as shown in the figure below.

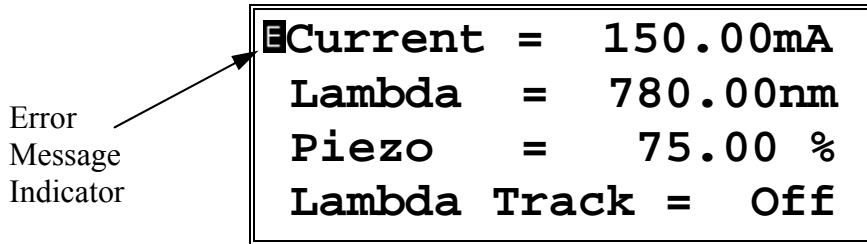


Figure 24 A Sample Main Setup Screen when Errors Present

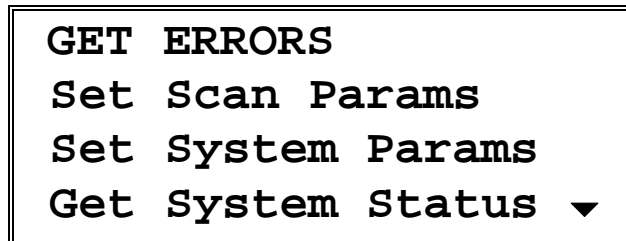


Figure 25 A Sample Setup Screen when Errors Present

Select the Get Errors menu item by pressing the UP arrow key. Once this item is selected press SETUP/ENTER key to enter the Error Messages screen. All the error messages generated are listed on this screen in a chronological order (oldest first). All the error messages can be viewed by pressing the UP and DOWN arrow keys. Press the Esc key to return to the Setup screen. Note that this process removes the errors from error buffer, and they will not be available for querying via USB communication interface.

## 4.11 Rear Panel

The Model 6700 rear panel has a USB connector, a LASER CONTROL connector, a TRIGGER INPUT connector, an AUXILIARY INPUT connector, a FREQUENCY MODULATION INPUT connector, a CURRENT MODULATION INPUT connector, a WAVELENGTH INPUT connector, a WAVELENGTH OUTPUT connector, an INTERLOCK connector, a POWER SWITCH, the AC power entry module and a GROUND post.

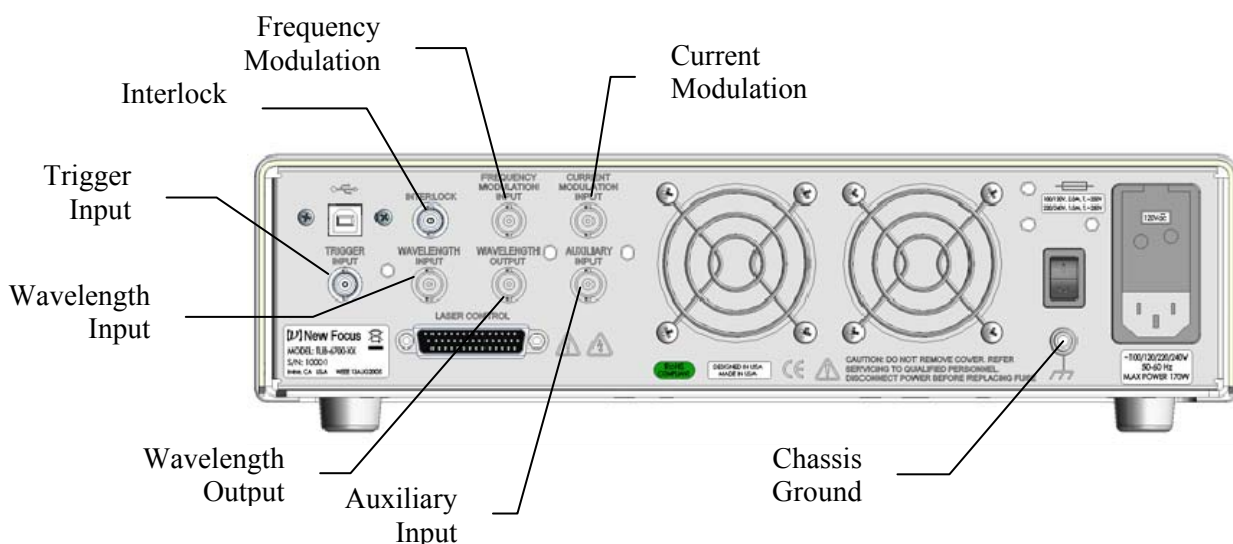


Figure 26 Rear Panel

### 4.11.1 USB Interface

The instrument is designed to communicate with standard USB Host interfaces. The connector on the rear panel is a standard USB-B (Full-Size, Device).

### 4.11.2 Chassis GND

This 4 mm banana jack is connected to chassis ground. It is intended to be used as an additional earth ground connection for the Model 6700's enclosure.


### 4.11.3 AC Power

The Model 6700 can be operated on either 50 or 60 Hz mains power. The instrument can be configured for operation at the following nominal AC line voltages -- 100, 120, 220, 230, or 240 VAC. See section 3.6 for information on properly configuring the Model 6700 for the available mains power.

The line cord supplied with each unit should be plugged only into a properly grounded outlet to prevent electrical shock in the event of an internal short circuit to the metal cabinet. The detachable line cord should be connected to the IEC320 connector on the power entry module.

#### 4.11.4 Fuses

The correct fuses must be installed into the fuse holder that is part of the AC power entry module. Please check the fuse label on the rear panel, before installing new fuses (see Figure 26).

	<p style="text-align: center;"><b>WARNING</b></p> <p>To avoid electric shock, the appropriate fuses for the AC input power voltage must be installed in the instrument. Only qualified service personnel should replace fuses. Failure to observe these precautions can result in fire, severe injury or death.</p>
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#### 4.11.5 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 certain models. 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 triangle waveforms from DC to 2 kHz with an amplitude of  $\pm 0.3$  V, and DC to 700 Hz with an amplitude of  $\pm 3$  V. The instrument will protect itself from going over these signal values, to prevent overheating of the piezo actuator or internal circuitry. The protection gradually decreases the input amplitude if the user inadvertently goes over the specified amplitude values. In the rare occasions when the unit overheats, especially when the vents are obstructed or the temperature in the room is above specifications, the unit will temporarily reduce the input signal amplitude to 1/10 of the maximum value. The instrument automatically resumes normal operation when the user responds appropriately to cool the system or reduce the input signal or frequency.

Decreasing 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.

### 4.11.6 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  $\Omega$  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.

#### 4.11.6.1 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 below 10 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<sub>p-p</sub>.



#### CAUTION

**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.

### 4.11.7 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 2 k  $\Omega$  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:

$$V = 10 * (\lambda_{\text{actual}} - \lambda_{\text{min}}) / (\lambda_{\text{max}} - \lambda_{\text{min}})$$

where  $\lambda_{\text{max}}$  and  $\lambda_{\text{min}}$  are the maximum and minimum wavelength ratings (nm) of the laser head,  $\lambda_{\text{actual}}$  is the actual wavelength (nm) and V is the Wavelength Output voltage (V).

#### 4.11.8 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 voltage that you apply to the Wavelength Input is digitized and a wavelength setpoint for wavelength control is determined.

$$\lambda_{\text{setpoint}} = 0.1 * (\lambda_{\text{max}} - \lambda_{\text{min}}) * V + \lambda_{\text{min}}$$

where  $\lambda_{\text{max}}$  and  $\lambda_{\text{min}}$  are the maximum and minimum wavelength ratings (nm) of the laser head, and V is the Wavelength Input voltage (V).

If this feature is used for scanning, please adjust the wavelength input modulation frequency such that the rate of change of  $\lambda_{\text{setpoint}}$  does not exceed head's maximum scan speed.

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 do not 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 via local menu interface (Set System Params menu – Wav. Input setting) or remote command (SYSTem:WINPut). 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 27 k  $\Omega$ . 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.

To exit Wavelength Input mode, go to the Set System Params menu and set “Wav. Input” parameter to “OFF”. Also, if you exit Track mode and then re-enter, the laser will still be in Wavelength Input mode.

#### 4.11.9 Auxiliary Input

The Auxiliary Input is a 16-bit analog-to-digital converter input to the digital signal processor (DSP). 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 Auxiliary Input will accept signals from 0 to +5 volts and presents a 40 k $\Omega$  load.



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## 4.12 Constant Power Mode

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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 ( $\sim 10$  ms), we recommend using this mode with a scan speed under 1% of the maximum speed.

To enable and disable Constant Power mode, select accordingly via front panel menu options. After leaving this mode, the power setting is stored in memory.

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# 5 Computer Interfacing

## 5.1 Introduction

---

The Model 6700 Tunable Laser Controller has a USB interface to receive commands from, and send responses to, a host PC. The commands supported by the controller can be divided into the following two categories: commands that cause it to take a desired action, and commands (queries) that cause it to return a stored value.

Query commands must end with a question mark (?). It is recommended that when a query command is sent, the response to that command from the instrument be read before issuing any other command.

Set commands, on the other hand, are used to configure/setup the controller for a desired mode of operation. These commands take at least one parameter. If the controller executed the command successfully, it responds with an “OK” string. Otherwise, it returns an error message. The subsequent sections in this chapter detail the communication protocols supported by the instrument.

## 5.2 Computer Interface Terminology

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Listed below are the key abbreviations and concepts used in the command reference section of this manual.

### 5.2.1 <...> Delimiting Punctuation

For the purposes of this manual, any string enclosed by <...> is considered to be a command, a string or numerical argument. The punctuation <...> is used to symbolize the typographic limits of the command, string or argument in question.

### 5.2.2 <CR> Carriage Return

The ASCII encoded byte 13 in decimal. (0D hex)

### 5.2.3 <LF> Line Feed

The ASCII encoded byte 10 in decimal. (0A hex)

**5.2.4 (;) Semicolons**

Semicolons are used to separate commands within a single transmission (concatenation).

**5.2.5 Command Termination**

All the commands sent to the driver must be terminated by a <CR><LF> sequence.

**5.2.6 Response Termination**

All the responses from the driver are terminated by a <CR><LF> sequence.

---

**5.3 Controller Operation Mode**

---

The Tunable Laser Controller supports two modes of operation: LOCAL and REMOTE. The controller will be in LOCAL mode, by default, following a power reset. In this mode, all the main setpoints, scan parameters and other system parameters can be adjusted by turning the control knob on the front panel of the controller. Output can be turned ON and OFF by pressing the Laser Power button. Please refer the “System Operation” chapter for a detailed description on how to accomplish these tasks. When it is in REMOTE mode, knob control is disabled; setpoints and other settings can be adjusted only by issuing appropriate commands from a host PC. The REMOTE or LOCAL status indicator character can be found in the LCD display.

The controller can be put into REMOTE mode by issuing the command “SYSTem:MCONtrol REM”. It can be put back in LOCAL mode by issuing “SYSTem:MCONtrol:LOC” command.

---

**5.4 USB Communication**

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The instrument is designed to communicate with a host PC via a standard USB interface. Before connecting the instrument to the USB interface the user should install the application included in the software CD that accompanies the Tunable Laser Controller. The application automatically installs the right USB drivers. Communication can be done through this interface by using the application or by developing software in the user’s preferred programming language. The software CD contains communication drivers and example programs in the following programming languages: LabVIEW and C#.NET

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## 5.5 Commands Summary

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### 5.5.1 Conventions

There are two types of device commands: commands that cause the instrument to take a desired action, and queries that return a stored value or state of the instrument. Queries must end with a question mark (?), while commands may require parameter(s) to follow:

**SOURce:WAVElength:START 780.00**

For example, the value “780.00” in the command

**SOURce:WAVElength:START 780.00** sets the start scan wavelength to 780.00 nm. The command/query **MUST** contain all of the letters shown in upper-case; lower-case letters in the commands are optional, and may be used for clarity.

The commands may be sent to the instrument in either upper or lower case or in any combination. For example, the following commands are equal:

**SOURce:WAVElength:START 780.00**

**SOUR:WAVE:START 780.00**

**source:wave:start 780.00**

**Source:Wavelength:Start 780.00**

COMMAND TERMINATION:

All commands sent to the controller must be terminated by <Carriage Return><Line Feed>.characters. All responses sent out by the controller are terminated by the same characters.

### 5.5.2 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. Each Source Control has an accompanying Query. Source Queries return the value of various controller set points.

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.

### 5.5.3 Index of Commands

#### Standard Commands

Syntax	Description
*IDN?	Identification string query
*RCL	Recall controller settings
*RST	Reset the controller
*SAV	Save controller settings
*STB?	Query status byte
*OPC?	Query operation complete status
BEEP	Set controller beeper status
BEEP?	Query controller beeper status
BRIGHT	Set Menu display brightness level
BRIGHT?	Query Menu display brightness
ERRSTR?	Query error string
LOCKOUT	Set controller front panel state
LOCKOUT?	Query controller front panel state
ONDELAY	Set laser output ON delay
ONDELAY?	Query laser output ON delay

#### Output Commands

Syntax	Description
OUTPut:STATe	Set laser output enable state
OUTPut:STATe?	Query laser output enable state
OUTPut:TRACk	Set wavelength track mode
OUTPut:TRACk?	Query wavelength track mode
OUTPut:SCAN:START	Start wavelength scan process
OUTPut:SCAN:STOP	Stop wavelength scan process
OUTPut:SCAN:RESET	Reset wavelength scan process

#### Sense Commands

Syntax	Description
SENSe:CURRent:DIODE	Sense diode current
SENSe:POWer:DIODE	Sense diode power
SENSe:TEMPerature:DIODE	Sense diode temperature
SENSe:TEMPerature:CAVity	Sense cavity temperature
SENSe:VOLTag:e:AUXiliary	Sense voltage from auxiliary input
SENSe:VOLTag:e:WAVEIN	Sense voltage from wavelength input
SENSe:WAVElength	Sense output wavelength

#### Source Control Commands

Syntax	Description
SOURce:CPOWer	Set constant power mode
SOURce:CURRent:DIODE	Set diode current setpoint
SOURce:POWer:DIODE	Set diode power setpoint
SOURce:VOLTag:e:PIEZo	Set piezoelectric voltage setpoint
SOURce:WAVElength	Set diode wavelength setpoint
SOURce:WAVE:DESSCANS	Set desired number of scans

<b>SOURce:WAVE:SCANCFG</b>	Set scan configuration
<b>SOURce:WAVE:START</b>	Set starting wavelength for scan
<b>SOURce:WAVE:STOP</b>	Set stopping wavelength for scan
<b>SOURce:WAVE:SLEW:FORWARD</b>	Set wavelength scan forward velocity
<b>SOURce:WAVE:SLEW:RETurn</b>	Set wavelength scan return velocity

### Source Query Commands

<b>Syntax</b>	<b>Description</b>
<b>SOURce:CPOWer?</b>	Query constant power mode
<b>SOURce:CURRent:DIODE?</b>	Query diode current setpoint
<b>SOURce:POWer:DIODE?</b>	Query diode power setpoint
<b>SOURce:TEMPerature:DIODE?</b>	Query diode temperature setpoint
<b>SOURce:TEMPerature:CAVity?</b>	Query cavity temperature setpoint
<b>SOURce:VOLTag:PIEZo?</b>	Query piezoelectric voltage setpoint
<b>SOURce:WAVElength?</b>	Query diode wavelength setpoint
<b>SOURce:WAVE:ACTSCANS?</b>	Query actual number of scans
<b>SOURce:WAVE:DESSCANS?</b>	Query desired number of scans
<b>SOURce:WAVE:SCANCFG?</b>	Query scan configuration
<b>SOURce:WAVE:START?</b>	Query starting wavelength for scan
<b>SOURce:WAVE:STOP?</b>	Query stopping wavelength for scan
<b>SOURce:WAVE:MAXVEL?</b>	Query wavelength scan max.velocity
<b>SOURce:WAVE:SLEW:FORWARD?</b>	Query wavelength scan forward velocity
<b>SOURce:WAVE:SLEW:RETurn?</b>	Query wavelength scan return velocity

### System Commands

<b>Syntax</b>	<b>Description</b>
<b>SYSTem:ENTIME?</b>	Query laser usage time
<b>SYSTem:MCONtrol</b>	Set controller operation mode
<b>SYSTem:MCONtrol?</b>	Query controller operation mode
<b>SYSTem:WINPut</b>	Set wavelength input mode
<b>SYSTem:WINPut?</b>	Query wavelength input mode
<b>SYSTem:LASer:MODEL?</b>	Query laser model number
<b>SYSTem:LASer:SN?</b>	Query laser serial number
<b>SYSTem:LASer:REV?</b>	Query laser revision number
<b>SYSTem:LASer:CALDATE?</b>	Query laser calibration date



## 5.6 Commands and Queries

### \*IDN?

**Description** Identification string query.

**Syntax** \*IDN?

**Remarks** This query will cause the instrument to return an identification string.

Model Name	Firmware Version #	Firmware Date	Controller Serial #
┌───┐	┌──┐	┌───┐	┌──┐
NEW_FOCUS XXXX vYYY mm/dd/yy, SNZZZZ			

### \*RCL

**Description** Recall command.

**Syntax** \*RCL *Bin*

Argument	Value	Description
<i>Bin</i>	0	Restores factory default settings
	1 to 5	Restores settings saved in specified bin

**Remarks** This command restores the instrument to the setup states saved in instrument's non-volatile flash memory. The parameters that can be restored are:

1. USB address
2. Beeper enable state
3. LCD display brightness
4. Dial (rotary knob) lockout state
5. Laser mode
6. Diode current setpoint
7. Diode power setpoint
8. Diode temperature setpoint
9. Cavity temperature setpoint
10. Wavelength input enable state
11. Wavelength setpoint
12. Piezo voltage setpoint
13. Starting wavelength for scan process
14. Stopping wavelength for scan process
15. Forward scan velocity
16. Return scan velocity

**See Also** \*RST, \*SAV

---

**\*RST****Description** Reset command.**Syntax** **\*RST****Remarks** This command performs a soft reset of the instrument.**See Also** **\*RCL**

---

**\*SAV****Description** Save command.**Syntax** **\*SAV Bin**

	<b>Argument</b>	<b>Value</b>	<b>Description</b>
	<i>Bin</i>	2 to 5	Saves current settings to specified bin

**Remarks** This command stores the current state of the instrument in non-volatile flash memory. This state is then recalled using the **\*RCL** command. See description of **\*RCL** command for a list of values saved/recalled by the instrument.

**See Also** **\*RCL**

---

**\*OPC?****Description** Operation Complete Query.**Syntax** **\*OPC?**

**Remarks** The laser has three long-term operations: wavelength scanning, wavelength scan resetting and setting the wavelength. Starting any of these 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 by stopping/resetting the scan process or by turning OFF the wavelength Track mode. This query command returns the OPC status bit.

	<b>Response</b>	<b>Description</b>
	<i>Status = 0</i>	Performing a long-term operation
	<i>Status = 1</i>	Not performing a long-term operation; system is available

**See Also** **OUTPut:SCAN:START; OUTPut:SCAN:STOP; OUTPut:SCAN:RESET; OUTPut:TRACK; SOURce:WAVElength**

---

## \*STB?

**Description** Status byte Query.

**Syntax** \*STB?

**Remarks** This command is used to query the status of the controller. A response of 128, implies that the controller's error buffer is not empty. This buffer can be emptied by issuing "ERRSTR?" command and reading error messages from the controller.

Response	Description
<i>Status = 0</i>	The error buffer is empty
<i>Status = 128</i>	The error buffer is not empty

**See Also** ERRSTR?

---

## BEEP

**Description** Beep command

**Syntax** BEEP *beep set*

**Remarks** This command controls the instrument's beeper. The beeper is used to signal error or warning conditions.

Response	Value	Description
<i>beep set</i>	0	Beeper off
	1	Beeper on
	2	Test beeper (100ms beep)

**See Also** BEEP?

---

## BEEP?

**Description** Beep query

**Syntax** BEEP?

**Remarks** This query returns the enable status of the beeper.

Response	Description
<i>beep set</i>	0 Beeper off
	1 Beeper on

**See Also** BEEP

---

## BRIGHT

**Description** Display brightness command

**Syntax** **BRIGHT** *brightness*

**Remarks** This command controls the brightness of the controller display.

Argument	Value	Description
<i>brightness</i>	Integer	Brightness, in percentage, from 1% to 100%

**See Also** **BRIGHT?**

---

## BRIGHT?

**Description** Display brightness query

**Syntax** **BRIGHT?**

**Remarks** This query returns the display brightness setting.

Response	Description
<i>brightness</i>	Display brightness, in percentage.

**See Also** **BRIGHT**

---

## ERRSTR?

**Description** Error string query.

**Syntax** **ERRSTR?**

**Remarks** This query returns a single error code along with the corresponding error text string that occurred since the last error query. Refer to Appendix A for a list of error codes and strings generated by the instrument.

Response	Description
<i>Error code, "text"</i>	Error code and text for error code as per chapter, 0 if no errors

**See Also** **ERRors?**

---

## LOCKOUT

**Description** Lockout the instrument front panel.

**Syntax** **LOCKOUT** *Value*

**Remarks** This command can be used to lockout all the buttons and dial knob or just the dial knob on the front panel.

Argument	Value	Description
<i>Value</i>	0	Front panel buttons and dial knob enabled
	1	Front panel buttons and dial knob disabled
	2	Front panel dial knob disabled

**See Also**      **None**

---

## LOCKOUT?

**Description**    Instrument front panel lockout state query.

**Syntax**          **LOCKOUT?**

**Remarks**        This query returns the instrument's front panel lockout state.

Response	Description
<i>Value</i>	Front panel lockout state

**See Also**        **LOCKOUT**

---

## ONDELAY

**Description**    Laser turn on delay command.

**Syntax**          **ONDELAY** *time*

**Remarks**        This command controls the laser turn on delay. This is the amount of time between the moment the laser on command is received and the moment the output is actually energized. This setting is also used when a laser is commanded to turn on by pushing the LASER POWER button on front panel of instrument when it is in local control mode.

Argument	Value	Description
<i>Time</i>	<i>Integer</i>	Time, in milliseconds. Valid values are between 3000 and 60000

**See Also**        **ONDELAY?, LAS:OUT, LAS:OUT?**

---

## ONDELAY?

**Description**    Laser turn on delay query

**Syntax**          **ONDELAY?**

**Remarks**        This command returns the laser turn on delay time.

Response	Description
<i>Value</i>	Time, in milliseconds

**See Also**        **ONDELAY, LAS:OUT, LAS:OUT?**

---

## OUTPut:STATe

**Description** Laser output enable command.

**Syntax** **OUTPut:STATe** *State*

**Remarks** This command turns the laser ON or OFF. When turning the laser ON, the light above the front panel's LASER POWER switch will flash for five seconds (default) before the power is turned ON. The flash time can be changed using the ONDELAY command.

Argument	Value	Description
<i>State</i>	0	0 or OFF turns the laser OFF
	1	1 or ON turns the laser ON

**See Also** **ONDELAY?; OUTPut:STATe?**

---

## OUTPut:STATe?

**Description** Laser output enable state query

**Syntax** **OUTPut:STATe?**

**Remarks** This command returns the laser output enable state.

Response	Description
<i>Value</i>	0 laser output OFF
	1 laser output ON

**See Also** **ONDELAY; OUTPut:STATe**

---

## OUTPut:TRACk

**Description** Wavelength Track mode command.

**Syntax** **OUTPut:TRACk** *Mode*

**Remarks** This command is used to turn the wavelength Track mode ON or OFF. When the Track mode is turned ON, the laser wavelength is actively controlled using the tuning motor that rotates the end mirror. When the tracking is turned OFF, 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 when the Track mode is turned OFF.

Argument	Value	Description
<i>Mode</i>	0	0 or OFF turns the Track mode OFF
	1	1 or ON turns the Track mode ON

**See Also** **OUTPut:TRACk?; SOURce:WAVE?**

---

## OUTPut:TRACk?

**Description** Wavelength Track mode query

**Syntax** **OUTPut:TRACk?**

**Remarks** This command returns the wavelength Track mode.

Response	Description
Value	0 wavelength Track mode is OFF
	1 wavelength Track mode is ON

**See Also** **OUTPut:TRACk; SOURce:WAVE**

---

## OUTPut:SCAN:START

**Description** Start wavelength scan process.

**Syntax** **OUTPut:SCAN:START**

**Remarks** This command is used to start the wavelength scan process. If the actual wavelength at the beginning of a scan is not equal to the starting wavelength, the controller will move the laser to starting wavelength at return velocity. Once the actual wavelength is at starting wavelength, the controller starts the scan from starting wavelength to stopping wavelength at forward velocity. When the wavelength has reached stopping wavelength, the controller stops the scan process for a few milli-seconds, and starts scan from stopping to starting wavelength at return velocity.

If the wavelength Track mode is OFF, the controller will automatically set this mode to ON at the beginning of scan. The Track mode will remain ON at the end of scan completion.

The \*OPC? command will return 0 while a scan is in progress.

Argument	Value	Description
None		

**See Also** **\*OPC?; SOURce:WAVE:START; SOURce:WAVE:STOP**

---

## OUTPut:SCAN:STOP

**Description** Stop wavelength scan process.

**Syntax** **OUTPut:SCAN:STOP**

**Remarks** This command is used to stop the wavelength scan process.

The \*OPC? command will return 1 once the scan is stopped.

Argument	Value	Description
None		

**See Also**      **\*OPC?; SOURce:WAVE:START; SOURce:WAVE:STOP**

---

## **OUTPut:SCAN:RESET**

**Description**      Reset wavelength scan process.

**Syntax**            **OUTPut:SCAN:RESET**

**Remarks**        This command is used to reset the wavelength scan process. When this command is received by the controller, it will stop the scan, wait a few milli-seconds and move the laser to starting wavelength.

The \*OPC? command will return 1 once the scan is stopped.

Argument	Value	Description
----------	-------	-------------

*None*

**See Also**      **\*OPC?; SOURce:WAVE:START; SOURce:WAVE:STOP**

---

## **SENSe:CURRent:DIODE**

**Description**      Actual laser diode current query

**Syntax**            **SENSe:CURRent:DIODE**

**Remarks**        This command returns the magnitude of actual laser diode current. The value returned is same as that seen on the front panel of the controller at the time this command is executed.

Response	Description
----------	-------------

<i>Value</i>	Actual laser diode current in milliamperes (mA).
--------------	--

**See Also**      **SOURce:CURRent:DIODE; SOURce:CURRent:DIODE?**

---

## **SENSe:POWer:DIODE**

**Description**      Actual laser diode power query

**Syntax**            **SENSe:POWer:DIODE**

**Remarks**        This command returns the magnitude of actual laser diode output power. The value returned is same as that seen on the front panel of the controller at the time this command is executed.

Response	Description
----------	-------------

<i>Value</i>	Actual laser diode output power in milliwatts (mW).
--------------	---

**See Also**      **SOURce:POWer:DIODE; SOURce:POWer:DIODE?**



---

## SENSe:TEMPerature:DIODE

**Description** Actual laser diode gain element temperature query

**Syntax** **SENSe:TEMPerature:DIODE**

**Remarks** This command returns the magnitude of actual laser diode gain element temperature. Note that 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	Description
<i>Value</i>	Actual laser diode gain element temperature in degC (°C).

**See Also** **SOURce:TEMPerature:DIODE; SOURce:TEMPerature:DIODE?**

---

## SENSe:TEMPerature:CAVity

**Description** Actual laser cavity temperature query

**Syntax** **SENSe:TEMPerature:CAVity**

**Remarks** This command returns the magnitude of actual laser cavity temperature. The laser cavity temperature is actively maintained by the controller at about 30°C. 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	Description
<i>Value</i>	Actual laser diode gain element temperature in degC (°C).

**See Also** **SOURce:TEMPerature:CAVity; SOURce:TEMPerature:CAVity?**

---

## SENSe:VOLTage:AUXiliary

**Description** Actual auxiliary detector input voltage query

**Syntax** **SENSe:VOLTage:AUXiliary**

**Remarks** This command returns the magnitude of actual auxiliary detector input voltage. The resolution of this voltage is about 79µV.

Response	Description
<i>Value</i>	Actual auxiliary detector input voltage in Volts (V).

**See Also** **SENSe:VOLTage:WAVEIN**

---

## SENSe:VOLTage:WAVEIN

**Description** Actual wavelength input voltage query

**Syntax** SENSe:VOLTage:WAVEIN

**Remarks** This command returns the magnitude of actual wavelength input voltage. The resolution of this voltage is about 0.16mV.

Response	Description
----------	-------------

<i>Value</i>	Actual wavelength input voltage in Volts (V).
--------------	---

**See Also** SENSe:VOLTage:AUXiliary

---

## SENSe:WAVElength

**Description** Actual laser wavelength query

**Syntax** SENSe:WAVElength

**Remarks** This command returns the magnitude of actual laser wavelength. The value returned is same as that seen on the front panel of the controller at the time this command is executed.

Response	Description
----------	-------------

<i>Value</i>	Actual laser wavelength in nanometers (nm).
--------------	---

**See Also** SENSe:CURREnt:DIODE; SENSe:POWer:DIODE

---

## SOURce:CPOWer

**Description** Constant power mode set

**Syntax** SOURce:CPOWer *Value*

**Remarks** This command enables/disables Constant Power mode.

If the laser output is ON and a mode change is commanded:

- The output is turned OFF.
- The controller returns “OUTPUT DISABLED DUE TO MODE CHANGE”
- The desired mode is set.

If the laser output is OFF and a mode change is commanded:

- The desired mode is set.
- The controller returns “OK”

Argument	Value	Description
----------	-------	-------------

<i>Value</i>	OFF or 0	If the string “OFF” or 0 is specified as value, the controller is set to Constant Current mode.
	ON or 1	If the string “ON” or 1 is specified as value, the controller is set to Constant Power mode.

**See Also**      **SOURce:CPOWer?**

---

## **SOURce:CURRent:DIODe**

**Description**      Diode laser current set.

**Syntax**            **SOURce:CURRent:DIODe** *Value*

**Remarks**        This command sets the diode laser current.

If the value specified is greater than the diode current rating:

- The controller returns “VALUE OUT OF RANGE”.
- No other action is taken.

If the value is in range:

- The diode laser current is changed to specified value.
- The controller returns “OK”.

<b>Argument</b>	<b>Value</b>	<b>Description</b>
<i>Value</i>	MAX	If the string “MAX” is specified as value, the diode current setpoint is set to the diode’s current rating
	Float	Desired diode laser current in milliamperes (mA)

**See Also**      **SOURce:CURRent:DIODe?**

---

## **SOURce:POWer:DIODe**

**Description**      Diode laser output power set.

**Syntax**            **SOURce:POWer:DIODe** *Value*

**Remarks**        This command sets the diode laser output power.

If the value specified is greater than the diode power rating:

- The controller returns “VALUE OUT OF RANGE”.
- No other action is taken.

If the value is in range:

- The diode laser power is changed to specified value.
- The controller returns “OK”.

<b>Argument</b>	<b>Value</b>	<b>Description</b>
<i>Value</i>	MAX	If the string “MAX” is specified as value, the diode power setpoint is set to the diode’s power rating
	Float	Desired diode laser power in milliwatts (mW)

**See Also**      **SOURce:POWer:DIODe?**

---

## SOURce:VOLTage:PIEzo

**Description** Piezoelectric transducer voltage set.

**Syntax** **SOURce:VOLTage:PIEzo** *Value*

**Remarks** This command sets the piezoelectric transducer voltage.

If the value specified is greater than 100:

- The controller returns “VALUE OUT OF RANGE”.
- No other action is taken.

If the value is in range:

- The piezo voltage is changed to specified value.
- The controller returns “OK”.

Argument	Value	Description
<i>Value</i>	MAX	If the string “MAX” is specified as value, the piezo voltage setpoint is set to 100%
	Float	Desired piezo voltage in percentage (%)

**See Also** **SOURce:VOLTage:PIEzo?**

---

## SOURce:WAVElength

**Description** Laser diode wavelength set.

**Syntax** **SOURce:WAVElength** *Value*

**Remarks** This command sets the laser wavelength setpoint.

If the value specified is less than the laser diode’s minimum wavelength rating or it is greater than the maximum wavelength rating:

- The controller returns “VALUE OUT OF RANGE”.
- No other action is taken.

If the value is in range:

- The wavelength setpoint is changed to specified value.
- The controller returns “OK”.
- If the wavelength Track mode is ON, the controller will drive the tuning motor until the actual diode wavelength is equal to the value specified here

Argument	Value	Description
<i>Value</i>	MAX	If the string “MAX” is specified as value, the diode wavelength setpoint is set to diode’s max. rating.
	MIN	If the string “MIN” is specified as value, the diode wavelength setpoint is set to diode’s min. rating.
	Float	Desired wavelength in nanometers (nm)

**See Also**      **SOURce:WAVElength?**

---

## SOURce:WAVE:DESSCANS

**Description**      Desired number of scans set.

**Syntax**            **SOURce:WAVE:DESSCANS** *Value*

**Remarks**          This command sets the desired number of scans. This setting is used by the controller to repeat a scan operation (from Start Wavelength to Stop Wavelength) once a scan is started.

If the value specified is less than 1 or it is greater than 9999:

- The controller returns “VALUE OUT OF RANGE”.
- No other action is taken.

If the value is in range:

- The desired number of scans is changed to specified value.
- The controller returns “OK”.

Argument	Value	Description
<i>Value</i>	Integer	Desired number of scans

**See Also**            **SOURce:WAVE:DESSCANS?; SOURce:WAVE:START**

---

## SOURce:WAVE:SCANCFG

**Description**      Scan configuration set.

**Syntax**            **SOURce:WAVE:SCANCFG** *Value*

**Remarks**          This command sets the scan configuration. This setting is used by the controller to determine whether laser output power must be reduced to 0 or otherwise when scanning in the reverse direction (from Stop Wavelength to Start Wavelength).

If the value specified is greater than 255:

- The controller returns “VALUE OUT OF RANGE”.
- No other action is taken.

If the value is in range:

- The scan configuration is changed to specified value.
- The controller returns “OK”.

Argument	Value	Description
<i>Value</i>	0	Do not reduce the laser output power to 0 during reverse scan
	1	Reduce the laser output power to 0 during reverse scan

**See Also**      **SOURce:WAVE:SCANCFG?; SOURce:WAVE:START**

---

## **SOURce:WAVE:START**

**Description**    Laser diode scanning start wavelength.

**Syntax**          **SOURce:WAVE:START** *Value*

**Remarks**        This command sets the laser diode scanning start wavelength.

If the value specified is less than the laser diode’s minimum wavelength rating or it is greater than the maximum wavelength rating:

- The controller returns “VALUE OUT OF RANGE”.
- No other action is taken.

If the value is in range:

- The scan start wavelength is changed to specified value.
- The controller returns “OK”.

Argument	Value	Description
<i>Value</i>	MAX	If the string “MAX” is specified as value, the scan starting wavelength is set to diode’s max. rating.
	MIN	If the string “MIN” is specified as value, the scan starting wavelength is set to diode’s min. rating.
	Float	Desired scan starting wavelength in nanometers (nm)

**See Also**          **SOURce:WAVE:START?**

---

## **SOURce:WAVE:STOP**

**Description**    Laser diode scanning stop wavelength.

**Syntax**          **SOURce:WAVE:STOP** *Value*

**Remarks**        This command sets the laser diode scanning stop wavelength.

If the value specified is less than the laser diode’s minimum wavelength rating or it is greater than the maximum wavelength rating:

- The controller returns “VALUE OUT OF RANGE”.

- No other action is taken.

If the value is in range:

- The scan stop wavelength is changed to specified value.
- The controller returns “OK”.

Argument	Value	Description
<i>Value</i>	MAX	If the string “MAX” is specified as value, the scan stopping wavelength is set to diode’s max. rating.
	MIN	If the string “MIN” is specified as value, the scan stopping wavelength is set to diode’s min. rating.
	Float	Desired scan stopping wavelength in nanometers (nm)

**See Also**      **SOURce:WAVE:STOP?**

---

## **SOURce:WAVE:SLEW:FORWard**

**Description**      Wavelength scan forward velocity set.

**Syntax**            **SOURce:WAVE:SLEW:FORWard** *Value*

**Remarks**        This command sets the wavelength scan forward velocity setpoint.

If the value specified is greater than the maximum velocity rating of the laser head:

- The controller returns “VALUE OUT OF RANGE”.
- No other action is taken.

If the value is in range:

- The wavelength scan forward velocity is changed to specified value.
- The controller returns “OK”.

Argument	Value	Description
<i>Value</i>	MAX	If the string “MAX” is specified as value, the wavelength scan forward velocity is set to diode’s max. rating.
	Float	Desired wavelength scan forward velocity in nanometers/sec (nm/s)

**See Also**            **SOURce:WAVE:SLEW:FORWard?**

---

## **SOURce:WAVE:SLEW:RETurn**

**Description**      Wavelength scan return velocity set.

**Syntax**            **SOURce:WAVE:SLEW:RETurn** *Value*

**Remarks**        This command sets the wavelength scan return velocity setpoint.

If the value specified is greater than the maximum velocity rating of the laser head:

- The controller returns “VALUE OUT OF RANGE”.
- No other action is taken.

If the value is in range:

- The wavelength scan return velocity is changed to specified value.
- The controller returns “OK”.

Argument	Value	Description
<i>Value</i>	MAX	If the string “MAX” is specified as value, the wavelength scan return velocity is set to diode’s max. rating.
	Float	Desired wavelength scan return velocity in nanometers/sec (nm/s)

**See Also**      **SOURce:WAVE:SLEW:RETurn?**

---

## SOURce:CPOWer?

**Description**      Constant Power mode query.

**Syntax**            **SOURce:CPOWer?**

**Remarks**        This query returns the Constant Power mode setting.

Response	Description
<i>Value</i>	0      Constant Current mode
	1      Constant Power mode

**See Also**        **SOURce:CPOWer**

---

## SOURce:CURREnt:DIODE?

**Description**      Diode laser current setpoint query.

**Syntax**            **SOURce:CURREnt:DIODE?**

**Remarks**        This query returns the diode laser current setpoint.

Response	Description
<i>Value</i>	Diode laser current setpoint in milliamperes (mA)

**See Also**        **SOURce:CURREnt:DIODE**



---

## SOURce:POWer:DIODe?

**Description** Diode laser output power setpoint query.

**Syntax** SOURce:POWer:DIODe?

**Remarks** This query returns the diode laser output power setpoint.

Response	Description
----------	-------------

<i>Value</i>	Diode laser power setpoint in milliwatts (mW)
--------------	---

**See Also** SOURce:POWer:DIODe

---

## SOURce:TEMPerature:DIODe?

**Description** Diode temperature setpoint query.

**Syntax** SOURce:TEMPerature:DIODe?

**Remarks** This query returns the diode temperature setpoint.

Response	Description
----------	-------------

<i>Value</i>	Diode laser temperature setpoint in degC (°C)
--------------	---

**See Also** SOURce:TEMPerature:DIODe

---

## SOURce:TEMPerature:CAVity?

**Description** Cavity temperature setpoint query.

**Syntax** SOURce:TEMPerature:CAVity?

**Remarks** This query returns the laser cavity temperature setpoint.

Response	Description
----------	-------------

<i>Value</i>	Laser cavity temperature setpoint in degC (°C)
--------------	--

**See Also** SOURce:TEMPerature:CAVity

---

## SOURce:VOLTage:PIEZO?

**Description** Piezoelectric transducer voltage setpoint query.

**Syntax** SOURce:VOLTage:PIEZO?

**Remarks** This query returns the piezo voltage setpoint.

Response	Description
----------	-------------

<i>Value</i>	Piezo voltage setpoint in percentage (%)
--------------	--

**See Also** SOURce:VOLTage:PIEZO

---

## SOURce:WAVElength?

**Description** Laser diode wavelength setpoint query.

**Syntax** SOURce:WAVElength?

**Remarks** This query returns the laser diode wavelength setpoint.

Response	Description
----------	-------------

<i>Value</i>	Laser diode wavelength setpoint in nanometers (nm)
--------------	--

**See Also** SOURce:WAVElength

---

## SOURce:WAVE:ACTSCANS?

**Description** Actual number of scans completed query.

**Syntax** SOURce:WAVE:ACTSCANS?

**Remarks** This query returns the actual number of scans completed during the last scan process.

Response	Description
----------	-------------

<i>Value</i>	Actual number of scans
--------------	------------------------

**See Also** SOURce:WAVE:DESSCANS

---

## SOURce:WAVE:DESSCANS?

**Description** Desired number of scans query.

**Syntax** SOURce:WAVE:DESSCANS?

**Remarks** This query returns the desired number of scans to be performed by the controller once a scan process is started.

Response	Description
----------	-------------

<i>Value</i>	Desired number of scans
--------------	-------------------------

**See Also** SOURce:WAVE:DESSCANS

---

## SOURce:WAVE:SCANCFG?

**Description** Scan configuration query.

**Syntax** SOURce:WAVE:SCANCFG?

**Remarks** This query returns the scan configuration setting.

Response	Description
----------	-------------

<i>Value</i>	Scan configuration setting
--------------	----------------------------

**See Also**      **SOURce:WAVE:SCANCFG**

---

## **SOURce:WAVE:START?**

**Description**      Laser diode scanning start wavelength query.

**Syntax**            **SOURce:WAVE:START?**

**Remarks**          This query returns the laser diode scan starting wavelength.

<b>Response</b>	<b>Description</b>
-----------------	--------------------

<i>Value</i>	Laser diode scan starting wavelength in nanometers (nm)
--------------	---

**See Also**          **SOURce:WAVE:START**

---

## **SOURce:WAVE:STOP?**

**Description**      Laser diode scanning stop wavelength query.

**Syntax**            **SOURce:WAVE:STOP?**

**Remarks**          This query returns the laser diode scan stopping wavelength.

<b>Response</b>	<b>Description</b>
-----------------	--------------------

<i>Value</i>	Laser diode scan stopping wavelength in nanometers (nm)
--------------	---

**See Also**          **SOURce:WAVE:STOP**

---

## **SOURce:WAVE:MAXVEL?**

**Description**      Laser diode scanning maximum velocity query.

**Syntax**            **SOURce:WAVE:MAXVEL?**

**Remarks**          This query returns the laser diode scanning maximum velocity.

<b>Response</b>	<b>Description</b>
-----------------	--------------------

<i>Value</i> (nm/sec)	Laser diode wavelength scanning maximum velocity in nanometers/sec
--------------------------	--

**See Also**          **SOURce:WAVE:SLEW:FORWard; SOURce:WAVE:SLEW:RETurn**

---

## SOURce:WAVE:SLEW:FORWard?

**Description** Laser diode wavelength scan forward velocity query.

**Syntax** SOURce:WAVE:SLEW:FORWard?

**Remarks** This query returns the laser diode wavelength scan forward velocity.

Response	Description
----------	-------------

<i>Value</i>	Laser diode wavelength scan forward velocity in nanometers/sec (nm/s)
--------------	---

**See Also** SOURce:WAVE:SLEW:FORWard

---

## SOURce:WAVE:SLEW:RETurn?

**Description** Laser diode wavelength scan return velocity query.

**Syntax** SOURce:WAVE:SLEW:RETurn?

**Remarks** This query returns the laser diode wavelength scan return velocity.

Response	Description
----------	-------------

<i>Value</i>	Laser diode wavelength scan return velocity in nanometers/sec (nm/s)
--------------	--

**See Also** SOURce:WAVE:SLEW:RETurn

---

## SYSTem:ENTIME?

**Description** Laser enable time query.

**Syntax** SYSTem:ENTIME?

**Remarks** This query returns the amount of time laser diode output has been enabled.

Response	Description
----------	-------------

<i>Value</i>	Laser diode enable time in minutes (min)
--------------	--

**See Also** OUTPut:STATe

---

## SYSTem:MCONtrol

**Description** Controller REMOTE/LOCAL operation mode set command.

**Syntax** SYSTem:MCONtrol *Mode*

**Remarks** This command is used to put the controller in remote/local operation mode. The controller will be in LOCAL mode, by default, following a power reset. In this mode, all the main setpoints, scan parameters and other system parameters can be adjusted by turning the control knob on front panel of the controller. Output can be turned ON and OFF by pressing the Laser Power button. When it is in

REMOTE mode, knob control is disabled; setpoints and other settings can be adjusted only by issuing appropriate commands from a host PC.

Argument	Value	Description
<i>Mode</i>	<i>String</i>	REM sets the controller to REMOTE mode LOC sets the controller to LOCAL mode

**See Also**      **SYSTem:MCONtrol?**

---

## SYSTem:MCONtrol?

**Description**      Controller REMOTE/LOCAL operation mode query

**Syntax**            **SYSTem:MCONtrol?**

**Remarks**        This command returns the controller operation mode.

Response	Description
<i>Value</i>	REM    controller is in REMOTE mode LOC    controller is in LOCAL mode

**See Also**      **SYSTem:MCONtrol**

---

## SYSTem:WINPut

**Description**      Wavelength input mode command.

**Syntax**            **SYSTem:WINPut** *Mode*

**Remarks**        This command is used to turn the wavelength input mode ON or OFF. When the wavelength input mode is turned ON, the laser wavelength is adjusted in proportion to the voltage at the wavelength modulation input.

Argument	Value	Description
<i>Mode</i>	<i>Integer</i>	0 turns the input mode OFF 1 turns the input mode ON

**See Also**      **SYSTem:WINPut?**

---

## SYSTem:WINPut?

**Description**      Wavelength input mode query

**Syntax**            **SYSTem:WINPut?**

**Remarks**        This command returns the wavelength input mode.

Response	Description
<i>Value</i>	0      wavelength input mode is OFF 1      wavelength input mode is ON

**See Also**      **SYSTem:WINPut**

---

## SYSTem:LASer:MODEL?

**Description** Laser head model number query

**Syntax** SYSTem:LASer:MODEL?

**Remarks** This command returns the model number of the laser head connected to the controller.

Response	Description
<i>Value</i>	<i>String</i> laser head model number

**See Also** SYSTem:LASer:SN?

---

## SYSTem:LASer:SN?

**Description** Laser head serial number query

**Syntax** SYSTem:LASer:SN?

**Remarks** This command returns the serial number of the laser head connected to the controller.

Response	Description
<i>Value</i>	<i>String</i> laser head serial number

**See Also** SYSTem:LASer:MODEL?

---

## SYSTem:LASer:REV?

**Description** Laser head revision number query

**Syntax** SYSTem:LASer:REV?

**Remarks** This command returns the revision number of the laser head connected to the controller.

Response	Description
<i>Value</i>	<i>String</i> laser head revision number

**See Also** SYSTem:LASer:SN?

---

## SYSTem:LASer:CALDATE?

**Description** Laser head calibration date query

**Syntax** SYSTem:LASer:CALDATE?

**Remarks** This command returns the calibration date of the laser head connected to the controller.

Response	Description
<i>Value</i>	<i>String</i> laser head calibration date

**See Also** SYSTem:LASer:SN?

# 6 Principles of Operation

## 6.1 Theory of Design

---

The New Focus 6700 series tunable lasers take advantage of the broad gain bandwidths available in semiconductor diode lasers.

In addition to being widely tunable, the 6700 series lasers offer narrow linewidths. This is accomplished by using a laser cavity design that began at the Massachusetts Institute of Technology. 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 0. 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.

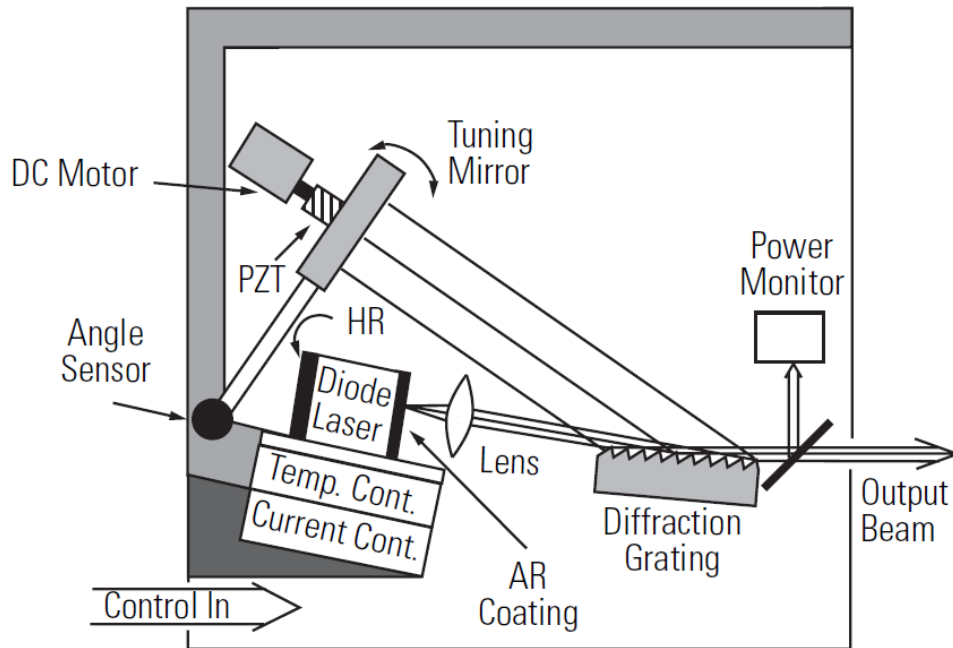


Figure 27 New Focus Laser Cavity

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 Velocity Tunable Diode Laser 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:

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



where  $\Lambda$  is the spacing between grooves in the grating while  $\theta_i$  and  $\theta_d$  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 28.) 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  $L(\sin \theta_i + \sin \theta_d)$ . Dividing the total cavity length by the wavelength, shows that the total number of waves in the cavity is  $L/\Lambda$  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 6700 series laser system.

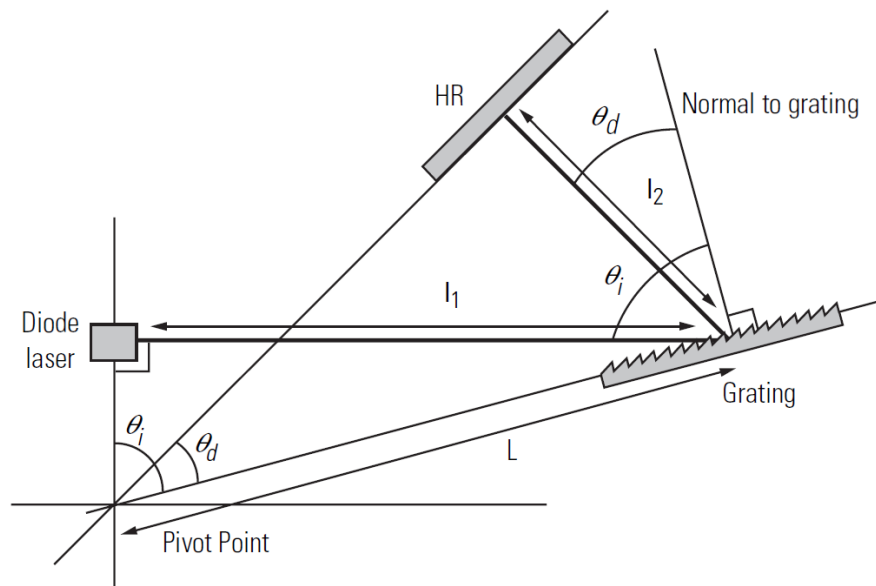


Figure 28 Drawing of Important Angles and Optimal Pivot Point

### 6.1.1 References

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- [5] K. C. Harvey and C. J. Myatt, "External-cavity diode laser using a grazing-incidence diffraction grating," *Optics Letters*, vol. 16, p. 910–912, 1991.
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# 7 Tips and Techniques

## 7.1 Introduction


---

This section explains operational details of the Model 6700 Tunable Diode Laser and provides application examples.

## 7.2 Grounding a Laser Head

---

The 6700 Tunable Laser outputs are isolated from earth (chassis) ground. Isolating the laser head case avoids damaging the device from multiple ground loop potentials, AC transients, or static discharge. Since test equipment probes, signal sources, and package mounts are often partially earth grounded, it is often necessary to also bond the device case to earth ground. It is strongly recommended that a single point ground scheme be established, specifically at the binding post. This will help minimize noise, transients, and ground loop hazards. Be sure to include any signal generators in your ground circuit.

	<p style="text-align: center;"><b>CAUTION</b></p> <p><b>Only one connection to ground is accepted. Failure to do so may result in the unit malfunction and/or damage. Be careful when connecting other instruments to 6700 Tunable Diode Laser, as they may have their ground connected to the Earth Ground.</b></p> <p><b>For example, oscilloscopes have the probe ground connected to Earth Ground.</b></p>
---	--

If you have additional questions about your earth grounding method, contact a New Focus applications engineer.

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## 8 Maintenance and Service



### WARNING

There are no user serviceable parts inside the Model 6700 Tunable Diode Laser. Work performed by persons not authorized by Newport Corporation will void the warranty.

### 8.1 Enclosure Cleaning

---



### WARNING

Before cleaning the enclosure of the Model 6700 Tunable Diode Laser, the AC power cord must be disconnected from the wall socket.

The source enclosure should only be cleaned with a mild soapy water solution applied to a damp lint-free cloth. Do not use an acetone or alcohol solution; this will damage the finish of the enclosure.

### 8.2 Technical Support

---

Information and advice about the operation of any New Focus product is available from our technical support engineers. For quickest response, ask for “Technical Support” and know the model and serial number for your product.

**Hours:** 8:00–5:00 PST, Monday through Friday (excluding holidays).

**Toll Free:** 1-866-NUFOCUS (1-866-683-6287)

(from the USA & Canada only)

**Phone:** (408) 284-6808

Support is also available by fax and email:

**Fax:** (408) 980-4300

**Email:** techsupport@newfocus.com

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

### **8.3 Service**

---

Your 67XX 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.

### **8.4 Obtaining Service**

---

The Model 6700 Tunable Diode Laser contains no user serviceable parts. To obtain information regarding factory service, contact New Focus or your New Focus representative. Please have the following information available:

1. Instrument model number (on the rear panel).
2. Instrument serial number (on rear panel or bottom of enclosure).
3. Description of the problem.

If the instrument is to be returned to New Focus, you will be given a Return Number, which you should reference in your shipping documents. Please fill out a copy of the service form, located on the following page, and have the information ready when contacting Newport Corporation. Return the completed service form with the instrument.

### **8.5 Warranty**

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New Focus, a division of Newport Corp, 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.

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## 8.6 Service Form

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New Focus U.S.A.  
Office: 408-919-1500  
FAX: 408-980-6083

Name \_\_\_\_\_ Return Authorization # \_\_\_\_\_  
(Please obtain RA# prior to return of item)

Company \_\_\_\_\_  
(Please obtain RA # prior to return of item)

Address \_\_\_\_\_ Date \_\_\_\_\_

Country \_\_\_\_\_ Phone Number \_\_\_\_\_

P.O. Number \_\_\_\_\_ FAX Number \_\_\_\_\_

***Item(s) Being Returned:***

Model # \_\_\_\_\_ Serial # \_\_\_\_\_

Description \_\_\_\_\_

Reason for return of goods (please list any specific problems):

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# 9 Appendix A – Error Messages

## 9.1 Introduction

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.

The communication errors can be retrieved with the following commands via USB: ERRSTR?. The descriptions of the returned errors are detailed in the next sections.

## 9.2 Error Description

A description of error codes and corresponding error strings generated by the TEC Driver is given below:

Error Code	Error String	Description
0	NO ERROR	No error exists in the error buffer
116	SYNTAX ERROR	<p>This error is generated when the instrument receives a command that cannot be processed.</p> <p>Some typical causes:</p> <ul style="list-style-type: none"><li>a. Using ASCII characters outside of a string constant that are not defined by the command language syntax.</li><li>b. Missing space between a set command and parameter.</li><li>c. Missing “?” character in case of query</li></ul>
126	WRONG NUM OF PARAMS	This error is generated when the instrument is unable to process a command due to a mismatch between the number of parameters received and the number of parameters required for the command.
201	VALUE OUT OF RANGE	This error is generated when the instrument is unable to process a command because the parameter value received is out of range of the acceptable values for the command.
424	TEC OVER TEMP	The temperature control subsystem output has been turned OFF because the internal heatsink temperature has

		exceeded safe levels. Please allow the unit to cool down, and reset the controller by turning it OFF and back ON.
501	LDD INTERLOCK FLT	The Laser Diode Driver subsystem output has been turned OFF because of remote interlock (BNC connector on rear panel) assertion.
502	LDD CURRENT LIMIT	The Laser Diode Driver subsystem output has been turned OFF because of actual current exceeding the current limit set point.
514	LDD MODE CHANGE	The Laser Diode Driver subsystem output has been turned OFF because a mode change was commanded using “SOURce:CPOWer” command or through front-panel interface.
524	LDD OVER TEMP	The Laser Diode Driver subsystem output has been turned OFF because the internal heatsink temperature has exceeded safe levels. Please allow the unit to cool down before turning the output ON again.
803	WAVE OVER TEMP	The Wavelength control subsystem output has been turned OFF because the internal heatsink temperature has exceeded safe levels. Please allow the unit to cool down before turning the wavelength tracking ON again.
802	WAVE FOLLOW ERROR	Wavelength tracking has been turned OFF because the difference between actual wavelength and wavelength setpoint exceeded 2nm. Please reduce the scan speed setting and turn wavelength tracking ON again.
804	PIEZO OVER TEMP	The piezo control subsystem setpoint has been changed to 0% because the internal heatsink temperature has exceeded safe levels. Please allow the unit to cool down before changing the piezo setpoint again.
805	CMD NOT SUPPORTED	This error is generated when the command received by the controller is not supported by laser head connected to it.
902	KEY ENABLE OFF	This error is generated when user tries to turn the Laser Diode Driver subsystem output ON with key switch in OFF position.
919	LASER DISCONNECTED	This error is generated when user tries to turn the Laser Diode Driver subsystem output ON without having a laser head connected to the controller.
920	LASER EEPROM ERROR	This error is generated when user tries to connect a laser head to the controller using an incompatible cable.

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