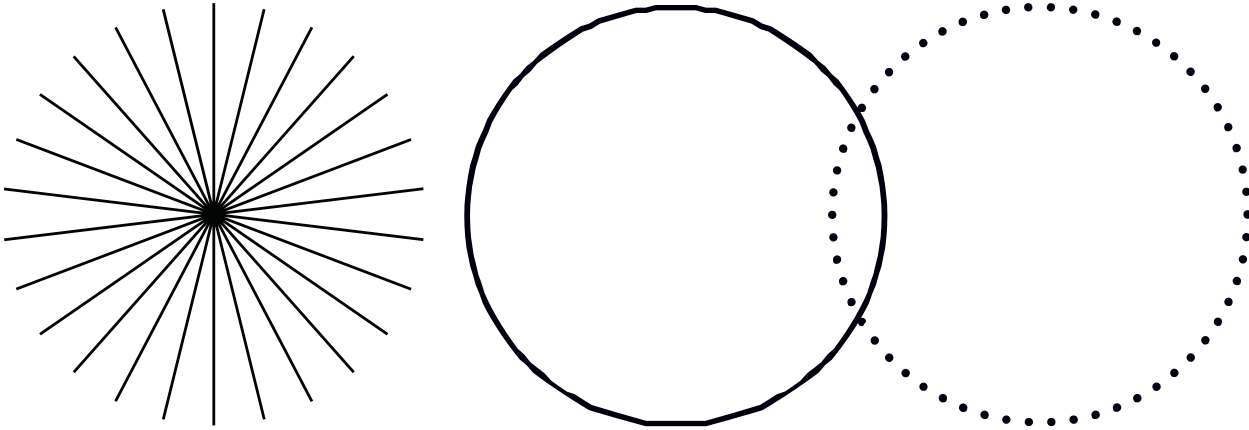


# TR-CleanLine™ Laser System

Operator's Manual



INNOVATIONS THAT RESONATE





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### In the U.S.:

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Telephone coverage is available weekdays Monday through Friday (except U.S. holidays and company shutdowns), 9am – 5pm, Pacific Standard Time (PST). Inquiries received outside of normal office hours will be captured by our automatic answering system and will be quickly returned the next business day.

### Outside the U.S.:

If you are located outside the U.S., please initially check our web site pages for this product [www.coherent.com](http://www.coherent.com). Should you need further information or assistance, please contact Coherent Technical Support, specific to this product, by e-mail at [sales.monrovia@coherent.com](mailto:sales.monrovia@coherent.com) or by telephone at +01-626-357-9600, or contact your Local or Regional Service Representative. Worldwide Service Representative telephone numbers and addresses can be found on the main Coherent web pages.

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## 1 Safety Precautions

This manual contains user information and instructions for the CleanLine™ Laser System.

Before use, please thoroughly read this manual. Pay special attention to the material in Section One: “Laser Safety”. After reading, keep it together with the product for reference when necessary. Please retain all original packaging material in the event the unit is stored or shipped in the future.

For non-OEM applications, we recommend following safety protocols for Class 3B products according to latest ANSI Z136.1 Standard for the Safe Use of Lasers.

Use protective eyewear to eliminate potential eye exposure in excess of the maximum permissible exposure levels as stated in either ANSI Z136.1 or IEC-60825-1.



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

*The Classification Label on the Left side (facing Front Panel) of the unit contains information specifying wavelength and maximum emitted power.*

### 1.1 Export Control Laws Compliance

It is the policy of Coherent to strictly comply with U.S. export control laws.

Export and re-export of lasers manufactured by Coherent are subject to U.S. Export Administration Regulations, which are administered by the Commerce Department. In addition, shipments of certain components are regulated by the State Department under the International Traffic in Arms Regulations.

The applicable restrictions vary depending on the specific product involved and its destination. In some cases, U.S. law requires that U.S. Government approval be obtained prior to resale, export or re-export of certain articles. When there is uncertainty about the obligations imposed by U.S. law, clarification must be obtained from Coherent or an appropriate U.S. Government agency.

Products manufactured in the European Union, Singapore, Malaysia, Thailand: These commodities, technology, or software are subject to local export regulations and local laws. Diversion contrary to local law is prohibited. The use, sale, re-export, or re-transfer directly or indirectly in any prohibited activities are strictly prohibited

### 1.2 Explanation Of Warning Symbols

This documentation may contain sections in which particular hazards are defined or special attention is drawn to particular conditions. These sections are indicated with signal words in accordance with ANSI Z-535.6 and safety symbols (pictorial hazard alerts) in accordance with ANSI Z-535.3 and ISO 7010.

Warning messages are intended to prevent accidents to operating personnel such as burns and electrical shocks.

### 1.3 Signal Words

Three signal words with color coded call-outs are used in this documentation:

**WARNING!**, **CAUTION**, and **NOTICE**.

The signal words **WARNING** and **CAUTION** designate the degree or level of a hazard when there is a risk of user injury:

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#### **WARNING!**

Indicates a hazardous situation that, if not avoided, could result in serious injury to eyes and/or skin.

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#### **CAUTION**

Indicates a hazardous situation that, if not avoided, could result in minor to moderate injury to eyes and/or skin.

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The signal word **NOTICE** is used when there is the risk of product or property damage:

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#### **NOTICE**

Indicates information important to take special note of, but is not hazard-related.

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### 1.4 Symbols

The signal words **WARNING**, and **CAUTION** are always emphasized with a safety symbol that indicates a special hazard, regardless of the hazard level:



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This symbol is intended to alert the operator to the presence of highly-important operating and maintenance instructions.

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This symbol is intended to alert the operator to the danger of exposure to hazardous visible and invisible laser radiation.

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This symbol is intended to alert the operator to the danger of Electro-Static Discharge (ESD) susceptibility.

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This symbol is intended to alert the operator to the presence of additional important information

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## 2 Laser and Operational Safety Precautions

### 2.1 Laser Safety

Laser light, because of its special properties, can cause safety hazards not present in light from typical sources. The safe use of lasers requires that all laser users and all persons near the laser system understand the possible dangers. The safe use of the laser depends on the operator understanding both the instrument, and the properties of coherent laser light.

While all of the laser light produced by the laser system is highly-divergent ('spreads out' quickly from the Output Aperture) and is solely designed to be *positively-coupled* into a delivery-fiber via the fiber connector, the laser output can be hazardous when the incorporated automated laser safety mechanisms are actively defeated and the output is directed toward the eyes.



---

**WARNING!** – *Direct eye contact with the laser output from the unit can cause both injury to the eye and damage to vision. This can be true even more-so with wavelengths that are not 'visible' to the naked eye, but may be more readily absorbed by ocular tissues and/or the skin (ie: 1064 nm). Therefore:*

*Never direct the laser output into or even at the eyes, nor place the output in direct contact with skin. Never use the eyes to 'verify' laser emission, gauge power levels, or evaluate 'Fiber-tip cleanliness' while the laser is operating.*

---

### 2.2 Optical Safety

It is recommended to connect the CleanLine™ Laser Module with the supplied fiber to an appropriate external device (e.g., SureBlock™ TR-Probe) before laser operation. It is the users responsibility to safely terminate all laser light emitted from the external device. Furthermore, follow these precautions at a minimum:

1. Follow all safety precautions detailed in this manual.
2. Limit laser access to qualified users who are familiar with the associated hazards, understand basic laser safety practices, and will adhere to protocols.
3. When operating the laser where laser light is not clearly terminated, operate the laser in a room with controlled and restricted access, and always post proper Caution Signage in the area of the laser operation.
4. Never introduce reflective-surface instruments (ie: hemostats or chromed alignment-tools) into the laser output without proper attenuative-eyewear.
5. When operating the laser where laser light is not clearly terminated, keep experimental setups at low heights to prevent accidental exposure near or at eye level.
6. When used outside a Class 1 enclosed setup, all users should wear approved laser safety eyewear appropriate for the wavelengths and power-levels being generated. **Note special caution on eyewear, below.**



**CAUTION** – *Laser safety eyewear can be both a benefit and a hazard. While glasses or goggles protect the eyes from possible damaging-levels of exposure, they can also hinder the user from clearly seeing the propagation of the output (the ‘beam’). Additionally, care must be taken to choose room/lab, enclosure, and/or work-area Emission Indicator colors that are not also blocked by the eyewear’s wavelength-attenuation (ie: eyewear that blocks near-IR wavelengths might also dim the visibility of a ‘red’ LED or lamp-based indicator). Thus, always use extra Caution when wearing laser safety eyewear.*

## 2.3 Electrical Safety

Although the laser system does not require hazardous levels of AC or DC voltages for operation, it is important to handle the Rear-side 'Terminal Block' interface with caution. Specifically, when the unit is connected via the DC 'Power jack' and powered on, certain pins (such as 5 and 6) will have active DC voltage present at the terminals. To prevent any damage to the unit and avoid voiding its warranty, it is crucial to avoid any conductive debris, like metal shavings from industrial or manufacturing environments, from causing a 'short' on these pins. Additionally, it is important to ensure that no liquid or solvent comes into contact with these pins while the unit is operating, as this could lead to a short-circuit and potential damage to the system.



**CAUTION** – *It is important to be aware that electrostatic charges can accumulate on the human body and equipment, reaching up to 4000 volts, and can discharge without being detected. While the electronics in the unit have built-in protection against electrostatic discharge (ESD), it is still possible for devices to suffer permanent damage from high levels of ESD. The most common occurrence of ESD damage happens during the installation process, such as when connecting wired connections to the Terminal Block interface while the unit is placed on an ungrounded surface with the Main Power switch left on.*

*To prevent ESD damage, it is recommended to take special precautions and install shielding in work areas or other settings where dry air and carpet are common, such as onsite customer demonstrations or trade show exhibitions. Creating an ESD-safe workstation and following proper working protocols are highly recommended to maintain optimal system performance.*

## 2.4 Safety Features For Compliance With U.S.21 CFR

The CleanLine Laser System complies with the United States Code of Federal Regulations (CFR) 21 CFR 1040.10 and 1040.11, except for deviations pursuant to CDRH (Center for Devices and Radiological Health) Laser Notice 50, dated July 24, 2007. The laser system is harmonized with both CDRH and International Electrotechnical Commission (IEC) 60825-1 standards, as a Class 3B (or, IIIb) laser product, and it may emit Visible or Invisible Laser Radiation in wavelengths from 0.4 to 1.064  $\mu\text{m}$  from the Output Aperture in the front.



The required Classification, Warning Logotype, Aperture, and Information labels are permanently affixed to (or screen-printed on) the housing, along with the Model Number, a unique Serial Number, Date Manufactured, and the units' maximum Output Power and Wavelength. Additionally, the wavelength is also found in the Model Number-graphic on the Top-cover label, which also seals the cover completely and prevents easy access to the fasteners.



**Figure 2.4-1: IEC-style Classification / Warning Logotype, and Manufacturer / Product-info Label, and location-illustration of Left-side (facing the Front Panel) of the unit.**

The safety controls of the laser system are designed to comply with regulations. These controls include a 'lockout' keyswitch that cannot be removed when the system is turned on, a dual-function Laser On/Off Button / Emission Indicator with a 'white' LED for using laser safety eyewear, a touchscreen display that shows laser emission status and a laser emission delay when interlock is defeated. Remote Interlock connections with other devices such as lab doors or enclosures is located on the rear. Additionally, the E2000 fiber coupler on the front of the system automatically blocks emission of laser radiation whenever fiber connector is not plugged. This helps prevent accidental laser exposure before inserting and securing the working-fiber.

## 3 Description and Specifications

### 3.1 System Description

This device is a CleanLine™ Laser Module with integrated ASE suppression filters and wavelength control suitable for use in low-frequency Raman applications. It plays a pivotal role in testing or manufacturing, and can be used in various applications such as Flow Cytometry, Confocal Microscopy, Protein Crystallography, DNA Sequencing, Semiconductor Defect Detection, Thin Film Analysis, High Density Data Storage, and Raman Spectroscopy.

- Plug & Play Operation
- ESD Protection
- Adjustable Output Power
- Integrated Key Switch with Remote Interlock Input (Shorted on Shipment)
- Remote Computer Control Capability
- Temperature and Wavelength Stabilized
- Compact Size

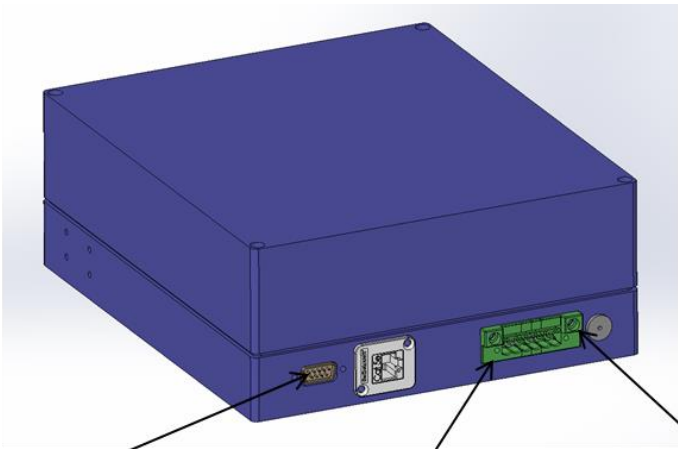
### 3.2 Specifications

<b>OPTICAL</b>	
Power Stability (over 1 hr)	< 5%
Laser Class	Class 3B (maximum power and wavelength listed on warning labels of the unit)
Laser operation	CW
Warm-up Time (min)	< 5
Fiber-size (recommended)	Configuration dependent. Typically, 50 $\mu$ m core 0.22nA armored jacket
Fiber-connector	E2000 PC
<b>ELECTRICAL</b>	
Input Voltage	90-240V AC, 50-60 Hz
Operating Voltage	5V DC
Operating Current	3 A
<b>MECHANICAL</b>	
Laser Dimensions (LxWxH)	230 mm x 200 mm x 90 mm
Weight	< 2 kg
<b>ENVIRONMENTAL</b>	
Ambient Operating Temp (C)	+10° to +40°
Storage Temperature (C)	-20° to +60°



## 4 Controls, Indicators, and Features

### 4.1 Laser System Controls



RS232: Null Modem Cable Connection to Computer

TERMINAL BLOCK SUPPLIED WITH INTERLOCK SHORTED						
	PIN 1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6
DESCRIPTION	POWER INPUT	POWER GND	INTERLOCK	INTERLOCK	N/A	N/A
COMMENTS	NOT NECESSARY WHEN 2.1MM DC JACK IS USED	NOT NECESSARY WHEN 2.1MM DC JACK IS USED	LASER ENABLED WHEN CONNECTED TO PIN 4	LASER ENABLED WHEN CONNECTED TO PIN 3		

DC DIN 5 pin power jack

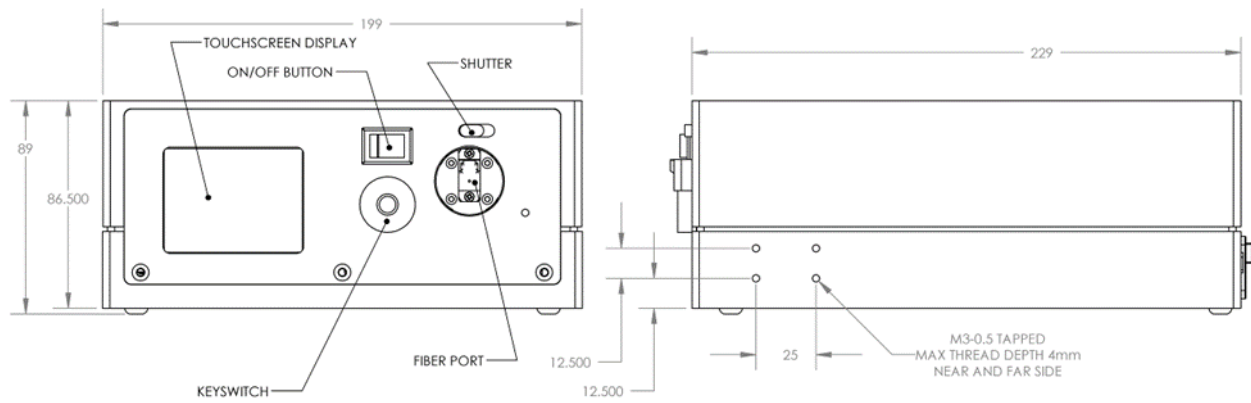


Figure 4.1-1: Mechanical Illustrations with Dimensions

- **Power on/off key switch** - This switch located on the front panel allows users to enable laser excitation output with the turn of a key. No laser emission is possible without this key
- **Remote interlock & connector** - This feature is located on the side of the unit. The unit will not operate without the interlock intact. Interlock needs to be shorted for laser emission, and can be connected to a remote switch (e.g. door interlock) for additional laser safety. For user convenience, the unit is shipped with interlock shorted as default
- **Integrated Excitation Electro-Mechanical Shutter (Version 3.1)** - Units with integrated electro-mechanical shutters would have a shutter status and button on the front display. The keyswitch and interlock are connected to the shutter. This allows laser to continue emission internally within the unit while blocking output emission. Activating keyswitch and interlock will open the shutter after a minimum of 2 second delay. The front panel buttons for shutter open/close will immediately operate the shutter as long as the keyswitch and interlock are in appropriate state.
- **Manual Shutter** - A slider to block the laser excitation manually. It is independent of all other beam blocks.
- **Laser Enable / Lockout Keyswitch** - This keyswitch is in serial with the interlock. When activated, there is a short delay before laser emission can occurs, a necessary part of the safety controls. Key is non-removable when On (for compliance with 21 CFR and IEC 60825-1) and conveniently removable when Off, to allow the user to 'lockout' the system
- **LCD Touchscreen Control Panel** - The LCD touchscreen control panel is located prominently in the center of the Front Panel, and features laser On/Off control, shutter control and laser power levels. It also allows for custom-configuration of some 'advanced' system features which is passcode-protected to prevent any accidental or unauthorized changes. **See Section Five for passcode and special Cautions on using this-specific feature.**
- **RS232 or RJ45 Network Connector** - Remote communication and control

## 4.2 Laser Safety Indicators

The CleanLine laser utilizes three types of indicators to communicate the System Status:

1. Powered On and laser is on or off
2. Powered On and blocked from emission due to internal shutter
3. Powered On, and not blocked

## 5 System Operations

### 5.1 Setting Up The System

Laser module can be operated with or without RS232 communications.

It is recommended to connect the CleanLine™ Laser Module with the supplied fiber to an appropriate external device (e.g. SureBlock™ TR-Probe) before laser operation. It is the users responsibility to safely terminate all laser light emitted from the external device.




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**NOTICE** - *Damage to fiber optic receptacle is not covered by Warranty. It is strongly recommended to clean both the FC connector, and the delivery -fiber tip before use. Please review Appendix 9.2 and 9.3 for recommended equipment and procedures for cleaning.*

## User Startup Procedure:

- Locate the laser module in a stable environment. Instrument is sensitive to vibration.
- Connect any planned Remote Interlock tie-ins (ie: Lab door, project-enclosure, instrument or external-system door-interlocks, etc) to the Remote Interlock Inputs (see diagram above) and verify connection. Additionally, ensure interlock circuit is electrically isolated and not tied to 'Earth Ground', or any Earth-grounds found in equipment chassis.



**CAUTION** - *The unit is shipped with the Remote Interlock pins shorted with a wire 'jumper' as the default state. Laser emission will occur when all other laser-controls in the Interlock circuit (ie: keyswitch, interlock) are satisfied, and Laser On/Off button is pressed. Ensure that all safety-protocols are in place, and laser output is positively terminated and coupled by delivery-fiber.*

- Clean fiber connector to ensure fiber tip is free of debris and avoid possible damage to the unit.
- Connect fiber connector to the unit. Verify that both ends of the fiber are secure in an eye safe condition.
- Verify key switch is off
- Verify that interlock is connected
- Connect power supply. Unit operating system requires 1 minute to start.
- Allow an additional 3 minutes for warm up.
- Turn key switch to permit laser emission.
- In the event that a turn off and then a turn on of the instrument is required, please wait at least 30 seconds after turn OFF (0) before toggling the switch to ON (1). This allows for settling of voltage levels in the control system and a consistent re-start of the system and Display Panel. The RESET button on the Laser Flags screen can also be used without turning off the laser.



**NOTICE** - *Damage to fiber optic receptacle is not covered by Warranty. It is strongly recommended to clean both ends of connector, and the delivery -fiber tip before use. Please review Appendix 9.2 and 9.3 for recommended equipment and procedures for cleaning.*



**CAUTION** - *Never connect both DC Power Adapter-plug into the Power Input jack, and hardwired-DC into Terminal Block inputs at the same time, as damage to the unit may occur, and void its Warranty. Only one input is to be connected at any time. Also, take note of the Cautions in Section 2.3 (never allow any liquids or other conductive-debris to short across wired-DC pins, and take special-precautions to ensure ESD does not occur into any of the Terminal Block input-pins.*

The unit should now be ready for Operation, so once again, ensure all laser safety protocols are in place (ie: Room interlocks, Caution signage in-place, external emission-indicators ready, etc) and working environment is stable, secure, and free from external distractions.

## **5.2 Powering On And Operating The Unit**

### **Laser Module Startup Process:**

Laser module controller will follow/indicate the following process after power on:

- Operating system starts. 40-50 second delay. Concurrently laser system starts to stabilize at the set point temperature and current.

**Warning: emission of light may occur any time after 30 seconds of receiving power if the key switch is turned on.**

- Operating system is active once the logo disappears and the power and touchscreen button appear.
- Once operating system is active, laser wavelength stabilization initiates and may require up to 3 minutes to fully stabilize. If the Interlock is not shorted, the shutters will not operate or indicate. In this case, turn off the laser and replace the Interlock.
- The power bar is green when conditions are optimal. It would show red when laser parameters are questionable. At power levels below 25%, power bar may be red since laser maybe approaching conditions that are difficult to manage

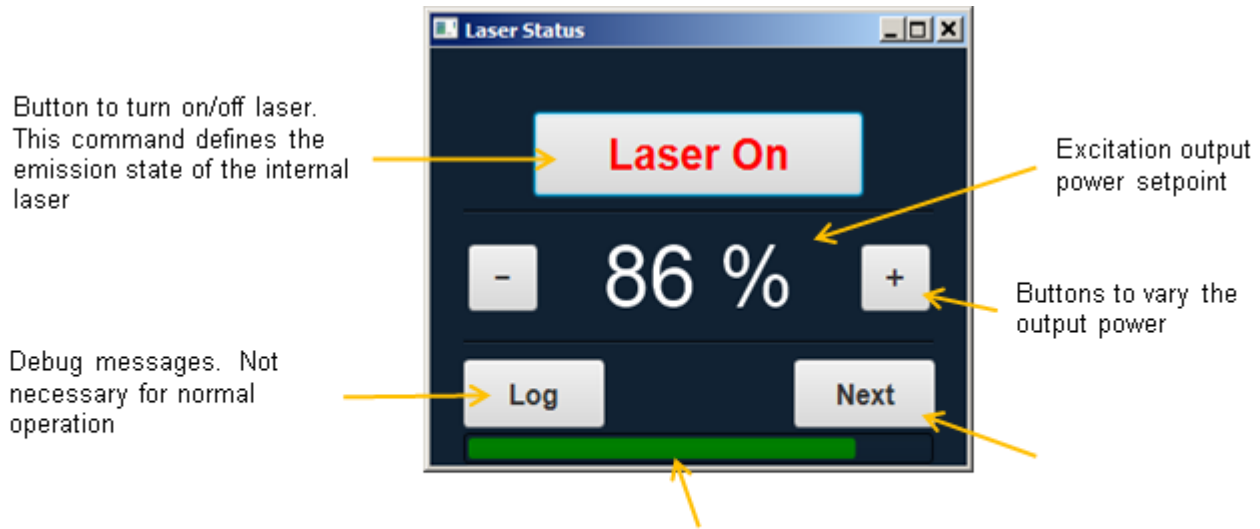
### **Electro-Mechanical Shutter Usage:**

If the system is provided with electro-mechanical shutter, use the key switch or front panel button to actuate the shutter for intermittent on-off of emission. The internal laser remains powered and stabilized when emission is blocked. This permits excitation emission to be immediately ready when shutter is open. To minimize consuming laser lifetime, turn off the laser via front panel when system would not be used for extended periods and the few minutes of re-stabilizing the laser is not a concern

**GUI**

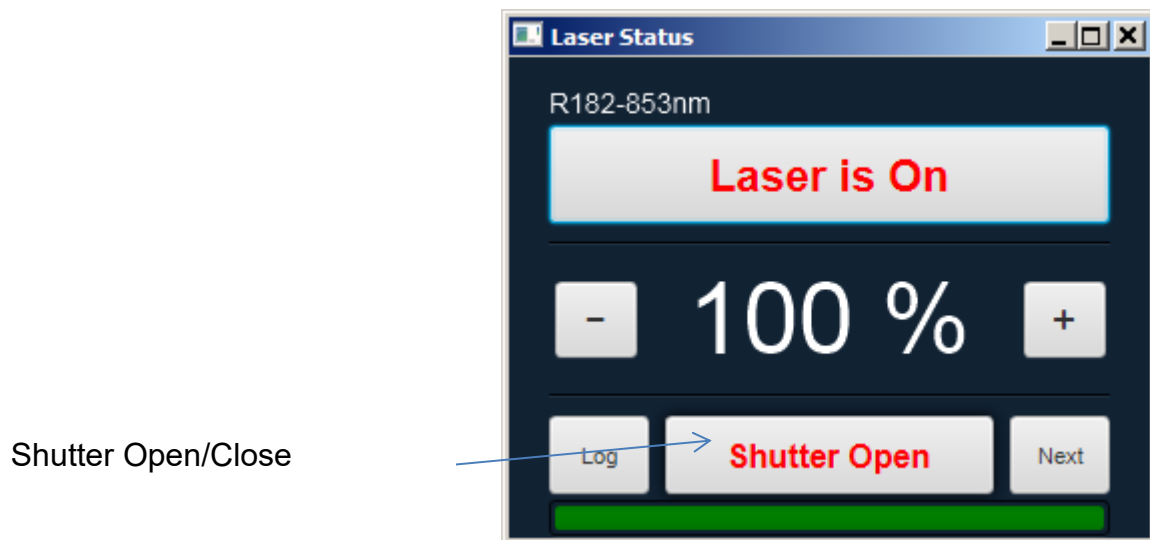
**Laser Status without Integrated Electro-Mechanical Shutter:**

This is the default / initial startup screen on the unit.



Internal laser power. Green bar indicates that power is as expected. Red bar indicates that either power is lower than expected or output power setpoint is lower than advisable. No bar indicates no optical power measured.

**Laser Status (with Integrated Electro-Mechanical Shutter):**



Shutter Open/Close

## 5.3 Advanced Features And Controls

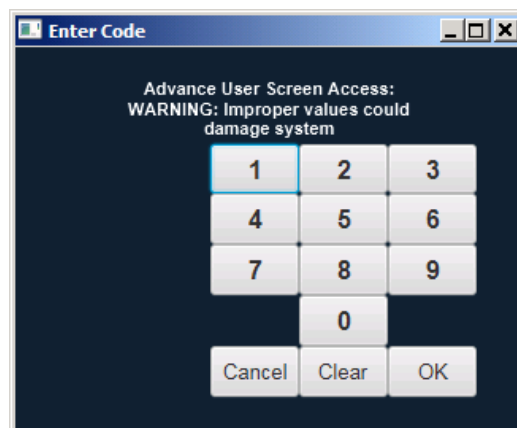
The “Next” button on the LCD Touchscreen provides access to laser diode current parameters and other advanced system-features and controls. These sub-menus and screens are password protected to prevent accidental or unauthorized changes. The passcode is 1979. The advance menus are subject to change and this manual may not thorough reflect those changes. **See Notice, below.**



**NOTICE** - It is strongly recommended to contact your Coherent Sales Rep for guidance in using these Menus, as incorrectly used values in certain settings can permanently damage the laser diode, which is not covered by Warranty.

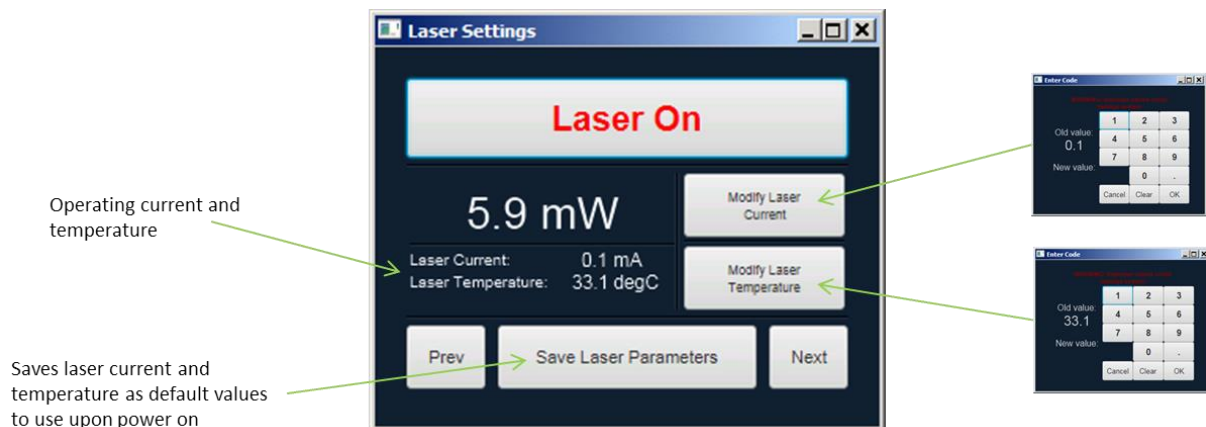
### Enter Code (Password Protect):

This screen blocks all access to subsequent screens which may be damaging to the module if used improperly. Improper use voids all warranties. Default password is “1979”



### Laser Settings (ADVANCED USERS ONLY):

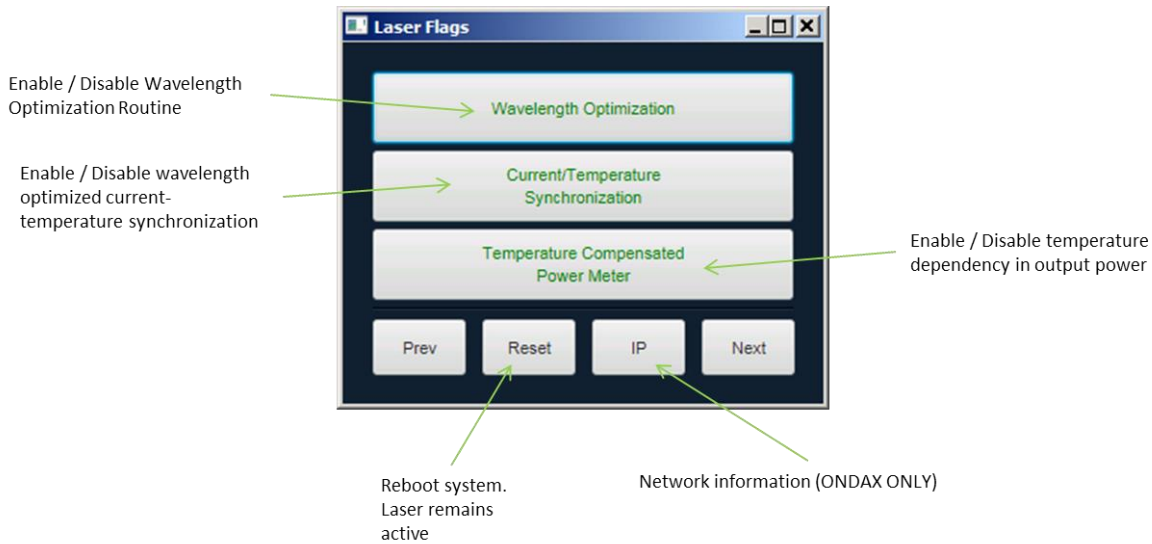
Allows users to configure laser parameters





### Laser Flags (ADVANCED USERS ONLY):

These parameters activate features. The module may have these features enabled or disabled depending on the system requirements.



## 6 External System Control

### 6.1 External Control

#### Operation via Communications Port:

The laser system includes complete remote-control capability through either RS232 or Ethernet cable. All commands are available after laser system auto start.



**CAUTION** – Values entered via communications port are not checked for validity or appropriateness. Permanent damage to laser is possible and is not covered by warranty.

#### Network Socket:

The unit is shipped with DHCP enabled. Under advance user, the IP number identified. The port number is set as 4015. It is suggested to close the port after each command and response sequence.

#### RS232 - Baud rates and serial port settings:

Each controller is shipped from the factory with a fixed 9600 baud, which cannot be changed. The other serial port parameters are: 8 data bits, 1 stop bit and no parity. A hardware flow control is not supported

### Command formatting and termination characters:

Each command to the controller must be terminated by a carriage return/line feed pair (ASCII 13 followed by ASCII 10, i.e.: “\r\n”).

All commands are case-sensitive.

Commands with arguments must be delimited with a space (ASCII 32) between the command and the argument.

### Handshaking:

Under no circumstances will the controller initiate communication. It only transmits characters in response to a message. Every message to the controller generates a response, either a numerical value or the acknowledgment string “OK”. In the event that the controller receives a message that it cannot interpret, it responds: “ERROR”. Every controller response is terminated by a carriage return/line feed pair (ASCII 13 followed by ASCII 10)

### Commands:

Command	Argument	Response	Function
\$ok?	No	OK	Replies “OK” if communication is established
\$pw:av?	No	**.*	Returns optical power in mW
\$en:tp?	No	**.*	Returns ambient temperature in Celsius
\$ls:on	No	OK	Turns on the laser
\$ls:of	No	OK	Turns off the laser
\$ls:on?	No	1 or 0	Returns 1 if laser is on. Returns 0 if laser is off
\$ls:pw:per:	**.*	OK	Set the optical power in percentage (0-100)
\$ls:pw:per?	No	**.*	Returns set point of optical power in percentage (0-100)
\$ls:sh?	No	1 or 0	(For integrated electromechanical shutter systems only) Returns a 1 if excitation emission is blocked. Returns a 0 if excitation emission is not blocked
\$ls:sh:block	No	OK	(For integrated electromechanical shutter systems only) Blocks excitation emission
\$ls:sh:open	No	OK	(For integrated electromechanical shutter systems only) Opens excitation emission shutter



#### **NOTE**

**Settings entered via terminal are not automatically stored in the unit's memory to be used after a power cycle.**

## 7 Maintenance And Troubleshooting

### 7.1 Maintenance

Routine cleaning of the fiber patch cable is required in order to prevent damage to the fiber and bulkhead due to high laser fluence. Please refer to Appendix (9) for details on how to clean E2000 fiber patch cables.

Bulkhead cleaning is not necessary as there is no fiber inside the bulkhead to get dirty.

Please note: cleaning fiber patch cables is best done with the use of a fiber inspection scope. Inspection to verify successful cleaning is advised.



***DO NOT open the unit's enclosure or attempt to disassemble it for any reason! There are no user-serviceable components inside. Operate all units only as-assembled. The Warranty will be voided if the enclosure is opened and may even expose the user to hazardous levels of laser radiation.***

### 7.2 Troubleshooting

If any problems with the laser output are detected, please contact Coherent at [sales.monrovia@coherent.com](mailto:sales.monrovia@coherent.com) prior to performing any troubleshooting on the system. Please note all symptoms when requesting service access to the system. Only open the system if instructed by Coherent technical support. Not all methods described below are suitable for all laser types:

- Inspect the enclosure for scratches, dings, dents, or other signs of damage due to handling.
- Verify that the module enclosure has not been opened and the factory seal is intact.
- Verify power source connections to the laser module.
- Verify interlock connection.
- Ensure that the operating environment is within specifications.
- Transient 100% voltage input drop off per IEC 61326-1:2020 may cause unit to shut down and return back to its default power on operating condition.

## 8 Service And Warranty

### 8.1 Service

Contact your Coherent Sales Rep for a Returned Material Authorization ('RMA') number, and further instructions. If you need more immediate assistance, contact Coherent Technical Support (specific to this Product) by telephone at 626-357-9600 (+01-626-357-9600 Outside the US) or by e-mail at [sales.monrovia@coherent.com](mailto:sales.monrovia@coherent.com).

### 8.2 Warranty

Coherent, Inc. warrants CleanLine™ Laser Systems to the original purchaser (the Buyer) only; that the laser system that is the subject of this sale,

(a) conforms to Coherent's published specifications, and (b) is free from defects in materials and workmanship.

Laser systems are warranted to conform to Coherent's published specifications and to be free from defects in materials and workmanship for a period of twelve (12) months\*. Replacement units shipped within warranty, carry the remainder warranty of the failed unit.

***Responsibilities of the Buyer***

The Buyer is responsible for providing the appropriate utilities and an operating environment as outlined in the product literature. Damage to the laser system caused by failure of Buyer's utilities or failure to maintain an appropriate operating environment, is solely the responsibility of the Buyer and is specifically excluded from any warranty, warranty extension, or service agreement.

The Buyer is responsible for prompt notification to Coherent of any claims made under warranty. In no event will Coherent be responsible for warranty claims made later than seven (7) days after the expiration of warranty.

***Limitations of Warranty***

The foregoing warranty shall not apply to defects resulting from any of the following conditions:

- Components and accessories manufactured by companies other than Coherent, which have separate warranties
- Improper or inadequate maintenance by the Buyer
- Buyer-supplied interfacing
- Operation outside the environmental specifications of the product
- Unauthorized modification or misuse
- Improper site preparation and maintenance
- Opening the housing
- Fiber tip and fiber damage due to mishandling and cleanliness

Coherent assumes no responsibility for customer-supplied material. The obligations of Coherent are limited to repairing or replacing, without charge, equipment that proves to be defective during the warranty period. Replacement sub-assemblies may contain reconditioned parts. Repaired or replaced parts are warranted for the duration of the original warranty period only. The warranty on parts purchased after expiration of system warranty is ninety (90) days.

This warranty does not cover damage due to misuse, negligence or accidents; or damage due to installations, repairs or adjustments not authorized specifically by Coherent.

This warranty applies only to the original purchaser at the initial installation point in the country of purchase, unless otherwise specified in the sales contract. The warranty is transferable to another location or to another customer only by special agreement, which will include additional inspection or installation at the new site. Coherent disclaims any responsibility to provide product warranty, technical or service support to a customer that acquires products from someone other than Coherent or an authorized representative.

**THIS WARRANTY IS EXCLUSIVE IN LIEU OF ALL OTHER WARRANTIES, WHETHER WRITTEN, ORAL OR IMPLIED, AND DOES NOT COVER INCIDENTAL OR CONSEQUENTIAL LOSS. COHERENT SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.**

**9 Appendix**

**9.1 Importance Of Maintaining Clean Fiber-Connections**

To ensure optimal performance of the laser system, it is crucial to maintain a pristine FC/PC connector on the unit and at the tips of the delivery fiber. Any contamination on the ends of the fiber connections can lead to undesirable performance outcomes and, if not addressed, may ultimately result in the failure of components or the entire system. There are also less apparent or even invisible contaminants that can cause unwanted attenuation, optical noise, or subpar performance. Examples include oils (e.g., from fingerprints), film coatings (e.g., condensates from vapors in a test chamber), and other residues (e.g., after the evaporation of water or solvents, dust, etc.). Furthermore, the laser output intensity at the very end of a fiber tip is so high that a small contaminant can be burned onto the end if it obstructs the core during operation at higher powers. This burn can damage the optical surface to the extent that it cannot be adequately cleaned, necessitating the replacement of the delivery fiber.

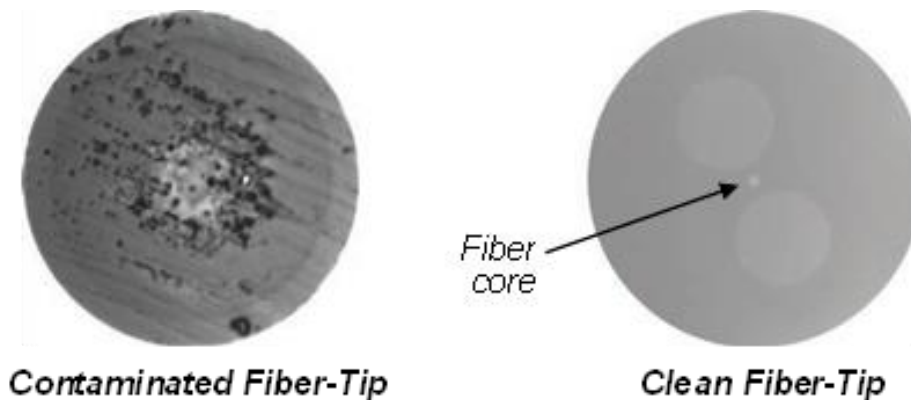


Figure 9.1-1: Contrast between a contaminated and clean Fiber-tip, as-viewed under magnification



**NOTICE** - When cleaning fiber components, always complete the steps carefully, and wear nitrile gloves when handling fiber-ends. NEVER touch the fiber end-face with bare fingertips, even if “clean”. The goal is to remove all dust and contamination to provide the cleanest mating surfaces possible for the optical connections. Remember that inspection, cleaning and re-inspection are very important steps which must be done before you make any fiber connections.



**WARNING!** – Always turn the unit OFF before you inspect a connected-fiber tip and/or clean the unit FC/PC connector:

Never look into a fiber-end or the output aperture , while the Laser Enable keyswitch is in the ON position, even if the ‘E-Stop’ and/or other safety-interlocks are open and laser emission is not occurring.

*Never attempt to inspect a fiber-end with a fiberscope while the laser is ON or operating.*

*Never use the eyes to verify laser emission, gauge power levels, or evaluate fiber-tip cleanliness' once the laser is ON and operating.*

**9.2 Cleaning the Fiber Connector**



**NOTE** - *The product recommendations presented here are provided for convenience and reference purposes only. Coherent explicitly disclaims any responsibility or implication of warranty or guarantee regarding the performance, durability, or availability of these products. Moreover, the instructions given herein are intended as general guidelines and should not be considered exhaustive or comprehensive. It is important to note that fiber-cleaning methods and recommendations may vary between manufacturers and tools. As Coherent cannot dictate the choice of cleaning products or tools a customer may select, it is strongly advised to carefully adhere to the fiber tip cleaning instructions outlined in the User Manual for each specific product.*

Coherent recommends use of either the US Conec IBC™ Brand Model 9392 (or, alternatively, Model M250) 'one-click' style FC/PC connector-cleaners each time before freshly-mating a new delivery-fiber to the unit



Figure 9.2-1: US Conec IBC™ Brand Model 9392 and M250 FC-connector cleaning tools



**NOTICE** - *No known cleaning method is absolutely 100% effective. Thus, it is imperative that inspection is included as an 'integral part' of your cleaning process and protocol. Incorrect cleaning can damage the fiber, and/or the laser internally.*

**9.3 Inspecting And Cleaning Delivery-Fiber Ends**

Inspection of delivery-fiber ends are done with either a desktop video-fiberscope or a hand-held fiberscope. Both tools are specialized microscopes used for inspecting optical fibers. Any scope chosen should provide

at least 200x total magnification. **Specific adapters may be needed for FC/PC connectors** to properly inspect the Fiber-tip. Figure 9.3-1 provides examples of popular scopes.



**E-2000 Service Adapter 1019034 to hold spring loaded cap open**

**Figure 9.3-1: Examples of Fiber-tip inspection scopes and tools**

To inspect a delivery-fiber tip:

1. Make certain that the laser is turned OFF before starting inspection.
2. Put the applicable inspection adapter or probe on your equipment.
3. Unscrew and remove the delivery-fibers' dust cap.
4. Insert the delivery-fiber connector into the fiberscope adapter and adjust the focus ring until you see a clear fiber tip image.
5. Clean the fiber tip and re-inspect, as necessary. See below for an overview on fiber tip cleaning.
6. Immediately plug the clean connector into the connector it will be mating-to decrease the risk of re-contamination.

### **Dry Cleaning Technique**

The recommended dry-cleaning technique utilizes a 'cartridge' cleaning tool. Coherent recommends use of the following cartridge cleaning tools and associated techniques. (source-websites, valid as-of the time of this writing).

**Figure 9.3-2 shows examples of these tools**



OPTIPOP R, P/N ATC-RE-02

<http://www.ntt-at.com/product/optipop/>

CLETOP-S TYPE A, P/N 14110501

<http://www.cletop.com/html/products.html>

Figure 9.3-2: Examples of recommended Cartridge Fiber-tip cleaning tools



**NOTE** – *Since fiber-cleaning techniques and advice can vary from manufacturer-to-manufacturer (and tool-to-tool), and Coherent cannot ‘control’ what cleaning product or tool a customer may choose to purchase, it is simply recommended to closely follow the Fiber-tip cleaning instructions provided in each products’ User Manual.*

#### Wet Cleaning Technique

1. Make certain that the laser is turned OFF before starting cleaning.
2. Carefully remove the delivery-fibers’ dust cap.
3. Inspect the fiber-tips with a fiberscope. (See Figure 9.2-1, above)
4. If a tip is dirty, clean with a cartridge cleaner, as-per the manufacturer’s instructions – or – follow a simple ‘Wet-to-Dry wipe’ technique, as-follows: (Also see Figure 9.3-3, below)



**CAUTION** – *Follow all safety instructions when using isopropyl alcohol and/or methanol (used for wet cleaning of the fiber tip). If you do not have a copy of the safety instructions and MSDS sheets for using IPA or methanol, contact your Industrial Safety Dept. before following the cleaning information described in this document.*

1. Start with a fresh sheet of lint-free, optical-grade lens paper, folded 3 times, to yield a cleaning surface with ‘8 layers’ of folded material. Be
2. careful not to touch or contaminate this cleaning ‘pad’.
3. Carefully drop spectroscopic-grade isopropyl alcohol (‘IPA’) or methanol onto the pad, until the ‘wet area’ is approximately the size of a penny.
4. Ensure that an area of the cleaning pad remains dry.
5. Place the ‘pad’ just created on a clean, smooth work-surface, and bring the fiber tip to a perpendicular-angle to the pad, and lightly contact it against the surface of the pad.
6. With very light pressure, and holding the tip to the cloth, ‘wipe’ the fiber tip lightly across the Wet area of the pad, using a ‘scaloped Figure 8’ motion. Do Not ‘scrub’ back and forth! At the same time, gently rotate the fiber-tip 90 – 180 degrees, maximum.



7. Immediately repeat this same action on a clean, dry-section of the pad to remove any traces of solvent. Again, Do Not 'scrub' back and forth!



**NOTICE** - Improper 'Wet' techniques can complicate fiber tip cleaning and should only be used when all dry, 'cartridge-tool based' techniques have failed to clean the tip sufficiently. The primary concern with using solvents is if it is not removed completely from the tip, residual liquid acts as a transport mechanism for loose debris elsewhere on the end-face. If the solvent is simply allowed to evaporate slowly off the end, it can leave residual contaminant on the fiber core. This is extremely difficult to clean off without another Wet cleaning and usually more difficult to remove than the original contaminant. Excess solvent can also remain in tiny 'surface-pits' where it can re-emerge upon fiber connection.

Additionally, 'scrubbing' the fiber back-and-forth on the pad or wiping over the same area more than once can re-contaminate or damage the Fiber-tip.

(See technique-steps illustrated in Figure 9.3-3, next-page)

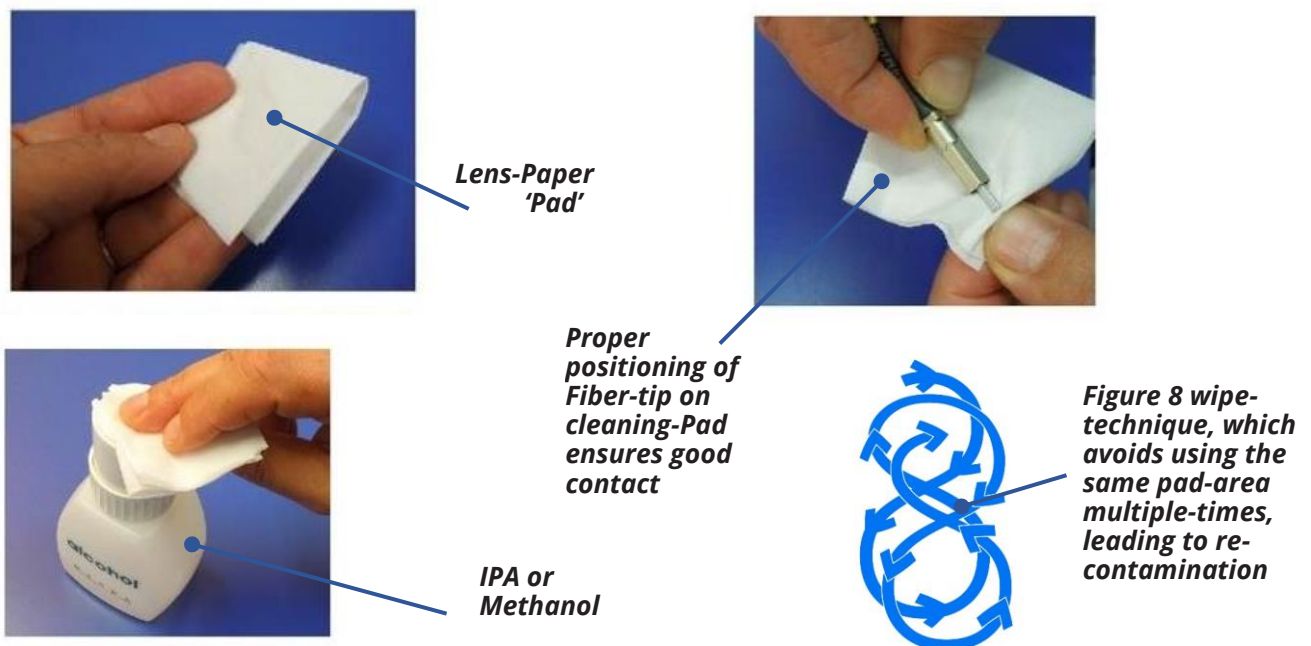


Figure 9.3-3: 'Figure 8' Wet-cleaning a fiber-tip with a 'cleaning pad' made from optical-grade lens paper.

**Summary:**

1. Inspect the delivery-fiber tip with a fiberscope or microscope, as per the instructions above. If the tip is dirty, use the Dry-cleaning technique to clean it, as-per the instructions above.
2. Re-inspect the fiber tip. If the connector is still dirty, repeat the Dry-cleaning technique, as-per above, a

second time.

3. Re-inspect the fiber tip again. If the connector is *still* contaminated, clean it with the Wet cleaning technique, as per the instructions above.
4. Re-inspect the fiber tip again. If the contaminate is still present, repeat the Wet cleaning process, as per above, until the fiber tip is clean.

If the delivery-fiber tip is *still* contaminated after several cleaning attempts using both the Dry and Wet cleaning techniques, contact your technical support

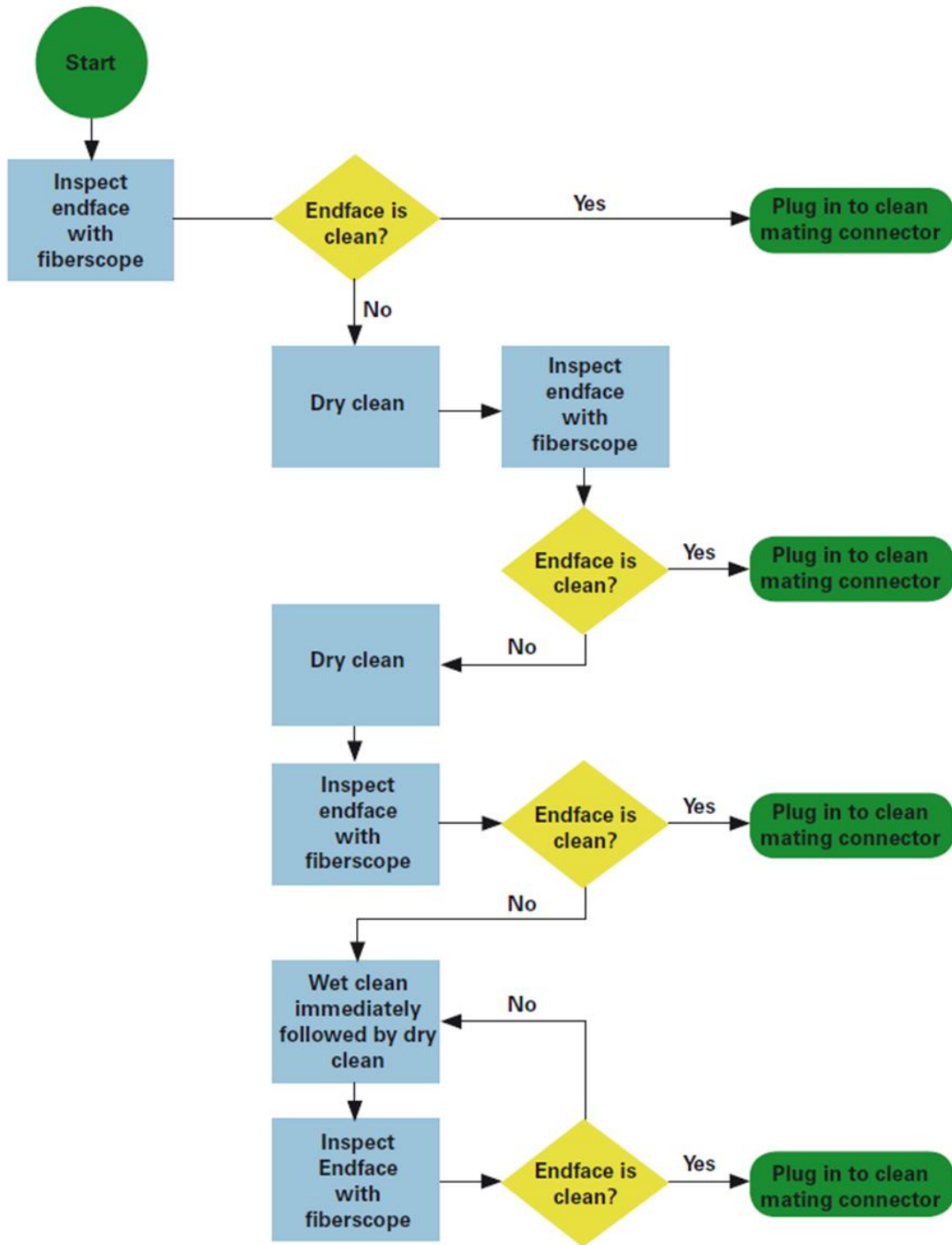


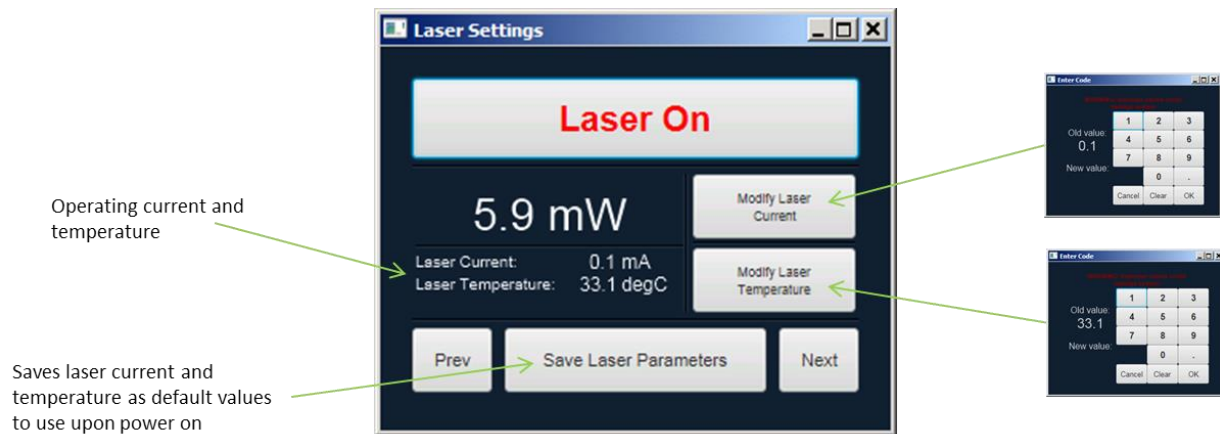
Figure 9.3-4: An example of a fiber cleaning process flow

## 9.4 Optimizing Output Coupler

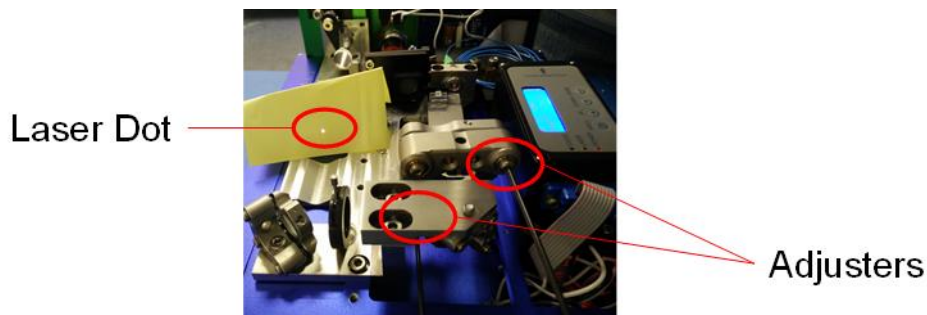
If technical support instructs you to realign the output coupler, please proceed with the following procedure. Do not conduct this procedure without contacting Coherent support. Not all units have suitable components. Furthermore, these steps are not eye safe and suitable eye protection must be used.

**WARNING: Use suitable laser safety precautions prior to opening the cover.**

- Note the minimum temperature in the test report
- Remove top lid from the laser module
- Place a piece of paper into the beam path as shown in the picture
- Verify that you have a 2mm wrench to use for the mirror mount adjusters
- Using the front panel touch pad, enter the laser settings page (see section 5.3) as shown below:



- Turn on the laser via the key switch and wait one minute for the laser to stabilize. A laser dot should be visible on the paper that was placed in the beam path.



- Using the front panel lower the temperature by a few degrees Celsius. Wait a few seconds for the temperature to stabilize. Verify that the laser dot remains visible. If you cannot see the laser dot, increase the temperature until you see the laser dot reappear.

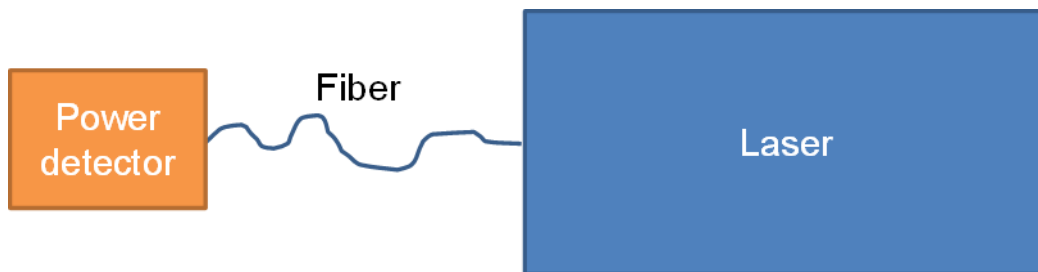
- Using the 2mm wrench, turn the adjusters until the laser dot power is visually maximized. Only small rotations (a few degrees of rotation) of the adjusters should be used. **Never turn the adjusters without being able to visualize the laser beam.**
- Iterate the previous two steps until the minimum temperature on the test report is reached. At temperatures near the minimum temperature, the sensitivity of the adjusters is fairly high.
- Remove the wrenches and verify that the laser dot remains visible. Remove the paper from the system. Remount the lid.
- Power cycle the system.

At this point, the output coupler is optimized. If the problem remains, please contact for further assistance.

### Fiber Coupling Adjustment

If technical support instructs you to optimize the fiber coupling, please proceed with the following procedure. Note that a power detector (not supplied) is necessary for this optimization. Please ensure that the power detector can be used with a FC/PC fiber.

**WARNING: Use suitable laser safety precautions prior to opening the cover.**



- Attach fiber to the laser and the power detector. See above picture.
- Remove top lid from the laser module
- Turn on laser and allow it to stabilize for a few minutes before proceeding. Use suitable laser safety precautions
- Turn off wavelength optimization in the window below:

The screenshot shows the 'Laser Flags' software window. It contains several control panels and buttons:

- Wavelength Optimization:** A panel with a green arrow pointing to it from the annotation 'Enable / Disable Wavelength Optimization Routine'.
- Current/Temperature Synchronization:** A panel with a green arrow pointing to it from the annotation 'Enable / Disable wavelength optimized current-temperature synchronization'.
- Temperature Compensated Power Meter:** A panel with a green arrow pointing to it from the annotation 'Enable / Disable temperature dependency in output power'.
- Buttons:** 'Prev', 'Reset', 'IP', and 'Next' are located at the bottom of the window.
  - A green arrow points from the 'Reset' button to the annotation 'Reboot system. Laser remains active'.
  - A green arrow points from the 'IP' button to the annotation 'Network information (ONDAX ONLY)'.

- By iterating small changes on the two adjustment screws shown below, maximize power on the detector.



- Remove wrenches and verify power.
- Re-mount top cover.





**INNOVATIONS THAT RESONATE**