# CellX™ Laser System

Operator's Manual

INNOVATIONS THAT RESONATE

COHERENT

# CellX

Operator's Manual

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Patents referenced in this manual are active when the manual is printed (see last page for the date). You are advised to check if the patents are still active www.coherent.com/legal/patents.

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Should you experience any difficulties with your laser or need any technical information, please go to our web site www.Coherent.com. Should you need further assistance, please contact Coherent Technical Support by e-mail customer.support@coherent.com or telephone, +1-734-456-3100. Please be prepared to supply the model and laser head serial number of your laser system, the description of the problem, and any attempted corrective steps to the Product Support Engineer responding to your request.

Telephone coverage is available Monday through Friday (except U.S. holidays and company shutdowns). Inquiries received outside of normal office hours will be captured by our automatic answering system and will be quickly returned the next business day.

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# 1 Introduction

Anyone setting up or operating the CellX laser system must first read and understand all safety information prior to beginning any tasks.

**WARNING!**
**The use of controls, adjustments, or performance of procedures—except those specified in this manual—can cause dangerous radiation exposure.**

## 1.1 Signal Words and Symbols

This section provides information about signal words and safety symbols that you need to know before you begin to use the CellX laser system.

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.

***NOTICE***
**This user information reported in this manual is in compliance with the following standards for Light-Emitting Products IEC 60825-1 / EN 60825-1 *“Safety of laser products – Part 1: Equipment classification and requirements”* 21 CFR Title 21 Chapter 1, Subchapter J, Part 1040 *“Performance standards for light-emitting products”*.**

### 1.1.1 Signal Words

Four signal words are used in this documentation: **DANGER**, **WARNING**, **CAUTION** and **NOTICE**.These signal words designate the degree or level of hazard when there is the risk of injury.

Messages relating to hazards that could result in both personal injury and property damage are considered safety messages and not property damage messages.

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**DANGER!**

**Indicates a hazardous situation that, if not avoided, <u>will</u> result in <u>death or serious injury</u>. This signal word is to be limited to the most extreme situations.**

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**WARNING!**

**Indicates a hazardous situation that, if not avoided, <u>could</u> result in <u>death or serious injury</u>.**

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**CAUTION!**

**Indicates a hazardous situation that, if not avoided, could result in <u>minor or moderate injury</u>.**

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

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***NOTICE***

**Indicates information considered important, but not hazard- related.**

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### 1.1.2 Symbols

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

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

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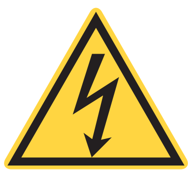
**This symbol is intended to alert the operator to the presence of important operating and maintenance instructions.**

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



**This symbol is intended to alert the operator to the presence of dangerous voltages within the product enclosure that may be of sufficient magnitude to constitute a risk of electric shock.**

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

**This symbol is intended to alert the operator to the danger of crushing injury.**

**This symbol is intended to alert the operator to the danger of a lifting hazard.**

## 1.2 Preface

This manual contains user information for the CellX.

***NOTICE***

**Read this manual carefully before operating the laser for the first time. Failure to follow the instructions and safety precautions in this manual can result in serious injury or death. Special attention must be given to the material in 'Safety and Compliance' (p. 7), that describes the safety features built into the laser. Keep this manual with the product and in a safe location for future reference.**

**DANGER!**

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

In addition to these safety warnings, also read the following sections for additional information about how to safely operating the laser system:

- 'Safety and Compliance' (p. 7)
- 'Laser Back Reflection' (p. 253)

## 1.3 Export Control Laws Compliance

It is the policy of Coherent to follow strictly the export control laws of the United States of America (USA).

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

The applicable restrictions vary depending on the product involved and its destination. In some conditions, U.S. law makes it necessary that U.S. Government approval be given prior to resale, export or re-export of certain articles. When there is uncertainty about the obligations imposed by laws in the USA, clarification must be received from Coherent or a correct agency of the U.S. Government.

Products made in the European Union, Singapore, Malaysia, Thailand: These commodities, technology, or software all apply to local export regulations and local laws. Diversion contrary to local law is not allowed. The use, sale, re-export, or re-transfer directly or indirectly in any unhallowed activities are strictly disallowed.

# 1.4 The Operator's Manual

This Operator Manual is designed to familiarize the user with the CellX system and its designated use. It contains important information on how to install, operate, and troubleshoot the laser system safely, properly, and most efficiently. Observing these instructions helps to avoid danger, reduce repair costs, and downtimes and increase the reliability and lifetime of the laser system.

This Manual:

- describes the physical hazards related to the laser system, the means of protection against these hazards, and the safety features incorporated in the design of the laser system
- briefly describes the purpose and operation as well as the primary features, system elements, subsystems, and fundamental laser control routines of the laser system
- describes the fundamental operation of the laser system
- describes the maintenance procedures for the laser system which can be performed by the end user. This includes a time schedule for all periodic routine replacement procedures and a basic troubleshooting section.

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**The screenshots in this manual are only examples and may show configurations or parameter settings which do not apply to the CellX laser system. Changing parameter settings to correspond with screenshots may reduce laser performance or even damage the laser system!**

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## 1.4.1 Intended Audience

The Operator's Manual is intended for all persons that are to work on or with the laser system. It assumes that the reader has received guidance from their company's laser safety officer on the safe operation of the laser system.

None of the procedures described in this manual requires the defeating of safety interlocks. Where specific training is required to perform procedures, this is clearly indicated at the beginning of the corresponding section.

### 1.4.2 Availability and Use

This Operator's Manual must always be available wherever the laser system is in use. Keep this manual in a safe location for future reference. It must be read and applied by any person in charge of carrying out work with and on the laser system, such as

- operation (including setting up, troubleshooting in the course of work, removal of production waste, care and disposal of consumables,
- service (maintenance, inspection, repair) and/or
- transport.

### 1.4.3 Numbering of Sections, Pages and Instructions

The sections are numbered continuously. The name of the section appears in the upper outside corner of every odd page. Each section ends with an even page number. Consequently, certain even pages at the ends of sections will be intentionally left blank.

The pages of this manual are numbered continuously by section. The page number appears in the bottom center of every page.

Each step within a procedure is sequentially numbered. Each procedure starts with the step number one.

## 1.5 Units of Measurements

In this manual, units of measurement are used according to the metric system (international system of units (SI)), e.g. meter, millimeter, square meter, cubic meter, liter, kilogram, bar, pascal; and imperial system, e.g. tons, pounds, and ounces; gallons and quarts; miles, yards, feet, and inch.

Temperatures are primarily indicated in degrees Celsius (°C) and Fahrenheit (°F).

# 2 Safety and Compliance

This section describes laser and electrical safety for persons setting up or operating the CellX™ laser system, and includes.

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**WARNING!**
**Use of controls or adjustments or performance of procedures other than those specified may result in exposure to hazardous radiation.**

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You must review this laser safety section thoroughly before operating the CellX laser system. Carefully follow all safety instructions presented throughout this manual.

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***NOTICE***
**This user information reported in this manual is in compliance with the following standards for Light-Emitting Products IEC 60825-1 / EN 60825-1 *“Safety of laser products – Part 1: Equipment classification and requirements”* 21 CFR Title 21 Chapter 1, Subchapter J, Part 1040 *“Performance standards for light-emitting products”*.**

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## 2.1 Laser Safety Hazards

Hazards associated with lasers generally fall into the following categories:

- Biological hazards from exposure to laser radiation that can damage the eyes or skin
- Electrical hazards generated in the laser power supply or associated circuits
- Chemical hazards resulting from contact of the laser beam with volatile or flammable substances, or released as a result of laser material processing

The above list is not intended to be exhaustive. Anyone operating the laser must consider the interaction of the laser system with its specific working environment to identify potential hazards.

**WARNING!**
**LASER RADIATION The CellX laser system is an OEM component with CLASS 4 laser emission levels. Avoid eye or skin exposure to both DIRECT and SCATTERED radiation.**

## 2.2 Optical Safety

Laser light, because of its optical qualities, poses safety hazards not associated with light from conventional light sources. The safe use of lasers requires all operators, and everyone near the laser system, to be aware of the dangers involved. Users must be familiar with the instrument and the properties of coherent, intense beams of light.

The safety precautions listed below are to be read and observed by anyone working with or near the laser. At all times, make sure that all personnel who operate, maintain or service the laser are protected from accidental or unnecessary exposure to laser radiation exceeding the accessible emission limits defined in the laser safety standards.

**WARNING!**
**Direct eye contact with the output beam from the laser can cause serious eye injury and possible blindness.**

The greatest concern when using a laser is eye safety. In addition to the main beam, there are often many smaller beams present at various angles near the laser system. These beams are formed by specular reflections of the main beam at polished surfaces such as lenses or beamsplitters. While weaker than the main beam, such beams can still be sufficiently intense to cause eye damage.

Laser beams are powerful enough to burn skin, clothing, or combustible materials, even at some distance. They can ignite volatile substances such as alcohol, gasoline, ether, and other solvents, and can damage light-sensitive elements in video cameras, photomultipliers, and photodiodes. The user is advised to follow the control measures below.

### 2.2.1 Precautions and Guidelines

The following recommended precautions and guidelines should always be observed.

1. Read and follow all safety precautions in the Installation and Operator's Manuals.
2. Always wear appropriate eyewear for protection against the specific wavelengths and laser energy being generated. See 'Laser Safety Eyewear' on page 9 for additional information.
3. Avoid wearing watches, jewelry, or other objects that may reflect or scatter the laser beam.
4. Stay aware of the laser beam path, particularly when external optics are used to steer the beam.
5. Provide enclosures for beam paths whenever possible.
6. Use appropriate energy-absorbing targets for beam blocking.
7. Block the beam before applying tools such as Allen wrenches or ball drivers to external optics.
8. Limit access to the laser to trained and qualified users who are familiar with laser safety practices. When not in use, lasers should be shut down completely and made off-limits to unauthorized personnel.
9. Terminate the laser beam with a light-absorbing material. Laser light can remain collimated over long distances and therefore presents a potential hazard if not confined. It is good practice to operate the laser in an enclosed room.
10. Post laser warning signs in the area of the laser beam to alert those present.
11. Exercise extreme caution when using solvents in the area of the laser.
12. Never look directly into the laser light source or at scattered laser light from any reflective surface, even when wearing laser safety eyewear. Never sight down the beam.
13. Set up the laser so that the beam height is either well below or well above eye level.
14. Avoid direct exposure to the laser light. Laser beams can easily cause flesh burns or ignite clothing.
15. Advise all those working with or near the laser of these precautions.

#### 2.2.1.1 Laser Safety Eyewear

Always wear appropriate laser safety eyewear for protection against the specific wavelengths and laser energy being generated.

The appropriate eye protection can be calculated as defined in the "EN 207 Personal eye protection equipment—Filters and eye-protectors against laser radiation (laser eye-protectors)", in other national or international standards (such as ANSI, ACGIH, or OSHA) or as defined in national safety requirements.

**CAUTION**

**Laser safety eyewear protects the user from accidental exposure to laser radiation by blocking light at the laser wavelengths.**

**However, laser safety eyewear can also prevent the operator from seeing the beam or the beam spot. Exercise extreme caution even while wearing safety glasses.**

### 2.2.1.2 Viewing Distance

The CellX laser system produces optical power levels that are dangerous to the eyes and skin if exposed directly or indirectly. This product must be operated only with proper eye and skin protection at all times. Never view directly emitted or scattered radiation with unprotected eyes.

When viewing the laser during operation, the operator must maintain the Nominal Ocular Hazard Distance (NOHD) between the laser or scatter radiation and the operator's eyes.

Table 2-1 summarizes the NOHD for the power range of the CellX laser system for direct viewing of the collimated beam along with two other common configurations.

The NOHD is based on the Maximum Permissible Exposure (MPE = 0.001 W/cm$^2$) level for each power condition as specified in ANSI Z136.1 and IEC 60825-1.

**Table 2-1. Nominal Ocular Hazard Distance (NOHD)**

| Condition | NOHD (m) |
|---|---|
| Intra-beam NOHD (all four laser beams ON) | 921 |
| Diffuse reflection in the Nominal Hazard Zone (NHZ) | 0.19 |

### 2.2.1.3 Maximum Accessible Radiation Level

The CellX laser system produces visible radiation over the various wavelengths. These range from 400 nm to 645 nm, with a maximum of 0.44 Watts continuous wave power. See the Product Label on the CellX laser system for details about maximum emission levels for that configuration of lasers.

# 2.3 Laser Compliance with Regulatory Requirements

This section describes the various regulatory requirements for laser safety, and the compliance with various regulations.

## 2.3.1 United States of America

The applicable United States Government laser safety requirements are contained in 21 CFR, Subchapter J, Part 1040 and are administered by the Center for Devices and Radiological Health (CDRH).

The CDRH accession number for the CellX laser system is 91R0252-200.

***NOTICE***

**This laser system is intended to be integrated into a laser product by an OEM using appropriate end-user safety mechanisms. Because this system is not intended for a stand-alone application, the CellX device does not fully comply with requirements for certified laser products as defined in the US FDA CFR 21, sections 1040.10 and 1040.11, or the IEC 60825-1:2014 standard.**

In the United States, it is the responsibility of the buyer that the product sold to the end user complies with all laser safety requirements prior to resale.

Integrators who incorporate an CellX laser system into other products that they introduce into United States commerce are defined in the law as manufacturers who are thus required to manufacture their products to conform to the Federal standard, certify them, and submit product reports to the CDRH.

The text of this federal standard is available from the U.S. Government Printing Office Bookstore located in most major cities in the U.S. as well as Washington, D.C. A report detailing how the laser product complies with the Federal standard is required before the product is shipped. The form of this report is covered in a pamphlet entitled: Compliance Guide for Lasers, HHS Publication FDA 86-8260. This pamphlet is available at no cost from:

U.S. Food and Drug Administration
Center for Devices and Radiological Health (CDRH)
Document Mail Center – WO66-G609
Sliver Spring, MD 20993-0002

Website: www.fda.gov

For jurisdictions outside of the United States, it is the responsibility of the buyer of this laser device to ensure that it meets the local laser safety requirements.

### 2.3.2 Compliance to Standards for CE Marking

The European Community requirements for product safety are specified in the Low-Voltage Directive (LVD) (published in 2014/35/EU).

This Directive requires that lasers comply with the standard EN 61010-1/IEC 61010-1 "Safety Requirements For Electrical Equipment For Measurement, Control and Laboratory Use" and EN 60825-1/IEC 60825-1 "Safety of Laser Products". Compliance with the European requirements is certified by CE Marking.

**CellX units are OEM products to be used as components to be integrated into complete systems. Because of this, the manufacturer or system integrator of the complete system is responsible for compliance with laser safety and other applicable standards for CE Marking.**

### 2.3.3 Electromagnetic Compatibility

The primary tasks for the system integrator are to design covers, shielding, grounding, routing of electrical cable assemblies, and control elements with the proper safety features for the complete system.

CellX laser systems have been tested and shown to be compliant with the relevant requirements of the following directives for Electromagnetic Compatibility EN 61326-1_Ed2:2013 (IEC 61326-1_Ed2:2012) and EN 61000-3-2:2006:

**Table 2-2. Compliance for Electromagnetic Compatibility**

| | Type | Product/Test Standards |
|---|---|---|
| **Emissions:** | | |
| | Radiated Emissions | CISPR 11:+A1:2010 Class A |
| | Conducted Emissions | CISPR 11:+A1:2010 Class A |
| | Power Line Harmonics | EN 61000-3-2:2006+A1:2009+, A2:2009 (IEC61000-3-2:2005+, A1:2008+A2:2009) |
| | Power Line Voltage Fluctuation and Flicker | EN 61000-3-3:2008 (IEC61000-3-3Ed2:2008) |

**Table 2-2. Compliance for Electromagnetic Compatibility (Continued)**

| | Type | Product/Test Standards |
|---|---|---|
| **Immunity:** | | |
| | Electrostatic Discharge (ESD) | EN 61000-4-2:2008 (IEC 61000-4- 2:2008Ed.2), Criteria B |
| | Radiated Electromagnetic Field | EN 61000-4-3:2006+A1:2008 +A2:2010 (IEC 61000-4-3:2006+A1:2007 +A2:2010), Criteria A |
| | Electrical Fast Transient/ Burst (EFT) | EN 61000-4-4:2004+A1:2010 (IEC 61000-4-4:2004+A1:2010), Criteria B |
| | Electrical Slow Transient (Surge) | EN 61000-4-5:2006(IEC 61000-4-5:2005), Criteria B |
| | RF Conducted | EN 61000-4-6:2009 (IEC 61000-4-6:2008Ed.3), Criteria A |
| | Voltage Interruptions | EN 61000-4-11:2004 (IEC 61000-4-11:2004Ed.2), Various Criteria |

Coherent recommends that OEM integrators follow these guidelines to control the amount of radiated interference:

- Use high-quality cables for all electrical connections
- Verify grounding of cable shields (at both ends of the cable)

## 2.3.4 Laser Classification

Governmental standards and requirements specify that the laser must be classified according to the output power or energy and the laser wavelength. The CellX is classified as Class 4 based on 21 CFR, Subchapter J, Part 1040, section 1040.10 (c) and/or IEC/EN 60825-1, Clause 5.

In this manual, the CellX laser classification is referred to as Class 4.

*NOTICE*

**The combined maximum power for all lasers in the system, under single-fault conditions, is used to determine the Laser Safety Classification of the CellX system. A potential combined maximum power output greater than 500 mW categorizes the system as a Class 4 laser.**

## 2.3.5 Protective Housing

The laser head is enclosed in a protective housing that prevents human access to radiation in excess of the limits of Class radiation as specified in the 21 CFR, Part 1040 Section 1040.10 (f)(1) and EN 60825-1/IEC 60825-1 Clause 6.2 except for the output beam, which is Class 4.

The CellX laser system offers several options for an external interlock connector on the unit. The terminals of this connector must be electrically joined for the laser to operate [CFR 1040.10 (f)(3)/ EN 60825-1/IEC 60825-1, Clause 6.4].

**WARNING!**
**Use of controls or adjustments or performance of procedures other than those specified in the manual may result in hazardous radiation exposure.**

## 2.3.6 Laser Radiation Emission Indicators

By default, the CellX system automatically begins the process of laser emission as soon as power is applied. The LED indicator for laser emission is located on the rear panel of the CellX laser system, and illuminates during warm-up. See 'System Warm-Up Time' (p. 100) for details about the various color indicators displayed by the Laser Status LED during different states of laser emission.

The LED indicators for laser status are visible both to the unaided eye and while wearing the proper type of safety glasses [CFR 1040.10(f)(5)/ EN 60825-1/IEC 60825-1, Clause 6.7]. See 'Next Steps' (p. 110) for more details.

**WARNING!**
***There is no shutter on the CellX unit.* Avoid any possibility of viewing either a direct or reflected beam. Always wear appropriate safety glasses for the specific wavelengths.**

## 2.3.7 Manual Reset Mechanism

Following an interlock fault or unexpected loss of electrical power, laser operation is manually reset by re-installing the external interlock connector on the rear panel [CFR 1040.10(f)(10)/ EN 60825-1/IEC 60825-1, Clause 6.5].

***NOTICE***

**Use of the system in a manner other than that described can impair the protection provided by the system.**

## 2.3.8 Electromagnetic Compatibility

The European requirements for Electromagnetic Compliance (EMC) are specified in the EMC Directive (published in 2014/30/EU).

### 2.3.8.0.1 Class A:

Conformance (EMC) concerning emission and immunity is achieved through compliance with the harmonized standard EN 61326-1:2013 (Electrical Requirement for Measurement, Control and Laboratory) for Class A.

### 2.3.8.0.2 Class B:

Conformance to the EMC requirements is achieved through compliance with the harmonized standards EN 55011 (1991) for emission and ENC 50082-1 (1992) for immunity.

The laser meets the emission requirements for Class 4, as specified in EN 55011. Compliance of this laser with the EMC requirements is certified by the CE mark.

## 2.4 Location of Safety Labels

Refer to the following for the location of laser safety markings:

- See Figure 2-1 and Figure 2-2 for the location of the laser aperture through which laser radiation is emitted.
- See Figure 2-3 for the Laser Radiation certification and identification label.

These markings are in compliance with [21 CFR § 1040.10(g), 21 CFR § 1010.2, and 21 CFR § 1010.3/ EN 60825-1/IEC 60825-1, Clause 7].

The directional arrow shown in Figure 2-1 that is printed on the top cover of the CellX unit shows the location of the laser aperture.

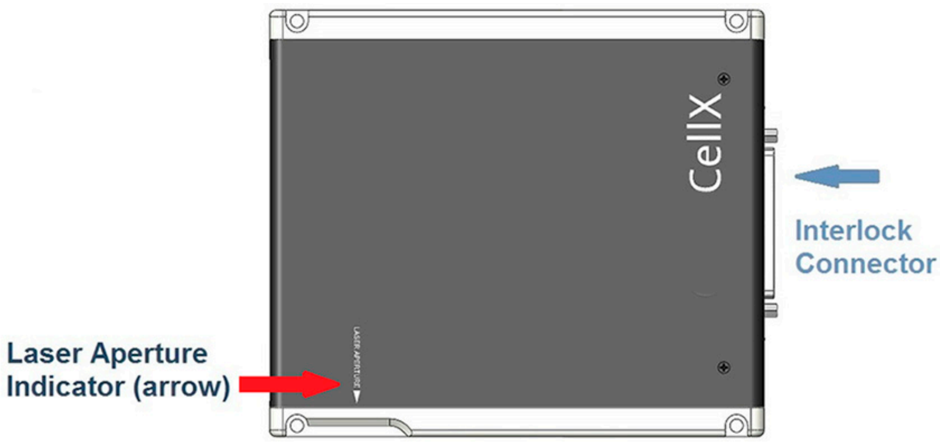



**Figure 2-1. Laser Aperture Indicator on the CellX**

**WARNING!**
***There is no shutter on the CellX unit.* Avoid any possibility of viewing either a direct or reflected beam. Always wear appropriate safety glasses for the specific wavelengths.**

The arrow in Figure 2-2 shows to the location of the output beam on the right side of the CellX unit.

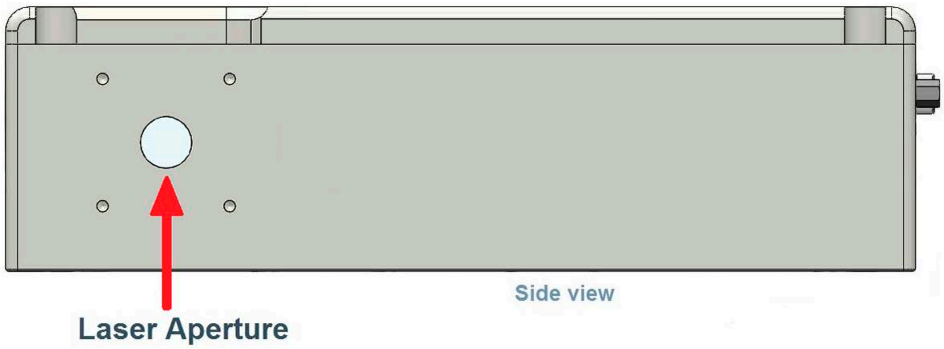



**Figure 2-2. Location of Laser Aperture**

In addition, a laser safety warning is incorporated into the Product Data label, as shown in Figure 2-3. This label is located on the side of the CellX unit. The yellow section of the label shows the Class of laser as well as compliance information.

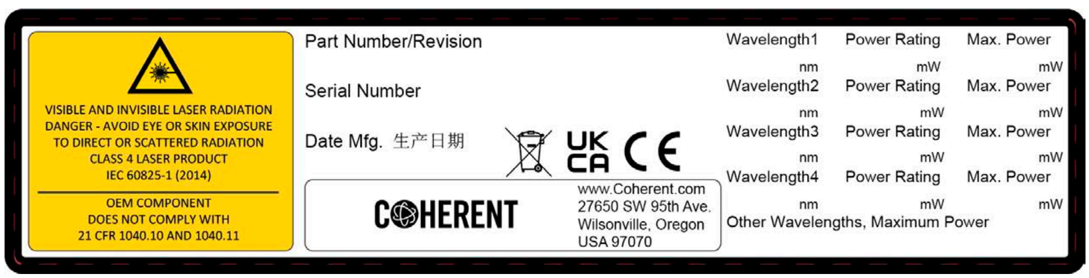



**Figure 2-3. Laser Safety Warning – CellX Product Label**

Note that information on the product label varies, depending on the product configuration. Each label is unique.

## 2.5 Electrical Safety

The CellX laser system does not have dangerous voltages.

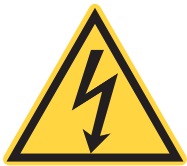
Coherent offers a power supply (P/N 1211389) for the CellX laser system, or users can supply +12VDC (+/- 2.0 VDC) from their own power supply.

***NOTICE***

**The CellX laser system is designed to be operated as assembled; there are no user-serviceable components in the device.**
**DO NOT disassemble the enclosure.**
***The Warranty is void if the enclosure is disassembled!***

## 2.5.1 Precautions and Guidelines

Everyone must observe the following precautions when working with potentially hazardous electrical circuitry.



**WARNING!**
**When working with electrical power systems, the rules for electrical safety must be strictly followed. Failure to do so could result in the exposure to damaging levels of electricity.**

1. Disconnect main power lines before working on any electrical equipment when it is not necessary for the equipment to be operating.
2. Do not short or ground the power supply output. Protection against possible hazards requires proper connection of the ground terminal on the power cable, and an adequate external ground. Check these connections at the time of installation, and periodically thereafter.

**WARNING!**
**Normal operation of the CellX laser system should not require access to the power supply circuitry. Removing the power supply cover exposes the user to potential electrical hazards. Contact an authorized service representative before attempting to correct any problem with the power supply.**

3. Never work on electrical equipment unless there is another person nearby who is familiar with the operation and hazards of the equipment, and who is competent to administer first aid.
4. When possible, keep one hand away from the equipment to reduce the danger of current flowing through the body if a live circuit is touched accidentally.
5. Always use approved, insulated tools.

## 2.5.2 ESD Protection

The most common ESD damage occurs when handling the device during installation or use.

**WARNING!**
**Damage can occur to the electronics features of the CellX system from Electrostatic Discharge (ESD).**

Electrostatic charges easily collect on the human body, equipment, and facilities, and can discharge without detection. Dry air and carpet create a higher potential for Electrostatic Discharge (ESD).

Take necessary precautions or shielding to protect the system from ESD to prevent performance degradation or damage to the system.

## 2.6 Environmental Compliance

This section describes compliance with various environmental regulatory directives to identify hazardous substances.

### 2.6.1 RoHS Compliance

The RoHS directive restricts the use of certain hazardous substances in electrical and electronic equipment. Coherent can provide RoHS certification upon request for products requiring adherence to the RoHS Directive.

Compliance of this laser with the EMC requirements is certified by the CE mark.

### 2.6.2 China-RoHS Compliance

This section details compliance with the China-RoHS (Restriction of Hazardous Substances) Directive SJ/T 11364-2014.

The China-RoHS Directive SJ/T 11364-2014 restricts the use of certain hazardous substances in electrical and electronic equipment. This Directive applies to the production, sale, and import of products into the Peoples Republic of China.

Any hazardous substances in the CellX laser system are shown on the label, shown the example in Figure 2-4.

The table shows that Lead (Pb) may be found in components of the CellX laser system. The environmental-friendly use period is 20 years, indicated by the number 20 inside the circle.

The China RoHS Directive also requires that the date of manufacture be identified (in Chinese characters) on the product label; see Figure 2-3 (p. 2-17) for an example.

| 产品中有害物质的名称及含量 | | | | | | |
|---|---|---|---|---|---|---|
| 部件名称 Part Name | 有害物质 Hazardous Substances | | | | | |
| | 铅 (Pb) | 汞 (Hg) | 镉 (Cd) | 六价铬 (Cr(VI)) | 多溴联苯 (PBB) | 多溴二苯醚 (PBDE) |
| 印刷电路板组装 Printed Circuit Board Assembly | X | O | O | O | O | O |

本表格依据 SJ/T 11364 的规定编制
O: 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下。
X: 表示该有害物质至少在该部件的某一均质材料中的含量超出GB/T 26572 规定的限量要求。

**Figure 2-4. China RoHS Label**

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

Coherent product(s) conform to all applicable requirements of the EU Waste Electrical and Electronic Equipment (WEEE)- Directive (2012/19/EU). WEEE management also covers EU Directive 2006/66/EC-EU Battery Directive and Directive 94/62/EC on Packaging and Packaging Waste. Do not dispose of these products or packaging as unsorted municipal waste.

Coherent joins approved compliance organizations to meet its collection and recycling obligations. For further information, please contact:

Email: info@rene-europe.com
Phone: +49 (0) 8266-869806
Website: www.rene-europe.com

### 2.6.4 Battery Directive

The battery used in the CellX laser system is in compliance with EU Directive 2006/66/EC, as amended by Directive 2008/12/EC, 2008/103/EC and 2013/56/EU ("EU Battery Directive").

**Table 2-3. Battery in CellX**

| Description | Type |
|---|---|
| 3v Manganese Rechargeable Lithium Coin-Type Battery | Manganese Lithium |

***NOTICE***
**This battery is soldered to the board and is NOT removable. Any attempt to replace the battery will void the Coherent warranty.**

## 2.7 Sources of Information

The following are sources for additional information on laser safety standards and safety equipment and training.

### 2.7.1 Laser Safety Standard

*American National Standard for Safe Use of Lasers*
ANSI Z136 Series
American National Standards Institute (ANSI)
www.ansi.org

*Performance standards for light-emitting products*
21 CFR Title 21 Chapter 1, Subchapter J, Part 1040
U.S. Food and Drug Administration
www.fda.gov

### 2.7.2 Publications and Guidelines

*Safety of laser products - Part 1: Equipment classification and requirements*
IEC 60825-1 / EN 60825-1

*Safety of laser products - Part 14: A user's guide*
IEC 60825-1 / EN 60825-1

*Safety Requirements For Electrical Equipment For Measurement, Control and Laboratory Use*
IEC 61010-1 / EN 61010-1

International Electrotechnical Commission (IEC)
www.iec.ch

Safety of laser products - Part 1: Equipment classification and requirements
BS EN 60825-1
British Standard Institute
www.bsigroup.com

*A Guide for Control of Laser Hazards*
American Conference of Governmental
and Industrial Hygienists (ACGIH)
www.acgih.org

*Laser Safety Guide*
Laser Institute of America
www.lia.org

### 2.7.3 Equipment and Training

*Laser Focus Buyer's Guide*
Laser Focus World
www.laserfocusworld.com

*Photonics Spectra Buyer's Guide*
Photonics Spectra
www.photonics.com

# 3 Description and Specifications

This section describes the features and specifications of CellX™ Laser Systems.

## 3.1 Description

The CellX lasers are low-cost, multi-wavelength laser systems in a single, compact module that offer alignment flexibility and ease-of-integration.

Originally designed for flow cytometry, the CellX platform now supports three applications: flow cytometry, free-space applications, and a fiber delivery system engineered for microscopy.

Figure 3-1 shows the major components of a CellX laser system for flow cytometry:

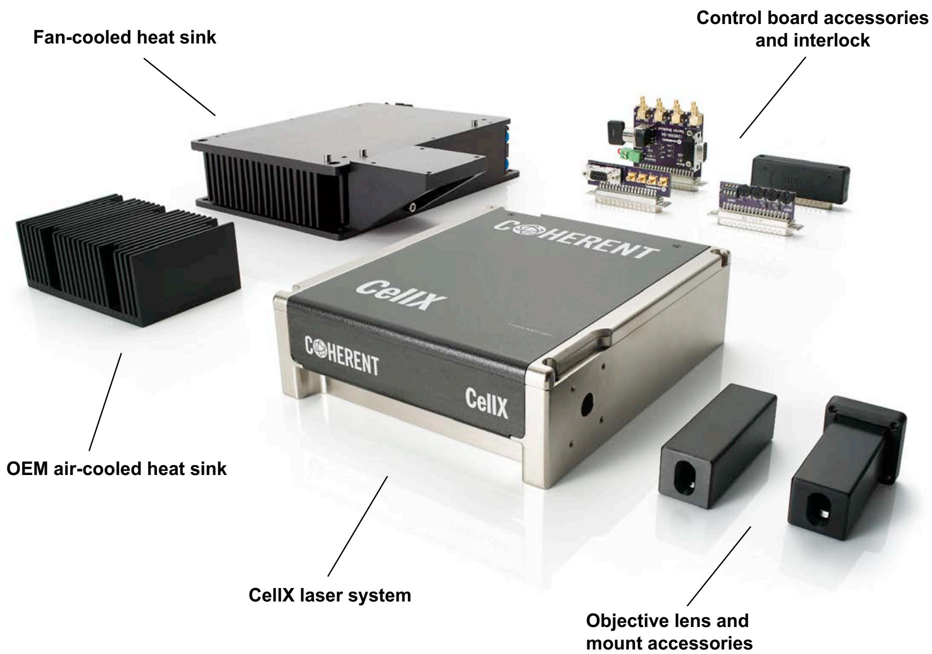



**Figure 3-1. CellX Laser System and Accessories**

One configuration of these laser systems includes user-adjustable steering and telescopes used to optimize the beams to target requirements.

Regular CellX is designed for flow cytometry where we are looking essentially to focus all 4 wavelengths down to a spot size of about 10um at a working distance of maybe ~40mm. To achieve this a) the beam diameters in CellX need to be larger, and b) the beam diameter increase for longer wavelengths. So, the beam diameter at 405nm is around 2.6mm; for 640nm it is around 4.5mm.

CellX with fiber launchers have much shorter focal length and are designed to work with a beam diameter of ~0.7mm. The beam diameter is approximately the same for all wavelengths.

The output at each laser wavelength can be individually controlled through a USB interface to a workstation or with discrete analog and digital control lines. CellX also has a single electrical interface for ease of installation.

This platform consolidates control, thermal management, and packaging to reduce the complexity when integrating multiple separate lasers into an application.

To view videos about CellX, go to the product page and scroll down:

- https://www.coherent.com/lasers/laser-engine/cellx

### 3.1.1 Applications

The CellX laser systems are multi-wavelength excitation source, designed from the ground up for bio-instrumentation and scientific applications. Leveraging OBIS technology, CellX optimizes performance and accessories to deliver application-specific functionality for:

- Flow cytometry and sorters
- Particle Measuring
- Microscopy (see ’CellX Options for External Fiber for Microscopy’ (p. 61))
- Medical imaging
- Optogenetics

### 3.1.2 Features and Benefits

This section describes features and benefits of CellX laser systems. Also see the CellX data sheet, available on:
www.coherent.com/resources.

For a high-level functional block diagram for a CellX laser system, see ’Block Diagram’ (p. 28).

### 3.1.2.1 Integrated Control of All Wavelengths

The CellX laser system uses a single main drive board that provides common controls for all installed lasers, as well as integrated interfaces for user interaction and external control.

- Single interface for up to 4 lasers
- USB for control and monitoring
- Coherent Connection application software to easily integrate CellX into a developer's system

### 3.1.2.2 Design Benefits

The CellX platform offers flexibility in configurations that require 1 to 4 laser wavelengths in a single module. For CellX for flow cytometer, the system can be aligned to give flexible patterns of focused stripes in a flow cytometer. The CellX laser system offers highly parallel beams for:

- Uniform intensity front-to-back in the flow cell
- Minimized divergence after the flow cell that simplifies obscuration bar design

By deleting redundant elements and leveraging volumes, the design of the CellX laser systems offer savings of time and money for application development:

- An off-the-shelf laser module requires less parts to manage, less space for inventory and manufacture, and reduces cycle time.
- Standardizing on the CellX laser reduces time-to-market for a product release and offers economies of scale for components such as optics and mounts.
- Developers can leverage the CellX laser module across various designs (rather than designing a new laser deck each time).

The plug-and-play simplicity of different configurations contributes to rapid start-up, ease of integration, and a focus on development of sensitive time–to-market applications.

A version with 0.7 mm beam diameters serves as a stand-alone laser engine or works with a fiber-coupled aligner to optimize power transmission for Microscopy applications. Telescope adjustments and beam steering can be performed to optimize the coupling.

## 3.1.3 Configurations Available

CellX is a multi-wavelength platform for use as the laser excitation Light Engine in applications requiring up to 4 lasers from a single module. CellX can serve three applications with its different models and accessories:

- Stand-alone free-space laser engine.
- Flow Cytometry with the beam diameters and adjustments for the best focus spot size and stripe locations.
- Microscopy with a common 0.7mm output beam and fiber aligner with FC/APC or collimated output.

### 3.1.3.1 CellX Laser System Configurations For Flow Cytometry

***NOTICE***
**The CellX laser systems for OEM (Original Equipment Manufacturer) integration are supplied only with mounting hardware and the Installation & Quickstart Guide. Any other accessories that may be required—such as heat sinks, objective lens assembly, interlock, tools or hardware—must be purchased separately.**

A variety of base configurations are available for OEM integration, shown in Table 3-1. These **CellX Laser Engines for OEMs** offer configurations from 1- to 4-channel wavelength models, and are available with either high or low output power.

**Table 3-1. CellX Laser System Configurations For Flow Cytometry**

| P/N | Description | Wavelengths | Power |
|---|---|---|---|
| 1426529 | CellX Laser System 2x50 mW | 2-channel: 405 and 488 nm | 50 mW each |
| 1426530 | CellX Laser System 2x50 mW | 2-channel: 488 and 561 nm | 50 mW each |
| 1426531 | CellX Laser System 2x50 mW | 2-channel: 488 nm and 637 nm | 50 mW each |
| 1426532 | CellX Laser System 50mW | 1-channel: 488 nm | 50 mW |
| 1318683 | CellX Laser System 4x100 mW | 4-channel: 405, 488, 561, 637 nm | 100 mW each |

**Table 3-1. CellX Laser System Configurations (Continued)For Flow Cytometry**

| P/N | Description | Wavelengths | Power |
|---|---|---|---|
| 1318681 | CellX Laser System 3x100 mW | 3-channel: 405, 488, 637 nm | 100 mW each |
| 1318682 | CellX Laser System 4x50 mW | 4-channel: 405, 488, 561, 637 nm | 50 mW each |
| 1318680 | CellX Laser System 3x50 mW | 3-channel: 405, 488, 637 nm | 50 mW each |
| 1424660 | CellX FR Laser System Fiber-ready 4x100 mW | 4-channel: 405,488,561,637 nm. | 100 mW each |

### 3.1.3.2 CellX Configuration for Standalone Freespace

A general-purpose configuration with 0.7mm output beam and no fiber aligner/launcher.

**Table 3-2. CellX Laser System Configurations For Microscopy**

| P/N | Description | Wavelengths | Power |
|---|---|---|---|
| 1424660 | CellX Laser with common 0.7 mm beam diameter. Fiber Ready. **Fiber/Launcher sold separately** | 405, 488, 561, 637 nm | 100 mW |

### 3.1.3.3 CellX Configurations for Microscopy

Two configurations are available with a common 0.7mm output beam and fiber aligner/launcher with FC/APC or collimated output.

**Table 3-3. CellX Laser System Configurations For Microscopy**

| P/N | Description | Wavelengths | Power |
|---|---|---|---|
| 2309912 | CellX FR Laser Fiber Ready. **Includes Fiber/Launcher for FC/APC output** | 405, 488, 561, 637 nm | 100 mW |
| 2309585 | CellX FR Laser Fiber Ready. **Includes Fiber/Launcher for Collimated output** | 405, 488, 561, 637 nm | 100 mW |

Configurations and accessories specific for microscopy applications are described in 'CellX Options for External Fiber for Microscopy' (p. 61).

### 3.1.4 Block Diagram

Following is a top-level block diagram for the CellX laser system.

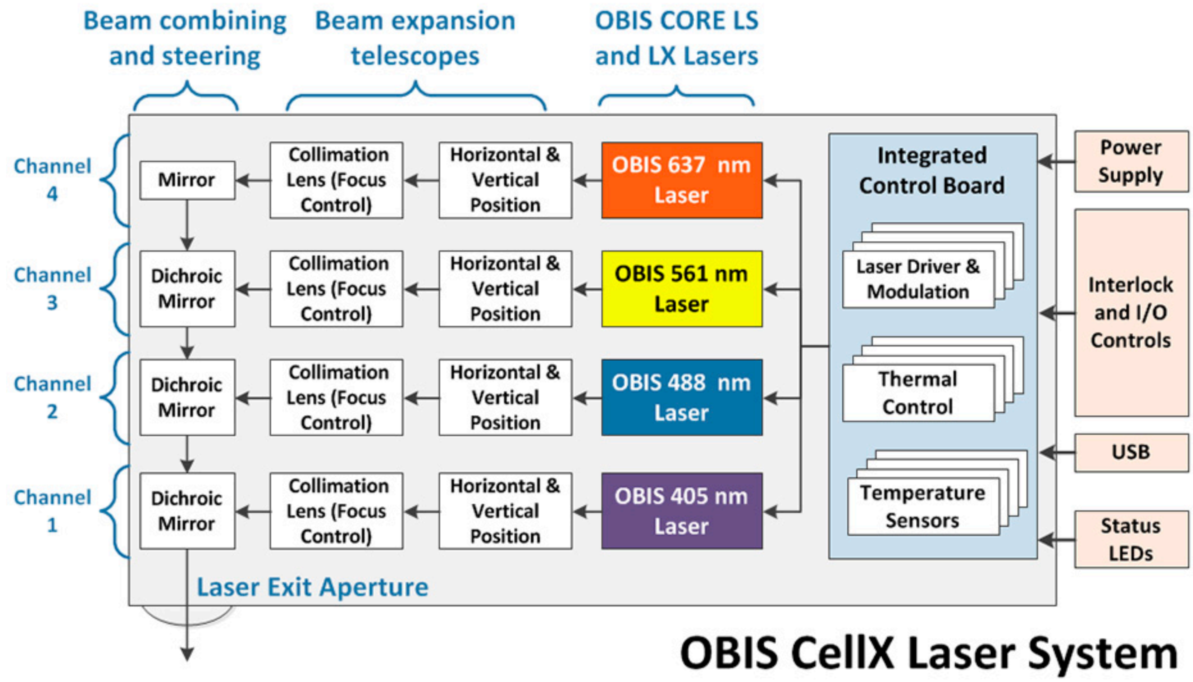



**Figure 3-2. CellX – Functional Block Diagram**

# 3.2 Controls, Indicators and Features

## 3.2.1 User-Accessible Beam Shaping and Alignment Controls

The design of the CellX laser system includes individual, user-adjustable beam expansion telescopes for each wavelength, followed by dichroic mirrors. This allows users to make adjustments that combine the individual wavelengths into a single, collimated, round multi-wavelength beam.

To access the controls that adjust each beam, the top outer cover of the CellX unit must be removed. Laser safety and ESD protection are still maintained.


**Figure 3-3. Top Cover off of CellX**

Developers can individually align and adjust the focus, pointing, and position for each wavelength in the CellX unit, as shown in the example in Figure 3-4.

This provides flexibility for cytometry applications where users make deliberate and adjustable separation of each individual wavelength to create patterns of laser stripes at the flow cell.

- Focus Control: Translation of the second telescope lens, adjusts the collimation so that it focuses at the flow cell.
- Tilt Adjustment: Fine adjustment of beam pointing to adjust vertical and horizontal position at the flow cell.

***NOTICE***
**The adjustable vertical and horizontal beam positions are set at the factory and fixed prior to shipment.**

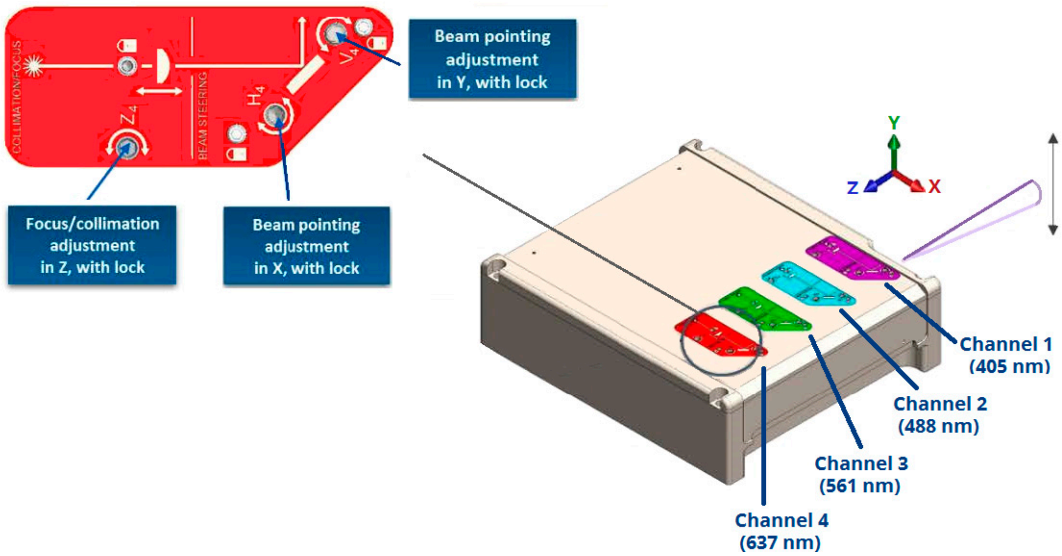



**Figure 3-4. Beam Alignment Overview**

Standard configurations of the CellX laser system are shipped with all wavelengths roughly aligned to be coaxial. CellX does not support top-hat beam shaping.

The CellX laser system also offers highly parallel beams for:

- Uniform intensity front-to-back in the flow cell
- Minimized divergence after the flow cell that simplifies obscuration bar design

For more information about beam adjustments, see 'Maintenance' (p. 183).

### 3.2.2 Control Interface Panel

One end of the CellX unit has the interface panel has input/output connectors and LED status indicator lights. Refer to Figure 3-5.

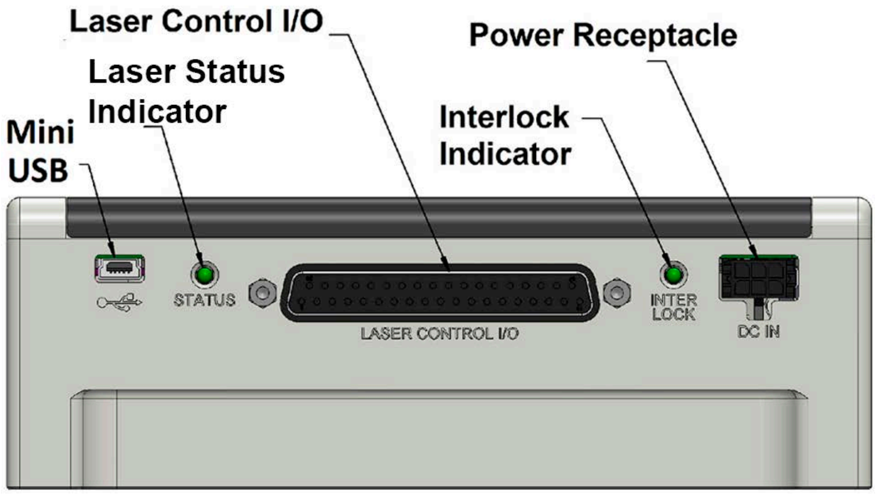



**Figure 3-5. Connectors and Indicators on Side of CellX**

### 3.2.2.1 LED Status Indicators

The LED indicators are located on the end of the CellX system with the connectors, as shown in Figure 3-5.

Light emission starts at the last power set point. Table 3-4 shows the color displayed for various states of each LED indicator.

**Table 3-4. Laser Status and Interlock Status LED Indicators**

| Laser Status LED | |
|---|---|
| **Color** | **Meaning** |
| **BLUE** | Standby[a] |
| GREEN | Warm-up |
| **WHITE** | Laser Emission |
| **RED** | Fault[b] |

| Interlock Status LED | |
|---|---|
| **Color** | **Meaning** |
| **BLUE** | Standby |
| **GREEN** | Keyswitch ON |
| **RED** | Interlock (Open / Not Connected) |

a. Light emission starts at the last power set point. If laser emission does not start within 5 minutes and the Laser Status LED indicator on the CellX displays a solid **Blue**, the Auto Start feature is not activated.
b. The Laser Status LED displays in solid **Red** when there is a fault or error condition (such as no communication, thermal issues, or other hardware issues). See tips in 'Troubleshooting Procedures' (p. 230).

# 3.3 Optional Components of the CellX Laser Systems

The CellX laser system offers a number of options:

- 'Heat Sink Options' (p. 32)
- 'Options for Control Accessories' (p. 41)
- 'Options for Objective Lenses' (p. 55)
- 'CellX Options for External Fiber for Microscopy' (p. 61)

Each of these are described in the sections that follow.

See 'Parts & Accessories' (p. 247) for a complete list of options with part numbers.

Note that, for ease of set-up, rapid deployment and evaluation for flow cytometry or variable beam applications, a CellX Developer's Kit (P/N 1323532) includes supporting components. These include a four-channel CellX Laser System plus multiple options for accessories (interlocks, objectives, and heat sinks), mounting hardware, and tools. See 'Components in the Developer's Kit' (p. 248) for a complete list.

## 3.3.1 Heat Sink Options

A heat sink provides correct thermal dissipation and mechanical positioning. The mounting of any laser is important in increasing the stability of the beam over time and temperature.

**CAUTION!**
Failure to integrate sufficient cooling in a system design can degrade performance and increase power consumption. This can potentially cause the CellX unit to activate the over-temperature shut-down mode to protect the lasers and other components.

For the CellX laser system, Coherent offers different heat sink accessories:

- Fan-cooled with stage platform extension
- Fan-cooled (no stage platform extension)
- OEM heatsink

These options are shown in Figure 3-6.

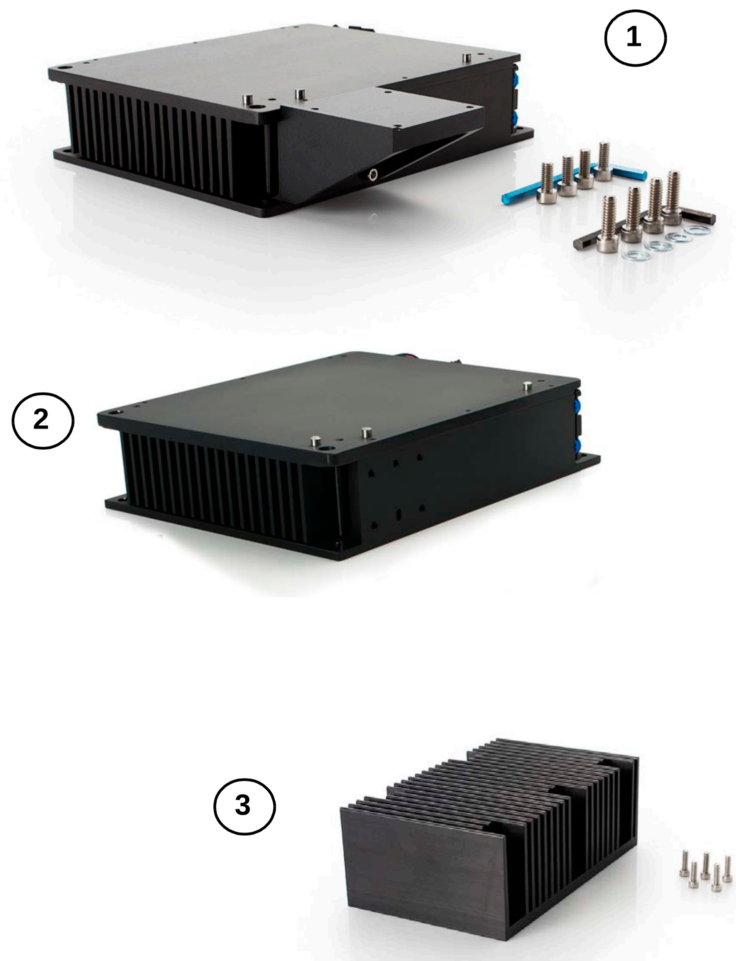



**Figure 3-6. Heat Sink Options - Fan-cooled with and without stage platform extension, OEM heatsink**

Table 3-5 shows the part number and description for each heat sink shown in the figure above.

**Table 3-5. CellX Heat Sink Accessories**

| Key | P/N | Part | Description |
|---|---|---|---|
| 1 | 1323285 | Heat Sink, Fan-Cooled with Stage Platform Extension | • Integrated cooling fan with vibration isolation<br>• Fan power connector that plugs directly into the CellX laser module<br>• Precision dowel-pin positioning<br>• Platform extension for translation stage with objective lens |
| 2 | 2324764 | Heat Sink, Fan-Cooled (without Stage Platform Extension) | • Integrated cooling fan with vibration isolation<br>• Fan power connector that plugs directly into the CellX laser module<br>• Precision dowel-pin positioning |
| 3 | 1315322 | Heat Sink, OEM | Compact unit. This heat sink is designed to use air flow provided by the customer design. Does not have platform extension. |

### 3.3.1.1 Fan-Cooled Heat Sinks

The fan-cooled heat sink modules include a dual-mounting pattern to bolt to an optical table for either a metric (M6 x 25 mm) grid or a U.S. (1/4-20 x 1-in.) grid.

Figure 3-7 shows a CellX unit mounted on a Fan-Cooled Heat Sink (P/N 1323285). This heat sink option includes a platform extension for the translation stage accessory and required hardware. As described in Table 3-5, the stage platform extension to install a translation stage with objective lens assembly.


**Figure 3-7. CellX Mounted on Fan-Cooled Heat Sink (with Platform Extension)**

The stage platform extension is shipped attached to the heat sink; however, it can be removed if developers do not want to use it.

The other fan-cooled heat sink model (PN 2324764) has no stage platform extension and allows installation of an external fiber aligner and external fiber. This configuration is used for microscopy. Refer to 'CellX Options for

External Fiber for Microscopy' (p. 61).


**Figure 3-8. CellX Mounted on Fan-Cooled Heat Sink With Beam Launcher for Microscopy**

Generally, the fan-cooled heat sinks are used either on an optical table in a lab, or integrated into a system that has no other laser cooling capability.

### 3.3.1.2 OEM Heat Sink Module

For some development projects, OEMs (Original Equipment Manufacturer) can choose to design their own cooling. Figure 3-9 shows a drawing of the CellX unit mounted on the OEM passive heat sink module (PN 1315322).

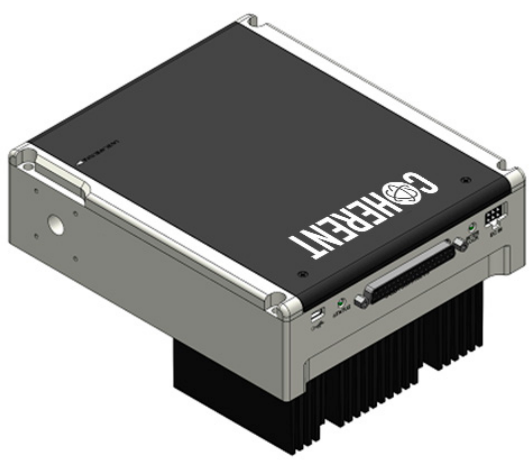



**Figure 3-9. OEM Heat Sink Mounted Under CellX**

Following are some of the factors that must be considered:

- The CellX laser system must be set up in a mount that allows it to be elevated to provide room for the heatsink, below it.

- The CellX laser system is primarily cooled through conduction through its baseplate and operates at baseplate temperatures from 10°C to 45°C.

- Internal to the CellX module, all OBIS CORE modules are mounted to a shared, TEC-cooled plate that heats/cools the modules to a stable temperature of approximately 25°C.

- At higher baseplate temperatures, total heat dissipated from the CellX laser system approaches 60 W, so additional cooling is required.

The hardware to mount the OEM Heat Sink, 5x of 4-40 threaded screws (5.6 mm/0.22 in.), is packaged with the Heat Sink.

Figure 3-10 is a graph for the thermal resistance for the OEM Heat Sink module (P/N 1315322). Thermal resistance is calculated based on a single 25.4 mm (1 in.) square heat source centered on the heat sink. Actual performance can slightly vary.

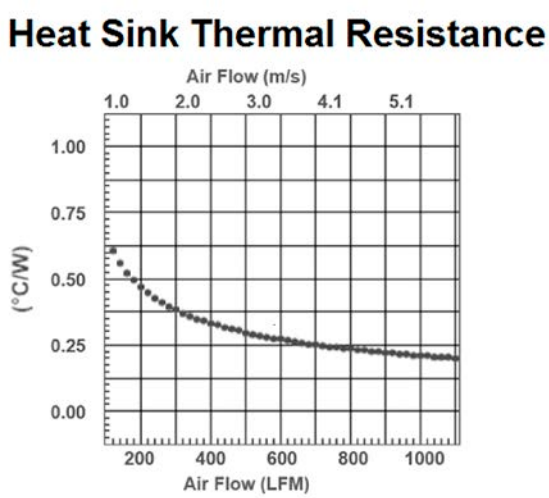



Figure 3-10. Thermal Resistance – OEM Heat Sink Module

### 3.3.1.3 Dimensions for the Fan-Cooled Heat Sink

Figure 3-11 shows the dimensions for a fan-cooled heat sink, including the stage platform extension, from the top view of the CellX unit.

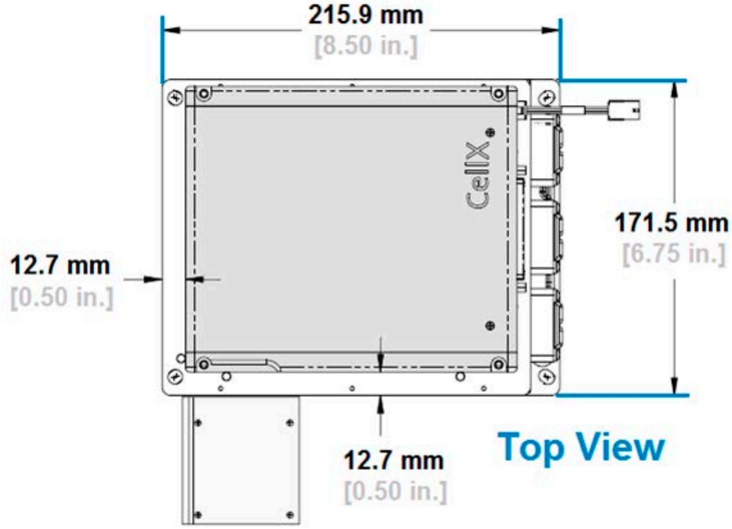



**Figure 3-11. Dimensions – Fan-Cooled Heat Sink, Top View**

Figure 3-12 shows the dimensions for the fan-cooled heat sink, including the stage platform extension, from the back (interface panel) view of the CellX unit.

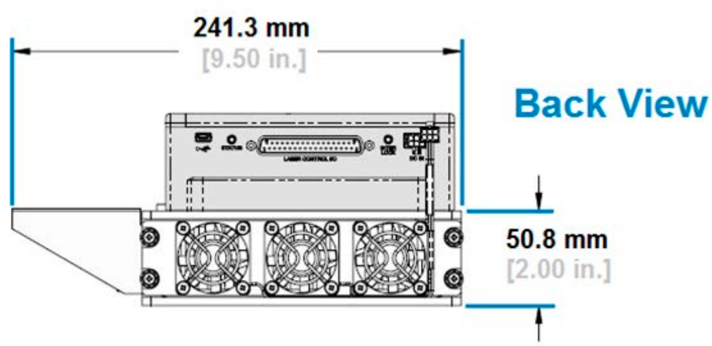



**Figure 3-12. Dimensions – Fan-Cooled Heat Sink, Back View**

Figure 3-13 shows the dimensions for the fan-cooled heat sink, including the translation stage platform, from the side (aperture out) view of the CellX unit.

This heat sink puts the optical axis of the CellX unit nominally at an even 3.0 in off the optical deck or table.

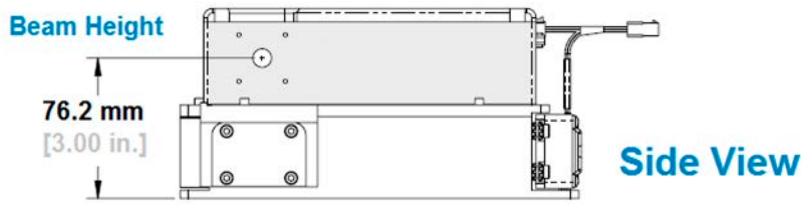



**Figure 3-13. Dimensions – Fan-Cooled Heat Sink, Side View**

### 3.3.1.4 Dimensions for the OEM Heat Sink Module

Figure 3-14 provides the dimensions for the OEM Heat Sink module, shown from the side (aperture out) view of the CellX.

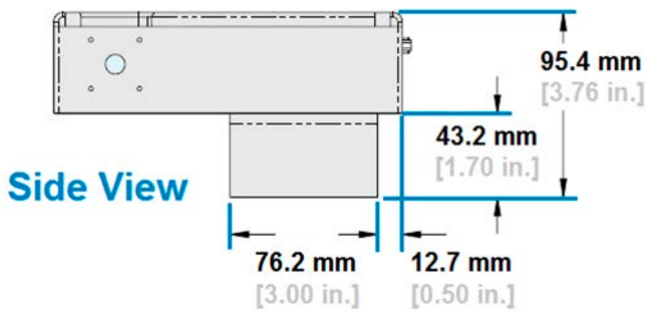



**Figure 3-14. Dimensions – OEM Heat Sink, Side View**

Figure 3-15 provides the dimensions for the OEM Heat Sink module, shown from the front and back of the CellX unit.

Beam height for the OEM heat sink module is a standard 1”. This assumes that the optical deck has sufficient clearance for the heat sink. if not, create support for the heat sink and mount the CellX laser system at a height above the optical deck sufficiently high or higher than the height of the OEM heat sink module (that is, greater than 1.7”).

Figure 3-16 provides the dimensions for the OEM heat sink module, shown from the bottom view of the CellX unit.

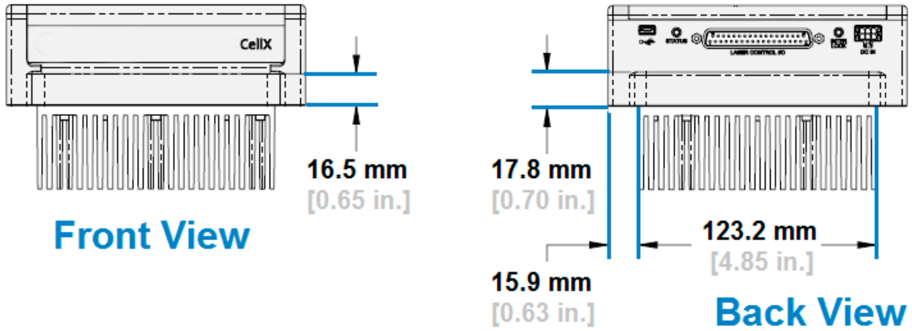



Figure 3-15. Dimensions – OEM Heat Sink, Front/Back Views

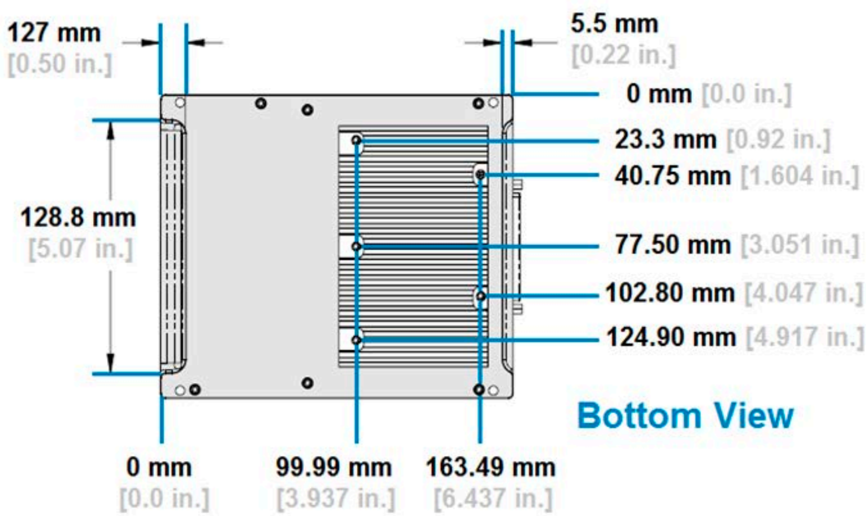



Figure 3-16. Dimensions – OEM Heat Sink, Bottom View

### 3.3.2 Options for Control Accessories

The control accessories shown in Figure 3-17 are also available. The interlock plug is included in the Accessories Kit. Refer to 'Standard CellX Accessory Kit' (p. 248).

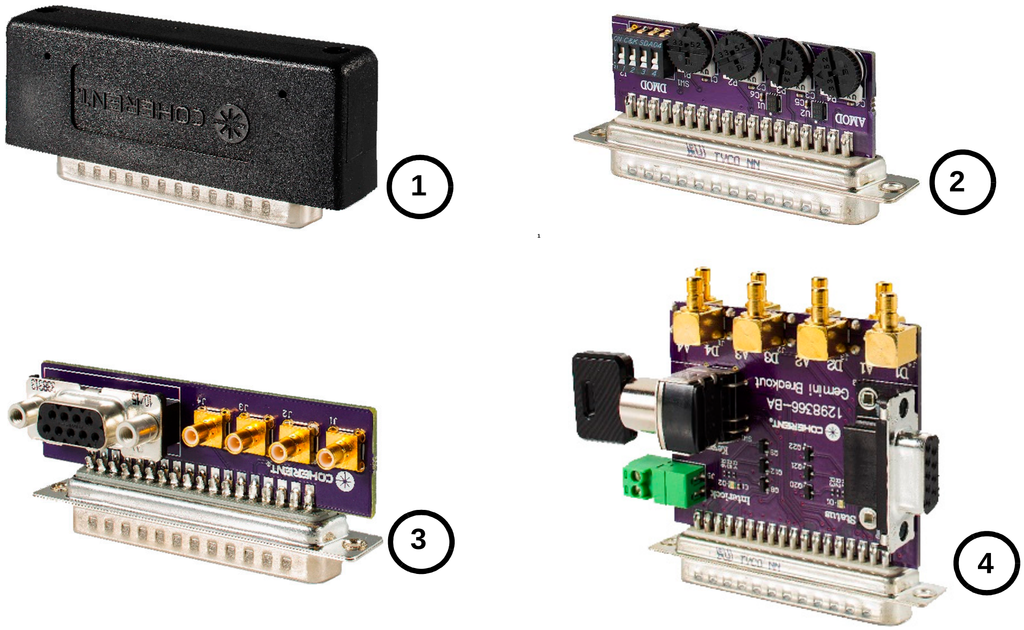



**Figure 3-17. CellX Control Boards**

Table 3-6 briefly describes each of the control boards. These can be ordered separately. Note that the DB37 interlock plug is available as part of the Accessories Kit, which is included in the Developer's Kit.

**Table 3-6. CellX Control Accessories**

| Key | P/N | Part | Description |
|---|---|---|---|
| 1 | 1313160 | Accessory, Interlock Plug, DB37 | Activates interlocks and a key switch. The DB37 pins are included in all other interlock accessories below. |
| 2 | 1299911 | Accessory, Control Board, Adjustable Power | Manual adjustments to lines up the flow.<br>• 4 DIP switches to set channels ON/OFF with digital modulation.<br>• 4 thumb wheels to increase/decrease power with analog modulation. |
| 3 | 1323597 | Accessory, Control Board, 4 Analog Modulation Inputs | All channels are SMB input.<br>• External digital modulation set to Low.<br>• External analog modulation set to High.<br>Also includes an RS-232 serial port. Use for debugging and other purposes. |
| 4 | 1298365 | Accessory, Control Board, Key-Switch, RS-232, Digital/Analog SMB | All-in-one SMB (SubMiniature version B) connector; includes an interlock plug; physical key switch; an RS-232 port; plus 4 analog and 4 digital inputs. |

Any control boards equipped with a DB-9F RS-232 connector require the use of a standard PC serial cable. This cable is not included with any of the CellX laser systems. In addition, OEMs are expected to provide their own interface cables to drive modulation inputs as needed.

More information about each these control accessories is provided in the sections that follow.

See 'Operation' (p. 117) for information about how these accessories are used to control operating modes (analog, digital, or mixed modulation) in the CellX unit.

### 3.3.2.1 DB37 Interlock Plug

The CellX interlock plug, shown in Figure 3-18, is included in the Accessory Kit. Refer to 'Standard CellX Accessory Kit' (p. 248). It connects the keyswitch and interlock pins.

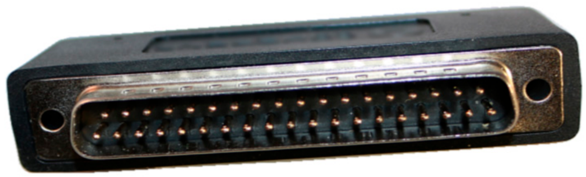


Figure 3-18. Interlock Plug (P/N 1313160)

**NOTICE**

**A DB37 connector is part of each of the control boards available for the CellX laser system.**

Figure 3-19 shows the pins that are connected together to create a short in the interlock plug. Pins 1, 10, and 19 are connected together and shorted to ensure the interlock is closed. Pin 37 indicates the last pin on the interlock.

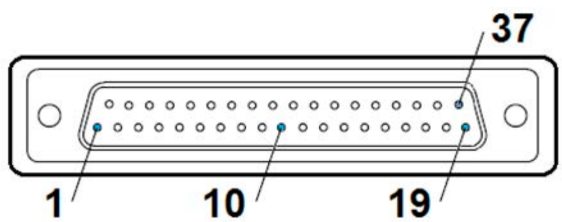



Figure 3-19. Pins on the Interlock Plug

Table 3-8 describes these pins.

Table 3-7. Description of Pins on the Interlock Plug

| Pin | Name | Description |
|---|---|---|
| 1 | KEYSW_CS | A 20 mA key switch current sink. |
| 10 | INTLK_P12V | Power input for the key switch and interlock. |
| 19 | INTLK_CS | A 20 mA interlock current sink. |
| 37 | GND | System Ground. Position for reference only. |

### 3.3.2.1.1 Pin Assignments–Interlock Plug and DB37 Connector

Table 3-8 shows the pin assignments for the DB37 connector. This connector is used on all control boards as well.

**Table 3-8. Pins Assignments for the DB37 Connector**

| Pin | Name | Description |
|---|---|---|
| 1 | KEYSW_CS | A 20 mA key switch current sink. Input. |
| 2 | GND | System Ground. |
| 3 | AMOD1 | Channel 1 analog modulation input. 2 KΩ pull-down. |
| 4 | DMOD2 | Channel 2 digital modulation input. 2 KΩ pull-down. |
| 5 | GND | System Ground. |
| 6 | AMOD3 | Channel 3 analog modulation input. 2 KΩ pull-down. |
| 7 | DMOD4 | Channel 4 digital modulation input. 2 KΩ pull-down. |
| 8 | GND | System Ground. |
| 9 | ExtAmod | Active high to enable external analog modulation inputs. 2 KΩ pull down. |
| 10 | INTLK_P12V | Power output for the key switch and interlock. |
| 11 | Shutdown | Active high to turn system off, 3-12V. 100 KΩ pull-down. |
| 12 | Unused | Not connected. |
| 13 | RX232 | RS-232 input to CellX from host. |
| 14 | GND | System Ground. |
| 15 | GreenOut | Green interlock LED state. 1 KΩ output impedance, active high. |
| 16 | Remote5V | +5 V @ 200mA to power remote LED/interface board. |
| 17 | ReadyOut | Blue status LED state. 1 KΩ output impedance, active high. |
| 18 | GND | System Ground. |
| 19 | INTLK_CS | A 20 mA interlock current sink. Input. |
| 20 | GND | System Ground. |
| 21 | DMOD1 | Channel 1 digital modulation input. 2 KΩ pull-down. |
| 22 | GND | System Ground. |
| 23 | AMOD2 | Channel 2 analog modulation input. 2 KΩ pull-down. |
| 24 | DMOD3 | Channel 3 digital modulation input. 2 KΩ pull-down. |
| 25 | GND | System Ground. |
| 26 | AMOD4 | Channel 4 analog modulation input. 2 KΩ pull-down. |

**Table 3-8. Pins Assignments for the DB37 Connector (Continued)**

| Pin | Name | Description (Continued) |
|---|---|---|
| 27 | ExtDMOD | Active high to enable external digital modulation inputs. 2 KΩ pull down. |
| 28 | GND | System Ground. |
| 29 | GND | System Ground. |
| 30 | Unused | Not connected. |
| 31 | GND | System Ground. |
| 32 | TX232 | RS-232 output from CellX to host. |
| 33 | BlueOut | Blue interlock LED state. 1 KΩ output impedance, active high. |
| 34 | RedOut | Red interlock LED state. 1 KΩ output impedance, active high. |
| 35 | StandbyOut | Green status LED state. 1 KΩ output impedance, active high |
| 36 | FaultOut | Red status LED state. 1 KΩ output impedance, active high. |
| 37 | GND | System Ground. |

#### 3.3.2.1.2 Schematic–Interlock Plug

Figure 3-20 shows the DB37M connector schematic for the interlock plug.

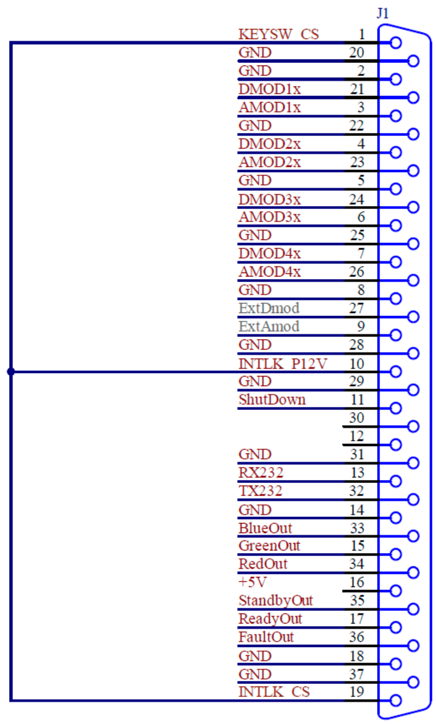



**Figure 3-20. Pin-out Schematic – DB37M Connector for Interlock Plug**

### 3.3.2.2 Control Board: Adjustable Power with Thumb Wheels

The control board with thumb wheels (P/N 1299911) lets users quickly and easily adjust power to the individual laser in the CellX unit. This is done with thumb wheels conveniently placed on the outside edge of the control board, shown in Figure 3-21:

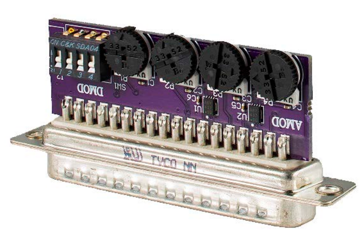



**Figure 3-21. Control Board with Thumb Wheels (P/N 1299911)**

#### 3.3.2.2.1 Pin Assignments–Control Board with Thumb Wheels

See Table 3-8 for a complete list of pin assignments for the DB37 connector.

### 3.3.2.2.2 Schematic–Control Board with Thumb Wheels

Figure 3-22 shows the schematic for modulation on this control board, the schematic digital modulation switching, as well as the schematic for the DB37M connector on this control board.

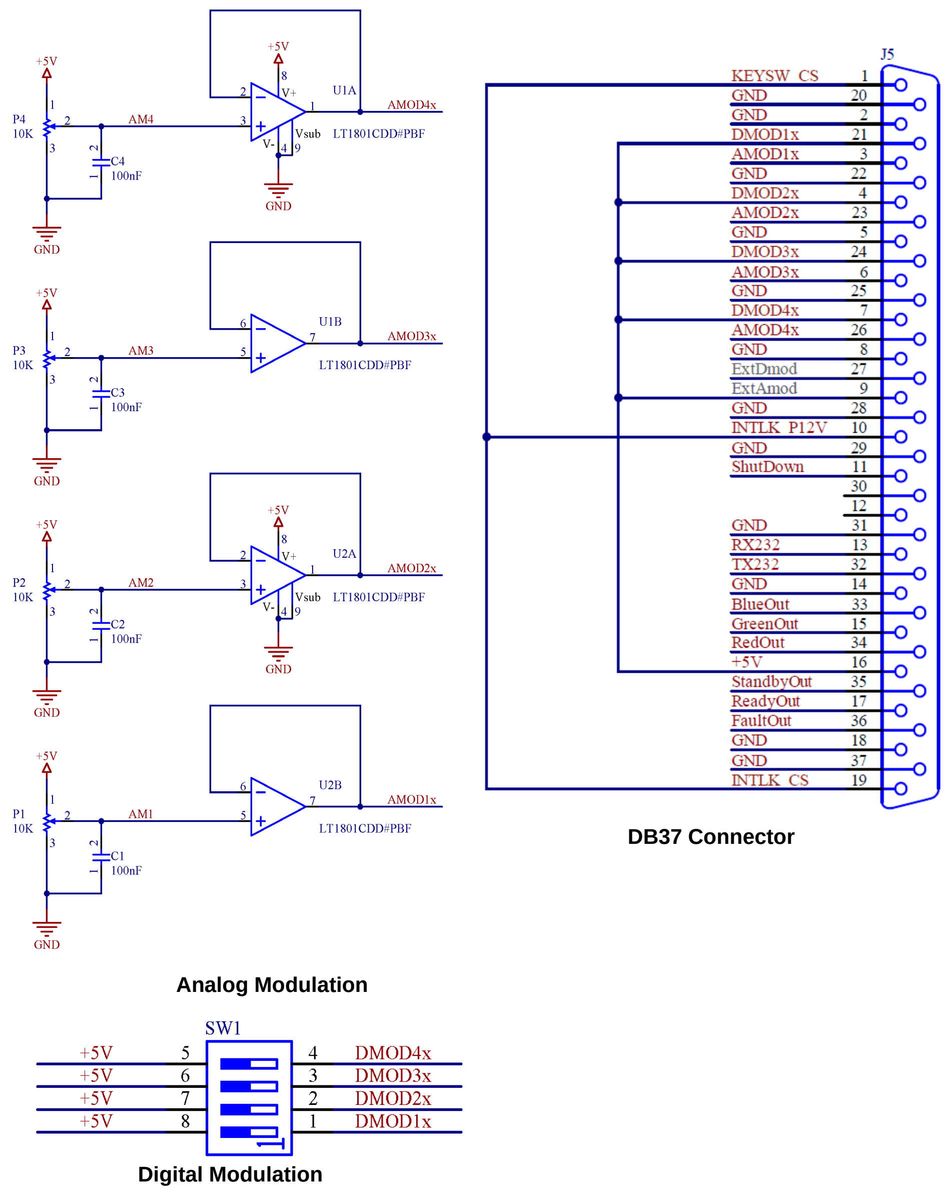



**Figure 3-22. Schematic – Control Board with Thumb Wheels**

### 3.3.2.3 Control Board, 4 Analog Modulation Inputs

This Control Board (P/N 1323597) provides four (4) analog modulation inputs to control lasers in the CellX laser system. This control board also provides an RS-232 connector, shown in Figure 3-23:

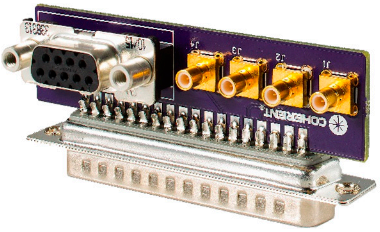


Figure 3-23. Control Board (P/N 1323597) – Analog Modulation Inputs

#### 3.3.2.3.1 Schematics – Control Board with Analog Modulation

Figure 3-24 shows the schematic for analog modulation, as well as the DB37M connector, with pin-outs, on this control board.

Figure 3-30 shows the schematic for the for the DB-9F serial port connector.

See Table 3-8 for a complete list of pin assignment descriptions for the DB37 connector.

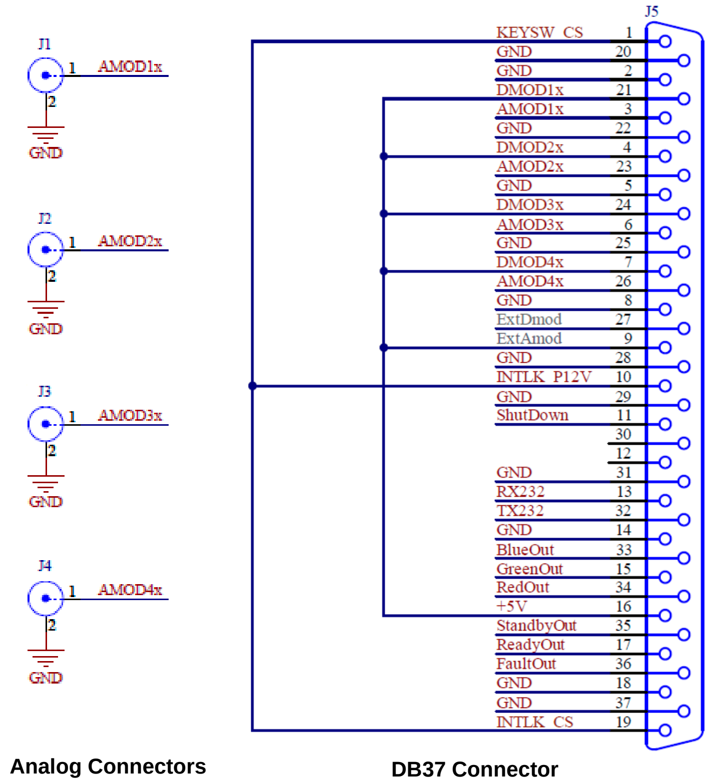



**Figure 3-24. Schematic – Analog Modulation Inputs**

### 3.3.2.4 Control Board, Key-Switch, RS-232, Digital & Analog SMB

This Control Board (P/N 1298365) provides a key switch, RS-232 connector, an interlock, and connectors for both analog and digital modulation, shown in Figure 3-25.

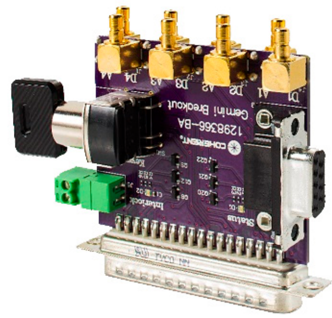


Figure 3-25. Control Board (P/N 1298365) – Analog & Digital Modulation

This control board drives the CellX unit with signal generators and SMB cables. This board is sometimes referred to as a 'Breakout Board'.

Control boards equipped with a DB-9F (RS-232) connector require the use of a standard PC serial cable. This cable is not included with any of the CellX laser systems. In addition, OEMs are expected to provide their own interface cables to supply modulation inputs, as needed.

### 3.3.2.4.1 Schematics–Digital/Analog Breakout Board

Figure 3-26 shows the schematic for the key switch, interlock plug, and DB37M output, with pin-outs, on this control board.

See Table 3-8 for a complete list of pin assignments for the DB37 connector.

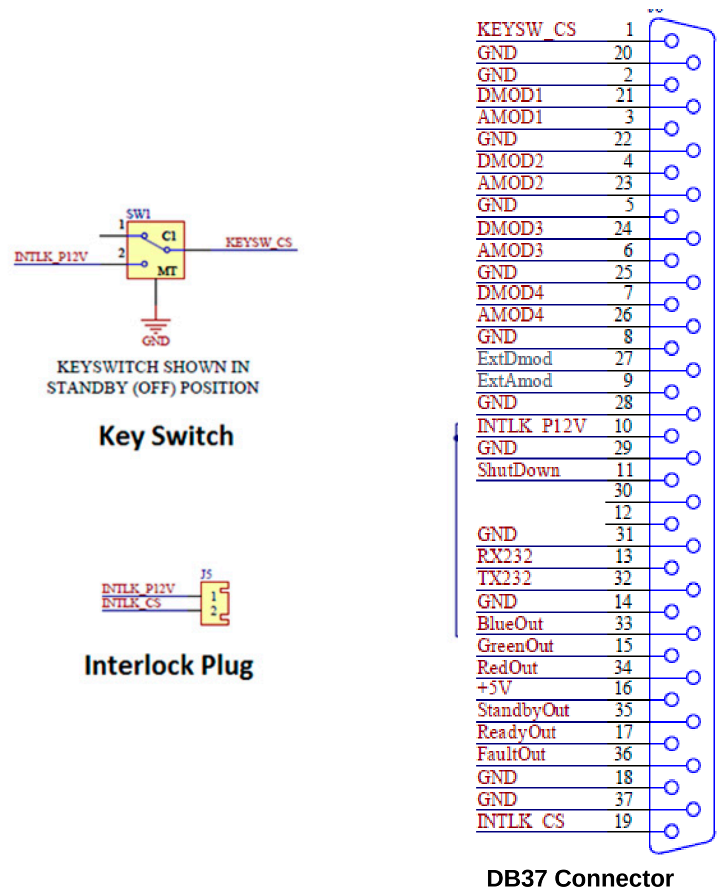



**Figure 3-26. Schematic – Control Board Key Switch, Interlock Plug, DB37M**

Figure 3-27 shows the schematic for digital and analog modulation on this control board.

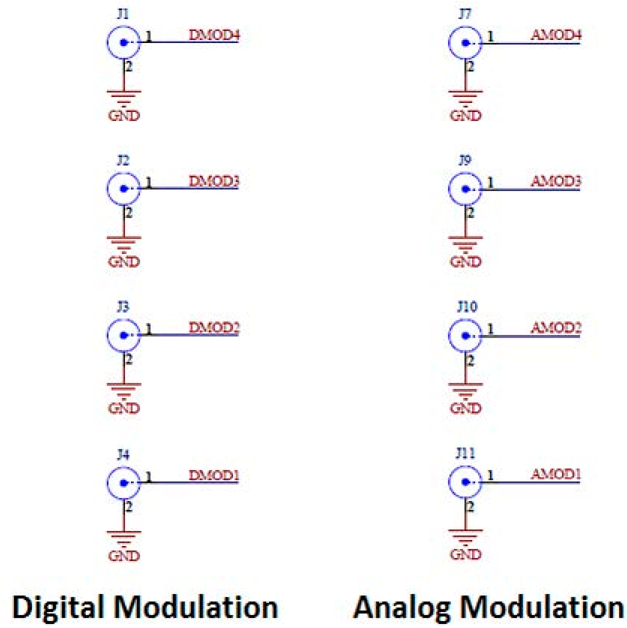



**Figure 3-27. Schematic – Control Board Digital & Analog Modulation**

Note that Coherent Connection now allows discrete analog and digital modulation, as well as mixed modulation, with this board.

Refer to Figure 3-30 for the schematic for the DB-9F serial port connector.

Figure 3-28 shows the schematic for the LEDs for laser status and the interlock status on this control board.

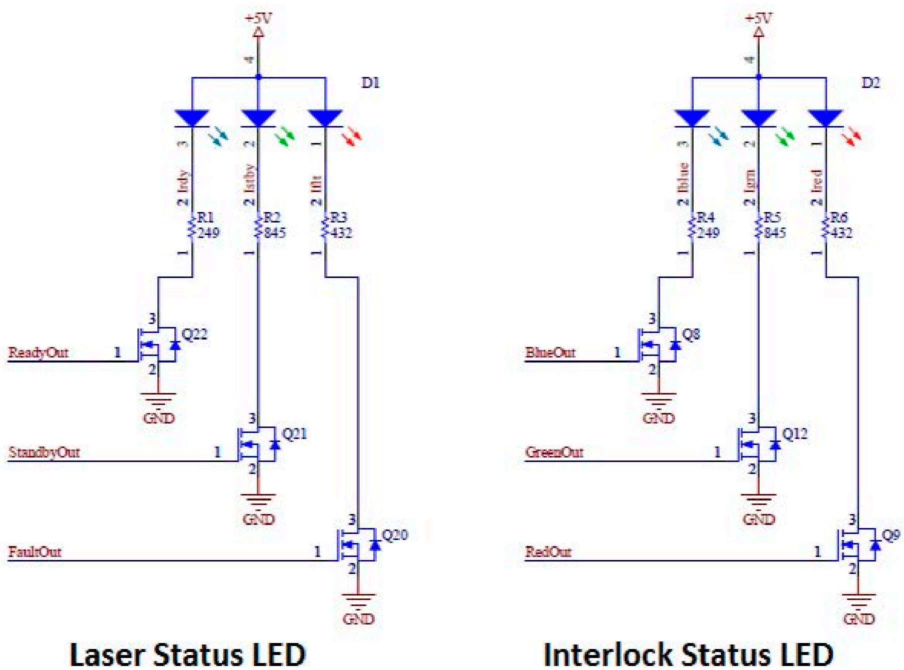



**Figure 3-28. Schematic – Control Board LEDs**

### 3.3.2.5 Schematics – RS-232 Connector on Control Boards

Any control board equipped with a DB-9F Serial Port (RS-232 connector, shown in Figure 3-29) requires the use of a standard PC serial cable (not included with any of the CellX components). In addition, OEMs are expected to provide their own interface cables to supply modulation inputs, as needed.

**Figure 3-29. DB-9F (RS-232) Connector**

Table 3-9 shows the pin-outs for the DB-9 serial port for RS-232 communications on the control board.

**Table 3-9. Pin Assignments – DB-9F (RS-232) Connector**

| Pin | Name | Description |
|---|---|---|
| 1 | DCD | Data Carrier Detect |
| 2 | TX232 | Transmit to the CellX unit |
| 3 | RX232 | Receive from the CellX unit |
| 4 | DTR232 | Data Terminal Ready |
| 5 | GND | Ground |
| 6 | DSR | Data Set Ready |
| 7 | RTS232 | Request to Send |
| 8 | CTS | Clear to Send |
| 9 | Reserved | Not used |

Table 3-10 shows the communication settings for the RS-232 port:

**Table 3-10. RS-232 Communication Settings**

| Setting | Value |
|---|---|
| Baud Rate | 115200 |
| Parity | None |
| Data Bits | 8 |
| Stop Bits | 1 |
| Flow Control | None |

Figure 3-30 shows the schematic for the DB-9F serial port connector.

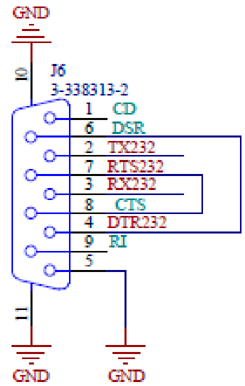



**Figure 3-30. Schematic – DB-9F (RS-232) Serial Port Connector**

### 3.3.3 Options for Objective Lenses

An external objective lens assembly can reshape and focus the collimated, circular output beam from a CellX laser system into a focused, elliptical stripe with a Gaussian profile needed for a typical flow cytometry application. This applies only to CellX for flow with variable beams, not for configurations for microscopy.

Objective lens assemblies generate a Gaussian beam profile in both the vertical and horizontal axes. Within a certain range, the major axis/aspect ratio can be increased through system adjustments.

The CellX system offers a choice of objective lenses and mounting assemblies, described in Table 3-11.

**Table 3-11. CellX Objective Lens Accessories**

| P/N | Part |
|---|---|
| 1365935 | Accessory, Objective Lens, OL10-UV, 10 μm Focus |
| 1383130 | Accessory, Objective Lens, OL15-UV 15 μm Focus |
| 1321963 | Accessory, Mount, Front Aperture Objective Holder |
| 1321964 | Accessory, Low-Profile Translation Stage to Mount Objective Lens |

Also note that the Fan-Cooled Heat Sink (P/N 1323285) is shipped with a stage platform extension and hardware required to mount an objective lens.

Objective lens assemblies and CellX modules are not shipped as matched pairs and can be swapped freely.

The CellX laser system and objective lens assemblies are tested using calibrated reference units during assembly to verify performance.

For users who develop their own objectives rather than using an objective lens assembly from Coherent, see the CellX datasheet. It gives specifications about the beam diameter.

### 3.3.3.1 Objective Lens Direct Mount

Figure 3-31 shows the objective lenses, plus the front aperture objective holder used to mount a lens directly to the output beam aperture on the CellX unit:

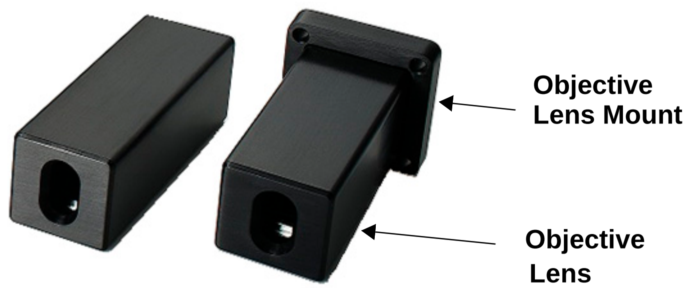



**Figure 3-31. CellX Objective Lenses**

Figure 3-32 shows an objective lens that is mounted directly to the laser aperture using the front aperture objective holder. See p. 57 for dimensions of this combination mounted to the CellX laser system


**Figure 3-32. Objective Lens Attached to CellX**

Figure 3-33 shows the dimensions for both the 10 µm and 15 µm objective lenses when mounted on the CellX unit:

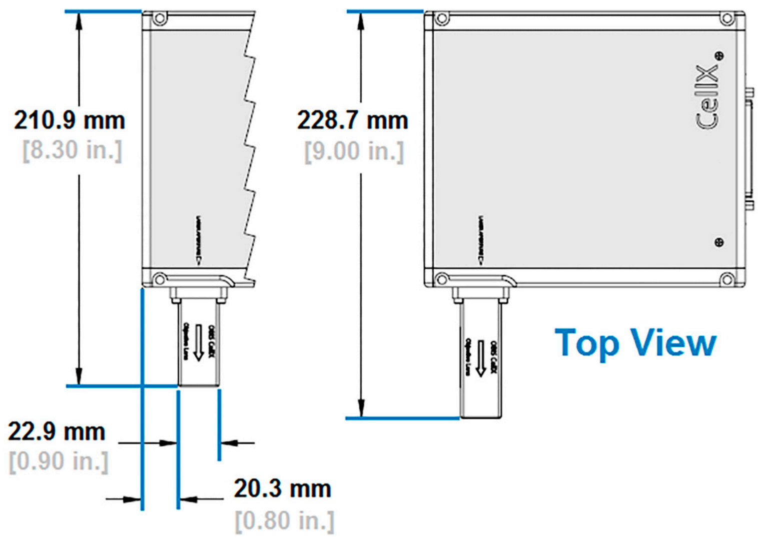



**Figure 3-33. Dimensions – Objective Lenses (10 μm and 15 μm)**

### 3.3.3.2 Objective Lens Mounted on Translation Stage

A translation stage accessory allows developers to adjust the working distance between the end of the lens assembly and the object (such as the flow cell on a flow cytometer).

The Translation Stage Accessory (P/N 1321964) provided in the CellX Developer's Kit is a low-profile model, ideal for work in limited spaces or optical experiments that require low optical axis. The micrometer is mounted on the right side and includes an opposed locking clamp to maximize holding power.

This package for the accessory includes the following parts and hardware. Refer to Figure 3-34.

- Low-profile x-axis steel stage (60 x 60 mm, ±6.5 mm travel, with micrometer with locking clamp on the right side)
- Stage mount bracket (P/N 1313256)
- Socket-head screw, hex socket drive, 2-56 x 0.1875-in. L, stainless steel
- Socket-head screw, hex socket drive, M4 x 10mm L, stainless steel 316

- Low-profile socket-head screw, hex socket drive, M4x6 hex


**Figure 3-34. Translation Stage Accessory Parts**

Figure 3-35 shows an example of a 15 μm objective lens that is already assembled on the translation stage. For instructions about how to assemble these components, see 'Install CellX System Hardware' (p. 77).

**Figure 3-35. Objective Lens Assembled on Translation Stage**

Figure 3-36 shows the dimensions (units in mm) for the translation stage:

Figure 3-37 shows an example of how to set the translation stage in position, in relationship to the CellX unit. Note the dimensions for the maximum distance as well as the working distance. For more information about the working distance when making adjustments, see 'Maintenance' (p. 183).

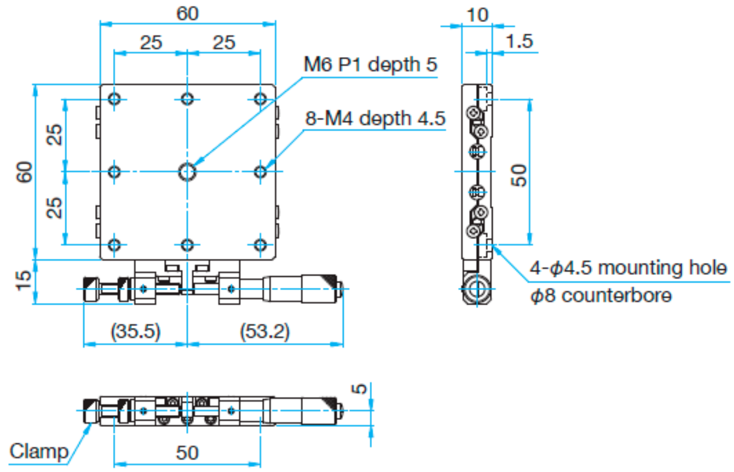



**Figure 3-36. Dimensions – Translation Stage**

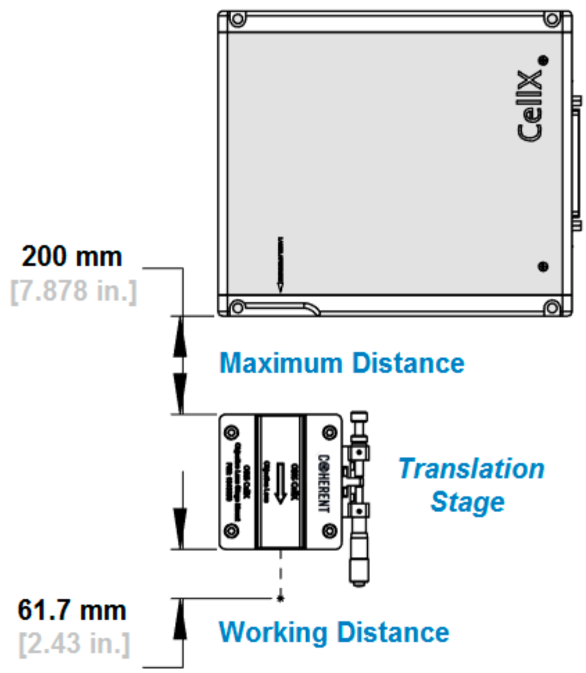



**Figure 3-37. Maximum Distance for Translation Stage Position**

### 3.3.3.3 Translation Stage Assembly Mounted on Stage Platform Extension

There are multiple options for heat sinks to use with the CellX laser system, described in 'Heat Sink Options' (p. 32). See Figure 3-11 to view dimensions for the fan-cooled heat sink with the translation stage platform.

Figure 3-38 shows an example of an objective lens assembly on the translation stage mount on the fan-cooled heat sink. This uses the low-profile translation stage to assist in mounting the objective lens.


**Figure 3-38. Objective Lens Assembly – Heat Sink Translation Stage Platform**

### 3.3.4 CellX Options for External Fiber for Microscopy

For a CellX configuration to support microscopy, a specific fiber-ready CellX laser system is used. A fiber is mounted and aligned with an external micromanipulator, designed to use an external fiber accessory for a 0.7 mm beam input. It supports beam steering to optimize the coupling. The aligner can be used to adjust the fiber assembly and to fine-tune the alignment of the laser to the optimal position for maximum output power transmission for fiber launch. Highly sensitive adjustments allow for very discrete laser alignment.

Figure 3-39 shows a CellX configuration with collimated fiber.


**Figure 3-39. Example External Fiber Configuration (Collimated Configuration)**

Figure 3-40 shows the CellX without fiber installed and with the alignment tool removed


**Figure 3-40. CellX with Fiber Launcher and Alignment Tool**

There are two fiber configurations, one with an FC/APC fiber output and one with a collimated output.

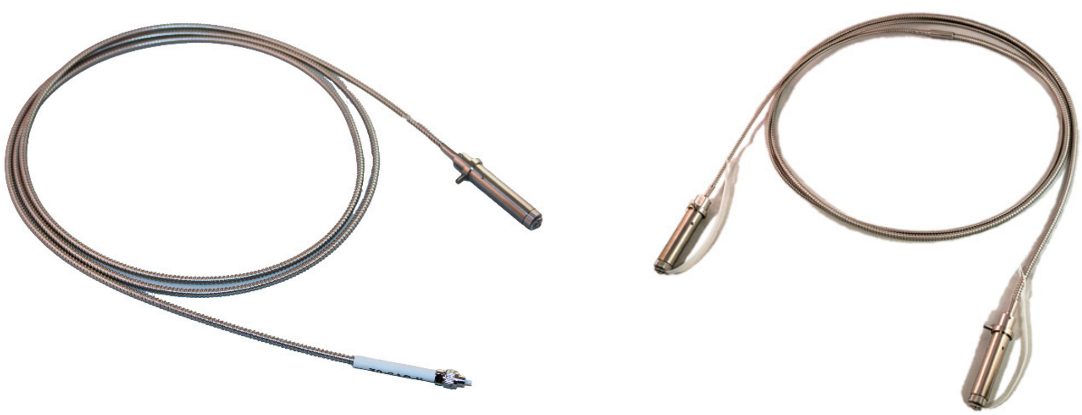


**Figure 3-41. Fiber Assembly – FC/APC (left), Collimated (right)**

Table 3-12 shows the configuration options for CellX for use with external fiber and accessory parts that are available to order separately. For detailed specifications, refer to the CellX datasheet available at:

https://coherent.com/resources

**Table 3-12. CellX Freespace Laser Accessories for Microscopy**

| P/N | Description |
|---|---|
| 2313364 | Fiber Launcher with alignment sleeve/tool and mounting hardware (purchased separately) |
| 2313508 | Fiber Assembly, FC/APC termination, 2m long |
| 2323509 | Fiber Assembly, Collimated termination, 2m long |
| 2324764 | Fan-cooled Heat Sink for microscopy (no stage platform extension). |
| 1211389 | Power Supply, 110/220V AC, 12V DC, IEC-320 |
| 1321203 | Accessory Kit for CellX (Alignment Tools, Interlock Plug, USB Cable, Coherent Connection software, Operator’s Manual) |

For instructions to set up the CellX with external fiber, refer to ’Install and Set Up Fiber for Microscopy’ (p. 101).

### 3.3.5 Developer’s Kit for Flow Cytometry

The **CellX Laser System Developer’s Kit** (P/N 1323532) is intended for initial development or research. The contents of the kit allow users to set up different configurations for flow cytometry applications. The components are not compatible for use with a CellX for Microscopy configuration.

This kit includes:

- CellX lasers in a 4-channel configuration, including laser wavelengths at 405 nm, 488 nm, 561 nm, and 637 nm
- A variety of accessories, including control board options, objective lenses, and heat sinks
- Mounting hardware and tools

For a complete list, see ’Components in the Developer’s Kit’ (p. 248).

# 3.4 Specifications

This section describes the various specifications for the CellX laser system. For complete and up-to-date specifications, refer to the CellX Datasheet available at:

https://coherent.com/resources

**CAUTION!**

**The CellX laser system is intended to be integrated into a laser product with appropriate end-user safety mechanisms.**

**Because this system is not intended for a stand-alone application, the CellX device does not fully comply with requirements for certified laser products as defined in the US FDA CFR 21, section 1040.10 and 1040.11, or the IEC 60825-1:2014 standard.**

## 3.4.1 Mechanical and Environmental Specifications

Mechanical and environmental specifications are published and available on the CellX product datasheet, located at:

https://coherent.com/resources

### 3.4.1.1 Dimensions

Figure 3-42 shows the dimensions for the top view of the CellX laser system:

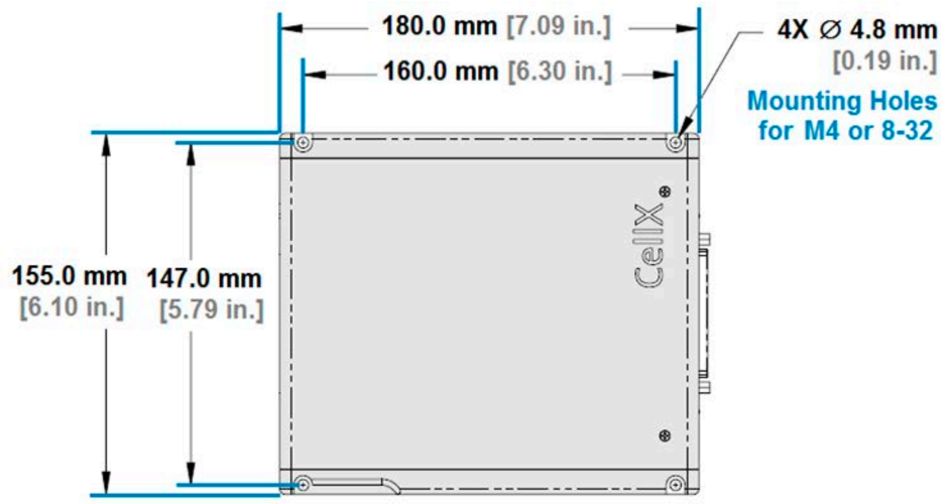



**Figure 3-42. Dimensions – CellX Unit, Top View**

Figure 3-43 shows the dimensions from the side view of the CellX laser system. This view also shows dimensions for the laser exit aperture.

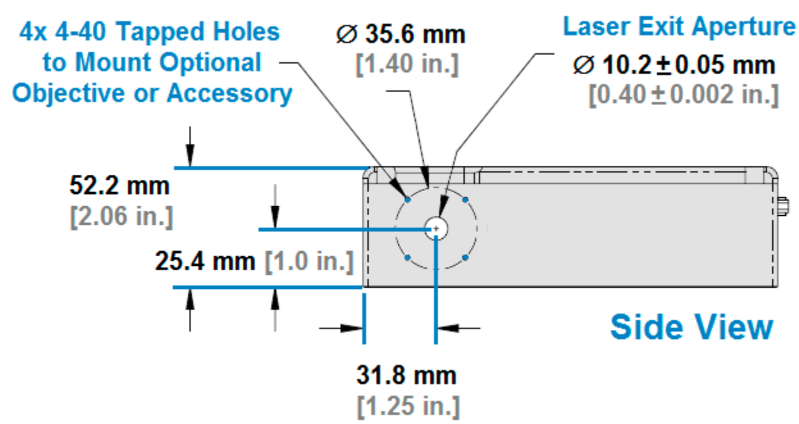



**Figure 3-43. Dimensions – CellX Unit, Side View**

### 3.4.2 Electrical Specifications

The CellX laser system offers individual control of power and modulation for each laser in the system via a single I/O connector.

Table 3-13 shows the electrical specifications for the CellX laser system:

**Table 3-13. CellX Electrical Specifications**

| Specification | Notes |
|---|---|
| Power Input Connector | Use Molex 0430250600 for the Power Cable Connector<br>• Pins 1, 2, 3 for Power<br>• Pins 4, 5, 6 for Ground |
| Supply Voltage (V DC) | 12 ± 2 (100 Watt minimum power supply) |
| Power Consumption (W) | Typical 20, Maximum 60 |
| ESD Protection | EN61326-1 (8 kV Air Discharge, 4 kV Contact Discharge) |

### 3.4.3 Humidity and Temperature

The humidity and ambient temperature around the laser need to be considered to prevent condensation on the diode and optics. Table 3-14 shows temperature and humidity requirements for the CellX laser system.

**Table 3-14. CellX Temperature & Humidity Specifications**

| Specification | Notes |
|---|---|
| Ambient Temperature, Non-Condensing | 10 °C to 45 °C |
| Non-Operating Condition Temperature | –20 °C to +60 °C |
| Baseplate Operating Temperature | 10 °C to 45 °C |
| Heat Dissipation of Laser Head | Typical 20 Watts, Maximum 60 Watts |

Heat Dissipation is typically 85% of the heat load through the baseplate.

Dew points above 25ºC can cause condensation. OBIS lasers in the CellX laser system include an active thermoelectric cooler to maintain the diode set temperature and optics at 25°C.

Table 3-15 shows the dew point numbers based on air temperature and humidity for the CellX laser system.

**Shaded areas** in the table represent conditions for condensation. For example, with the cold block at 25°C and the air temperature 30°C with 80% relative humidity, the condition is condensing. At 70% relative humidity, it is no longer condensing.

**Table 3-15. CellX Safe Operating Humidity Levels**

| Air Temp (°C) | Relative Humidity (%) | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 100 | 95 | 90 | 85 | 80 | 75 | 70 | 65 | 60 | 55 | 50 | 45 | 40 | 35 | 30 | 25 | 20 | 15 | 10 |
| 45 | 45.0 | 44.0 | 43.0 | 41.9 | 40.7 | 39.5 | 38.2 | 36.9 | 35.4 | 33.8 | 32.1 | 30.3 | 28.2 | 25.9 | 23.4 | 20.4 | 16.8 | 12.3 | 6.3 |
| 44 | 44.0 | 43.0 | 42.0 | 40.9 | 39.8 | 38.5 | 37.3 | 35.9 | 34.5 | 32.9 | 31.2 | 29.4 | 27.3 | 25.1 | 22.5 | 19.5 | 16.0 | 11.6 | 5.6 |
| 43 | 43.0 | 42.0 | 41.0 | 39.9 | 38.8 | 37.6 | 36.3 | 35.0 | 33.5 | 32.0 | 30.3 | 28.5 | 26.5 | 24.2 | 21.6 | 18.7 | 15.2 | 10.8 | 4.8 |
| 42 | 42.0 | 41.0 | 40.0 | 38.9 | 37.8 | 36.6 | 35.4 | 34.0 | 32.6 | 31.1 | 29.4 | 27.6 | 25.6 | 23.3 | 20.8 | 17.9 | 14.4 | 10.0 | 4.1 |
| 41 | 41.0 | 40.0 | 39.0 | 38.0 | 36.8 | 35.7 | 34.4 | 33.1 | 31.7 | 30.1 | 28.5 | 26.7 | 24.7 | 22.5 | 19.9 | 17.0 | 13.5 | 9.2 | 3.3 |
| 40 | 40.0 | 39.0 | 38.0 | 37.0 | 35.9 | 34.7 | 33.5 | 32.1 | 30.7 | 29.2 | 27.6 | 25.8 | 23.8 | 21.6 | 19.1 | 16.2 | 12.7 | 8.4 | 2.6 |
| 39 | 39.0 | 38.0 | 37.0 | 36.0 | 34.9 | 33.7 | 32.5 | 31.2 | 29.8 | 28.3 | 26.6 | 24.9 | 22.9 | 20.7 | 18.2 | 15.4 | 11.9 | 7.6 | 1.8 |
| 38 | 38.0 | 37.1 | 36.1 | 35.0 | 33.9 | 32.8 | 31.6 | 30.2 | 28.9 | 27.4 | 25.7 | 24.0 | 22.0 | 19.8 | 17.4 | 14.5 | 11.1 | 6.8 | 1.1 |
| 37 | 37.0 | 36.1 | 35.1 | 34.0 | 33.0 | 31.8 | 30.6 | 29.3 | 27.9 | 26.4 | 24.8 | 23.1 | 21.1 | 19.0 | 16.5 | 13.7 | 10.3 | 6.1 | 0.3 |
| 36 | 36.0 | 35.1 | 34.1 | 33.1 | 32.0 | 30.8 | 29.6 | 28.4 | 27.0 | 25.5 | 23.9 | 22.2 | 20.2 | 18.1 | 15.7 | 12.8 | 9.5 | 5.3 | -0.4 |
| 35 | 35.0 | 34.1 | 33.1 | 32.1 | 31.0 | 29.9 | 28.7 | 27.4 | 26.1 | 24.6 | 23.0 | 21.3 | 19.4 | 17.2 | 14.8 | 12.0 | 8.7 | 4.5 | -1.2 |
| 34 | 34.0 | 33.1 | 32.1 | 31.1 | 30.0 | 28.9 | 27.7 | 26.5 | 25.1 | 23.7 | 22.1 | 20.4 | 18.5 | 16.3 | 13.9 | 11.2 | 7.8 | 3.7 | -1.9 |
| 33 | 33.0 | 32.1 | 31.1 | 30.1 | 29.1 | 28.0 | 26.8 | 25.5 | 24.2 | 22.7 | 21.2 | 19.5 | 17.6 | 15.5 | 13.1 | 10.3 | 7.0 | 2.9 | -2.7 |
| 32 | 32.0 | 31.1 | 30.1 | 29.2 | 28.1 | 27.0 | 25.8 | 24.6 | 23.2 | 21.8 | 20.3 | 18.6 | 16.7 | 14.6 | 12.2 | 9.5 | 6.2 | 2.1 | -3.4 |
| 31 | 31.0 | 30.1 | 29.2 | 28.2 | 27.1 | 26.0 | 24.9 | 23.6 | 22.3 | 20.9 | 19.3 | 17.7 | 15.8 | 13.7 | 11.4 | 8.6 | 5.4 | 1.3 | -4.2 |
| 30 | 30.0 | 29.1 | 28.2 | 27.2 | 26.2 | 25.1 | 23.9 | 22.7 | 21.4 | 20.0 | 18.4 | 16.8 | 14.9 | 12.8 | 10.5 | 7.8 | 4.6 | 0.5 | -4.9 |
| 29 | 29.0 | 28.1 | 27.2 | 26.2 | 25.2 | 24.1 | 23.0 | 21.7 | 20.4 | 19.0 | 17.5 | 15.8 | 14.0 | 12.0 | 9.7 | 7.0 | 3.8 | -0.3 | -5.7 |
| 28 | 28.0 | 27.1 | 26.2 | 25.2 | 24.2 | 23.1 | 22.0 | 20.8 | 19.5 | 18.1 | 16.6 | 14.9 | 13.1 | 11.1 | 8.8 | 6.1 | 2.9 | -1.1 | -6.5 |
| 27 | 27.0 | 26.1 | 25.2 | 24.3 | 23.2 | 22.2 | 21.0 | 19.8 | 18.6 | 17.2 | 15.7 | 14.0 | 12.2 | 10.2 | 7.9 | 5.3 | 2.1 | -1.8 | -7.2 |
| 26 | 26.0 | 25.1 | 24.2 | 23.3 | 22.3 | 21.2 | 20.1 | 18.9 | 17.6 | 16.2 | 14.8 | 13.1 | 11.3 | 9.3 | 7.1 | 4.4 | 1.3 | -2.6 | -8.0 |
| 25 | 25.0 | 24.1 | 23.2 | 22.3 | 21.3 | 20.3 | 19.1 | 18.0 | 16.7 | 15.3 | 13.8 | 12.2 | 10.5 | 8.5 | 6.2 | 3.6 | 0.5 | -3.4 | -8.7 |
| 24 | 24.0 | 23.1 | 22.3 | 21.3 | 20.3 | 19.3 | 18.2 | 17.0 | 15.7 | 14.4 | 12.9 | 11.3 | 9.6 | 7.6 | 5.3 | 2.8 | -0.4 | -4.2 | -9.5 |
| 23 | 23.0 | 22.2 | 21.3 | 20.3 | 19.4 | 18.3 | 17.2 | 16.1 | 14.8 | 13.5 | 12.0 | 10.4 | 8.7 | 6.7 | 4.5 | 1.9 | -1.2 | -5.0 | -10.3 |
| 22 | 22.0 | 21.2 | 20.3 | 19.4 | 18.4 | 17.4 | 16.3 | 15.1 | 13.9 | 12.5 | 11.1 | 9.5 | 7.8 | 5.8 | 3.6 | 1.1 | -2.0 | -5.8 | -11.0 |
| 21 | 21.0 | 20.2 | 19.3 | 18.4 | 17.4 | 16.4 | 15.3 | 14.2 | 12.9 | 11.6 | 10.2 | 8.6 | 6.9 | 4.9 | 2.8 | 0.2 | -2.8 | -6.6 | -11.8 |
| 20 | 20.0 | 19.2 | 18.3 | 17.4 | 16.4 | 15.4 | 14.4 | 13.2 | 12.0 | 10.7 | 9.3 | 7.7 | 6.0 | 4.1 | 1.9 | -0.6 | -3.6 | -7.4 | -12.5 |

## 3.4.4 Optical Specifications

This section describes the optical specifications, by wavelength, for the OBIS lasers used in the CellX laser system, and includes:

- Laser output power
- Optical properties
- Optical performance

### 3.4.4.1 Laser Output Power

Output powers are specified at the output of the CellX laser system. Please note:

- A multi-wavelength system built from individual 100 mW lasers delivers less than 100 mW to the flow cell because of optical losses, especially during dichroic beam combining;
- In a CellX rated at this same power level, the full 100 mW will be delivered. This is because higher power lasers are used insided CellX in order to compensate for these optical losses.
- A CellX laser system rated at 100 mW delivers more power than a system built from 100 mW lasers.

Table 3-16 shows the output power by wavelength, measured at the CellX output aperture, for various models of CellX.

**Table 3-16. Output Power for Different CellX Laser Models**

| Wavelength | 405 nm | 488 nm | 561 nm | 637 nm |
|---|---|---|---|---|
| P/N 1426532 | - | 50 | - | - |
| P/N 1426531 | - | 50 | - | 50 |
| P/N 1426530 | - | 50 | 50 | - |
| P/N 1426529 | - | 50 | - | - |
| P/N 1318680 | 50 mW | 50 mW | N/A | 50 mW |
| P/N 1318682 | 50 mW | 50 mW | 50 mW | 50 mW |
| P/N 1318681 | 100 mW | 100 mW | N/A | 100 mW |
| P/N 1318683 | 100 mW | 100 mW | 100 mW | 100 mW |

- Output power is measured at the output aperture of CellX.

- Output power is variable in Continuous Wave (CW) Mode from 1% (405 nm and 640 nm) to 110% of rated power.

- Output power is variable in Continuous Wave (CW) Mode from 10% (488 nm and 561 nm) to 110% of rated power. Specifications are valid for 100% power.

- For 488 nm and 561 nm, any residual laser emission at 808 nm fundamental is <0.1 mW.

#### 3.4.4.2 Optical Properties

The CellX laser system is specified at 50 kHz modulation speed and at <0.25% RMS noise for all wavelengths, the same performance specification as for OBIS LS lasers. Unlike the OBIS LX and LS range, though, there is no specification difference between diode and optically pumped solid-state laser (OPSL) wavelengths.

Optical properties specifications for are published and available on the CellX product datasheet, located at:

https://coherent.com/resources

### 3.4.4.3 Optical Performance

The **Focus Spot Size (Horizontal)** is measured at the location of best vertical focus. The laser system is aligned to the lower limit on delivery. The horizontal beam size can be adjusted up to the upper limit. Pre-alignment to a wider horizontal waist is also available.

The **Working Distance** is measured from mechanical surface (output end) of the objective assembly. See Figure 3-42 for dimensions.

**Vertical and horizontal adjustment** assumes the following:

- Measured from nominal beam axis. Adjustment using tilt/yaw adjustment internal to CellX, while meeting all optical specifications.

- Assumes the objective assembly mounted within less than 200 mm (optical path length) from the output face of CellX.

The **focus adjustment** uses a telescope adjustment internal to CellX, while meeting all optical specifications.

Figure 3-44 shows the nominal optical performance for these two objectives.

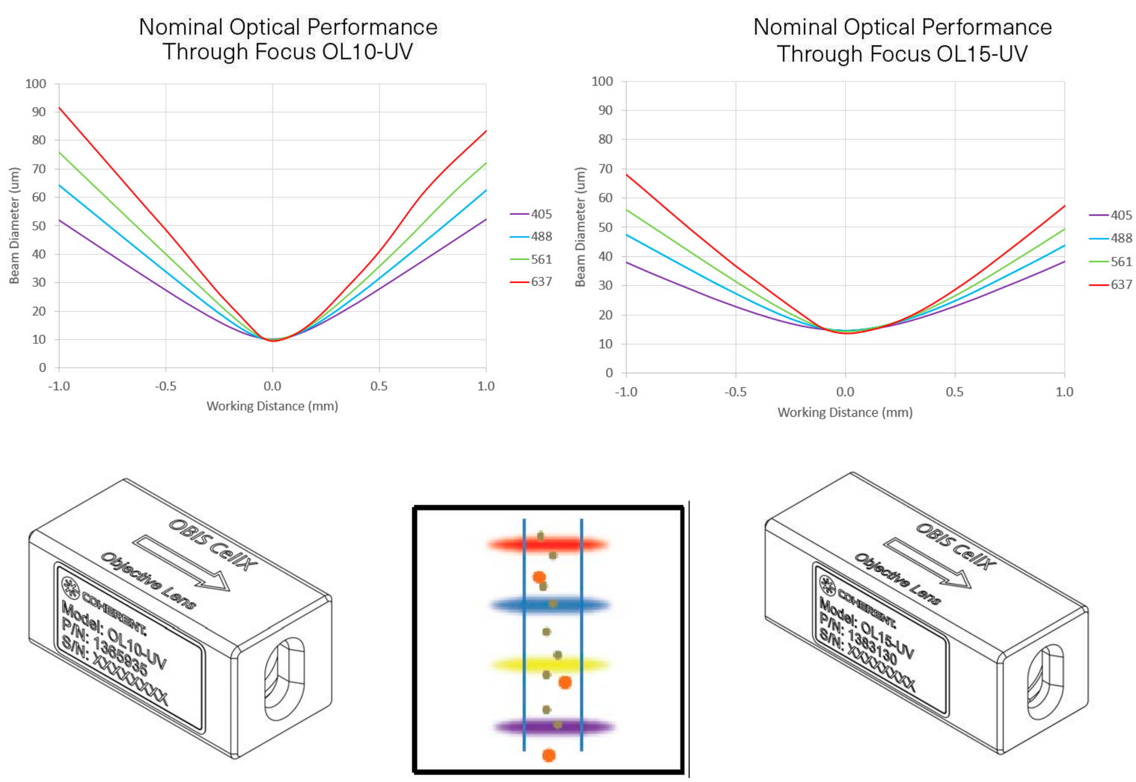



**Figure 3-44. Nominal Optical Performance**

The graphic in the bottom center of Figure 3-44 shows an example of flow cytometry with the use of a four-laser focus with separated positions. These are user-adjustable positions.

Full optical performance specifications are published and available on the CellX product datasheet, located at:

https://coherent.com/resources

### 3.4.5 Control Specifications

This section describes the control specifications for the CellX laser system, and includes:

- Interface for computer control
- Operating modes
- Digital modulation
- Analog modulation

#### 3.4.5.1 Interface for Computer Control

There are two interfaces for computer control of the CellX laser system:

- USB (mini-B)
- RS-232 (from DB37, 115200 Baud)

See 'Coherent Connection Software' (p. 171) for details about these interfaces.

### 3.4.5.2 Operating Modes

There are four operating modes, described in Table 3-17. Each Mode can be individually selected for each wavelength using the USB or RS-232 interface.

**Table 3-17. CellX Operating Modes**

| Mode | Description |
| --- | --- |
| Continuous Wave (CW) | Operation at constant power, at levels set through the USB or RS-232 interfaces. The Coherent Connection interface (v4.0 and higher) operates with the CellX laser system and allows users to:<br>• Adjust power<br>• Set lasers on and off together or individually<br>• Monitors system parameters |
| Analog Modulation | Power on each wavelength channel can be controlled individually from 1% to 110% of nominal using an external analog voltage and at up to 50 kHz bandwidth. |
| Digital Modulation | Power for each wavelength channel can be individually controlled digitally ON/OFF, at up to 50 kHz bandwidth, with the ‘laser on’ power level adjustable through software. |
| Mixed Mode | Simultaneous Analog and Digital Modulation. Power on each wavelength channel can be individually turned on and off, at up to 50 kHz bandwidth, with the ‘laser on’ power level controlled using an external analog voltage. |

Analog and digital inputs, along with interlock and key-switch functions, are via an I/O Interface control board with Key-Switch, Digital & Analog SMB inputs, RS-232 and Interlock (PN 1298365, see Item 4 in Figure 3-17).

For more details, see ’Operation’ (p. 117).

### 3.4.5.3 Digital Modulation

Digital modulation is configured to have a 0-3.3 V active high inputs with 2K input impedance to ground and a 1.6MHz cutoff. The digital modulation source is independently selectable for each channel.

Figure 3-45 shows an example of the rise and fall time as well as measured bandwidth for a 405 nm laser @ 50 kHz digital modulation.

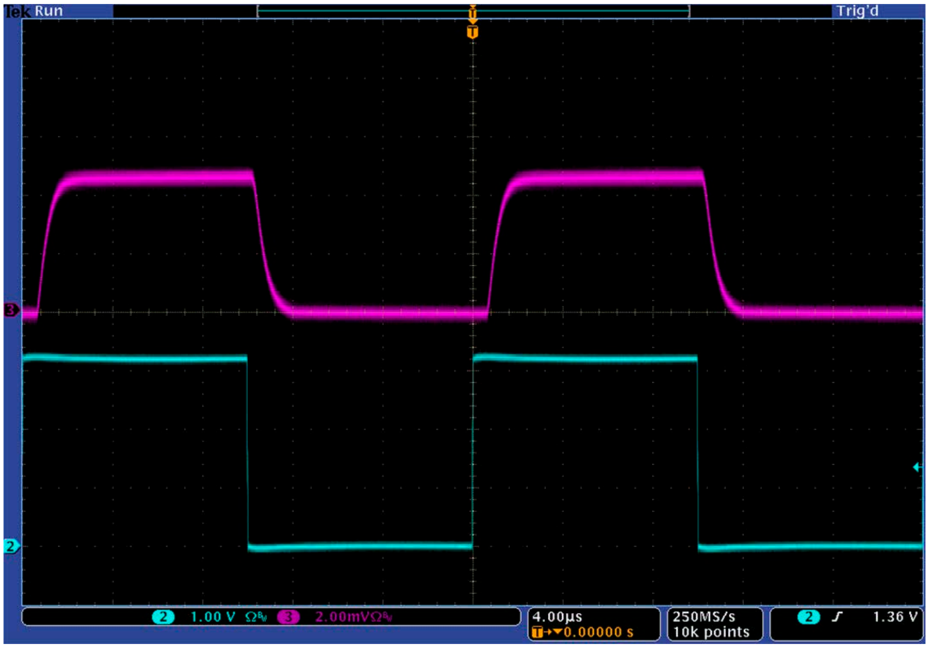



**Figure 3-45. Example of Digital Modulation**

Table 3-18 shows the specifications for digital modulation. Digital input is 5 V tolerant.

**Table 3-18. Specifications for Digital Modulation**

| Specification | Values |
|---|---|
| Connection on DB37 Interface | • 405 nm — Pin 21<br>• 488 nm — Pin 4<br>• 561 nm — Pin 24<br>• 637 nm — Pin 7 |
| Voltage and Impedance | 0-5 V, 2K Ω input impedance each, Normally Low (off) |
| Maximum Bandwidth | 50 kHz |
| Rise Time (10% to 90%) | <5 µsec |
| Fall Time (90% to 10%) | <5 µsec |
| Modulation Depth (extinction ratio) | Infinite |
| Power Range | Modulate from 0% to Set Power (USB or RS-232) in Digital Mode |

### 3.4.5.4 Analog Modulation

Analog modulation is configured to have a 0-5 V active-high inputs with 2K input impedance to ground. Analog modulation is independently selectable for each channel.

Figure 3-46 shows an example of the rise and fall time as well as measured bandwidth for a 405 nm laser @ 50 kHz analog modulation.

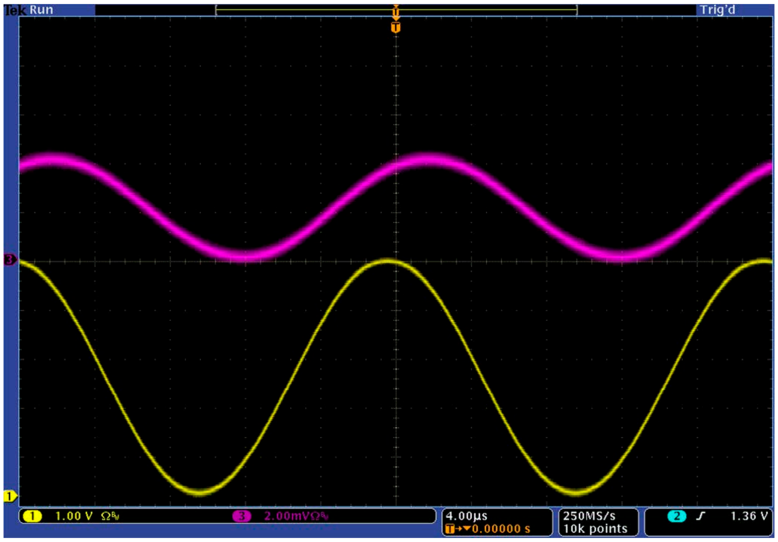



**Figure 3-46. Example of Analog Modulation**

Table 3-19 shows the specifications for analog modulation.

**Table 3-19. Specifications for Analog Modulation**

| Specification | Values |
|---|---|
| Connection on DB37 Interface | • 405 nm — Pin 3<br>• 488 nm — Pin 23<br>• 561 nm — Pin 6<br>• 637 nm — Pin 26 |
| Voltage and Impedance | 0-5V, 2K Ω input impedance each, Normally Low (off) |
| Maximum Bandwidth | 50 kHz |
| Rise Time (10% to 90%) | <5 µsec |
| Fall Time (90% to 10%) | <5 µsec |
| Modulation Depth (extinction ratio) | >50:1 |
| Power Range | Modulate from 0% to Set Power (USB or RS-232) in Digital Mode |

## 3.5 Factory Default Settings

Table 3-20 summarizes the factory default settings for the CellX laser system.

**Table 3-20. Factory Default Settings**

| Description | Setting |
|---|---|
| Auto Start for Laser Emission | ON |
| CDRH Delay | ON |
| Laser Warm-up/LED Status Indicator | ON |
| Command: Message Prompt | ON |
| Command: Message Handshake | ON |
| Output Power Level | Nominal power |
| Minimum Power Output Limit | Depends on individual laser |
| Maximum Power Output Limit | 110% of nominal power |
| Operating Mode | Continuous Wave Constant Power (CWP) |
| Unit for Temperature Settings | Degrees Celsius |
| Laser Diode Set Temperature | ON |
| Laser Thermoelectric Cooler | ON |
| Blanking | ON |
| Baud Rate | 115200 |
| User Names x 7 | Up to 32 characters each (**USER1…7**) |

# 4 Installation

## 4.1 Receive and Inspect

After the product is received, immediately inspect the shipping boxes for any indication of damage.

If there is any damage, document this on the packing list. Also immediately contact both the shipping carrier and either an authorized Coherent representative or the Coherent Order Administration Department, as follows:

- Inside the USA: 1-(800)-367-7890 or (734)-456-3100
- Outside the USA: 1-(734)-456-3100

*NOTICE*
**After unpacking the system, save the shipping boxes for later shipments—refer to 'Pack and Ship the Product' (p. 240) for more information.**

## 4.2 Install CellX System Hardware

This section describes how to unpack and set up and install a base CellX Laser System configuration. It applies to configurations for flow cytometry, for microscopy and for standalone freespace applications. The following sections show how to set up accessories for specific configurations.

To set up accessories for a CellX Laser System configured for flow cytometry, go to, 'Install Accessories for Flow Cytometry' (p. 89).

To set up accessories for a CellX Laser System configured for microscopy that uses an external fiber and fiber aligner, refer to 'Install Fiber Assembly' (p. 102).

*NOTICE*
**Save the shipping box and packing materials after initial purchase—these materials are required to ship the CellX laser system to any other location or return the laser system to the factory. See 'Pack and Ship the Product' (p. 240) for instructions.**

### 4.2.1 Before Work is Started

Before work is begun, gather the tools and equipment needed to set up the system. This procedure should be done in a clean environment under normal humidity and temperature conditions.

**CAUTION!**
**Use of controls or adjustments or performance of procedures other than those specified can result in hazardous radiation exposure.**

Refer to 'Safety and Compliance' (p. 7) to learn about required safety precautions when working with lasers.

### 4.2.2 Components for Basic Setup

At a minimum, the parts shown in Figure 4-1 are needed to follow the set-up instructions in this guide. When a base CellX laser system is set up, either for a flow cytometry, a microscopy, or a freespace standalone 0.7mm configuration, it should look similar to that shown in the figure.

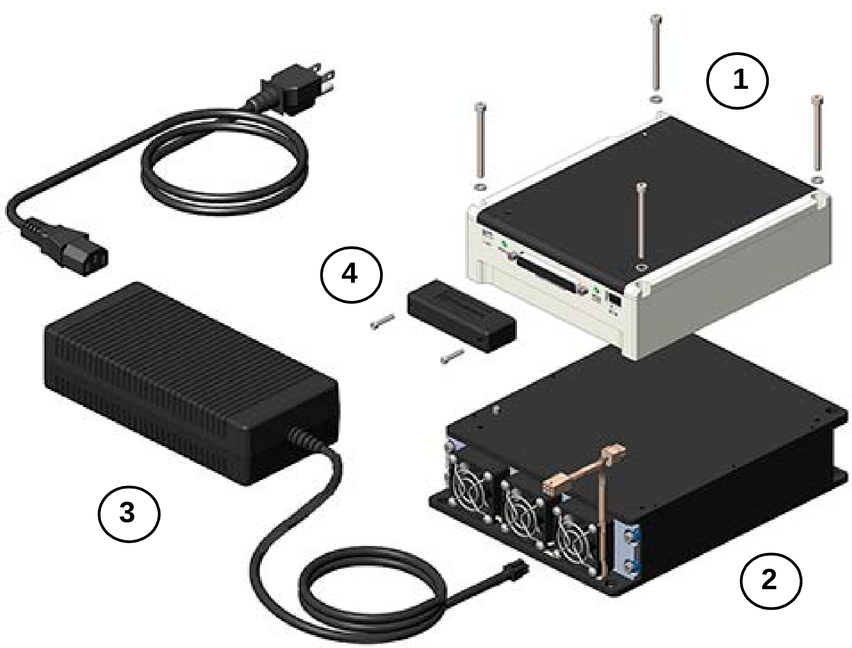



**Figure 4-1. CellX Laser System – Parts Required for Assembly**

Table 4-1 identifies the items in Figure 4-1. Not included in the figure are the optional objective lens and translation stage, which has mounting options described in 'Install Objective Lens' (p. 89).

**Table 4-1. Components Shown for Base CellX in Figure 4-1**

| Key | Description |
|---|---|
| 1 | CellX Laser System |
| 2 | Heat Sink |
| 3 | Power Supply |
| 4 | Interlock Plug |

Table 4-2 shows the components used in these set-up instructions.

**Table 4-2. Components for CellX Set-Up**

| P/N | Description |
|---|---|
| Varies | **CellX Lasers** Refer to 'Configurations Available' (p. 26) |
| Varies | **Heat Sink**, Fan-Cooled (larger heat sink), with Translation Stage Platform |
| 1321203 | **Accessory Kit** for CellX, including interlock plug, hardware and cables. Refer to 'Standard CellX Accessory Kit' (p. 248). |
| 1211389 | **Power Supply** Assembly–6L OBIS<br>Includes a Type B 3-pin grounded power cord. |

For OEM development projects that ordered only the CellX laser system and not the complete developer's kit, individual parts can be ordered from Coherent or build users can build their own (depending on applications). See 'Parts & Accessories' (p. 247) for available options.

#### 4.2.2.1 Accessory Kit and Tools

The Accessory Kit includes the interlock plug, as well as tools and hardware used to set up a CellX laser system. For part numbers and details see 'Standard CellX Accessory Kit' (p. 248) for details.


**Figure 4-2. CellX Accessory Kit Components**

#### 4.2.2.1.1 Hardware

Use the following hardware included to connect the various components:

*To connect the CellX laser system to a heat sink:*

- (4) Socket head screw, M4 x 50 mm L, stainless steel
- (4) Washer, flat #8, stainless steel 18-8

*To connect the Interlock Plug to the CellX system:*

- (2) Socket head screw, 4-40 x 0.625-in. L, stainless steel

*To attach an Objective Lens:*

- Socket head screw, hex socket drive, 2-56 x 0.1875-in. L, stainless steel
- Socket head screw, hex socket drive, 4-40 x 0.375-in. L, stainless steel
- Low-profile socket head screw, hex socket drive, M4x6 hex

### 4.2.3 Set up the Base Laser System

Refer to ’Safety and Compliance’ (p. 7) first to learn about required safety precautions when using lasers.

The following sections describe how to assemble and set up the components for a base CellX Laser System for operation.

### 4.2.3.1 Put CellX on a Fan-Cooled Heat Sink

This section describes how to set up the CellX unit on the fan-cooled heat sink.

1. Remove all the parts from the packaging. Keep the box and all packaging materials in case they are needed to ship the system to another location or to return any parts/components to Coherent. See 'Pack and Ship the Product' (p. 240) for more information.

**WARNING!**
**Take precautions to prevent damage from Electrostatic Discharge (ESD) to the CellX laser system when setting up equipment.**

2. Put the large heat sink on a flat, stable surface. For options about the two heat sinks available for the CellX laser system, see p. 32.

   (Optional) Attach the heat sink to an optical table. The heat sink aligns with metric (M6) or Imperial (1/4”-20) holes.

***NOTICE***
**Never use thermal grease or compound between the CellX and the heat sink or mounting surface. *The use of such materials voids the Coherent warranty!***

3. Put the CellX unit on top of the heat sink, as shown in Figure 4-3.

**Figure 4-3. CellX Set on the Fan-Cooled Heat Sink**

Both units should face in the same direction, as shown in figure, so that the connector from the Heat Sink can be plugged into the power receptacle on the CellX unit.

---

*NOTICE*

**For purposes of illustration, the power connector attached to the Heat Sink is not shown until Figure 4-27.**

---

4. Align the CellX unit by moving the laser system towards the dowel pins set in one corner of the Heat Sink.
5. Locate the provided CellX mount screws (M4) and washers.
6. Put a flat washer in each corner of the cover.
7. Set a CellX mount screw (M4) into each corner of the CellX unit, as shown in Figure 4-4.

**Figure 4-4. Align and Set Washers and Screws in Both Units**

8. *FIRST*: Lightly hand-tighten the four socket head screws just until the screw heads contact the washers. Do this in a 1-2-3-4 sequence in a diagonal pattern, as shown in Figure 4-5.

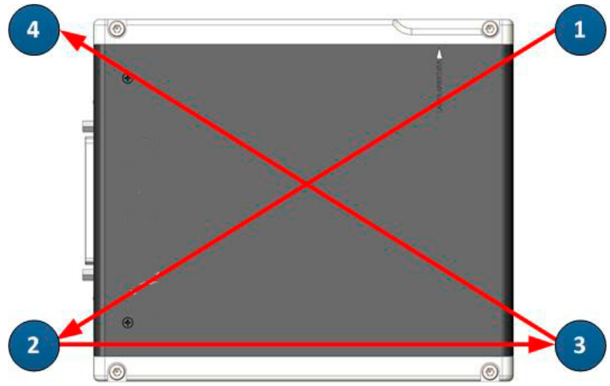



**Figure 4-5. Pattern to Tighten Screws**

9. Continue to tighten. Torque the mount screws three times with a 3.0mm hex torque driver:

   a.) *SECOND*: Torque all of the mount screws to 0.25 N-m (2.2 in-lb) in the same diagonal 1-2-3-4 sequence shown in the previous step.


**Figure 4-6. Attach CellX to the Heat Sink Securely**

   b.) *THIRD*: Torque all of the mount screws to 1.13 N-m (10 in-lb) in the same diagonal 1-2-3-4 pattern.

   c.) *FOURTH*: Torque all of the mount screws to 2.26 N-m (20 in-lb) in the same diagonal 1-2-3-4 pattern.

   **Avoid use of excessive force.**

10. Connect power from the heat sink to the CellX unit. Attach the connector, as shown in Figure 4-7.

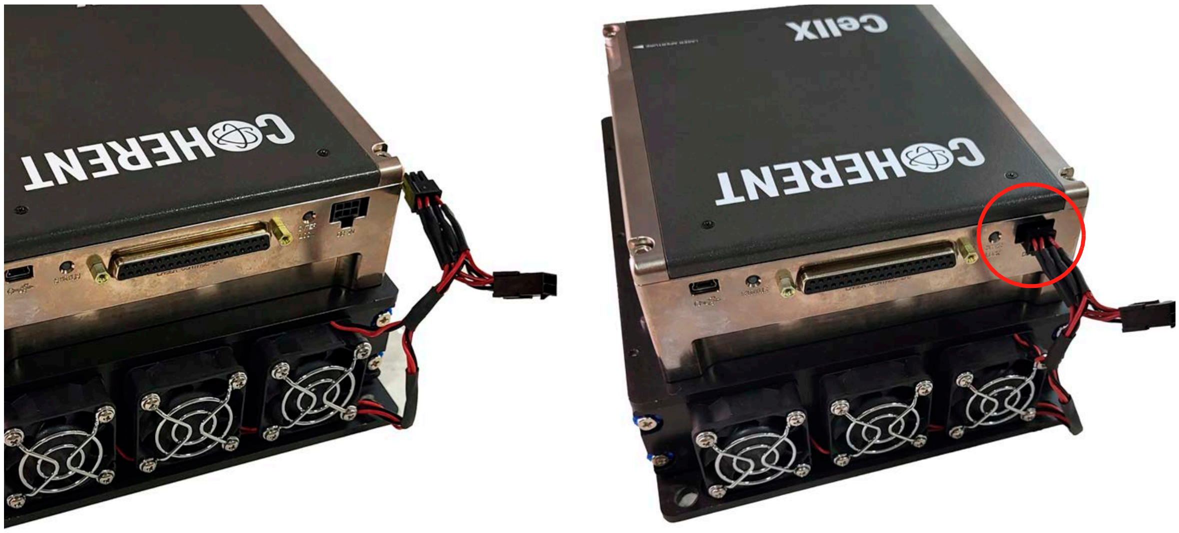


**Figure 4-7. Connect Power Cable – CellX to Heat Sink**

### 4.2.3.2 Insert the Interlock Accessory

An interlock plug or control board accessory containing an interlock is required. The interlock plug is not included and must be purchased separately in the Accessory Kit, part number 1321203. Refer to 'Standard CellX Accessory Kit' (p. 248).

See 'Options for Control Accessories' (p. 41) for information and schematics about optional control boards for the CellX laser system.

***NOTICE***

**The CellX laser system cannot be powered on until an Interlock is in place.**

1. Locate the Interlock Plug shown in Figure 4-8, used in these up instructions. Refer to 'DB37 Interlock Plug' (p. 42).

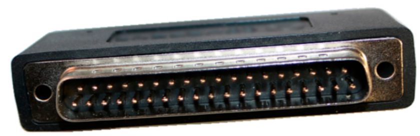


**Figure 4-8. DB37 Interlock Plug Provided in Developer's Kit**

   Control boards can be used instead, such as one of the Control Boards for CellX shown in 'Options for Control Accessories' (p. 41). These also use the DB37 connector.

2. Locate the DB37 mating connector on the back of the CellX unit, with label **Laser Control I/O** (see 'Control Interface Panel' (p. 30)).

**Figure 4-9. Laser Control I/O Port on CellX and Interlock Plug**

3. Set the Interlock Plug in position to correctly align to the laser control I/O connector on the back of the CellX system.

**Figure 4-10. Interlock Plug Attached to CellX**

**CAUTION!**
**The Interlock Plug can be accidentally shorted if pins are inserted at an angle with the mating connector. Use care when the connecting parts are aligned.**

4. Gently insert the interlock plug until it securely connects with the mating connector on the back of the CellX laser system.
5. Insert and then hand-tighten the supplied screws to the interlock plug, as shown in Figure 4-11.

**Figure 4-11. Interlock Plug with Screws**

For a complete list of pin assignments for the Interlock Plug and DB37 Connector, see 'DB37 Interlock Plug' (p. 42).

To view the schematic, see 'Schematic–Interlock Plug' (p. 45).

## 4.2.4 Connect Controller Cables

This section describes how to create a connection to control the CellX laser system. To create the physical connection requires either:

- A standard USB Type A to Type Mini B 1.8 meter cable (P/N 1108906), included in the Accessories Kit (see p. 247)
- An RS-232 cable (a standard PC serial cable), not included with this product

Both the USB and RS-232 connections use the same syntax, commands, and queries.

***NOTICE***
**When both USB and RS-232 cables are connected to the CellX unit, the USB connection overrides the RS-232 connection and the RS-232 port is disabled.**

### 4.2.4.1 Connect with a USB cable

To use a USB cable to connect the CellX laser system to a workstation:

1. Make sure that power is set to ON to both devices.
2. Insert the small connector on the USB cable into the USB port on the back of the CellX unit.
3. Insert the connector into a USB port on the workstation (personal computer or laptop).

The connection using a USB cable is shown in the example in Figure 4-12:


**Figure 4-12. USB Connection from an CellX to a PC**

## 4.2.5 Connect with an RS-232 cable

To set up the connection from the CellX laser system to the serial port of a workstation with an RS-232 cable, users must select one of the accessory control boards (described on p. 41) with a DB-9F (RS-232) connector.

1. Make sure that power is set to OFF to both devices.
2. Insert the selected control board into the DB37 connector on the back of the CellX unit, with label **Laser Control I/O**.
3. Insert the RS-232 cable into the DB-9F port on the back of the control board.
4. Insert the other end of the cable to a serial port on the workstation.

Figure 4-12 shows an example of the completed connection, used in operation, with use of an RS-232 cable.

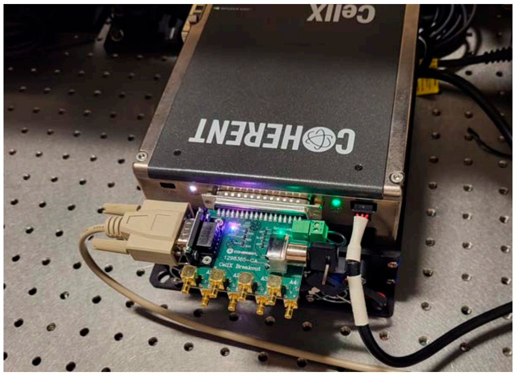


**Figure 4-13. RS-232 Connection from Control Board on a CellX**

The sections that follow give instructions for options to install objective lenses. If the system is to be used with an external fiber for microscopy, go to 'Install and Set Up Fiber for Microscopy' (p. 101).

## 4.2.6 Developer's Kit

A Developer's Kit (P/N 1323532) provides all the parts needed to create a working system. This kit includes heat sinks, objective lenses, interlock plug, as well as tools and accessories. Parts can also be ordered separately. For details refer to Table A-2 (p. 248).

# 4.3 Install Accessories for Flow Cytometry

This section describes installation of accessories specific to a flow-cytometry application For installation and setup for configurations for microscopy applications, refer to 'Install Accessories for Flow Cytometry' (p. 89).

## 4.3.1 Install Objective Lens

**Table 4-3. Accessory Components for Flow Cytometry**

| P/N | Description |
|---|---|
| 1365935, | Objective lens,10 μm focus, with mount bracket (P/N 1321963) |
| 1383130 | Objective lens, 15 um focus, with mount bracket (P/N 1321963) |
| 1321964 | Translation Stage Accessory |

The procedures in this section are for configurations where users choose to use an objective lens with the CellX laser system, without an external fiber. For CellX configurations that use a fiber launcher and an external fiber, refer to 'Install Fiber Assembly' (p. 102).

There are different ways in which objective lenses can be mounted:

- Directly over the laser exit aperture on the side of the CellX unit. Refer to 'Option 1 - Mount Directly Over Laser Exit Aperture' (p. 89).
- Set up independently of the CellX unit with the translation stage Refer to 'Option 2 - Assemble Translation Stage and Mount Lens' (p. 91).
- Set up on the translation stage platform for the fan-cooled heat sink with use of the translation stage. Refer to 'Mount Lens with Translation Stage on Fan-Cooled Heat Sink' (p. 95).

Each of these are described in the sections that follow. See 'Options for Objective Lenses' (p. 55) for information and specifications for lenses available from Coherent for the CellX laser system.

### 4.3.1.1 Option 1 - Mount Directly Over Laser Exit Aperture

Depending on the application, users can attach an objective lens directly to the laser exit aperture on the CellX unit, as shown in Figure 4-14.

To attach an Objective Lens directly to the CellX unit:

1. Locate the package for the Mount Bracket Accessory (P/N 1321963). This package includes:
   - Enclosure mount bracket


Figure 4-14. Objective Lens – Attached to CellX

- Socket head screw, hex socket drive, 2-56 x 0.1875-in. L, stainless steel
- Socket head screw, hex socket drive, 4-40 x 0.375-in. L, stainless steel

Figure 4-15. Mount Bracket and Hardware (left), An Objective Lens (right)

2. Insert the objective lens into the enclosure mount bracket. Make sure that there is a snug fit and that the lens is straight.
3. Use the smaller 4-40 x 0.375-in. L socket-head screws on the inside screw holes of the mounting bracket, and connect the two parts.
4. Set the assembled parts in position directly in front of the laser exit aperture on the CellX unit.

5. Use the larger 2-56 x 0.1875-in. L socket-head screws in the outside screw holes of the mount bracket, and attach the assembled bracket and objective lens directly on the CellX unit, as shown in Figure 4-16:


**Figure 4-16. Attach Objective Lens Directly to CellX**

6. Tighten carefully.

### 4.3.1.2 Option 2 - Assemble Translation Stage and Mount Lens

This section describes how to mount an objective lens with the low-profile translation stage. A translation stage is used to precisely adjust the position along a single axis and lock that position in place. The translation stage includes a top and bottom section that slide back and forth using the micrometer attached on the side of the translation stage.

Users can put the translation stage in position on a plate in the system or the translation stage platform attached to the fan-cooled heat sink.

***NOTICE***

**The translation stage is not intended to be attached directly to an optical table or a lab bench.**
**The translation stage must be mounted to the translation stage platform. That platform is attached to the fan-cooled CellX heat sink. If the translation stage were directly mounted to an optical table, the CellX's beam path would NOT align with the Z-axis of the objective lens.**

See 'Optional Components of the CellX Laser Systems' (p. 32) for dimensions of both the translation stage (p. 57) as well as the fan-cooled heat sink (p. 38).

Before work is started, open the package for the Translation Stage Accessory (P/N 1321964). For part detailed description, refer to ’Objective Lens Mounted on Translation Stage’ (p. 57).


**Figure 4-17. Translation Stage Platform, Translation Stage, and Hardware**

Figure 4-18 provides an exploded view of the relationship of sections of the translation stage (bottom), mount bracket (middle), an objective lens (top) and associated screws:

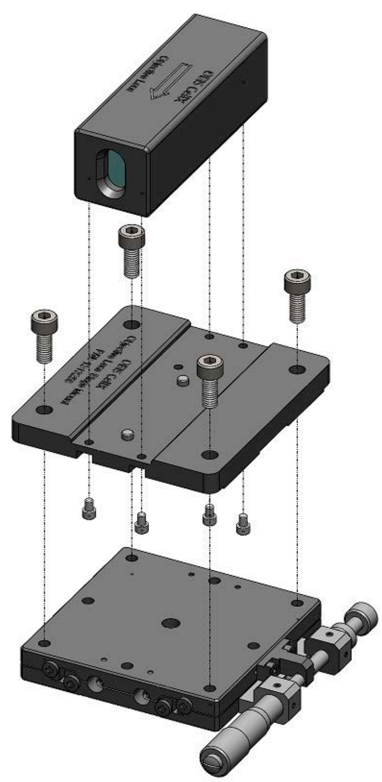


**Figure 4-18. Translation Stage Platform (bottom), Lens Stage Mount (middle), Objective Lens (top)**

### 4.3.1.3 Mount the Stage Platform on a Surface

Before work is begun, identify a surface that is planned to mount the base section (bottom) of the translation stage.

That surface can either be a flat surface designed into your system, or the translation stage platform of the fan-cooled heat sink, or a surface set at an approximate working distance from the CellX unit.

1. Prepare the surface with mounting holes that align with the translation stage. (See p. 57 for dimensions of the translation stage and the location of mounting holes).
2. Remove the contents from the package and set out the two wrenches (3 mm x 2.5-in. L hex and 5/64-in. hex L-key).
3. Put the base of the translation stage platform on the prepared surface.

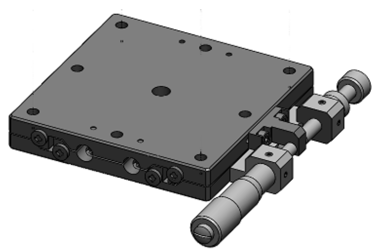


**Figure 4-19. Translation Stage Platform**

4. Adjust the control knob on the micrometer to move the top half (platform section) of the translation stage. The platform section slides to reveal the mounting holes at one end of the base.
5. Use two (2) low-profile M4x6 hex screws, and attach that end of the translation stage to the prepared surface.
6. Adjust the control knob on the micrometer to move the platform to the other end of the translation stage. Use the other two (2) low-profile m4x6 hex screws to attach the other end of the translation stage to the prepared surface.
7. Adjust the control knob to slide both sections of the translation stage into alignment.

### 4.3.1.4 Mount the Objective Lens into Bracket

Next, mount the objective lens (top) onto the lens stage mount (bottom):

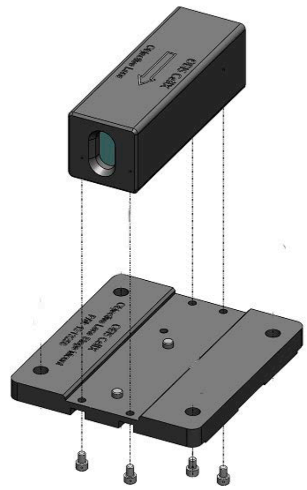


**Figure 4-20. Objective Lens, Stage Mount Bracket, and Screws**

1. Put the objective lens in the center slot of the lens stage mount (P/N 1313256), as shown in Figure 4-20.
2. Align the holes in the bottom of the objective lens with the mounting holes in the lens stage mount (bottom). Refer to Figure 4-20.
3. Insert the smaller 2-56 x 0.1875-in. L hex screws into the underside of the bracket, facing up, and screw into the objective lens to attach it.

### 4.3.1.5 Attach the Bracket with Lens to Translation Stage

To attach the lens stage mount, already assembled with the objective lens, onto the translation stage:

1. Align the lens stage mount (bottom) with the mounting holes on the translation stage.
2. Using the larger 2-56 x 0.1875-in. L socket-head screws, attach the lens stage mount (bottom) to the translation stage platform.

The completed assembly is shown in Figure 4-21.

For information about how to establish the working distance between the translation stage and the CellX unit or to make adjustments to laser beams, see 'Maintenance' (p. 183).

Figure 4-21. Translation Stage with Objective Lens Mounted

### 4.3.2 Mount Lens with Translation Stage on Fan-Cooled Heat Sink

The fan-cooled heat sink includes a stage mount extension on which users can mount either of the two objective lenses from Coherent. The objective lens must first be assembled with the low-profile translation stage assembly, as follows.

If the more simple model of a heat sink with no built-in cooling is planned, refer to, 'Heat Sink Options' (p. 32).

**CAUTION!**
**Failure to integrate the appropriate level of cooling for prevailing humidity and temperature can damage the lasers and the system.**

#### 4.3.2.1 Mount Translation Stage on the Platform

***NOTICE***
**The translation stage platform must be installed to the stage mount extension on the fan-cooled heat sink to perform this procedure. If the mount was removed, re-install it first.**

To mount the translation stage platform onto the stage mount extension on the heat sink:

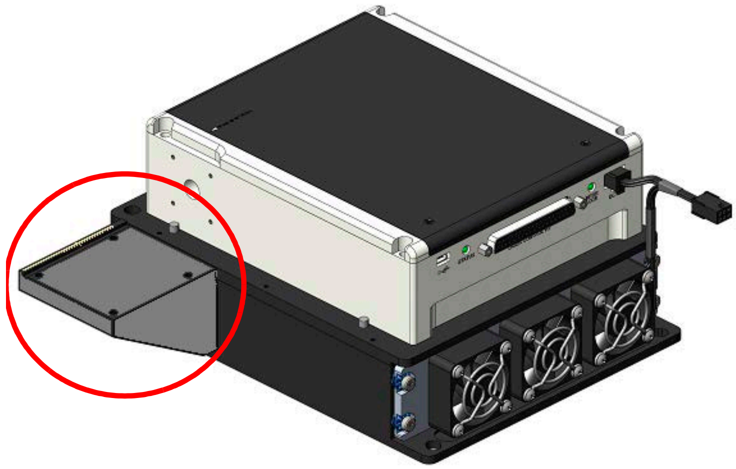


**Figure 4-22. Stage Platform Extension on Fan-Cooled Heat Sink with CellX**

1. Put the translation stage platform (Figure 4-22) on the stage platform extension (Figure 4-22) on the fan-cooled heat sink.

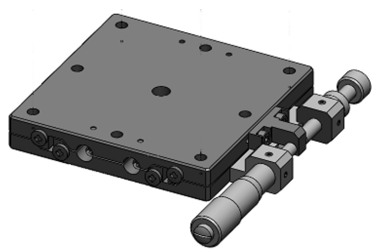


**Figure 4-23. Translation Stage Platform**

2. Adjust the control knob on the micrometer to move the top section of the translation stage. The platform slides to reveal the mounting holes at one end of the base.
3. Use two (2) low-profile M4x6 hex screws, and attach that end of the translation stage to the stage mount extension on the heat sink.
4. Adjust the control knob on the micrometer to move the top section to the other end of the translation stage. Use the other two (2) low-profile M4x6 Hex screws to attach that end of the translation stage to the stage platform extension.
5. Adjust the control knob to slide both sections of the translation stage into alignment.

### 4.3.2.2 Mount Objective Lens into Lens Bracket

Next, mount the objective lens into the lens stage mount:

1. Put the objective lens (top) in the center slot of the lens stage mount (bottom). Refer to Figure 4-24.

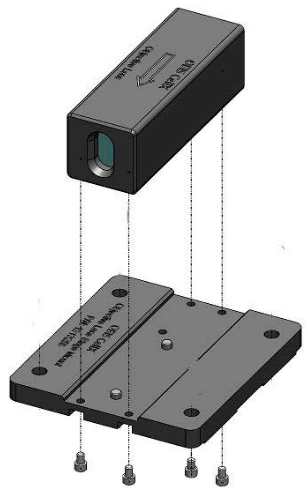


**Figure 4-24. Objective Lens, Stage Mount Bracket, and Screws**

2. Align the holes in the bottom of the objective lens with the mounting holes in the bracket.
3. Insert the smaller 2-56 x 0.1875-in. L hex screws into the underside of the mount bracket, facing up, and screw into the objective lens to attach it.

### 4.3.2.3 Attach Lens Mount Bracket with Lens to Translation Stage

To attach the stage mount bracket, already assembled with the objective lens, into the translation stage:

1. Align the stage mount bracket, with the objective lens, to the mount holes in the translation stage.
2. Use the larger 2-56 x 0.1875-in. L socket-head screws, and attach the stage bracket to the translation stage.

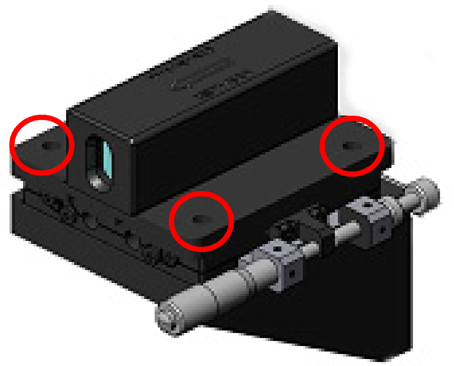


**Figure 4-25. Objective Lens Mounted on Translation Stage**

The translation stage with objective lens (top) is now connected to the translation stage. The translation stage is on the stage platform extension on the heat sink, as shown in Figure 4-26.


**Figure 4-26. Objective Lens With Translation Stage on Heat Sink Mount**

For information about how to establish the working distance between the translation stage and the CellX unit or make adjustments to laser beams, see 'Maintenance' (p. 183).

## 4.4 Connect the Power Supply

All configurations of the CellX laser system require a power connection at 12 Volts DC with a power supply capable of a minimum of 100 W of power.

Refer to ’Electrical Specifications’ (p. 66) for specifications and power requirements.

***NOTICE***

**If the 12 VDC laser diode supply line at the DC connector is used for STANDBY/ON control, Auto Start must be enabled. If Auto Start is not enabled, the laser stays in STANDBY and waits for a digital command via USB or RS-232 before starting emission. See ’Understand CellX Auto-start Settings’ (p. 118) for more information.**

To connect the power supply:

Attach the connector on the power supply into the mating connector. The connector has a joint connection to the fan-cooled heat sink and to the CellX laser, as shown in Figure 4-27.


**Figure 4-27. Connect Power Supply to Heat Sink Extension**

3. The upper pins of the Molex connector (shown in Figure 4-28) are positive and the lower pins are the ground (negative). A locking clip holds the connector in place.

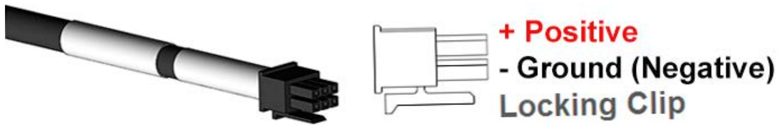



**Figure 4-28. Pins on the Power Supply Connector**

4. Plug the power supply into a grounded wall receptacle (110/220V).
5. Set the toggle switch at the back of the power supply (shown in Figure 4-29) to On to give 12 V power to the CellX system

**Figure 4-29. Toggle Switch on Power Supply**

A power-on LED indicator on the power supply illuminates in green when the power switch is set to ON, as shown in Figure 4-30.

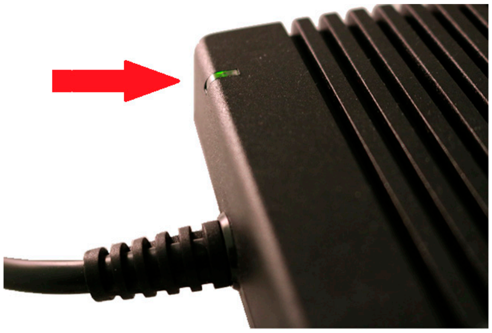


**Figure 4-30. Power Supply On/Off LED Indicator**

### 4.4.1 System Warm-Up Time

For information about the LED indicators and status definitions for the CellX unit, refer to 'Controls, Indicators and Features' (p. 29).

After power-up, there is a **warm-up period** as the components in the system come up to the operating temperature. The warm-up period depends on both ambient temperature and whether power was recently applied.

- On initial start-up, the typical power-on time delay is approximately 1 minute, but can take longer (up to 5 minutes) on a cold start.
- Warm-up time is followed by a CDRH delay of approximately 5 seconds, if activated in software GUI. After the CDRH delay, the CellX laser system begins laser emission.

**WARNING!**
**LASER EMISSION STARTS NOW! There is no shutter on the CellX system.**

**The CellX system automatically starts laser emission after power is applied. Take precautions to avoid exposure of the eyes or skin to direct or scattered radiation.**

Because auto-start is activated by default, the laser automatically starts emission after DC power is connected. See 'Safety and Compliance' (p. 7) for precautions. For information about Auto Start see 'Understand CellX Auto-start Settings' (p. 118).

Default settings such as Auto Start and the CDRH delay can be changed using Coherent Connection software.

## 4.5 Install and Set Up Fiber for Microscopy

The procedures in this chapter are done to complete set up specific fiber-ready CellX configurations, used for microscopy applications with a 0.7mm external fiber. A CellX fiber-ready configuration comes with a fiber launcher/aligner pre-installed and aligned.


**Figure 4-31. CellX with Fiber Aligner and Fiber Installed (Collimated configuration)**


**Figure 4-32. CellX for Microscopy Components (APC Fiber Example)**

A launcher/aligner can also be ordered and installed to an existing 0.7mm CellX laser engine for microscopy. Refer to 'CellX Options for External Fiber for Microscopy' (p. 61).

### 4.5.1 Install Fiber Assembly

**CAUTION!**
**The bend radius when the fiber is handled should be 51mm (2-in) maximum.**

This procedure is done to install a fiber assembly to for compatible CellX laser systems that are configured with external fibers for microscopy. This is done for compatible CellX units that have an external fiber launcher installed.

For a list of lasers and accessories for microscopy, refer to Table 3-12 (p. 63).

Note the location of the adjustment knobs and buttons on the external fiber launcher. Refer to the diagram in Figure 4-33, as necessary, when these procedures are performed.

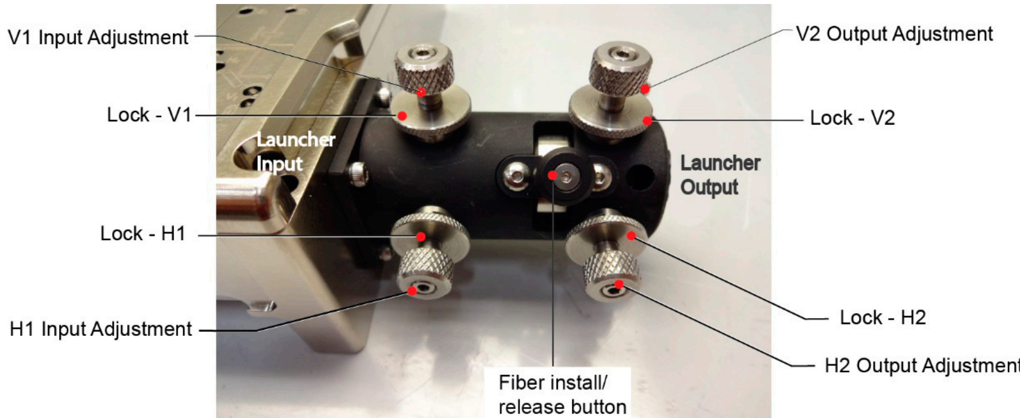



**Figure 4-33. Launcher Input / Output Adjustment Locations**

**CAUTION!**
**DO NOT touch or adjust any of the knobs unless specifically instructed to do so. Even slight unintended adjustments or touch of a knob could cause the beam aligner/launcher to go out of alignment.**

1. Remove the CAUTION tag on the beam launcher. The label warns about the high sensitivity of the adjustment knobs. Refer to Figure 4-34.


**Figure 4-34. Fine-Adjustment Caution Tag**

2. Push and hold the fiber release/hold button, and remove the alignment tool/tube. Refer to Figure 4-35.

**Figure 4-35. Remove Alignment Tool**

3. Set the tool aside. It is only used for coarse alignment, if needed.
4. Locate the correct fiber assembly. Figure 4-36 shows the two types of available fiber assemblies.

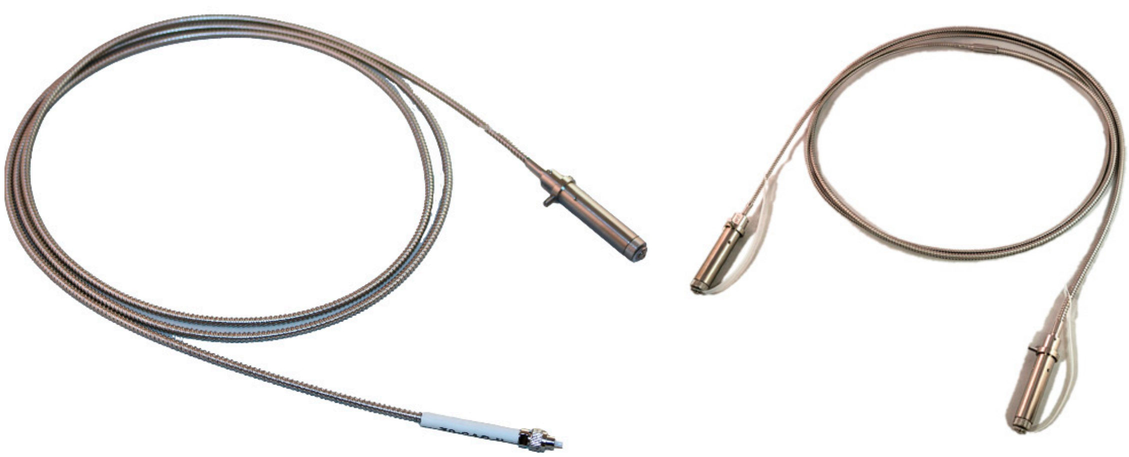


**Figure 4-36. Fiber Assembly – FC/APC (left), Collimated (right)**

5. If the hold-down screw on the side of the launcher (circled, Figure 4-37) is tightened, loosen it with a hex driver so that the fiber

can be installed. The screw can be used as an additional way to keep the fiber end from coming out.

**Figure 4-37. Fiber Hold-down Screw Location**

6. Locate the alignment key on the fiber head that is made to match with the alignment slot in the launcher. Refer to Figure 4-38.

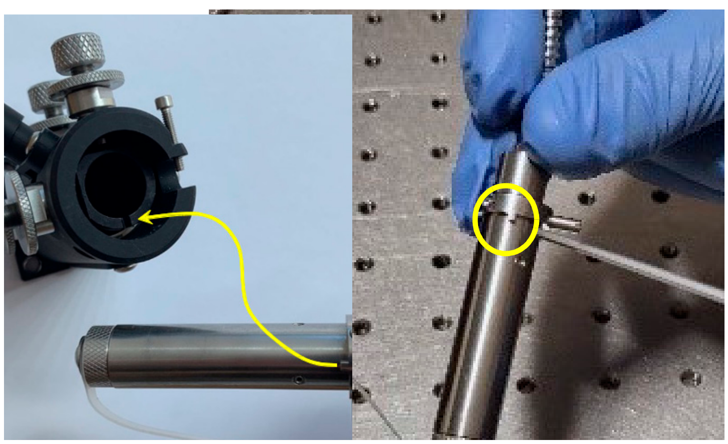


**Figure 4-38. Alignment Key and Launcher Input Slot and Key Locations**

7. Inspect and clean an FC/APC fiber:

    a.) Put the fiber tip in a fiber scope to inspect the fiber end (see Figure 4-39) Refer to the full procedure in ’Inspect and Clean the External Fiber’ (p. 220).


**Figure 4-39. Attach Fiber to Scope (FC example)**

    b.) Re-examine the fiber tip, as necessary.

8. Unscrew and remove the cap from the input end of the fiber. Refer to Figure 4-40.

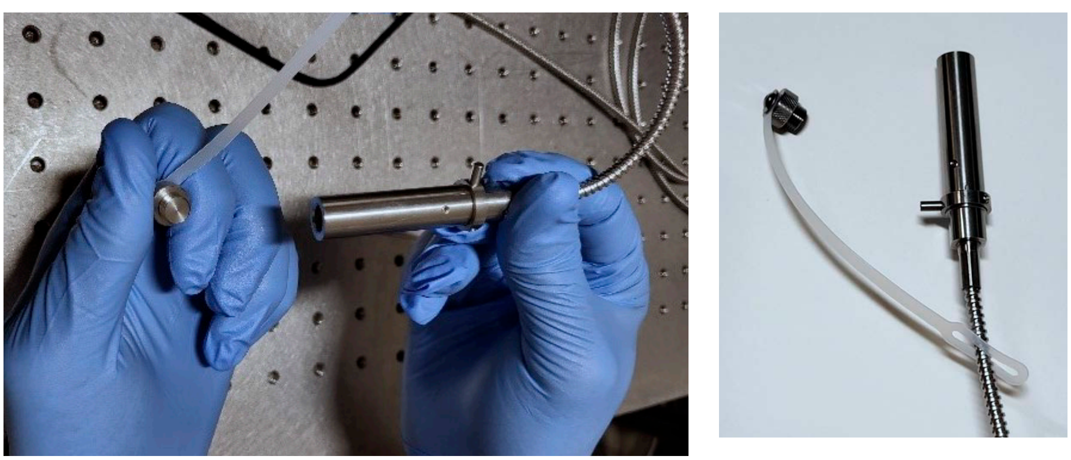


**Figure 4-40. Protective Cap Removed**

9. Insert the fiber connector toward and into the fiber launcher. Refer to Figure 4-41. Make sure that the alignment key on the fiber head is

in-line with the slot on fiber launcher. Note that the alignment key is on the underside of the fiber connector when installed and not visible in the figure.

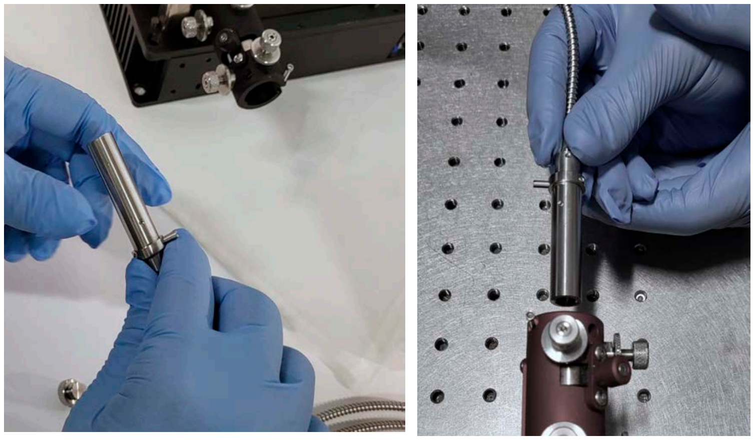


**Figure 4-41. Insert Fiber Into Launcher**

10. Firmly push and hold the release/hold button on the launcher in and gently rotate the fiber input side back and forth while the fiber is inserted. Some force is needed to release necessary tension. Refer to Figure 4-42. Make sure that the fiber is inserted to the end.

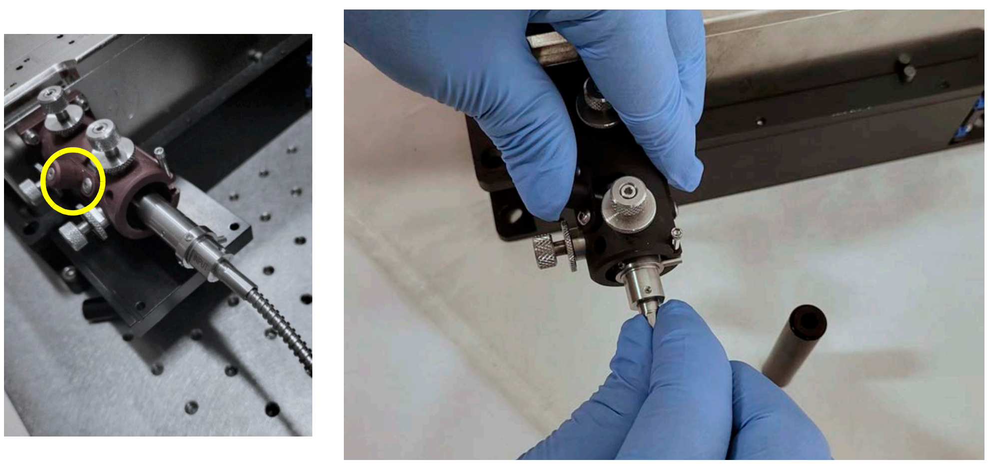


**Figure 4-42. Push Button, Insert Fiber Connector Completely in Launcher**

11. Make sure that the insertion is complete, and then release the button. Refer to Figure 4-43. Note that sometimes it looks like the fiber is inserted but not to the end.

**CAUTION!**
**Power sensor must be in a direction where no light can be reflected back into the laser.**

Figure 4-43. Fiber Completely Inserted

12. Put the output end of the fiber toward and directed into a power sensor, with all laser safety precautions followed. Refer to Figure 4-44.

13. Make sure that sensor is set up so no light can be reflected back to the laser. Refer to 'Laser Back Reflection' (p. 253).

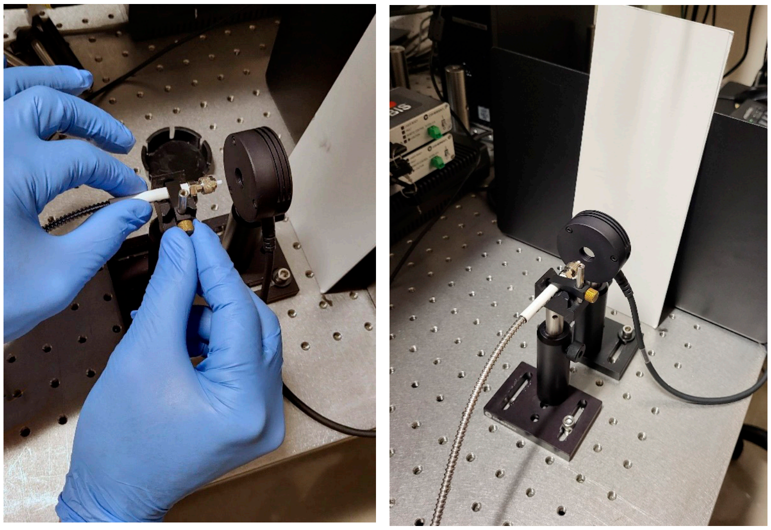


Figure 4-44. Fiber Output End Directed at Sensor

14. Examine the alignment of the external fiber. Refer to 'Examine and Adjust Fine Fiber Alignment' (p. 200). This is done to make sure that the fiber is aligned in accordance with factory alignment that was performed before shipment.

15. If no further operation is to be done, re-install the dust cap on the fiber end.

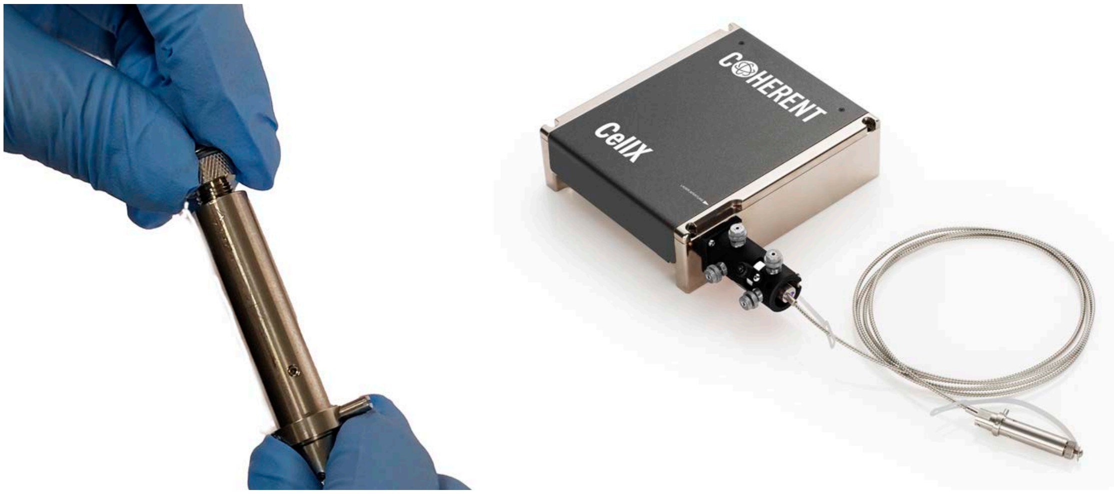



**Figure 4-45. Fiber Installed and Stowed with Protective Cap Installed**

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**CAUTION**

**When fiber is uninstalled from CellX, the dust cap must be reinstalled to prevent contaminants from getting in.**

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16. When the system is not in use, make sure that the caution tag is re-applied to the beam launcher to avoid unintended adjustment and misalignment.

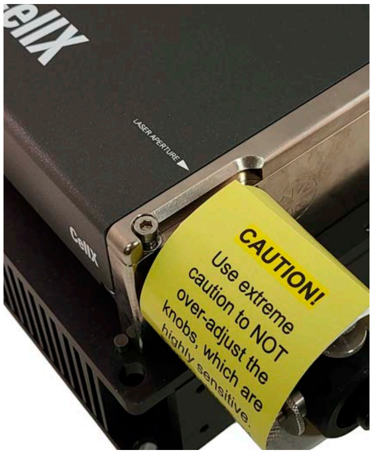


**Figure 4-46. Fine-Adjustment Caution Tag**

# 4.6 Next Steps

After all of the hardware is set up, go to ’Install Software’ (p. 103) for instructions about how to install the software and related drivers.

For information about the user interface and settings to set start-up options and operating modes, change laser power, and view laser status and information, go to ’Coherent Connection Software’ (p. 171).

For information about modes in which users can operate the CellX laser system, go to ’Operation’ (p. 117).

# 4.7 Install Software

## 4.7.1 Introduction

This section describes how to set up and install the Coherent Connection software and related drivers for the CellX laser system.

Through the Coherent Connection software, users can control laser power or other parameters directly through a USB or RS-232 connection. (The RS-232 connector is located on an accessory control board (P/N 12298366); see ’Options for Control Accessories’ (p. 41).

This section assumes that you have already set up the hardware (see ’Install CellX System Hardware’ (p. 77).

### 4.7.1.1 System Requirements

It is recommended to use the most current and robust systems possible. Support for the CellX laser system is provided on the following operating systems:

- Windows v10 (32- and 64-bit)
- Windows v11 (32- and 64-bit)

In addition, the workstation must meet the following minimum requirements:

- 512 MB of RAM
- USB port

- Microsoft .NET Framework 4.0 or higher. If no version (or an older version) is found on the workstation, then the installation program installs a version of Microsoft .NET Framework.

#### 4.7.1.2 Supported Lasers

In addition to CellX, Coherent Connection software supports the following laser products: CellX PT, OBIS LX, OBIS LS,OBIS LX SF, OBIS CORE LS, OBIS LG, OBIS XT, StingRay, BioRay, Sapphire LP, Sapphire SF, and controllers.

See ’Configurations Available’ (p. 26) for the wavelengths and power ratings available in current configurations of the CellX laser system.

#### 4.7.1.3 Drivers Included

The CellX laser system and OBIS lasers use the same USB communication protocols. The OBIS driver is compatible with the CellX laser system, and is automatically installed when users start the set-up program and install the Coherent Connection software.

Using the OBIS USB driver allows communication with the laser system with either Coherent Connection software, a terminal program, or a custom-developed program. The driver creates a virtual COM device in the host computer that provides access to its controls.

If a terminal program or custom-developed program is used, users should install Coherent Connection for the USB driver to be installed. If installation of the Coherent Connection software is not an option, the driver can be installed manually. For help with manual driver installation, or if there are errors with COM port assignment after installation, contact Coherent Support for assistance. Refer to ’Contact Product Support’ (p. 229).

### 4.7.2 Install Coherent Connection Software

Before the Coherent Connection software is installed, it is recommended that to first close all other applications. The installation requires a restart of the workstation when installation is complete.

To start the software installation:

1. Download the software from the Coherent website at:

   https://www.coherent.com/resources

   Click the ‘Software’ checkbox in the search filter, and then do a search for keywords ‘Coherent Connection Software’.

2. Double-click the latest version of the file named **`Coherent_Connection_Setup_vX.0.0.XX`**, where the last two digits represent the number for the current software build.

   The following message displays. Available languages include English, Italian, French, German, Hebrew, and Japanese. Note that the language selection applies only to software set-up instructions on-screen, and not to the Coherent Connection software itself (available in English only).

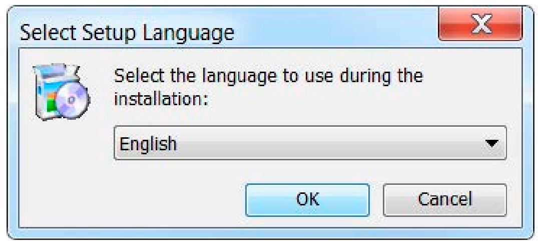


**Figure 4-47. Select Language for Software**

For detailed installation instructions, refer to the Coherent Connection Software manual, available at:

https://www.coherent.com/resources

When done, a shortcut displays on the workstation desktop and/or in the Quick Launch menu, as shown in Figure 4-48:

**Figure 4-48. Desktop Icon for Coherent Connection Software**

### 4.7.2.1 Connect to a Host Workstation

Make sure that the CellX laser system is connected to a workstation (personal computer or laptop). A USB cable can be used. The USB driver was automatically loaded onto the computer as part of the installation process.

Chapter 'Operation' (p. 117) describes how to configure start-up options (such as the AutoStart feature or a CDRH delay) for the CellX laser system.

## 4.7.3 Set up Ports to Use a Terminal Program

To use a terminal program to open a communication session and enter commands manually, users must first configure the COM port for the CellX laser system.

When the devices are connected, the workstation identifies the CellX as a COM port on the workstation. To determine which COM port is assigned to the CellX, connect using either:

- A USB port with use of the Control Panel
- An RS-232 connection, accessible with one of the accessory control modules shown in 'Components in the Developer's Kit' (p. 248)

### 4.7.3.1 Port Setup through USB in Device Manager

To check the COM port using the Windows Device Manager for the workstation:

1. Connect the CellX to a workstation through the USB connection.
2. Open Windows Device Manager on the workstation.
3. Look for the Coherent device under the list of Ports (COM & LPT), shown in the example in Figure 4-49.

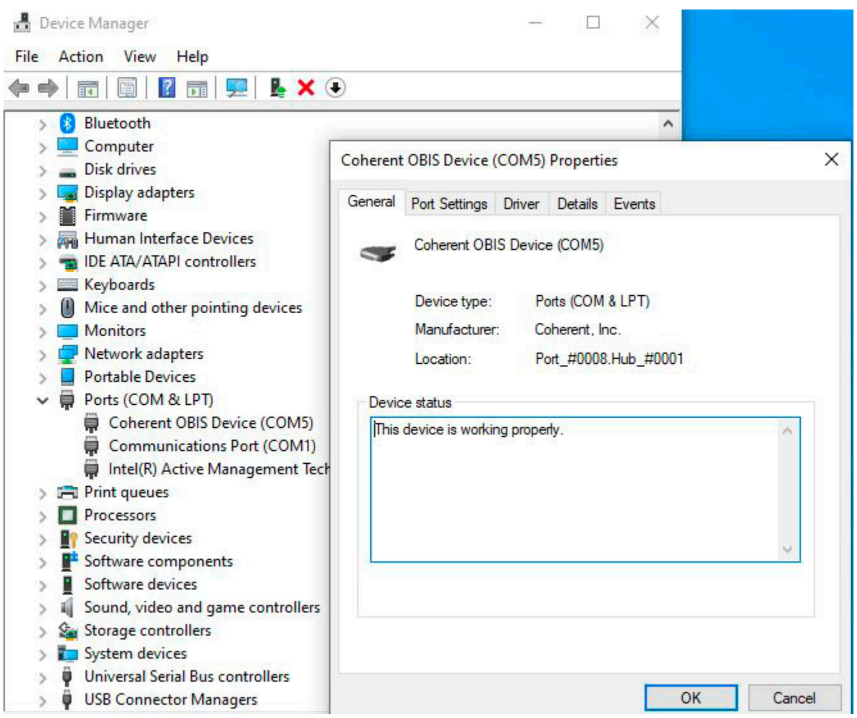


**Figure 4-49. COM Port in the Device Manager**

4. Double-click the device to show the device properties dialog. Refer to Figure 4-49.
5. Click the **Port Settings** tab.
6. Select the necessary port settings and then click **OK**.

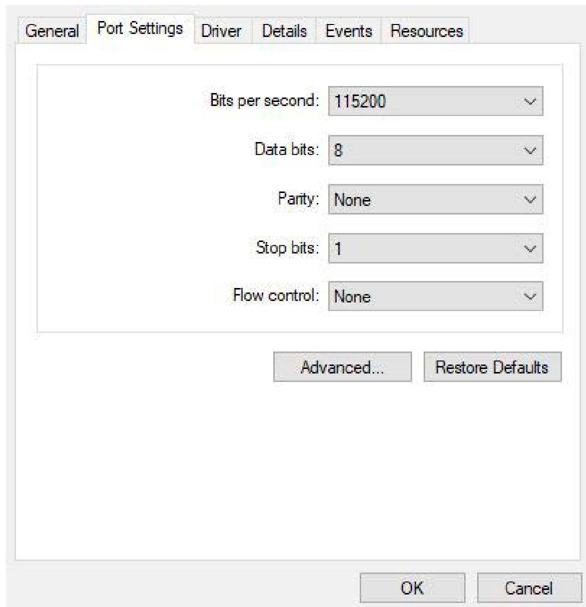


**Figure 4-50. COM Port in Device Manager**

### 4.7.3.2 Port Setup through an RS-232 Serial Connection

To open a communications session with an RS-232 cable:

1. First attach the cable to one of the accessory modules for the CellX unit that includes the standard DB-9F (RS-232) connector:
   - P/N 1323597: Accessory, Control Board, with 4 Analog Modulation Inputs, and an RS-232 serial port

- P/N 1298365: Accessory, Control Board, with physical Keyswitch, RS-232 serial port, plus 4 analog and 4 digital inputs

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**NOTICE**

**If the Coherent Connection software is used, the COM port is usually auto-assigned. For RS-232 use, it must be assigned manually. When accessory boards are installed, the port number is auto-assigned.**

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2. If using Coherent Connection, select the COM port in the User Preferences, and then click **Save**.

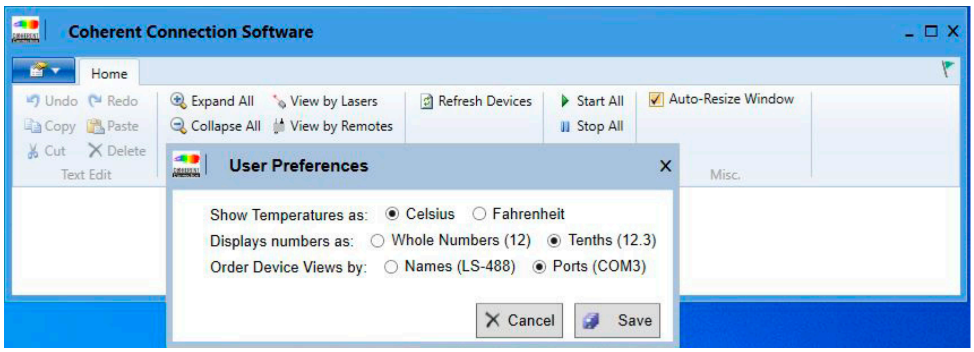


**Figure 4-51. Set COM Port via RS-232 Connection**

3. Open a terminal program and then create a file name for the new connection.
4. Select the COM port that is assigned to the CellX and follow the recommended terminal menu settings.
5. Open a terminal main window and activate the connection. The example in Figure 4-52 shows queries used to check the nominal power level and wavelength of the laser.

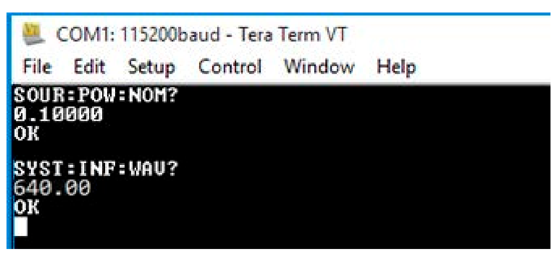


**Figure 4-52. Example Query Commands**

## 4.7.4 Next Steps

Now that the software is installed, go to 'Coherent Connection Software' (p. 171) to learn about the Coherent Connection software host interface.

The next section also describes the various options and how to individually configure start-up options using the Coherent Connection software for communications through a terminal program.

# 5 Operation

This section describes the operating modes offered in the CellX laser system.

**WARNING!**
**Use of controls or adjustments or performance of procedures other than those specified may result in exposure to hazardous radiation.**

For details about control specifications, see the descriptive sections about ’Digital Modulation’ (p. 74) and ’Analog Modulation’ (p. 75).

For a brief on-line video presentation about modulation modes for OBIS lasers, see: Discover OBIS Laser Modulation Modes

## 5.1 Before Work is Started

This section assumes that the hardware and components have already been set up, installed and connected, as follows:

1. Applicable laser safety controls are set up—refer to ’Safety and Compliance’ (p. 7).

**CAUTION!**
**Optics or objects in front of the laser can reflect a part of the beam back into the laser. This event—known as *back reflection*—can cause instability, noise, or laser damage. Refer to ’Laser Back Reflection’ (p. 253) for details.**

2. The laser is mounted with the appropriate heat sink; see p. 80.
3. The interlock jumper is inserted into the DB37 connector on the back of the CellX; see ’Insert the Interlock Accessory’ (p. 84).
    - If the CellX laser system is to be operated using analog and/or digital modulation, instead use one of the Control Boards listed in ’Options for Control Accessories’ (p. 41).
    - For analog and/or digital modulation, also ensure that any signal generator to be used is connected to the control board.
4. The power supply cable is connected to the CellX and the power supply switch is in the OFF (‘0’) position; see ’Connect the Power Supply’ (p. 99).

**NOTICE**
**If the 12 VDC laser diode supply line at the DC connector is used for STANDBY/ON control, Auto Start must be enabled. If Auto Start is not enabled, the laser stays in STANDBY and waits for a digital command via USB or RS-232 before starting emission. See 'Understand CellX Auto-start Settings' (p. 118) for more information.**

5. The USB interface cable connects the CellX laser system to a workstation; see 'Next Steps' (p. 110).
6. Coherent Connection software is already installed on the workstation, as described in 'Install Software' (p. 103).

### 5.1.1 Understand CellX Auto-start Settings

The CellX laser system uses an internal auto start switch that allows laser emission to start without toggling a keyswitch. The default setting is auto start ON.

**WARNING!**
**There is no keyswitch on the CellX laser system, unless an accessory (Control Board with Key-Switch, Interlock, Digital & Analog modulation SMB connectors and RS-232) is in use.**

**With Auto Start enabled on the CellX, the laser starts at the next power cycle (with keyswitch ON) even if the laser was previously turned OFF (0) through the USB command.**

Customers who want the system to automatically start when 12 V power is applied to the CellX unit can leave the power switch ON and a keyswitch ON. The laser starts with NO user intervention. The laser warm-up period still applies.

Table 5-1 shows the status of auto start settings for the CellX laser system at the moment that power is applied to the system.

**Table 5-1. AutoStart Settings**

| Key Switch | Auto Start Setting | Status |
|---|---|---|
| **STANDBY** | Auto Start OFF | The status is the same.<br>Laser emission does not occur when the keyswitch on a modulation board is in STANDBY mode, whether Auto Start is set to ON or OFF. |
| | Auto Start ON | |

**Table 5-1. AutoStart Settings**

| Key Switch | Auto Start Setting | Status |
|---|---|---|
| **ON** | Auto Start OFF | If the keyswitch on a modulation board is ON at Power ON, the keyswitch must be toggled to STANDBY mode, then back to ON again to start emission. |
| | Auto Start ON | Light emission starts automatically when warm-up is completed.<br>• If the CellX Laser operates in either Digital or Mixed Modulation mode, there is zero laser emission.<br>• If the CellX Laser operates in Analog Modulation mode without an input signal, the laser output power remains at minimum levels. |

## 5.2 Operating Modes

The CellX laser system operates at a constant power at levels set through the Coherent Connection interface.

The CellX laser system provides the capability for Continuous Wave (CW) or modulated laser emission. The pulsed output must be controlled with external analog or digital signals or both (Mixed Modulation).

For more technical information about Operating Modes with CellX, refer to ’Operating Modes’ (p. 73).

Using the Coherent Connection software, users can set lasers ON and OFF (either all at the same time or individually), adjust power, change modulation modes, and monitor system parameters.

### 5.2.1 Equipment Required

To control the lasers using modulation signals on the CellX, use one of the Control Boards shown in ’Options for Control Accessories’ (p. 41).

If analog or digital modulation (or mixed modulation) is to be used, also gather any other equipment to be used (such as a two-channel analog/digital signal generator).

### 5.2.2 Select an Operating Mode

To select an operating mode for the CellX unit:

1. Start the Coherent Connection software.
2. When the user interface displays, click the down arrow to select the individual laser that is desired to define an operating mode.

   The operating mode cannot be changed while the laser is emitting.
3. If the selected laser is active, click the **Stop** button. Notice that the button then displays as **Start**, awaiting actions to be completed before the laser is started again.
4. Click the **Advanced** tab for that laser.
5. From the Operating Mode drop-down menu, select the Operating Mode needed for that individual laser. Refer to the example in Figure 5-1:

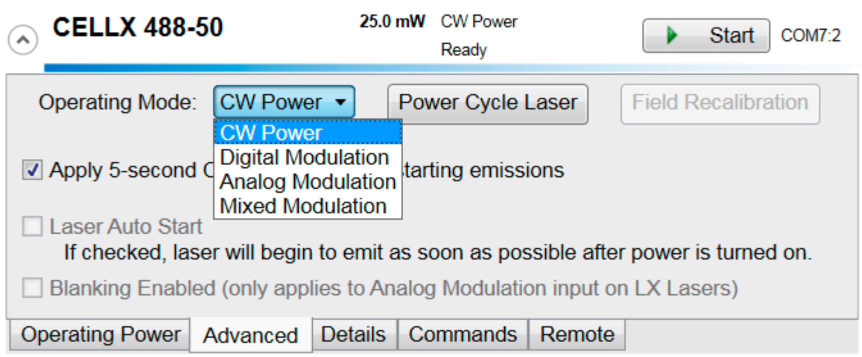


**Figure 5-1. Advanced Tab–Select Operating Mode**

Note that all lasers in the CellX laser system operate in power mode, rather than current mode. Power modes are more accurate, with small modulation overshoots, but are slower to do modulation.

For remaining instructions, see information about each operating mode in the sections that follow.

## 5.2.3 Operating States Displayed

Notice that the information displayed beside the name of the individual laser indicates the power draw, the operating mode, and the state. Each of these operating modes are described in the sections that follow.

The state of readiness can vary, and users can select different operating modes for an individual laser. Information for different modes changes, as shown in the example in Figure 5-2:

To see more information about the state of the CellX unit as well as an individual laser, hover the mouse over the text. A pop-up box displays the status, as shown in Figure 5-3:

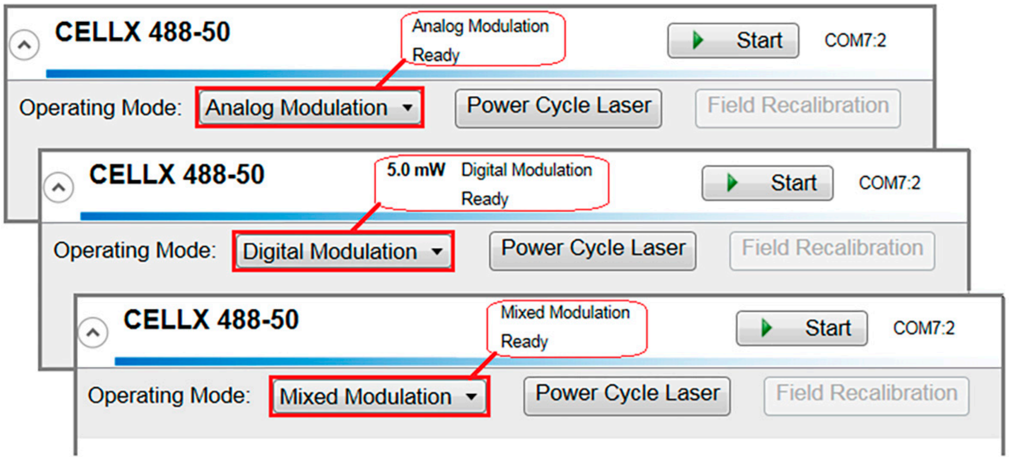


**Figure 5-2. Examples of Operating Modes**

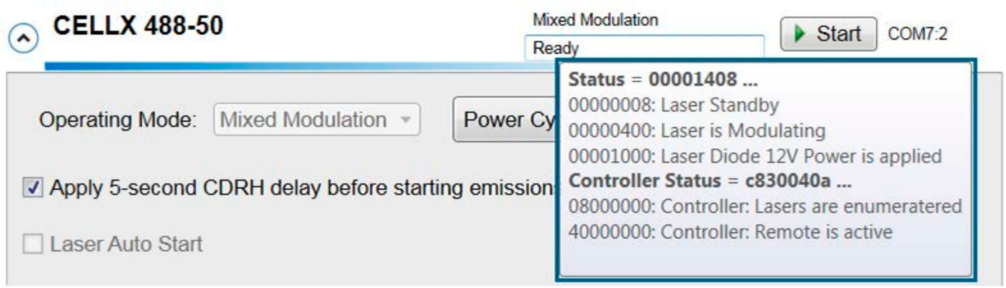


**Figure 5-3. Pop-Up Box with Status**

The states displayed are shown in the tables that follow. Note that only the states appropriate to that laser are displayed. Not all states apply to all lasers.

Table 5-2 shows the various states for the CellX unit.

**Table 5-2. States for the CellX**

| Status Code | State | Description |
|---|---|---|
| 00000100 | Controller warm-up | Laser heads are still warming up. |
| 00100000 | External Analog Mode Pin Selected | External Analog Modulation Mode Pin is selected. |
| 00200000 | External Digital Mode Pin Selected | External Digital Modulation Mode Pin is selected. |
| 02000000 | Controller Standby | Key switch is in “STANDBY” position. |
| 04000000 | Controller Interlock | “INTERLOCK” is open. |
| 08000000 | Controller Enumeration | One or more laser heads have been enumerated. |
| 10000000 | Controller Error | Controller error flag. |

**Table 5-2. States for the CellX**

| Status Code | State | Description |
|---|---|---|
| 20000000 | Controller Fault | Controller fault status. |
| 40000000 | Remote Active | Host is connected. |
| 80000000 | Controller Indicator | Status word is from controller. |

Table 5-3 shows the various states for OBIS LS/LX lasers inside the CellX unit.

**Table 5-3. States for the Lasers**

| Status Code | State | Description |
|---|---|---|
| 00000001 | Fault Detected. | Laser head faults. |
| 00000002 | Emitting | Laser emission status. |
| 00000004 | Laser Ready | Laser ready status. |
| 00000008 | Ready | Laser standby status. |
| 00000010 | CDRH | Laser CCRH delay status. |
| 00000020 | HW Fault Detected | Hardware-related faults. |
| 00000040 | Laser Error | Laser Error is queued. |
| 00000080 | Laser Power Calibration | Laser power is within factory calibration specifications. |
| 00000100 | Warming Up | Laser warm-up status. |
| 00000200 | Not used for CellX. | |
| 00000400 | External Opt Mode | External operating mode is selected. |
| 00001000 | Power Supply Present | If the12 V for the diode is above 9V, then laser emission is possible. |
| 02000000 | Controller Standby | Always 0. |
| 04000000 | Controller Interlock | Always 0. |
| 08000000 | Controller Enumeration | Always 0. |
| 10000000 | Controller Error | Always 0. |
| 20000000 | Controller Fault | Always 0. |
| 40000000 | Remote Active | Always 0. |
| 80000000 | Controller Indicator | Always 0. |

## 5.3 Continuous Wave (CW) Operation

This section describes the Continuous Wave (CW) operating mode, which is the default operating mode for the CellX laser system.

Continuous Wave (CW) operating mode is a closed light loop circuit internal to the laser itself that operates the laser in a constant power mode.

The laser output power can be adjusted using the Coherent Connection software. Power can be adjusted from 1% to 110% of the nominal power.

***NOTICE***
**By default, the CellX laser system operates in Continuous Wave (CW) mode. Changing from CW Operating mode to any other operating mode requires a USB connection to run either Coherent Connection software or a terminal program (such as Windows HyperTerminal).**

To select Continuous Wave (CW) operating mode:

1. Make sure that the Interlock Plug is connected to the DB37 connector at the back of the CellX unit.
2. Start the Coherent Connection software.
3. When the user interface displays, click the down arrow to select the individual laser desired to define an operating mode.
4. If the selected laser is in operation, click the **Stop** button. Operating modes cannot be changed while the laser is emitting. Notice that the button now displays as **Start**, awaiting actions to be completed before you again start the laser.
5. Click the Advanced tab for the selected laser.
6. Click the drop-down menu for ‘Operating Mode’ and then select **CW Power**. Refer to Figure 5-4.

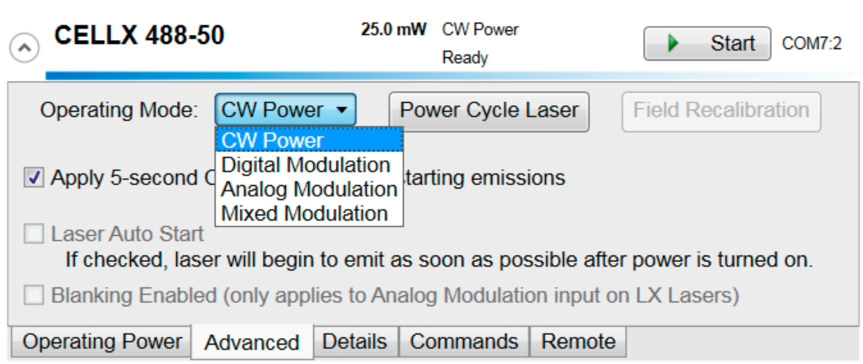


**Figure 5-4. Coherent Connection–Advanced Tab, Operating Mode**

7. After the Operating Mode is selected for the desired individual laser, click the Operating Power tab, as shown in Figure 5-5:

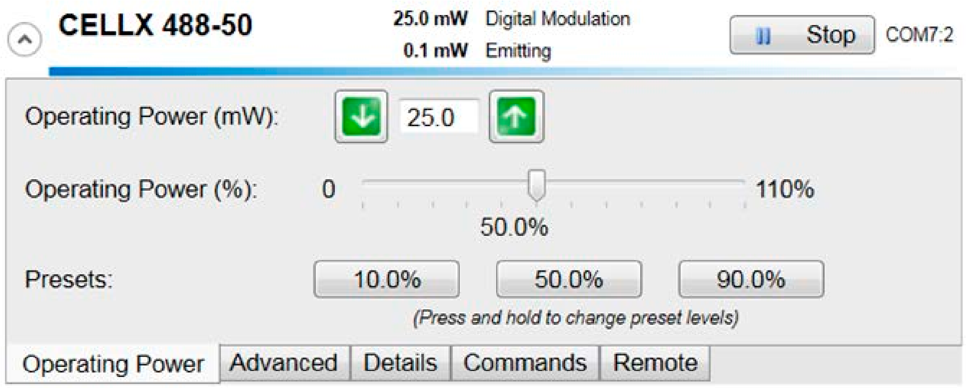


**Figure 5-5. Adjust Operating Power**

8. Change the output power level in a variety of ways in the user interface:
   - Increase or decrease the default value by clicking the green up/down arrows
   - Type a value in the 'Operating Power (mW)' dialog box
   - Use the 'Operating Power (%)' slider control
   - Apply or set preset power level values by clicking the buttons next to Presets (**10**, **50** or **90** %).

     If changes cannot be made, remember that changes cannot be made while the laser is in operation. Check the status information above the dialog box to see if the laser is emitting or warming up.
   - If the laser is emitting, first click the **Stop** button, and then make any desired changes to the power levels.

   If the laser is warming up, the **Stop** button is grayed out. Users must wait until the laser completes warm-up and is emitting; the **Stop** button is then activated.

9. When done making changes to the operating power, click the **Start** button.

   The **Start** button is grayed out if either Analog Modulation or Mixed Modulation was selected as the Operating Mode.

## 5.4 Analog Modulation

The internal lasers can be controlled with the analog input to:

- Change the output power

- Perform modulation with an arbitrary waveform
- Apply a square wave of different voltage levels, and control the laser with different output power levels

When operating the CellX laser system with Analog Modulation, each individual laser can be controlled with analog input to change laser output power.

The lasers in the CellX unit use a closed light loop circuit, internal to the laser itself. With analog input, the power modulates with an arbitrary sine wave, triangle wave, square wave, or any arbitrary waveform to control the laser at different power levels.

Power on/off for each wavelength channel can be individually controlled with an external DC voltage source, at up to 50 kHz bandwidth.

Analog voltage input to the lasers range from 1% to 110% of nominal.

- At 0 V input, there is minimum output power.
- At 5 V input, the laser operates at 110% of the nominal power.

### 5.4.1 Set-Up for Analog Modulation

Modulation signals are connected to the back of the CellX laser system through connectors such as the control boards described in 'Options for Control Accessories' (p. 41).

To set up the unit to use Analog Modulation:

1. Toggle the switch on the power supply to set power to OFF to the CellX laser system.
2. Connect a control board for the analog signal to the laser.
3. Connect a signal generator (such as a two-channel analog/digital signal generator) to the control board.
4. Toggle the switch on the power supply to set power to ON to the CellX laser system.

### 5.4.2 Select and Apply Analog Modulation

To select Analog Modulation mode for an individual laser:

1. Start the Coherent Connection software.
2. When the user interface displays, click the down arrow to select the individual laser for which you want to define an operating mode.

3. If the selected laser is in operation, click the **Stop** button. The operating modes cannot be changed while the laser is emitting. Notice that the button now displays as **Start**, awaiting actions to be completed before the laser is restarted.

4. Click the Advanced tab.

5. From the 'Operating Mode' drop-down menu, select **Analog Modulation** as the operating mode, as shown in Figure 5-6.

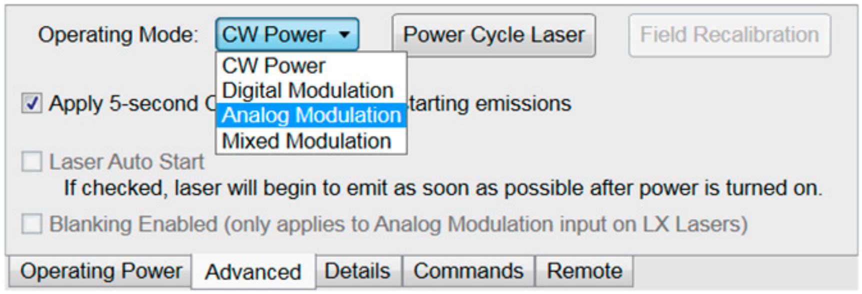


**Figure 5-6. Operating Mode–Select Analog Modulation**

6. Click the Remote tab.

7. Apply analog voltage (0 V to 5.0 V). This can be done either with the appropriate pins on the DB37 connector or through an accessory control board connected to the CellX laser system.

   The laser power adjusts from a minimum of 1% up to 110%, with a corresponding analog voltage from 0 V to 5 V. Figure 5-7 shows:

   - When blanking function is enabled.
   - At 5 volts, the laser operates at 110% of the nominal power.

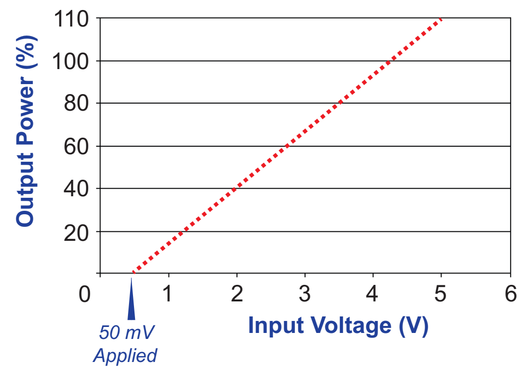


**Figure 5-7. Analog Modulation Power vs. Input Voltage**

## 5.4.2.1 Modulation Input Voltage Levels

Table 5-4 shows voltage levels for the analog modulation input. It also shows the related laser output power.

**Table 5-4. Analog Modulation Input Voltage Levels**

| Analog Modulation | % of Nominal Power | Voltage at Input | Laser Output Power @ 50 mW | Laser Output Power @ 100 mW |
|---|---|---|---|---|
| Maximum Power | 110% | 5.0 V | 55 mW | 110 mW |
| Nominal Power | 100% | 4.55 V | 50 mW | 100 mW |
| Minimum Power | Varies by laser | 0.0 V | 0* | 0* |

* Blanking is enabled

***NOTICE***

**Blanking is always set to on (by default) for the CellX unit. The output at 0 V is 0 W, not the minimum power (1%).**

Figure 5-8 shows a typical waveform when Analog Modulation is used with an OBIS LX 405 nm laser at 50 KHz.

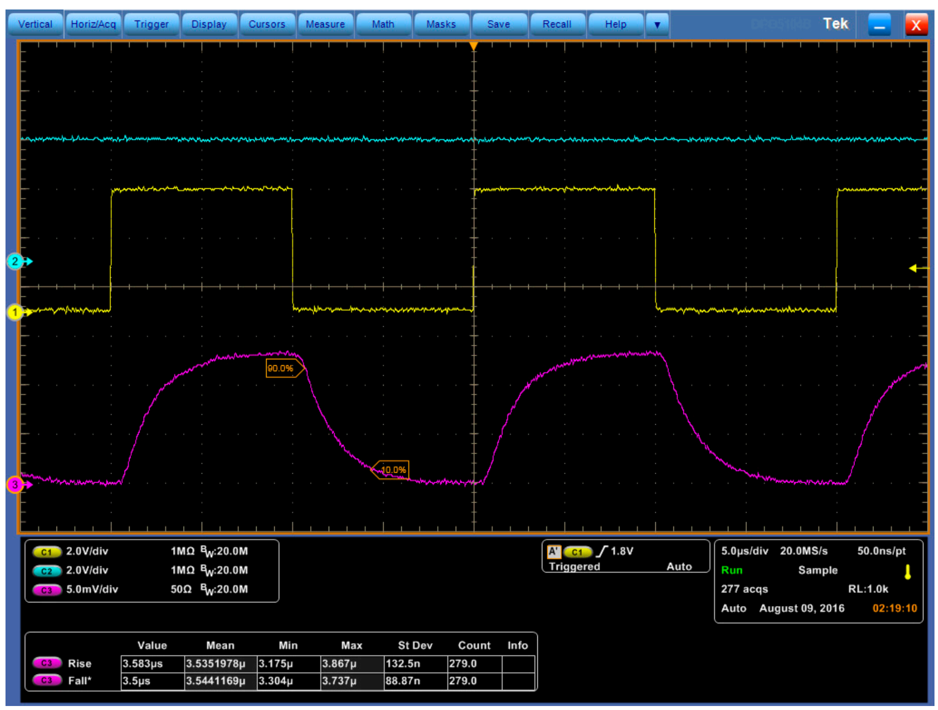


**Figure 5-8. Analog Modulation–LX 405 nm Laser @ 50 KHz**

The blue line is the digital modulation input, the yellow line is the analog modulation input, and the magenta line is the detector output.

# 5.5 Digital Modulation

The CellX laser system can be controlled with digital input to turn laser output power from ON to OFF (and vice versa).

The digital power mode in the CellX drives the lasers to turn on or completely off in a closed light loop circuit internal to the laser itself. The ‘laser on’ power level is adjustable using Coherent Connection software.

## 5.5.1 Set-Up for Digital Modulation

Modulation signals are connected to the back of the CellX laser system through connectors such as the control boards described on p. 41. The operating mode for the CellX unit is determined by the pins that are set on these control boards.

To set up equipment for digital modulation mode:

1. Connect a signal generator (such as a two-channel analog/digital signal generator) to the control board or appropriate pins on the DB37 connector.
2. Toggle the switch on the Power Supply to turn power OFF to the CellX laser system.
3. Connect a digital signal into the CellX unit using an accessory control board. See ’Options for Control Accessories’ (p. 41) for a list of control boards available for CellX. These connectors are set with 2K Ω input impedance for digital modulation.
4. Connect a signal generator (such as a two-channel analog/digital signal generator) to the control board.
5. Toggle the switch on the power supply to turn power ON to the CellX laser system.

## 5.5.2 Select and Apply Digital Modulation

To select Digital Modulation mode for an individual laser:

1. Start the Coherent Connection software.
2. When the user interface displays, click the down arrow to select the individual laser desired to define an operating mode.
3. If the selected laser is in operation, click the **Stop** button. Operating Modes cannot be changed while the laser is emitting. Notice that the button then displays as **Start**, awaiting actions to be completed before you again start the laser.

4. Click the Advanced tab.
5. On the Advanced tab for the selected laser, click the drop-down menu for Operating Mode and select **Digital Modulation**, as shown in Figure 5-9:

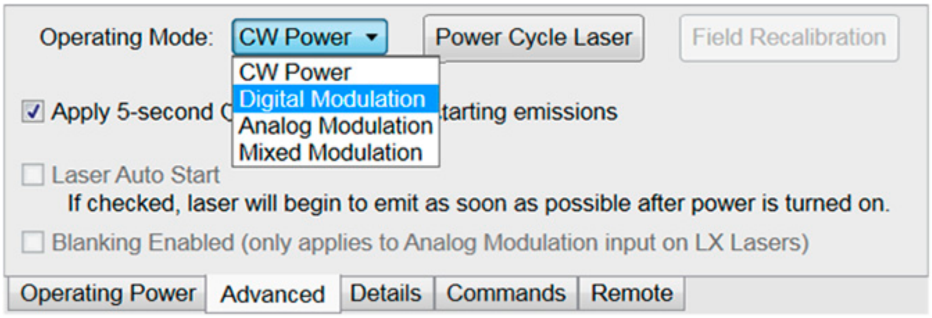


**Figure 5-9. Operating Mode–Select Digital Modulation**

6. Apply digital voltage (0 V to 5.0 V) through the control board on the back of the CellX laser system.

   Power on/off for each wavelength channel can be individually controlled digitally, at up to 50 kHz bandwidth. Digital voltage input to the lasers range from 0 V to 5 V.

   - With voltages < 1 V = zero output power.
   - With voltages > 2 V, the laser operates at 100% of set power.

## 5.5.3 Input Voltage Levels for Digital Modulation

The lasers in the CellX laser system can be modulated in Digital mode from minimum power to the set power.

Table 5-5 shows the input voltage levels for Digital Modulation:

**Table 5-5. Digital Modulation Input Voltage Levels**

| Descrip-tion | Setting | Voltage at the SMB Input | Laser Output Power |
|---|---|---|---|
| Digital ON | Set Power | > 2.0 VDC | Set Power |
| Digital OFF | Minimum Power | < 1.0 VDC | 0 mW |

Figure 5-10 shows typical waveforms and rise/fall time under Digital Modulation for an OBIS LX 405 nm laser at 50 KHz. The blue line is the digital modulation input, the yellow line is the analog modulation input, and the magenta line is the detector output.

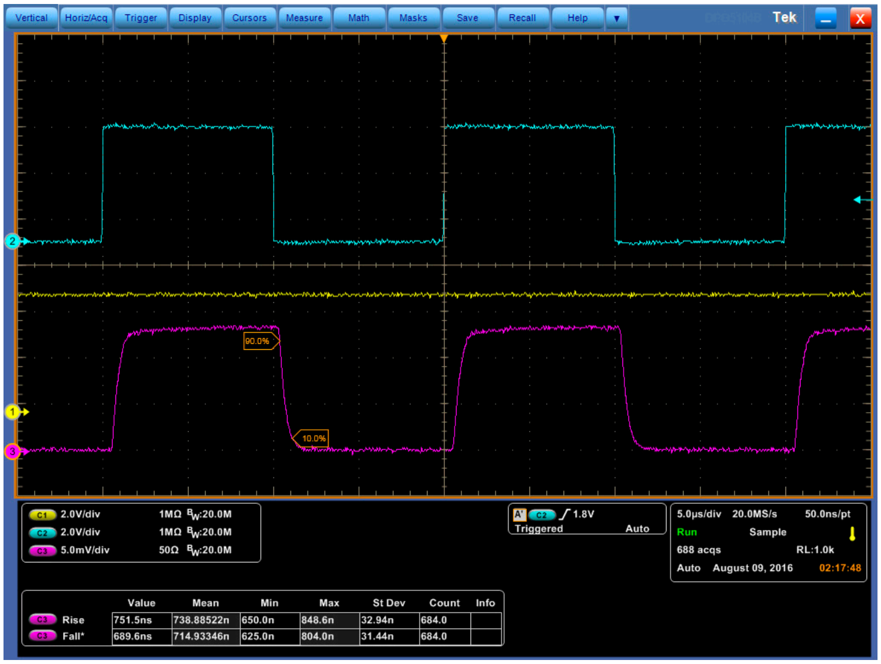


**Figure 5-10. Digital Modulation – LX 405 nm Laser @ 50 KHz**

## 5.6 Mixed Modulation

The CellX laser system can be operated with a simultaneous analog signal and digital signal to change laser output. This operating mode for Mixed Modulation requires the use of one of the Control Boards described in 'Options for Control Accessories' (p. 41).

Mixed Modulation mode in the software controls outputs separately for each individual wavelength channel by using:

- An external analog voltage to vary the laser power level, from 0.0 VDC to 5.0 VDC.
- A digital signal to set the laser signal ON and OFF, at up to 50 kHz bandwidth.

The combination of both of these together in Mixed Modulation mode drives the output power. Adjust power with analog modulation while simultaneously turning the laser ON and OFF with digital input.

### 5.6.1 Set Up for Mixed Modulation

To control the lasers using Mixed Modulation signals on the CellX:

Modulation signals are connected to the back of the CellX laser system through connectors such as the control boards described on p. 41. The operating mode for the CellX unit is determined by the pins that are set on these control boards.

For Mixed Modulation mode, set up both Digital and Analog Modulation, as follows:

**To first set up equipment for Digital Modulation mode:**

1. Toggle the switch on the Power Supply to set power to OFF to the CellX laser system.
2. Connect a signal generator (such as a two-channel analog/digital signal generator) to the Control Board.

**To then select Analog Modulation:**

1. Connect an analog signal into the CellX unit using a Control Board. See 'Options for Control Accessories' (p. 41) for a list of control boards available for CellX. These connectors are set with 2K Ω impedance for digital modulation.
2. Connect a signal generator (such as a two-channel analog/digital signal generator) to the control board.
3. Toggle the switch on the power supply to set power to ON to the CellX laser system.

## 5.6.2 Select and Apply Mixed Modulation Mode

To select Mixed Modulation for an individual laser:

1. Start the Coherent Connection software.
2. When the user interface displays, click the down arrow to select the individual laser for which you want to define an operating mode.
3. If the selected laser is in operation, click the **Stop** button. Operating modes cannot be changed while the laser is emitting. Notice that the button then displays as **Start**, awaiting actions to be completed before you again start the laser.

4. On the Advanced tab for the selected laser, click the drop-down menu for Operating Mode. Then, select **Mixed Modulation**, as shown in Figure 5-11:

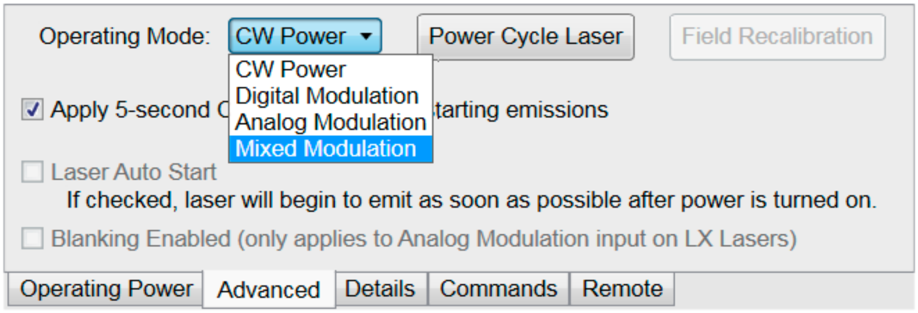


**Figure 5-11. Operating Mode–Select Mixed Modulation**

5. Apply **digital** voltage (0.0V to 5.0V) through the signal generator to the Control Board on the CellX laser system.
6. Apply **analog** voltage (0.0V to 5.0V) through the signal generator to the control board on the CellX laser system.

### 5.6.3 Example: Mixed Modulation Mode

The CellX laser system offers **Mixed Modulation** mode to drive the laser in a closed light-loop control.

Figure 5-12 shows a plot for mixed modulation for an OBIS LX 405 nm laser, with Analog Modulation at 5 KHz and digital modulation at 50 KHz.

The blue line is the digital modulation input, the yellow line is the analog modulation input, and the magenta line is the detector output.

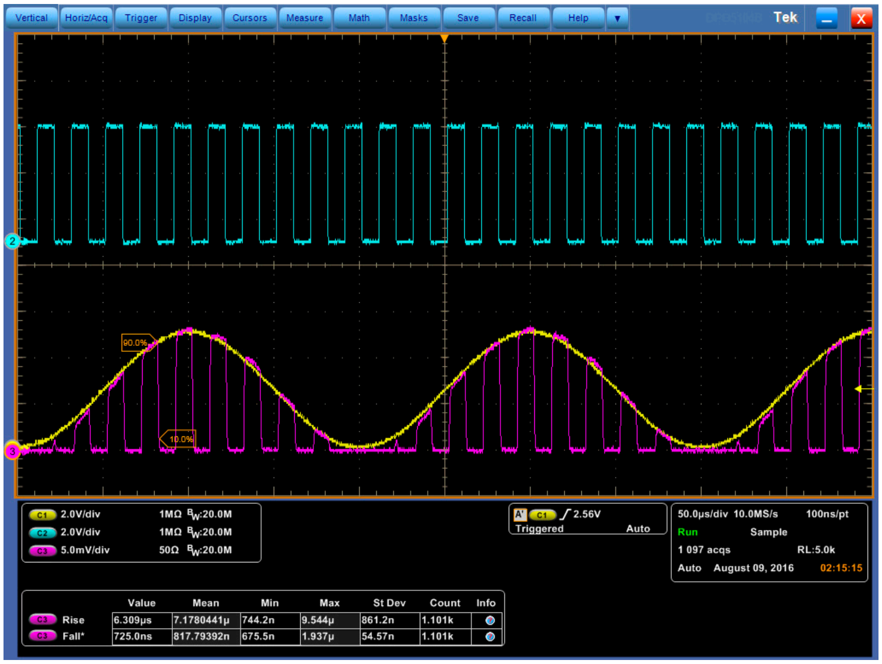


**Figure 5-12. Mixed Modulation – 405 nm Laser**

# 6 External Control Host Interface

This section describes the host interface commands, queries, and responses for the CellX laser system.

*NOTICE*

**Some commands used with individual CORE LX or CORE LS lasers are not available in the CellX command set.**

**Enter the query enter <LIST?> or see ’Commands and Queries’ (p. 140) for a complete list of CellX commands.**

The CellX laser system uses the same command set as other multi-laser products, such as the OBIS Laser Box or the OBIS 6-Laser Scientific Remote.

## 6.1 Message Considerations

This section describes the following conventions:

- Message terminators
- Message syntax
- Command prompt
- Broadcast commands
- USB and RS-232 Interface

### 6.1.1 Message Terminators

This section describes message terminators.

All ASCII message strings passing through the host interface are terminated to signal the end of a message string.

A command or query is considered incomplete without proper termination.

#### 6.1.1.1 Messages Received by CellX

Messages received by the device must be terminated by a carriage return (decimal 13). Line feed characters (decimal 10) are discarded so message terminator flexibility can be attained. The maximum length of any message received by the unit is limited to 200 bytes.

#### 6.1.1.2 Messages Sent by CellX

All messages sent by the device are terminated by a carriage return (decimal 13) and line feed (decimal 10) pair.

### 6.1.2 Message Syntax

Syntax specified by the SCPI and IEEE 488.2 Standards is followed unless otherwise specified. Refer to those Standards and specifications for detailed information about SCPI commands and syntax.

Notably, the base-10 numeric data format specification is used heavily in this document and covered in the IEEE 488.2 Standard. Unless otherwise specified, numeric data items referred to as NRf (IEEE flexible numeric representation) are interchangeable and can be represented in any of these formats:

- Integer values
- Non-scientific notation floating point values
- Scientific notation floating point values (upper or lower case E)

For example, the following data values are functionally equivalent:

- 31256
- 31256.0
- 3.1256E4
- 31.256E3
- +3.1256E+4

Unless otherwise specified, non-numeric data items (typically referred to as strings) will not be quoted.

Devices interpret hexadecimal data using the following rules:

- Upper case and lower case are accepted ("FE" is the same as "fe")
- Leading zeros are not required and are accepted ("0A" is the same as "A")

- The data string can optionally be preceded by a “0x” or “0X” C hexadecimal notation idiom (0xD2C4 is the same as D2C4)
- Following the optional “0x” prefix, the acceptable characters come from the list 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, a, b, c, d, e, f, A, B, C, D, E, and F

Enumerated values must match exactly using the long form/short form comparison rules defined under the SCPI Standard.

Dates (manufacturing date, calibration date, etc) shall use the YYYYMMDD format. Using this format dates can be stored as ASCII strings or as numeric long integers and converted easily from one format to the other.

#### 6.1.2.1 Laser Module Selection Syntax

Many common commands are supported by all OBIS devices. When such a command is transmitted by a host workstation to a system of devices (a controller and one or more laser heads), an ambiguity exists where the exact destination device is not clear.

The SCPI protocol provides a method to communicate with multiple virtual devices within an instrument. Since a complete CellX laser system could be considered an “instrument” (controller) with multiple “virtual devices” (laser heads), this mechanism is used to disambiguate the destination of a command.

An SCPI command consists of one or more words separated by delimiters. The first word in a command string is called the base word.

SCPI channel selection is performed by appending a numeric suffix to the base word in any command string. When the numeric suffix is left off or has a value of zero the command refers to the first connected device.

For example, “*idn?* and “*idn0?” query strings both refer to the first connected device and, in the case of CellX, the controller is the first. If a host workstation is connected to CellX and this query is issued, it will be responded to by the controller logic.

- If the host issues the “*idn?” query, the CellX controller should respond.
- If, however, the host appends a numeric suffix to the base word of the query, then the suffix specifies the device that should respond. In this scenario:
    - ‘*idn?’ and ‘*idn0?’ would be responded to by the CellX controller.
    - ‘*idn1?’ would be responded to by the laser head in the first slot.
    - ‘*idn2?’ would receive a response from the laser module in slot 2.

The numeric suffix mechanism can be applied to the base word of any command or query.

As an implementation detail, the laser modules always respond to commands with either the suffix of 1…4 or 255 to accommodate connections to a bus and also directly to a host workstation.

The numeric suffix of 255 refers to a command (not query) that is broadcast to all devices on the bus. Queries cannot be broadcast because a stream of query results does not make any sense to the host. As an example:

- The command 'SYSTem255:PROMpt ON' enables the system prompt for all devices
- The command 'SYSTem0:PROMpt ON' enables the prompt for the first connected device.

In summary, the suffix addressing is assigned as follows:

**Table 6-1. Numeric Suffix Channel Addressing**

| Suffix | Address |
|---|---|
| **0** | Controller commands or queries, the zero is optional |
| **1** | Laser module in Channel #1 |
| **2** | Laser module in Channel #2 |
| **3** | Laser module in Channel #3 |
| **4** | Laser module in Channel #4 |
| **255** | All laser modules |

### 6.1.2.2 CellX Notation Conventions

For commands and queries, in general:

- Enter commands with the appropriate value after the command and a space between the command and the value.
- To query a laser, add a question mark (?) at the end of the command.

Table 6-2 provides a few examples:

Following is a brief description of the notation conventions for CellX commands:

- Parameter(s) following a control command is required.

**Table 6-2. Examples of Syntax**

| Example | Description |
|---|---|
| `*idn?` | Returns the information of the CellX controller base unit. |
| `*idn2?` | Returns the information of the CellX laser in Channel #2. |
| `SOURce4:AM:STATe?` | Returns the laser emission state of laser in Channel #4. |
| `SOURce255:AM:STATe ON` | Turns on all lasers simultaneously. |

- Item(s) within the angle brackets following a control or query command is required.
- Item(s) within the curly brackets following a control or query command is optional.
- Acceptable parameters or items required for a control or query command are separated by the OR symbol “|”.
- The upper and lower bounds of the range for a parameter or item are given in parentheses.

## 6.1.3 Command Prompt

Each device implements the ability to output a command prompt to support interactive operation by an operator typing commands in a terminal program. A command has been specified to describe the command prompt behavior (see p. 145).

Note that the command prompt is not transmitted in response to a command that has been broadcast to all devices.

## 6.1.4 Broadcast Commands

It is possible that a host message could be broadcast to all attached devices. Generally, the broadcast capability is best used when a command is needed to synchronize the action of a group of devices (such as turning all connected lasers on or off simultaneously). The ability to broadcast device queries is prohibited.

CellX responds to queries that are broadcast by returning error -400, along with optional handshake and command prompt strings.

CellX responds to a command that is broadcast by:

- Rebroadcasting it to all devices on the bus,.
- Performing the broadcast action locally if appropriate for the command.
- Returning any optional handshake and command prompt strings to the host.

This method allows the host to receive a single handshake and/or command prompt when a command is broadcast to several devices.

Table 6-3 provides examples of broadcast commands:

**Table 6-3. Syntax Examples—Broadcast Commands**

| Example | Description |
|---|---|
| `SOURce255:AM:STATe ON` | Turns on all lasers simultaneously. |
| `SOURce255:AM:STATe?` | Returns error -400. |

### 6.1.5 USB and RS-232 Interface

This section describes considerations when using the USB or RS-232 interfaces.

- **USB**: When the device is connected to a host via USB, it shall be viewed as a virtual serial communications port.
- **RS-232**: When using an RS-232 interface, no software or hardware flow control methods for serial communication will be used.

## 6.2 Commands and Queries

The following sections provide descriptions of the these commands and queries:

***NOTICE***

**When a command is sent to the CellX laser system, the parameter for the command is stored in internal persistent memory.**

**Internal persistent memory has a logic cell life of one million cycles for the laser or 10,000 cycles for the laser system. The cell life sets the limits for repetitive commands sent to the laser.**

**This information applies only to commands and not to queries.**

## 6.2.1 Mandatory Host Commands and Queries

The CellX control and query command set conforms to the Standard Commands for Programmable Instruments (SCPI) that specifies a mandatory set of IEEE-488.2 commands. All commands and queries begin with an asterisk.

- An SCPI control command consists of a header built with keyword(s) plus one or more optional parameters. The header and the parameter(s) are separated by a space.
- A query command is formed by directly appending a question mark to the end of the header.

Table 6-4 summarizes the SCPI common commands and queries. For specific command or query details, refer to the page listed in the right column.

**Table 6-4. Mandatory Commands and Queries**

| Commands and queries | Description | Page |
|---|---|---|
| **IEEE-488.2** | | |
| ***IDN?** | Obtains the laser's identification string. | p. 142 |
| ***RST** | Resets all operational parameters to power-on states. Reset does not affect calibration settings. | p. 143 |
| ***TST?** | Starts a laser self-test procedure, if implemented. | p. 143 |
| **LIST?** | Returns all available SCPI commands in the system. | p. 144 |
| **SESSION CONTROL** | | |
| SYSTem:COMMunicate:HANDshaking {ON\|OFF} | Toggles the system handshaking. | p. 144 |
| SYSTem:COMMunicate:HANDshaking? | Queries the system handshaking. | p. 144 |

**Table 6-4. Mandatory Commands and Queries (Continued)**

| Commands and queries | Description | Page |
|---|---|---|
| **SYSTem:COMMunicate:PROMpt {ON\|OFF}** | Toggles the system command prompt. | p. 145 |
| **SYSTem:COMMunicate:PROMpt?** | Queries the system command prompt. | p. 145 |
| SYSTem:COMMunicate:SERial:BAUD | Selects transmit and receive baud rates together when the device has an RS-232 serial host port. | p. 145 |
| SYSTem:COMMunicate:SERial:BAUD? | Queries the currently selected baud rate. | p. 145 |
| **SYSTem:AUTostart {ON\|OFF}** | Enables or disables the laser Auto Start feature. | p. 145 |
| **SYSTem:AUTostart?** | Queries the laser Auto Start feature. | p. 145 |
| **SYSTem:STATus?** | Queries the system status code. | p. 146 |
| **SYSTem:FAULt?** | Queries current system faults. | p. 147 |
| **SYSTem:INDicator {ON\|OFF}** | Turns the laser status indicator (LED) on or off. | p. 148 |
| **SYSTem:INDicator?** | Queries the laser status indicator. | p. 148 |
| ERROR COLLECTION AND REPORTING | | |
| **SYSTem:ERRor:COUNt?** | Queries the number of records in the error queue. | p. 149 |
| **SYSTem:ERRor:NEXT?** | Queries the next records in the error queue. | p. 149 |
| **SYSTem:ERRor:ALL?** | Queries all records in the error queue. | p. 149 |
| **SYSTem:ERRor:CLEar?** | Clears all records in the error queue. | p. 150 |

***NOTICE***
**Include a numeral to the base word in the query for any laser channel. No numerical suffix has the same result as use of a zero. For example, *idn? = *idn0? The response would be returned from the CellX controller.**

**Refer to the assigned suffix address parameters in Table 6-1 (p. 138)**

### 6.2.1.1 IEE488.2 Mandatory Commands

Following are commands that conform to the IEEE-488.2 Standard.

#### 6.2.1.1.1 Identification Query

Gets the laser's identification string, such as model name, firmware version, and firmware date.

| | |
|---|---|
| QUERY | `*IDN?` |
| REPLY | `“Coherent, Inc” + “-” + <model name> + “-” + <firmware version> + “-” + <firmware date>` |

The dash sign separates all fields within the reply string.

- The first field is always ‘Coherent, Inc’.
- The second field is the model name, which varies based on the laser.
- The third field is the firmware version number, with the format “V<major>.<minor><optional qualifier characters>”.
- The fourth field is the firmware date, having the form YYYYMMDD.

The reply string is not quoted.

A typical identification string might be displayed as follows:

```
Coherent, Inc - OBIS 405nm 50mW C - V1.3 -
20090630
```

#### 6.2.1.1.2 Reset Command

Resets all operational parameters to power-on states. This command can be used to clear a fault condition. Reset does not affect calibration settings.

| | |
|---|---|
| COMMAND | `*RST` |
| REPLY | None |

Message handshaking, if enabled, is transmitted prior to the execution of reset. If the command is not implemented, then no error is returned and no response is necessary.

#### 6.2.1.1.3 Self-Test Query

Starts a laser self-test procedure, if implemented. Any detected faults are set in the laser fault code.

| | |
|---|---|
| QUERY | `*TST?` |
| REPLY | `<System Fault Code>` |

The returned system fault code is formatted as a 32-bit hex value. A value of 0 indicates no fault conditions. If the self-test is not implemented, a value of `0xffffffff` is returned.

#### 6.2.1.1.4 SCPI Commands Query

Returns the entire list of SCPI commands available in the CellX system.

| | |
|---|---|
| QUERY | **`LIST?`** |
| REPLY | **`Returns the entire list of SCPI commands.`** |

### 6.2.1.2 Session Control Commands and Queries

The CellX system commands and queries access functionality that is exclusive of laser module functions. These commands can be sent at any time without affecting any other functions in progress.

#### 6.2.1.2.1 Message Handshaking

Toggles the state of SCPI message round trip handshaking on and off. Setting is saved in persistent memory. Factory default is ON.

| | |
|---|---|
| COMMAND | **`SYSTem:COMMunicate:HANDshaking {ON|OFF}`** |
| REPLY | **`OK`** if **`ON`** is selected; otherwise, no reply is sent. |

| | |
|---|---|
| QUERY | **`SYSTem:COMMunicate:HANDshaking?`** |
| REPLY | **`ON|OFF`** |

If handshaking is ON:

- Empty commands (those with only whitespace characters) are ignored.
- Valid commands with valid data reply with **`OK\r\n.`**
- Valid queries with valid data will reply as explicitly defined elsewhere in this document followed by **`OK\r\n`**.
- Valid commands or queries that result in an error reply with **`ERR<n>\r\n`**, where <**n**> is the error code number.
- Unrecognized commands or queries will reply with **`ERR<n>\r\n.`**
- Error queuing occurs as explicitly defined elsewhere in this document.

If handshaking is OFF:

- All command and query response behavior is explicitly defined elsewhere in this document.

Note that the handshaking reply is not transmitted in response to a command that has been broadcast to all devices, except by a controller device.

### 6.2.1.2.2 Command Prompt

Toggles the system command prompt on and off. The setting is saved in persistent memory. Factory default is OFF.

| | |
|---|---|
| COMMAND | **SYSTem:COMMunicate:PROMpt {ON\|OFF}** |
| QUERY | **SYSTem:COMMunicate:PROMpt?** |
| REPLY | **ON\|OFF** |

When enabled, the device outputs a command prompt after each reply string. The command prompt is preceded by a carriage return and line feed, and consists of a “**>**” character and a space character.

Note that the command prompt is not transmitted in response to a command that has been broadcast to all devices, except by a controller device.

### 6.2.1.2.3 Baud Rate Settings

The following command selects transmit and receive baud rates together when the device has an RS-232 serial host port. The default setting is 115200.

The command has no effect when the device has a USB host port.

- If SCPI message handshaking is enabled, the new baud rate takes effect after the handshake is transmitted.
- If SCPI message handshaking is disabled, the new baud rate takes effect immediately.

Baud Rate options include:

**{9600|14400|19200|38400|57600|115200}**

The query returns the currently selected baud rate.

| | |
|---|---|
| COMMAND | **SYSTem:COMMunicate:SERial:BAUD {BAUD RATE}** |
| QUERY | **SYSTem:COMMunicate:SERial:BAUD?** |
| REPLY | **9600\|14400\|19200\|38400\|57600\|115200** |

### 6.2.1.2.4 Auto Start Command

Enables or disables the laser Auto Start feature. Setting is saved in persistent memory. Factory default is OFF.

If Auto Start is enabled, when the device is powered up, the device automatically starts emission at a previously-set level.

| | |
|---|---|
| COMMAND | `SYSTem:AUTostart {ON|OFF}` |
| QUERY | `SYSTem:AUTostart?` |
| REPLY | `ON|OFF` |

The Auto Start setting is saved in the non-volatile memory of the laser. If the laser is connected to an CellX through a Control Board, this setting is overridden by the hardware switch of the Control Board. However, the ON/OFF position of the switch does not overwrite the setting in the laser memory.

#### 6.2.1.2.5 System Status Query

Gets the system status code. The status code is returned in a string expressed in uppercase hex. The MSB of the code is used to indicate decimal integer form. The 32-bit word represents a bit-mapped status indicator.

The code represents the status of a controller or a laser. If the MSB is set, the code represents controller status. This is important because the meaning of some bits is subtly different for a controller.

| | |
|---|---|
| COMMAND | None |
| QUERY | `SYSTem:STATus?` |
| REPLY | `<status word>` |

As an example, if the laser is turned on but is being delayed by the CDRH required delay, the system status query returns:

**00000012** (*Laser emission enabled but delayed by CDRH*)

Table 6-5 describes status code bit mapping.

- The 'Controller' column specifies the meaning of each bit when the status word is read from the CellX controller.
- The 'Laser' column specifies the bit meaning when the status word is read from an individual laser.
- The status word MSB indicates whether a status word is from a laser head or from a controller.

Unspecified bits are reserved and are zero.

**Table 6-5. Status Code Bit Definitions**

| Bit Code | Mask Value | Bit Label | Description | |
|---|---|---|---|---|
| | | | CellX controller | Laser |
| 0 | 00000001 | Laser Fault | Logical OR from all lasers | Laser fault; Fault words are listed in Table 6-12, "Fault Codes—Individual Lasers," on page 167 |
| 1 | 00000002 | Laser Emission | Logical OR from all lasers | Laser emission status |

**Table 6-5. Status Code Bit Definitions (Continued)**

| Bit Code | Mask Value | Bit Label | Description | |
|---|---|---|---|---|
| | | | CellX controller | Laser |
| 2 | 00000004 | Laser Ready | Logical OR from all lasers | Laser ready status |
| 3 | 00000008 | Laser Standby | Logical OR from all lasers | Laser standby status |
| 4 | 00000010 | CDRH Delay | Logical OR from all lasers | Laser CDRH delay status |
| 5 | 00000020 | Laser Hardware Fault | Logical OR from all lasers | Hardware related fault |
| 6 | 00000040 | Laser Error | Logical OR from all lasers | Laser error is queued |
| 7 | … | … | | |
| 8 | 00000100 | Laser Warm Up | Logical OR from all lasers | Laser warm-up status |
| 9 | 00000200 | N/A | N/A | N/A |
| 10 | 00000400 | External Operating Mode | Logical OR from all lasers | External operating mode is selected |
| 11 | 00000800 | N/A | N/A | N/A |
| 12 | 00001000 | Laser Power Voltage | Logical OR from all lasers | Laser Diode supply power present |
| … | … | … | | |
| 23 | 00100000 | External Analog Mode Pin Selected | External Analog Modulation Mode Pin is selected. | Always 0 |
| 24 | 00200000 | External Digital Mode Pin Selected | External Digital Modulation Mode Pin is selected. | Always 0 |
| 25 | 02000000 | Controller Standby | Keyswitch is in “STANDBY” position. | Always 0 |
| 26 | 04000000 | Controller Interlock | “INTERLOCK” is open | Always 0 |
| 27 | 08000000 | Controller Enumeration | One or more laser heads have been enumerated. | Always 0 |
| 28 | 10000000 | Controller Error | Controller error flag. | Always 0 |
| 29 | 20000000 | Controller Fault | Controller fault status. | Always 0 |
| 30 | 40000000 | Remote Active | Host is connected. | Always 0 |
| 31 | 80000000 | Controller Indicator | Status word is from Controller. | Always 0 |

#### 6.2.1.2.6 System Fault Query

Gets the system fault code. The fault code is returned in a string expressed in uppercase hexadecimal integer form. The 32-bit word represents a bit-mapped fault indicator.

| | |
|---|---|
| QUERY | `SYSTem:FAULt?` |
| REPLY | `<fault word>` |

As an example, if the base plate and laser diode temperature limits are both exceeded, the system fault query returns:

**00000003** (Base Plate & Laser Diode Temp. Limits Exceeded)

The Most Significant Bit (MSB) of the code is always unset. For details about Fault codes, see See ’Fault Codes’ on page 166. (fault code bit mapping).

### 6.2.1.2.7 Turn On/Off Controller Status Indicator

Turns on (or turns off) the status indicator(s) associated with the CellX laser engine. The setting is saved in persistent memory. The factory default is ON.

| | |
|---|---|
| COMMAND | `SYSTem:INDicator {ON|OFF}` |
| QUERY | `SYSTem:INDicator?` |
| REPLY | `ON|OFF` |

This command is used to turn on (or turn off) the Status LED indicator(s) that is visible to the user. However, the status bits returned by **SYSTem:STATus?** are not affected by this command.

Table 6-6 shows the various operating states and their corresponding LED color:

**Table 6-6. Operating States – Laser Status LED Indicator**

| LED Color | Laser Head Operating State |
|---|---|
| **WHITE** | Laser emission |
| **BLUE** | Standby |
| GREEN | Warm-up |
| **GREEN BLINKING** | Warm-up |
| **RED** | Fault/Error |
| **YELLOW** | No lasers detected on start-up |
| YELLOW BLINKING | Firmware update |

### 6.2.1.3 Error Collection and Reporting

Programming and system errors occasionally occur while testing or debugging remote programs and during measurement.

Error strings follow the SCPI Standard for error record definition:

**<error code>,<quoted error string><CR><LF>**

The host queries for errors in two steps.

1. First, the host queries for the number of error records available (N).
2. Secondly, the host queries N times for the error records.

Errors are stacked up to 20 deep. In the case of error overflow, the last error in the error list is an indication of error overflow. Note that the error records defined are the errors generated in response to external commands or queries.

### 6.2.1.3.1 Error Count Query

Gets the number of error records in the error queue at the time of the query.

| | |
|---|---|
| COMMAND | None |
| QUERY | **`SYSTem:ERRor:COUNt?`** |
| REPLY | **`<count of error records stored in integer format>`** |

### 6.2.1.3.2 Error Query

Gets the next error record(s) in the error queue.

- More than one error record can be queried using this optional parameter, which must be an integer value: **`<error record count>`**.
- A single error record is returned if **`<error record count>`** is not specified.

| | |
|---|---|
| COMMAND | None |
| QUERY | **`SYSTem:ERRor:NEXT?`** |
| REPLY | **`<next available error record>`** |

No reply is transmitted if there are no available error records.

As the device transmits each error record:

- The error record is permanently removed from the error queue.
- The queued error record count is decremented by one.

### 6.2.1.3.3 All Error Query

This query gets all error records in the error queue at the time of the query. No reply is transmitted if no error records are available.

| | |
|---|---|
| **COMMAND** | None |
| **QUERY** | `SYSTem:ERRor:ALL?` |
| **REPLY** | `<all available error record(s>` |

After the completion of the reply transmission:

- The error queue is empty.
- The queued error record count is zero.

### 6.2.1.3.4 All Error Clear

Clears all error records in the error queue.

| | |
|---|---|
| **COMMAND** | `SYSTem:ERRor:CLEar` |
| **QUERY** | None |

Table 6-13 lists possible error codes and briefly describes the text strings returned.

**Table 6-7. Error Codes and Description Strings**

| Error Code | Error String | Error Description |
|---|---|---|
| -400 | Query Unavailable | Broadcast of query is prohibited.<br>Occurs when sending a query as a broadcast message. Queries can not be broadcast. |
| -350 | Queue overflow | Error queue is full.<br>Non-**`Queue overflow`**" errors are replaced by **`Queue overflow`** errors when there is exactly one available storage location available in the error queue. No additional errors are added to the error queue if the error queue is full. |
| -321 | Out of memory | Internal memory is exhausted.<br>Occurs when there is an internal memory related error. This error could be caused by exhaustion of the memory heap, overflow of a fixed memory buffer, or similar type of problem. |
| -310 | System error | Unexpected/unrecoverable hardware or software fault.<br>Occurs when the device firmware detects an unexpected or unrecoverable error. This error condition includes unrecoverable hardware faults. |
| -257 | File to open not named | The file open is not possible because the file has not been named. Occurs when an attempt is made to open a file without specifying a file name. |
| -256 | File does not exist | The specified file does not exist.<br>Occurs when an attempt is made to open a file that does not exist. |
| -241 | Device Unavailable | Command was sent to a device that is not available.<br>Occurs when sending a message to a device that is not currently available. |

**Table 6-7. Error Codes and Description Strings (Continued)**

| Error Code | Error String | Error Description |
|---|---|---|
| -221 | Settings conflict | Command not executed due to current device state.<br>Occurs when a command is received that is at odds with the current device settings. |
| -220 | Invalid parameter | The command or query parameter is invalid.<br>Occurs when an invalid parameter has been specified. |
| -203 | Command protected | Command is password protected.<br>Occurs when an attempt is made to execute a password protected command when in user mode. |
| -200 | Execution error | Command is out of order.<br>Occurs when an order-dependent command sequence is issued out of order (for example, when trying to read from a file before the file has been opened). |
| -109 | Parameter missing | No or fewer parameters were received.<br>Occurs when there are no or fewer parameters for a received command or query. |
| -102 | Syntax error | Unrecognized command or data type was encountered.<br>Occurs when command or data type is not recognized. |
| -100 | Unrecognized command or query | The command or query is not recognized.<br>Occurs when the device receives an unrecognized command or query. This is a generic syntax error for devices that cannot detect more specific errors. |
| 0 | No error | No error. |
| 510 | I2C bus fault | A device internal I2C bus error was encountered. |
| 520 | Controller Timed Out | No response was received within 0.7 seconds from a slave device and the message was resent three (3) times by the controller. |
| 600 | Laser calibration fault | Any error encountered during calibration. |

Any errors generated from the internal operation of the lasers or controller are reflected in the fault code—see p. 167.

## 6.2.2 Common Commands and Queries

Common commands and queries include:

- System information (p. 152)
- State of the CellX system (p. 157)
- Operational, including temperature and factory defaults (p. 159)

### 6.2.2.1 System Information

Table 6-8 summarizes the common commands and queries about system information for the CellX laser system.

**Table 6-8. Commands/Queries—System Information**

| Command | Description | Page |
|---|---|---|
| SYSTEM INFORMATION | | |
| `SYSTem:INFormation:MODel?` | Retrieves model name of the laser. | p. 152 |
| `SYSTem:INFormation:MDATe?` | Retrieves manufacture date of the device. | p. 153 |
| `SYSTem:INFormation:CDATe?` | Retrieves calibration date of the device. | p. 153 |
| `SYSTem:INFormation:SNUMber?` | Retrieves serial number of the laser. | p. 153 |
| `SYSTem:INFormation:PNUMber?` | Retrieves manufacturer part number of the laser. | p. 153 |
| `SYSTem:INFormation:FVER?` | Retrieves current firmware version. | p. 153 |
| `SYSTem:INFormation:PVER?` | Retrieves current protocol version. | p. 153 |
| `SYSTem:INFormation:TYPe?` | Retrieves device type. | p. 154 |
| `SYSTem:TYPE?` | Retrieves system type | p. 154 |
| `SYSTem:INFormation:PORTs?` | Retrieves the number of lasers supported. | p. 154 |
| `SYSTem:INFormation:ENUMeration?` | Identifies the Channels enabled for use. | p. 154 |
| `SYSTem:INFormation:POWer?` | Retrieves power rating of a laser. | p. 155 |
| `SYSTem:INFormation:WAVelength?` | Retrieves wavelength of a laser. | p. 155 |
| `SYSTem:INFormation:USER`<br>`SYSTem:INFormation:USER?` | Sets and retrieves the user-defined ID. | p. 156 |

***NOTICE***

**Include a numeral to the base word in the query for any laser channel. No numerical suffix has the same result as use of a zero. For example, *idn? = *idn0? The response would be returned from the CellX controller.**

**Refer to the assigned suffix address parameters in Table 6-1 (p. 138)**

#### 6.2.2.1.1 System Model Name Query

Retrieves the model name of the CellX controller board.

| | |
|---|---|
| QUERY | `SYSTem:INFormation:MODel?` |
| REPLY | `<model name>` |

#### 6.2.2.1.2 System Manufacture Date Query

Retrieves the manufacture date of the device.

| | |
|---|---|
| QUERY | **SYSTem:INFormation:MDATe?** |
| REPLY | **<manufacture date>** |

#### 6.2.2.1.3 System Calibration Date Query

Retrieves the calibration date of the device.

| | |
|---|---|
| QUERY | **SYSTem:INFormation:CDATe?** |
| REPLY | **<calibration date>** |

#### 6.2.2.1.4 System Serial Number Query

Retrieves the serial number of the laser.

| | |
|---|---|
| QUERY | **SYSTem:INFormation:SNUMber?** |
| REPLY | **<serial number>** |

#### 6.2.2.1.5 System Part Number Query

Retrieves the manufacturer part number of the laser.

| | |
|---|---|
| QUERY | **SYSTem:INFormation:PNUMber?** |
| REPLY | **<manufacturer part number>** |

#### 6.2.2.1.6 System Firmware Version Query

Retrieves the current firmware version from the laser firmware. The format of the returned firmware version number string is identical to that described in the ***IDN?** Query.

| | |
|---|---|
| QUERY | **SYSTem:INFormation:FVER?** |
| REPLY | **<current firmware version>**<br>For example: 1.0.0 |

#### 6.2.2.1.7 System Protocol Version Query

Retrieves the current CellX protocol version from the laser firmware.

The firmware version is the format:

| | |
|---|---|
| **QUERY** | **`SYSTem:INFormation:PVER?`** |
| **REPLY** | **`<current protocol version>`** |

```
P<major>.<minor><optional qualifier characters>
```

For example, P1.0a is a valid firmware version format.

#### 6.2.2.1.8 Device Type Query

Retrieves the device type. The device includes laser and controller.

| | |
|---|---|
| **QUERY** | **`SYSTem:INFormation:TYPe?`** |
| **REPLY** | **`DDL|OPSL|MULTI4`** |

The types of lasers supported include Direct Diode Lasers (DDL), Optically Pumped Semiconductor Lasers (OPSL), and MULTI4 (the CellX laser system).

The set of extended laser-specific commands is determined by the response to this query. The type of the controller is hard-coded in the controller.

#### 6.2.2.1.9 System Type Query

This query returns a string for the system type (controller in the CellX laser system).

| | |
|---|---|
| **COMMAND** | None |
| **QUERY** | **`SYSTem:TYPE?`** |
| **REPLY** | **`MULTI4`** |

#### 6.2.2.1.10 Ports Query

This query will retrieve the number of lasers supported by the device. Typical configuration is four, so a common reply is "4".

| | |
|---|---|
| **QUERY** | **`SYSTem:INFormation:PORTs?`** |
| **REPLY** | **`<number of lasers supported>`** |

#### 6.2.2.1.11 Enumeration Query

This query identifies the Channels in the CellX device that are enabled for use.

| | |
|---|---|
| QUERY | `SYSTem:INFormation:ENUMeration?` |
| REPLY | Decimal value that describes the slot position that is enabled. |

Table 6-9 lists the decimal values associated with each Channel.

**Table 6-9. Channels Enabled for Use**

| Decimal Value | Channels Enabled (0=OFF, 1=ON) | | | |
|---|---|---|---|---|
| | 4 | 3 | 2 | 1 |
| 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 1 | 1 |
| 4 | 0 | 1 | 0 | 0 |
| 5 | 0 | 1 | 0 | 1 |
| 6 | 0 | 1 | 1 | 0 |
| 7 | 1 | 1 | 1 | 1 |
| 8 | 1 | 0 | 0 | 0 |
| 9 | 1 | 0 | 0 | 1 |
| 10 | 1 | 0 | 1 | 0 |
| 11 | 1 | 0 | 1 | 1 |
| 12 | 1 | 1 | 0 | 0 |
| 13 | 1 | 1 | 0 | 1 |
| 14 | 1 | 1 | 1 | 0 |
| 15 | 1 | 1 | 1 | 1 |

#### 6.2.2.1.12 System Power Rating Query

Retrieves the power rating of the laser. The power rating is minimum output power under a given set of operating conditions.

| | |
|---|---|
| QUERY | `SYSTem:INFormation:POWer?` |
| REPLY | `<power>` |

The reply string represents the nominal power value in watts.

#### 6.2.2.1.13 System Wavelength Query

Retrieves the actual wavelength (in nanometers) of the laser.

| | |
|---|---|
| **QUERY** | **SYSTem:INFormation:WAVelength?** |
| **REPLY** | **<wavelength>** |

#### 6.2.2.1.14 User-Defined ID Command/Query

Enters and stores user-defined identification or any other information the user desires to store. The information entered is stored in nonvolatile memory.

| | |
|---|---|
| **COMMAND** | **SYSTem:INFormation:USER <item number>, <item>** |
| **QUERY** | **SYSTem:INFormation:USER? <item number>** |
| **REPLY** | Item stored at the location pointed to by **<item number>**. |

The user can enter up to seven (7) items, with each comprised of up to 32 characters. The item number starts at zero.

For example, three different users could customize their settings, or set up tests can be set up and with specific parameters and given a unique user name.

### 6.2.2.2 State of the CellX System

Table 6-10 summarizes the queries and commands about the state of the CellX laser system.

**Table 6-10. Commands/Queries—State of CellX**

| Query/Command | Description | Page |
|---|---|---|
| `SYSTem:NOISe?` | Queries noise in the laser head. | p. 157 |
| `SYSTem:HOURs?` | Retrieves the number of hours the laser head has been powered on. | p. 158 |
| `SYSTem:DIODe:HOURs?` | Retrieves the number of hours the laser diode has operated. | p. 158 |
| `SOURce:POWer:LEVel?` | Returns the present output power of a laser module. | p. 158 |
| `SOURce:POWer:CURRent?` | Returns the present output current of a laser module. | p. 158 |
| `SYSTem:LOCK?` | Returns the status of the system interlock | p. 159 |
| `SYSTem:RESTore` | Restores all user settings to the factory state. | p. 159 |

***NOTICE***

**Include a numeral to the base word in the query for any laser channel. No numerical suffix has the same result as use of a zero. For example, *idn? = *idn0? The response would be returned from the CellX controller.**

**Refer to the assigned suffix address parameters in Table 6-1 (p. 138)**

#### 6.2.2.2.1 Noise Query

Queries the noise level of the laser head. The returned integer is a relative measure of laser power stability.

| | |
|---|---|
| QUERY | `SYSTem:NOISe?` |
| REPLY | `0` |

This is a qualitative measure of laser head system noise that includes electronic noise seen by the photodiode as well as noise from digital power control.

A value under 10 is normal, a value between 10 and 30 is acceptable, and a value greater than 30 is considered noisy.

This feature applies to constant power mode only. All other operating modes always return a value of zero.

***NOTE:*** It is normal to see a relatively high noise level when the laser is warming up or when the laser power is changed.

#### 6.2.2.2.2 Power Hours Query

The query returns the number of hours the laser head has been powered on.

| | |
|---|---|
| QUERY | `SYSTem:HOURs?` |
| REPLY | `<value in x.xx format>` |

#### 6.2.2.2.3 Diode Hours Query

This query returns the number of hours the laser diode has operated. This is defined as the accumulation of time while the "Laser Enable" pin is asserted.

| | |
|---|---|
| QUERY | `SYSTem:DIODe:HOURs?` |
| REPLY | `<value in x.x format>` |

#### 6.2.2.2.4 System Output Power Level Query

Returns the present output power of a laser module, measured in watts.

| | |
|---|---|
| QUERY | `SOURce:POWer:LEVel?` |
| REPLY | `<x.xxxxx>` |

#### 6.2.2.2.5 System Output Current Query

Returns the present output current of the laser module.

| | |
|---|---|
| QUERY | `SOURce:POWer:CURRent?` |
| REPLY | `<immediate current level in Amps>` |

The reply string is an NRf value representing the present laser output current measured in amps.

#### 6.2.2.2.6 System Interlock Query

This query returns the status of the system interlock. The method of determining the interlock status is device-dependent. This feature may not apply to a laser module itself.

A Query returns the interlock state in string format.

| | |
|---|---|
| QUERY | `SYSTem:LOCK?` |
| REPLY | `ON\|OFF` |

#### 6.2.2.2.7 System Restore Command

This command restores all user settings to the factory state. This command can also be used on individual laser modules within CellX.

| | |
|---|---|
| COMMAND | `SYSTem:RESTore` |
| QUERY | None |

### 6.2.3 Operational Commands

Table 6-11 summarizes the operational commands and queries used to configure and operate the lasers in the CellX laser system.

**Table 6-11. Operational Commands/Queries**

| Command/Query | Description | Page |
|---|---|---|
| OPERATING MODE | | |
| **SOURce:AM:SOURce?** | Retrieves the currently selected source operating mode. | p. 161 |
| **SOURce:AM:INTernal** | Sets the laser operating mode to internal Continuous Wave with constant power (CWP). | p. 161 |
| **SOURce:AM:EXTernal** | Sets the laser operating mode to external modulation. | p. 162 |
| **SOURce:AM:STATe ON\|OFF** | Turns the laser ON or OFF. | p. 162 |
| **SOURce:AM:STATe?** | Returns the present laser ON/OFF state. | p. 162 |
| **SYSTem:CDRH** | Enables or disables the CDRH 5-second laser emission delay. | p. 162 |
| **SYSTem:CDRH?** | Returns the present CDRH setting in string format. | p. 162 |

**Table 6-11. Operational Commands/Queries (Continued)**

| Command/Query | Description | Page |
|---|---|---|
| POWER AND CURRENT | | |
| **SOURce:CURRent:LEVel?** | Returns the present output current of a laser head. | p. 163 |
| **SOURce:POWer:LEVel:IMMediate: AMPLitude <value>** | Sets the present laser power level. | p. 163 |
| **SOURce:POWer:LEVel:IMMediate: AMPLitude <value>?** | Returns the present laser power level. | p. 163 |
| **SOURce:POWer:NOMinal?** | Returns the nominal CW laser output power. | p. 163 |
| **SOURce:POWer:LIMit:LOW?** | Returns the minimum CW laser output power. | p. 163 |
| **SOURce:POWer:LIMit:HIGH?** | Returns the maximum CW laser output power. | p. 163 |
| TEMPERATURE | | |
| **SYSTem:INFormation:TEMPera-ture:INTernal?** | Retrieves the temperature internal to the CellX controller. | p. 164 |
| **SOURce:TEMPerature:INTernal? {C\|F}** | Retrieves the temperature internal to the laser. | p. 164 |
| **SYSTem:INFormation:TEMPera-ture:BASeplate?** | Retrieves the CellX baseplate temperature | p. 164 |
| **SOURce:TEMPerature:BASeplate?** | Retrieves the baseplate temperature Low limit. | p. 165 |
| **SOURce:TEMPerature:DSETpoint?** | Returns the diode set point temperature that the TEC controller manages to maintain. | p. 165 |
| **SOURce:TEMPerature:DIODe? [C\|F}** | Returns the present laser diode temperature. | p. 165 |
| **SOURce:TEMPerature:SOURce: TEMPerature:RESonator? [C\|F}** | Returns the present laser head resonator temperature. | p. 166 |
| **SOURce:TEMPerature:PROTection: DIODe:HIGH? {C\|F\|K}** | Returns the maximum laser diode tempera-ture without triggering a fault condition. | p. 166 |
| **SOURce:TEMPerature:PROTection: DIODe:LOW? {C\|F\|K}** | Returns the minimum laser diode tempera-ture without triggering a fault condition. | p. 166 |
| **CALibration:CURRent?** | Retrieves the maximum current limit of the laser module. | p. 166 |

***NOTICE***

**Include a numeral to the base word in the query for any laser channel. No numerical suffix has the same result as use of a zero. For example, *idn? = *idn0? The response would be returned from the CellX controller.**

**Refer to the assigned suffix address parameters in Table 6-1 (p. 138)**

## 6.2.3.1 Operating Modes

The following mutually exclusive operating modes are available in the CellX:

- CWP (continuous wave, constant power)
- DIGITAL (CW with external digital modulation)
- ANALOG (CW with external analog modulation)
- MIXED (CW with external digital + analog modulation)

The exact meaning of the selected mode is device-dependent.

### 6.2.3.1.1 Laser Source Mode Query

Retrieves the currently selected source operating mode for the laser.

| | |
|---|---|
| QUERY | `SOURce:AM:SOURce?` |
| REPLY | `<currently selected source)`<br>Such as CWP\|DIGITAL\|ANALOG\|MIXED |

The reply string represents the present laser operating mode, where CWP is not modulated externally and the other modes imply external modulation.

### 6.2.3.1.2 Select CW Mode Command

Sets the laser operating mode to internal Continuous Wave (CW) and deselects external modulation. The setting is saved in non-volatile memory.

The default setting is CW with constant power, or CWP.

| | |
|---|---|
| COMMAND | `SOURce:AM:INTernal CWP` |

#### 6.2.3.1.3 Select Modulation Mode Command

This commands sets the laser operating mode to external modulation and deselects the internal CWP mode. MIXED source combines both external digital and external analog modulation The setting is saved into non-volatile memory.

| | |
|---|---|
| COMMAND | `SOURce:AM:EXTernal DIGital|ANALog|MIXed` |

**Example:** The command **`SOURce255:AM:EXTernal MIXED`** selects mixed modulation mode where both an analog and/or digital signal are accepted into the laser drive circuit.

#### 6.2.3.1.4 Set/Query Laser Enable

Turns the laser ON or OFF.

| | |
|---|---|
| COMMAND | `SOURce:AM:STATe ON|OFF` |
| QUERY | `SOURce:AM:STATe?` |
| REPLY | `ON|OFF` |

Query returns the present laser ON/OFF state in string format.

When turning the laser ON, actual laser emission may be delayed due to internal circuit stabilization logic and/or a CDRH delay. For example, if CDRH delay is enabled, there may be a 5-second delay between the request and actual laser emission.

#### 6.2.3.1.5 Set/ Query CDRH Delay

This command is used to enable or disable the CDRH 5 second laser emission delay. The setting is saved in persistent memory. The factory default is ON.

A Query returns the present CDRH setting in string format.

| | |
|---|---|
| COMMAND | `SYSTem:CDRH {ON|OFF}` |
| QUERY | `SYSTem:CDRH?` |
| REPLY | `ON|OFF` |

### 6.2.3.2 Power and Current Commands and Queries

This section describes queries used to determine the output current and power ratings.

#### 6.2.3.2.1 Output Current Query

This query returns the present output current of a laser head measured in amps.

| | |
|---|---|
| QUERY | `SOURce:CURRent:LEVel?` |
| REPLY | `<x.xxxxx>` |

#### 6.2.3.2.2 Set/Query Laser Power Level

Sets the present laser power level. Setting the power level does not turn the laser on.

| | |
|---|---|
| COMMAND | `SOURce:POWer:LEVel:IMMediate:AMPLitude <value>` |
| QUERY | `SOURce:POWer:LEVel:IMMediate:AMPLitude?` |
| REPLY | `<x.xxxxx>` |

The reply string represents the present laser power level setting as an NRf value in watts.

#### 6.2.3.2.3 CW Nominal Power

Returns the nominal CW laser output power.

| | |
|---|---|
| QUERY | `SOURce:POWer:NOMinal?` |
| REPLY | `<x.xxxxx>` |

The reply string represents the nominal power value in watts.

#### 6.2.3.2.4 CW Minimum Power Query

Returns the minimum CW laser output power.

| | |
|---|---|
| QUERY | `SOURce:POWer:LIMit:LOW?` |
| REPLY | `<x.xxxxx>` |

The reply string represents the minimum power in watts.

#### 6.2.3.2.5 CW Maximum Power Query

Returns the maximum CW laser output power.

| | |
|---|---|
| QUERY | `SOURce:POWer:LIMit:HIGH?` |
| REPLY | `<x.xxxxx>` |

The reply string represents the maximum power value in watts.

### 6.2.3.3 Temperature Commands and Queries

This section describes command and queries related to temperature in the CellX laser system.

#### 6.2.3.3.1 Internal Temperature Query (System)

This query returns the temperature for the controller in the CellX laser system. The value in degrees is returned in Celsius, Fahrenheit, or Kelvins. A Celsius value is returned if no option is specified.

| | |
|---|---|
| QUERY | `SYSTem:INFormation:TEMPerature:INTernal? {C|F|K}` |
| REPLY | `Degrees {C|F|K}` |

#### 6.2.3.3.2 Internal Temperature Query (Laser)

Returns the present internal temperature for a laser.

| | |
|---|---|
| QUERY | `SOURce:TEMPerature:INTernal? {C|F}` |
| REPLY | `<x.xU where U is the unit indicator 'C' or 'F'>` |

An optional unit indicator can be specified.

- If the 'C' unit indicator is specified, or if the unit indicator is left off, the returned value represents the internal laser temperature in degrees C.

- If the 'F' unit indicator is specified the returned value represents the laser base temperature in degrees F.

The reply string represents the internal laser temperature in NRf format with a unit indicator of 'C' or 'F' appended.

#### 6.2.3.3.3 Baseplate Temperature Query (System)

This query returns the degrees temperature in Celsius, Fahrenheit, or Kelvins for the baseplate in the CellX laser system. A Celsius value is returned if no option is specified.

| | |
|---|---|
| QUERY | `SYSTem:INFormation:TEMPerature:BASeplate? {C|F|K}` |
| REPLY | `Degrees {C|F|K}` |

An optional unit indicator can be specified.

- If the ‘C’ unit indicator is specified, or if the unit indicator is left off, the returned value represents the laser Base Plate temperature in degrees C.
- If the ‘F’ unit indicator is specified the returned value represents the laser base temperature in degrees F.

#### 6.2.3.3.4 Laser Baseplate Temperature

This query retrieves the baseplate temperature Low limit.

| | |
|---|---|
| QUERY | **SOUR4ce:TEMPerature:BASeplate?** |
| REPLY | **<laser channel baseplate temperature “C” or “F”>** |

#### 6.2.3.3.5 Diode Set Point Temperature Query

Returns the diode set point temperature that the TEC controller manages to maintain.

| | |
|---|---|
| QUERY | **SOURce:TEMPerature:DSETpoint? {C\|F}** |
| REPLY | **<x.xU where U is the unit indicator 'C' or 'F'>** |

An optional unit indicator can be specified.

- If the ‘C’ unit indicator is specified, or if the unit indicator is left off, the returned value represents the laser Base Plate temperature in degrees C.
- If the ‘F’ unit indicator is specified the returned value represents the laser base temperature in degrees F.

The reply string represents the target temperature in NRf format with a unit indicator of 'C' or 'F' appended.

#### 6.2.3.3.6 Diode Temperature Query

Returns the present laser diode temperature.

| | |
|---|---|
| QUERY | **SOURce:TEMPerature:DIODe? [C\|F}** |
| REPLY | **<x.xU where U is the unit indicator 'C' or 'F'>** |

An optional unit indicator can be specified.

- If the ‘C’ unit indicator is specified, or if the unit indicator is left off, the returned value represents the laser Base Plate temperature in degrees C.

- If the 'F' unit indicator is specified the returned value represents the laser base temperature in degrees F.

The reply string represents the diode temperature in NRf format with a unit indicator of 'C' or 'F' appended.

#### 6.2.3.3.7 Resonator Temperature Query

This query returns the present laser head resonator temperature.

| | |
|---|---|
| QUERY | **SOURce:TEMPerature:RESonator? [C\|F}**<br>(or)<br>**SOURce:TEMPerature:RESonator:LEVel?** |
| REPLY | **<x.xU where U is the unit indicator 'C' or 'F'>** |

#### 6.2.3.3.8 Diode Temperature High Limit Query

This query returns the maximum laser diode temperature without triggering a fault condition.

| | |
|---|---|
| QUERY | **SOURce:TEMPerature:PROTection:DIODe:HIGH? {C\|F\|K}** |
| REPLY | **<xxx.x C\|F\|K>** |

#### 6.2.3.3.9 Diode Temperature Low Limit Query

This query returns the minimum laser diode temperature without triggering a fault condition.

| | |
|---|---|
| QUERY | **SOURce:TEMPerature:PROTection:DIODe:LOW? {C\|F\|K}** |
| REPLY | **<xxx.x C\|F\|K>** |

#### 6.2.3.3.10 Current Query

This query retrieves the maximum current limit of the laser module.

| | |
|---|---|
| QUERY | **CALibration:CURRent?** |
| REPLY | **<max current value in Amps>** such as 1.95 amps |

## 6.3 Fault Codes

This section describes the Fault codes that can be issued for both the controller in the CellX laser system as well as individual lasers.

***NOTICE***

**A warm or cold device reboot is required to clear an CellX laser system or laser fault.**

## 6.3.1 Fault Codes for Individual Lasers

Table 6-12 shows the Fault codes that can be issued for individual lasers in the CellX unit. Unspecified bits are reserved and considered to be zero.

**Table 6-12. Fault Codes—Individual Lasers**

| Code Bit | Error Value | Error Description | Cause and Possible Solution |
|---|---|---|---|
| 0 | 00000001 | Baseplate temperature fault | **Cause**: Baseplate temperatures is out of range; that is, greater than 40°C or lower than 10°C.<br>**Solution**: Improve heatsink to reduce baseplate temperature or adjust the ambient temperature where the laser operates. |
| 1 | 00000002 | Diode temperature fault | **Cause**: Diode temperature is greater than 40°C or lower than 10°C.<br>**Solution**: Make sure that the TE cooler is on and/or adjust the ambient temperature where the laser operates. |
| 2 | 00000004 | Internal temperature fault | **Cause**: Internal laser temperature or controller temperature is out of range, or exceeds the factory-set limit.<br>**Solution**: Make sure that the TE cooler is on and the ambient temperature is within the specified range. |
| 3 | 00000008 | Laser power supply fault | **Cause**: There is no electrical power to the laser diode.<br>**Solution**: Make sure that the SDR cable is plugged in and secured properly on both ends. |
| 4 | 00000010 | Device internal I2C bus error | **Cause**: An error was encountered in internal I2C bus communications.<br>**Solution**: Perform a warm or cold reboot of the laser system. If the problem persists, contact Coherent Technical Support. |
| 5 | 00000020 | Laser diode over-current error | **Cause**: Diode temperature is greater than 40°C or lower than 10°C.<br>**Solution**: Make sure the TE cooler is on and/or adjust the ambient temperature where the laser operates. |
| 6 | 00000040 | Laser checksum error | **Cause**: Internal laser temperature or controller temperature is out of range, or exceeds the factory-set limit.<br>**Solution**: Make sure the TE cooler is on and the ambient temperature is within the specified range. |
| 7 | 00000080 | Checksum recovery error | **Cause**: There is no electrical power to the laser diode.<br>**Solution**: Make sure the SDR cable is plugged in and secured properly on both ends. |

**Table 6-12. Fault Codes—Individual Lasers (Continued)**

| Code Bit | Error Value | Error Description | Cause and Possible Solution |
|---|---|---|---|
| 8 | 00000100 | Message buffer overflow | **Cause**: An error was encountered in internal I2C bus communications.<br>**Solution**: Perform a warm or cold reboot of the laser system. If the problem persists, contact Coherent Technical Support. |
| 9 | 00000200 | Warm-up limit fault | **Cause**: Laser diode current exceeds the specified upper limit.<br>**Solution**: Turn off laser emission and reboot the device. If the problem persists, contact Coherent Technical Support. |
| 10 | 00000400 | TEC control error | **Cause**: An error associated with the TEC operation was encountered. It can be caused by insufficient heatsink.<br>**Solution**: Make sure heatsink is sufficient, then perform a device reboot. If the problem persists, contact Coherent Technical Support. |
| 11 | 00000800 | Reserved | … |
| 12 | 00001000 | Diode temperature limit error | **Cause**: Laser diode temperature deviates from the temperature set point by more than 3°C.<br>**Solution**: Make sure the TE cooler is turned on. If the laser warm-up process is disabled, keep the laser running for 10-15 minutes, then perform a device reboot. |
| 13 | 00002000 | Laser ready fault | **Cause**: Laser fails to emit within ± 2% of the set power level.<br>**Solution**: If the problem persists, contact Coherent Technical Support for a system recalibration. |
| 14 | 00004000 | Photodiode fault | **Cause**: Readings from the internal photodiode for power control were negative.<br>**Solution**: Reboot the laser. If the problem persists, Contact Coherent Technical Support. |
| 15 | 00008000 | Device fatal fault | **Cause**: A device error not recoverable if persistent.<br>**Solution**: Contact Coherent Technical Support. |
| 16 | 00010000 | Startup error | **Cause**: Errors were encountered during firmware startup.<br>**Solution**: Perform a cold or warm device reboot. |
| 17 | 00020000 | Watchdog timer reset | **Cause**: Firmware was resumed from a processor watchdog reset.<br>**Solution**: Contact Coherent Technical Support. |
| 18 | 00040000 | N/A | N/A |
| 19 | 00080000 | N/A | N/A |
| 20 | 00100000 | Overpower fault | **Cause:** Error occurs when actual power is 10% over the maximum power setting.<br>**Solution:** Perform a cold or warm device reboot. If the problem persists, contact Coherent Technical Support. |

### 6.3.2 Fault Code for the CellX Controller

Table 6-13 lists the fault codes that can be issued for the internal controller in the CellX laser system.

**Table 6-13. Fault Codes–CellX System Controller**

| Code Bit | Error Value | Error Description | Cause and Possible Solution |
|---|---|---|---|
| 30 | 40000000 | Controller checksum error | **Cause**: An error associated with persistent memory was encountered.<br>**Solution**: Reboot the CellX laser system. If the problem persists, contact Coherent Technical Support. |
| 31 | 80000000 | Fault status from CellX laser system | **Cause**: A firmware or hardware fault was encountered in the CellX laser system.<br>**Solution**: Reboot the CellX laser system. If the problem persists, contact Coherent Technical Support. |

# 7 Coherent Connection Software

This section introduces the Coherent Connection 6 software, an easy-to-use interface between the CellX laser system and a workstation. Workstation is the term used in this manual to refer to either a personal computer (PC) or laptop.

Refer to the Coherent Connection Help for details on the full functionality of the software.

---

**WARNING!**
**Use of controls or adjustments or performance of procedures other than those specified can result in exposure to hazardous radiation.**

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## 7.1 Main Home Window and Menus

When Coherent Connection first launches, the main Home window shown in Figure 7-2 displays. The functions on the Home tab are available to all lasers shown.

If the CellX laser system is not yet connected to a workstation, the main window is blank, as shown in Figure 7-1.

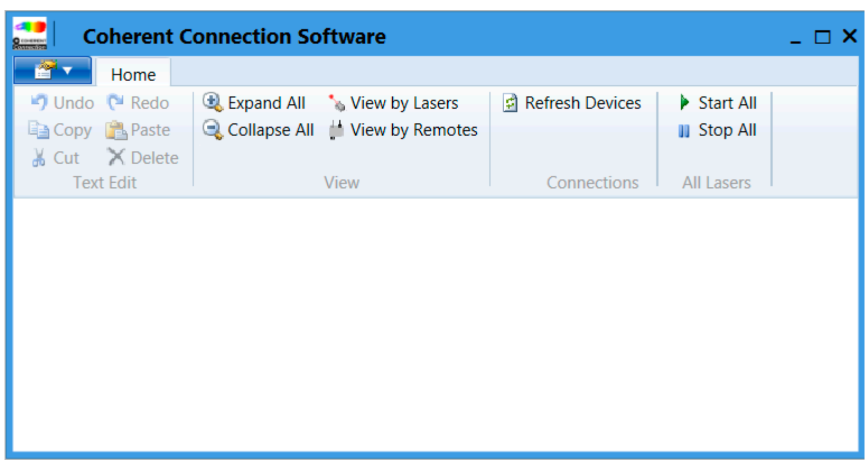



**Figure 7-1. Coherent Connection–Blank Window**

The function of each area in the toolbar is described in Table 7-1:

**Table 7-1. Home Toolbar Functions**

| Section | Command | Description |
|---|---|---|
| Text Edit | • Undo/Redo<br>• Copy/Paste<br>• Cut/Delete | Standard text editing commands used in any text box in the software. |
| View | • Expand All/<br>• Collapse All | Expands or collapses detailed information about each individual laser installed in the CellX laser system. |
| | • View by Lasers<br>• View by Remotes | Organizes the devices shown in the Main window by individual lasers or by remotes |
| Connections | Refresh Devices | Checks all ports for Coherent devices. |
| All Lasers | • Start All<br>• Stop All | Starts or stops running all lasers at one time. |

If lasers are installed, the main home window shows all lasers installed, and the Channel (position) in which they are installed. Refer to Figure 7-2.

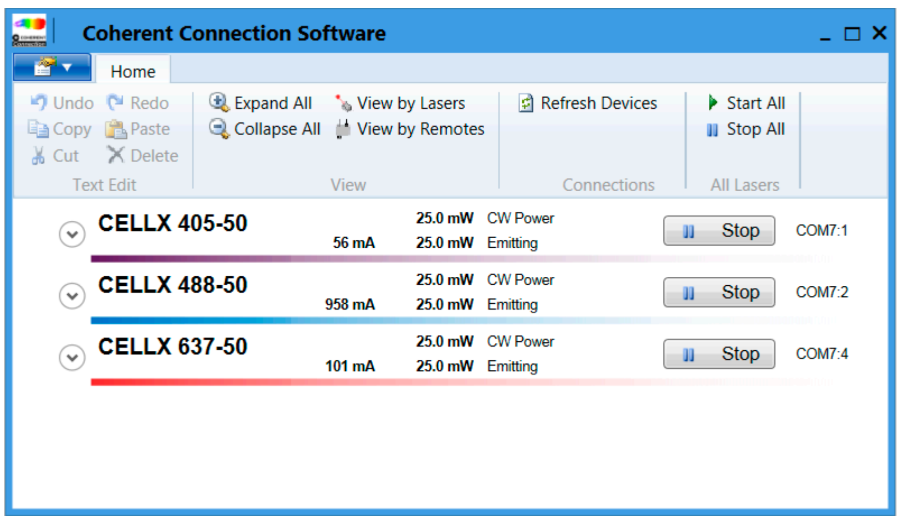



**Figure 7-2. Coherent Connection–Main Window**

Notice the 'COM7-*n*' designation to the right side of each laser. For example, 'COM7-1' identifies the port and Channel, where Channel 1 is the position closest to the laser exit aperture in the CellX unit.

The Main window drop-down menu for system utilities, at top left, shown in Figure 7-3.

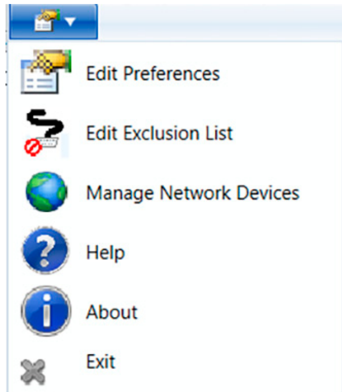



**Figure 7-3. Home Page–Drop-Down Menu**

## 7.2 Settings for Individual Lasers in CellX

Users can show details about settings and status for each laser, and display those in the Main window either for one laser at a time or for all lasers.

- To expand detailed information for only one laser, as shown circled in Figure 7-4, click the down arrow at left of the laser name.

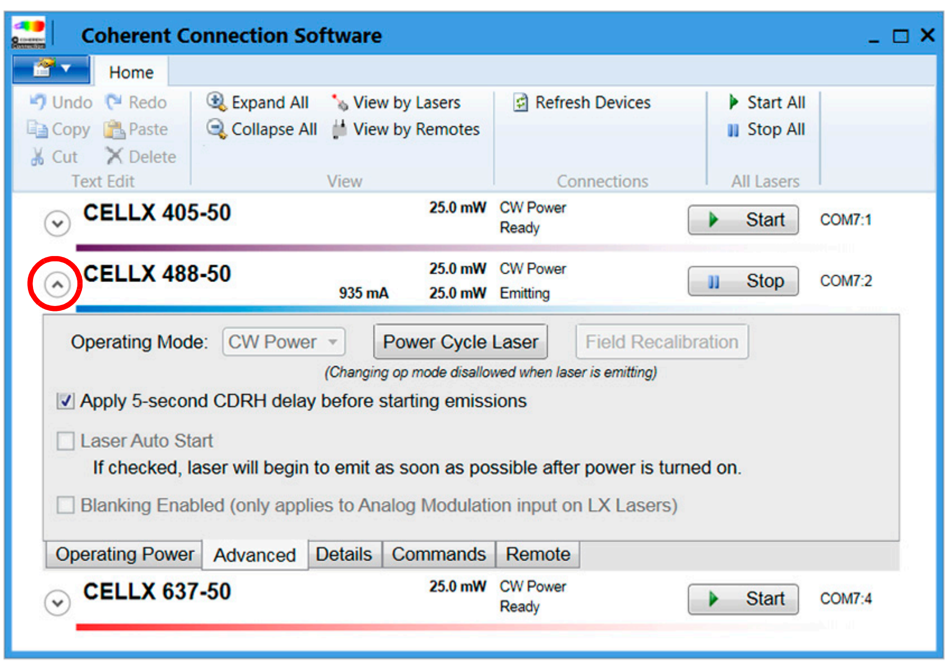



**Figure 7-4. Home Page–Show Details for One Laser**

- To expand detailed information for all lasers in the CellX unit, as shown in Figure 7-15, click the **down** arrow beside each laser name.

The following tabs display at the bottom of each section when information is expanded for each individual laser:

- Operating Power
- Advanced Settings
- Details
- Commands
- Remote (the controller internal to the CellX laser system)

Each of these tabs and features of the Coherent Connection software are described in the subsections that follow.

## 7.2.1 Operating Power Tab

The Operating Power tab shown in Figure 7-5 allows users to increase or decrease the power level for an individual laser.

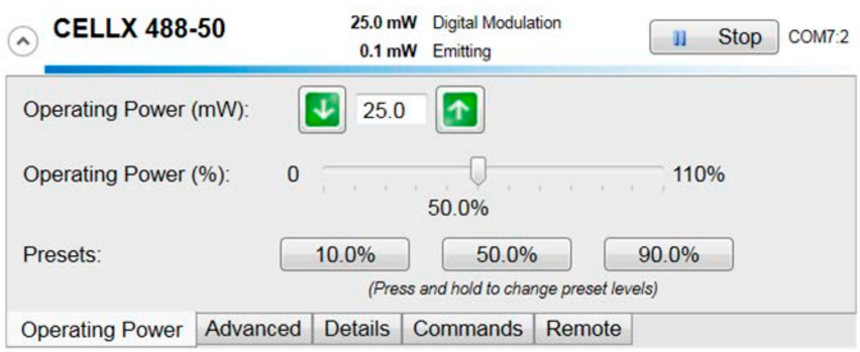



**Figure 7-5. Coherent Connection–Operating Power Tab**

Use the various fields in the interface to increase or decrease the power level:

- Click the **Up** or **Down** buttons to increase or decrease the power level by 1 mW at a time.
- Edit the power level as text in the 'Operating Power (mW)' field.
- Drag the 'Operating Power (%)' slider to adjust the power level by 1% at a time.
    - Drag the slider to the left to decrease power level.

- Drag the slider to the right to increase power level.

- Press, and hold, for greater than 2 seconds, any of the three ‘Preset’ buttons to change power by the default settings.

Users can also edit the preset buttons, one at a time, to set different power levels:

1. Click the slider to select a power level.
2. Press and hold a preset button to select the power level indicated in the slider, and release.

After the new levels are set, simply click a preset button to change power by the percentage indicated.

### 7.2.2 Advanced Tab

The Advanced tab allows users to cycle power or apply the following settings for each individual laser:

- Operating Mode—see details in ’Operation’ (p. 117)
- CDRH Delay—see instructions in ’CDRH Delay’ (p. 177)
- Auto Start for each laser—see instructions in ’Auto Start Settings’ (p. 177)

*NOTICE*
**The following functions are disabled and are not available for the CellX laser system:**
**—The Field Calibration button is grayed out.**
**—The check box for the Blanking option is grayed out.**

Figure 7-6 shows the Advanced tab for an individual laser.

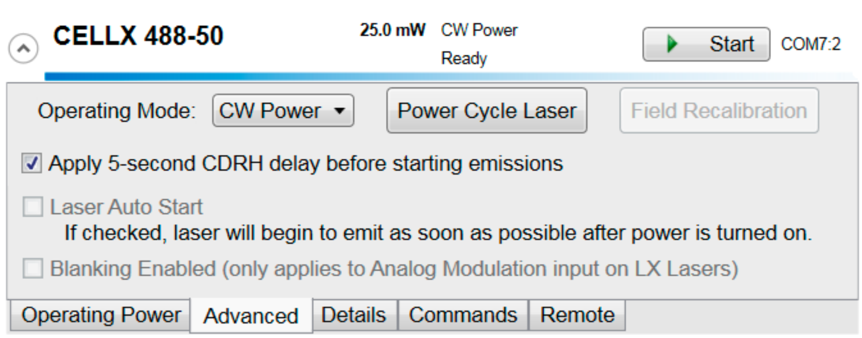



**Figure 7-6. Coherent Connection–Advanced Tab for One Laser**

### 7.2.2.1 Operating Mode

Operating modes are described more fully in 'Operation' (p. 117). Select a mode from the 'Operating Mode' drop-down menu, as shown in Figure 7-7:

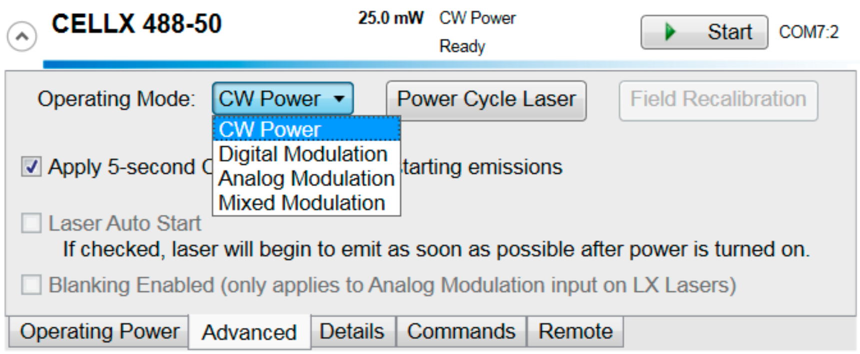



**Figure 7-7. Coherent Connection–Advanced Tab, Operating Mode**

***NOTICE***
**The Operating Mode cannot be changed while the laser is emitting.**

To change the Operating Mode for an individual laser:

1. First click the **Stop** button.
2. From the drop-down menu, select a different Operating Mode. The mode is now displayed in the window.
3. Click the **Start** button to again set power to ON to the laser.

### 7.2.2.2 Power Cycle Laser

The **Power Cycle Laser** button on the Advanced tab resets an individual laser by setting power off, then on again. This is different than using the option in the Remote tab to cycle power to the entire CellX system (see 'Remote Tab' (p. 179)).

To power cycle an individual laser:

1. Click the **Power Cycle Laser** button.
2. The system closes the detailed page for that laser and sets the power to OFF, then ON again.
3. The window stays in the streamlined view until the down arrow beside the individual laser is clicked to display all settings for that laser.

### 7.2.2.3 CDRH Delay

The CDRH-required delay of five seconds or more occurs between a laser-ready condition and emission of laser light. This delay lets the user take correct safety precautions before laser emission.

The CDRH setting is controlled by the Coherent Connection software. The default setting for the CellX is CDRH delay enabled at start-up, as shown in Figure 7-8.

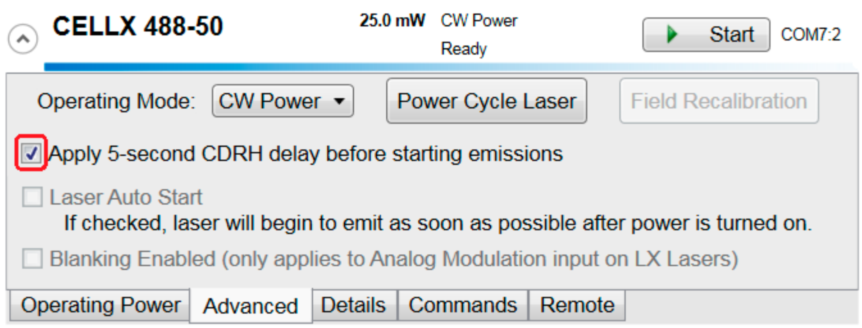



**Figure 7-8. Coherent Connection–Advanced Tab, CDRH Delay**

To disable the CDRH Delay:

1. Click to the **Advanced** tab for an individual laser.
2. Uncheck the box for 'Apply 5-second CDRH delay...'. This removes the CDRH Delay.

The setting for the CDRH Delay is applied the next time the laser is set to ON.

**WARNING!**
**Removing or disabling the 5-second CDRH delay defeats safety controls required by the applicable regulatory agencies. The customer takes full responsibility for safety and compliance to CDRH 21 CFR 1040 and IEC60825-1.**

**The CDRH Delay setting is stored in persistent memory inside the CellX laser system.**

### 7.2.2.4 Auto Start Settings

The CellX laser system uses an internal auto start switch that allows laser emission to start without toggling a keyswitch. The default setting is auto start ON. For more information about auto-start function see 'Understand CellX Auto-start Settings' (p. 118).

## 7.2.3 Details Tab

The Details tab provides product-specific information about an individual laser installed in the CellX unit. Figure 7-9 shows an example of data displayed:


**Figure 7-9. Coherent Connection–Details Tab**

## 7.2.4 Commands Tab

The Commands tab shows commands and responses sent to and received from an individual laser. Users can also view commands in use or enter new commands.

Notice the 'Auto-Scroll' check box at the top of this window. Refer to Figure 7-10. By default, auto-scroll is enabled at start-up.

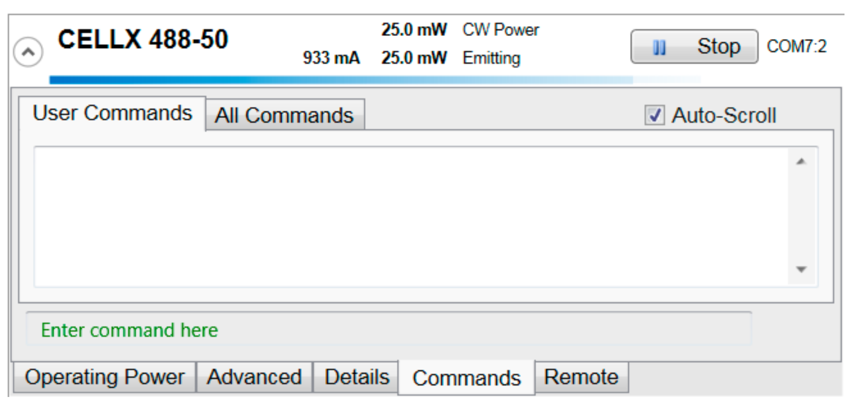



**Figure 7-10. Coherent Connection–User Commands Tab**

- Deselect the check box, then use the scroll bar at the side of the window to manually view the list of commands. The most recent command is at the bottom of the list.
- Selecting the 'Auto-Scroll' check box immediately starts rapid scrolling of the commands in use.

There are two sections within this tab. Click the tab at the top of the window to show users commands that have been entered, or all commands in use.

- **User Commands**, the first section displayed, as shown in Figure 7-10. If no user commands have yet been used, the screen area is blank.

To enter a command, click the line in green to **Enter command here**. Refer to Figure 7-10. The area changes to a text box, as shown in Figure 7-11, where users can enter the command:

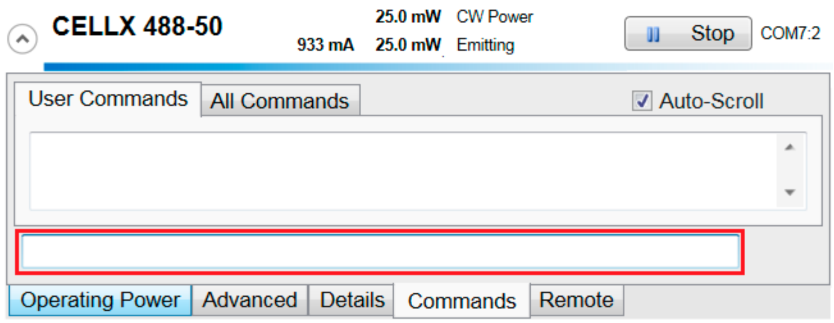



**Figure 7-11. Coherent Connection–Enter Command**

- Click the **All Commands** sub-tab to view all commands in use, as shown in the example in Figure 7-12.

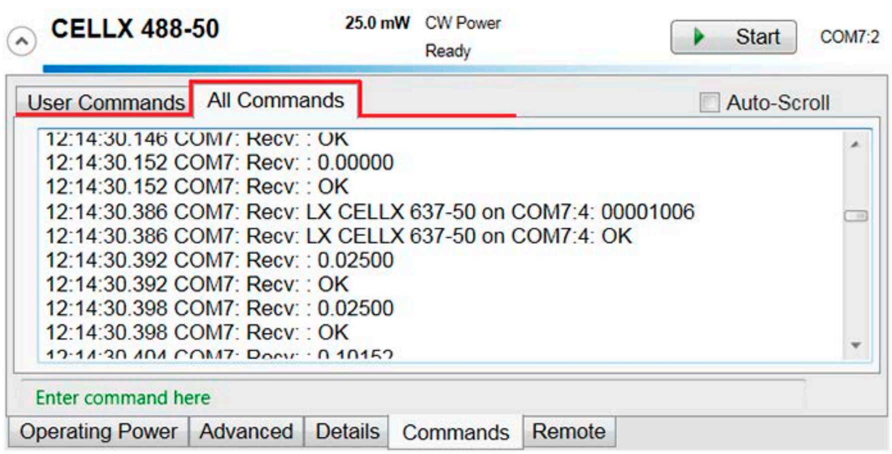



**Figure 7-12. Coherent Connection–All Commands Tab**

## 7.2.5 Remote Tab

A remote is a device that controls lasers through a single interface. The Coherent Connection software identifies the device being used on the Remote tab.

The CellX laser system includes a controller board internal to the CellX unit to which the lasers are connected. The CellX laser system connects to a host workstation via a USB cable to allow use of the Coherent Connection software.

The Remote tab in the software controls settings for each individual laser, as shown in Figure 7-13. In this example, notice the line for 'Device Type' — 'CellX 3x50mW' indicates the channel (the laser is installed in the third position in the CellX unit) and power (50mW) for that individual laser.

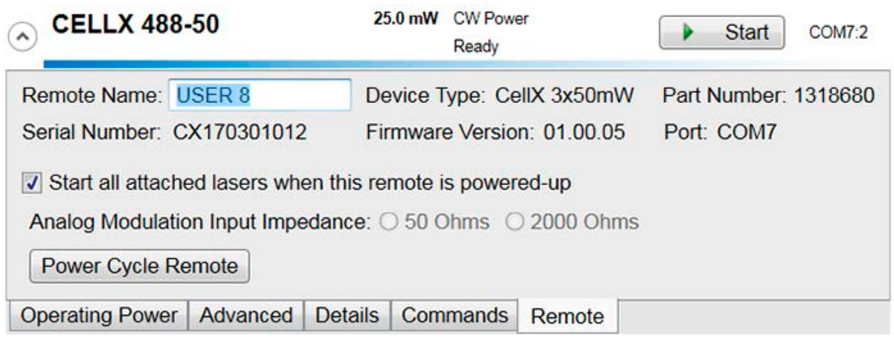



**Figure 7-13. Coherent Connection–Remote Tab**

The Remote tab provides information about the internal Controller Board in the CellX laser system. Data includes the device configuration, Part Number, Serial Number, Firmware version installed, and Port on the host workstation to which the remote is connected.

The design and connection of the CellX laser system differs from other Coherent 'remotes' such as the OBIS 1L Remote, the OBIS 6L Scientific Remote, and the OBIS Laser Box.

Accessory adapter boards used with the CellX, described in 'Options for Control Accessories' (p. 41), provide controls to adjust power and drive modulation inputs. Note that they are not identified in the software as remote devices.

In addition, the Remote tab provides the following options:

- **Start ALL attached lasers when power is applied to the controller board internal to the CellX laser system**. This setting is checked by default.
  - If users ***deselect*** this setting, the change takes effect immediately and remains in effect the next time the CellX laser system is powered on.

- If users then ***select*** the check box, a warning pop-up dialog box displays, shown in Figure 7-14. Read the warning, and then click either button to select **No Change** or **Enable Auto-Start**.

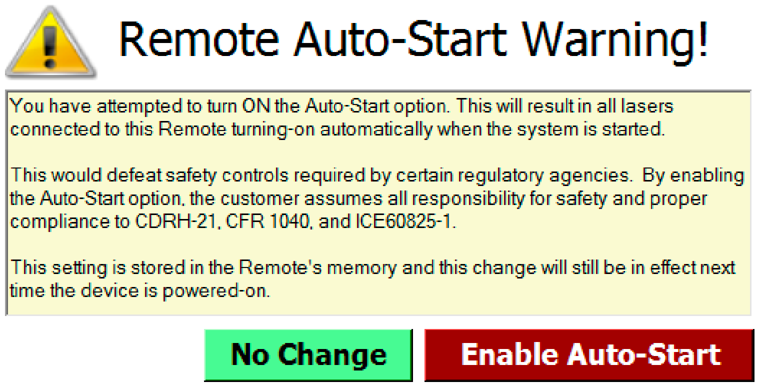



**Figure 7-14. Coherent Connection–Auto-Start Warning**

- **Analog Modulation Input Impedance**. The radio button selections are grayed out and cannot be changed. This function is set at 2 KΩ for all lasers in the CellX laser system.

- **Power Cycle Remote Button.** Clicking this button cycles power to the entire CellX unit. This is different than use of the Advanced tab to cycle power for individual lasers.

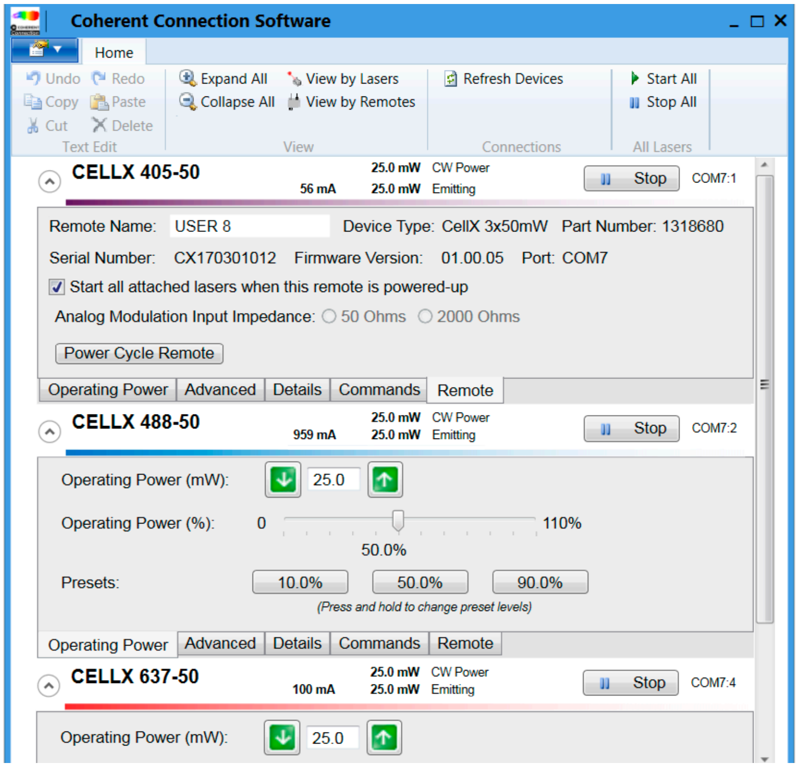



**Figure 7-15. Home Page–Show Details for ALL Installed Lasers**

# 8 Maintenance

In this section:



## 8.1 Internal Beam Alignment

This section gives instructions to adjust the size and shape of the beam in the CellX laser system, internally.

Additional information and considerations about beam properties is given in 'Beam Alignment Properties and Considerations' (p. 259).

---

**WARNING!**
**The CellX laser system does not have a shutter. *Always* wear laser safety glasses when the CellX unit is aligned to an optical assembly.**

**Also, avoid back reflections when aligning the CellX unit. Back reflection of as little as 5% can damage the diode. Back reflection can also cause noise in the CellX system. Refer to 'Laser Back Reflection' (p. 253).**

---

## 8.1.1 Overview

Standard CellX laser systems are set up with collimated beams (i.e., minimized divergence) for all wavelength channels. When the objective lenses are used with all collimated beams, each wavelength has a different working distance. To achieve focused beams at a common working distance, each CellX channel must be slightly de-collimated.

Users can individually align and adjust the focus, pointing, and position for each wavelength in the CellX unit, as shown in the example in Figure 8-1.

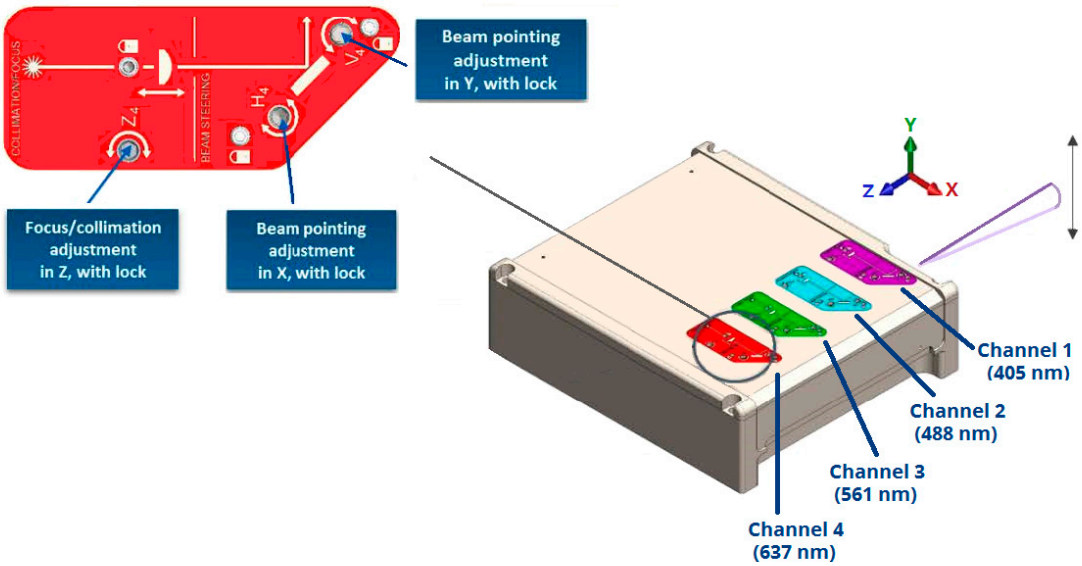



**Figure 8-1. Beam Alignment Overview**

## 8.1.2 Tools Required

The following tools are recommended for these instructions:

- Appropriate laser safety eyewear
- A 5.3-in L cross-head screwdriver (included in accessories kit - 'Standard CellX Accessory Kit' (p. 248))
- L-shaped hex wrench (included in the accessories kit)
- Torque screwdriver. Mountz FGV-25z (3-25 in-oz), with a 5/64-in hex bit, is recommended.
- A beam profiler to assist with alignment
- Small cross-head screwdriver

In addition, for the focus spot alignment procedure, the following equipment is useful:

- Any laser beam profiler (such as a slit or knife-edge type) with a measuring resolution of ≤5 µm can be used.

- A beam attenuating tool (such as a reflective ND filter) is required to avoid damaging the beam profiler.

## 8.1.3 Preliminary Requirements

This procedure assumes that equipment is set up, and that there is an objective lens already assembled and mounted on a translation stage. This section assumes that users have already completed the following actions:

- Set up the system; see 'Install CellX System Hardware' (p. 77). The CellX unit must be mounted on a platform with appropriate heat sink.
- Connected the CellX laser system to a workstation with a USB cable.
- Installed the latest Coherent Connection software; see 'Install Software' (p. 103).
- Made sure that the beam profiler or the objective lens is Z-adjustable for fine-tune of the working distance. For the best alignment one or both of them should be on X-Y translation stages as well.
(**NOTE**: There is some rough X-Y-yaw adjustability from the oversized screw holes on the objective lens mounting plate).

If an objective lens is planned to be used on a translation stage, it should already be assembled. See 'Option 2 - Assemble Translation Stage and Mount Lens' (p. 91).

Be sure to gather any other equipment or tools that the set-up may require for this task.

### 8.1.3.1 Understand Beam Alignment Steps

The following subsections describe how to set up and use the beam adjustment controls of the CellX laser system. The general steps involved include:

- First, reduce power for each laser beam.
- Align the beam from the CellX (without an objective lens) to the target (such as a flow cell).
- Align the objective lens to both the beam and the target.
- Finally, lock the adjustments.

## 8.1.4 Access Adjustment Controls

Before following any steps to align the beam, users must first remove the top cover of the CellX unit to access the adjustment controls for each laser. Do the following:

1. Use the small cross-head screwdriver and loosen the two screws that attach the top cover of the CellX unit, as shown in Figure 8-2.


**Figure 8-2. Remove Top Cover from CellX**

2. Gently lift the edge from the side that the two cover screws were removed until the lip on the opposite side dislodges from the CellX-chassis.


Figure 8-3. Remove Top Cover off of CellX

3. Set aside the cover and screws to attach the cover later.


Figure 8-4. Top Cover off of CellX

Removal of the top cover exposes the beam adjustment mechanism for each of the four lasers installed in the CellX unit, as shown in Figure 8-5. The location of the lasers are also referred to as channels, with Channel 1 closest to the laser exit aperture.


**Figure 8-5. Location of Beam Adjustments and Channels**

## 8.1.5 Understand Internal Beam Adjustment Controls

Each laser in the CellX unit has its own adjustment controls, identified in Figure 8-6. Note that the channel is identified by the subscript number (as in **$Z_4$**).

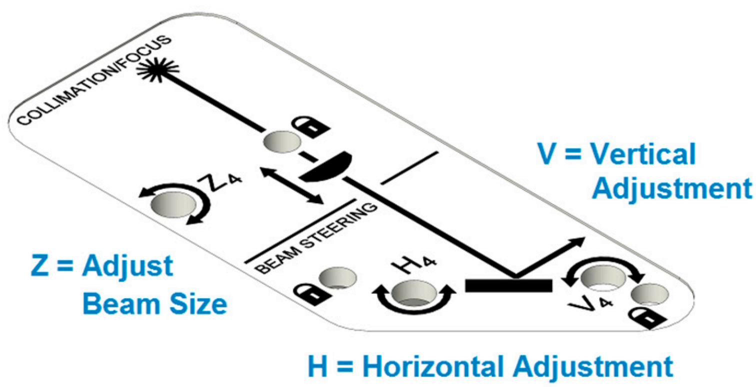



**Figure 8-6. Individual Beam Adjustment Controls**

These adjustments are described in the steps that follow:

- Z = Collimator that adjusts the beam size
- V = Control to tilt the vertical adjustment

- H = Control to tilt the horizontal adjustment

The **Focus Spot Size (Horizontal)** is measured at the location of best vertical focus after the Objective Lens. The laser system is aligned to the lower limit on delivery. The horizontal beam size can be adjusted up to the upper limit. Pre-alignment to a wider horizontal waist is also available.

The **focus adjustment** uses a telescope adjustment internal to CellX, while meeting all optical specifications.This is the 'Z' adjustment for collimator that adjusts the beam size.

The **Vertical (V) and Horizontal (H) adjustment** assumes the following:

- Measured from nominal beam axis. Adjustment using tilt/yaw adjustment internal to CellX, while meeting all optical specifications.

- Assumes the objective assembly is mounted within less than 200 mm (optical path length) from the output face of the CellX unit.

The **Working Distance** is measured from mechanical surface (output end) of the objective lens to the focus spot. Figure 8-7 shows the dimensions for the maximum distance from the CellX unit.

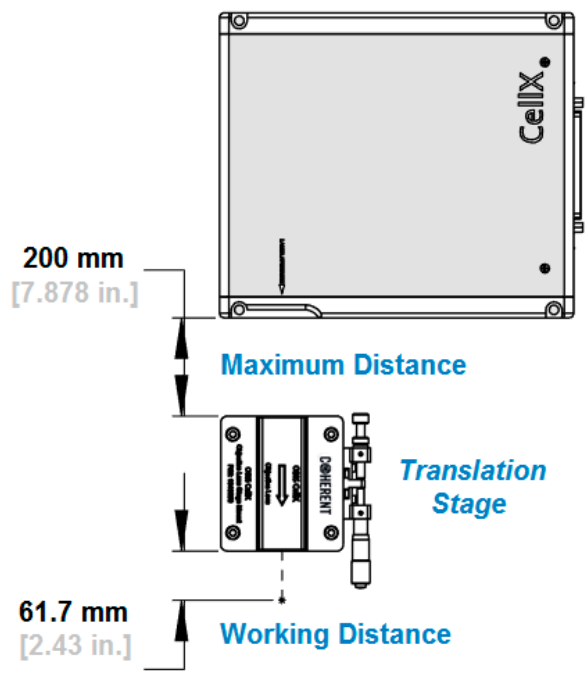



**Figure 8-7. Maximum Distance to Position Translation Stage**

### 8.1.6 De-Collimate the Beam to Match the Objective Lens

Standard CellX laser systems are shipped with collimated beams (minimized divergence) for all wavelength channels.

When the objective lenses (OL10-VIS or OL15-VIS) are used with all collimated beams, each wavelength has a different working distance. To achieve focused beams at a common working distance, each CellX channel must be slightly diverging, with use of the Z-adjustment for collimation/focus.

Users can use the following instructions to adjust the CellX collimation to the objective lens. Users must have a laser beam profiler available to measure the laser spot size.

In this instruction, Z axis is always the optical beam axis, Y axis is the up-and-down direction (height), and X axis is the side-to-side direction.

---

**WARNING!**
**Use of controls or adjustments or performance of procedures other than those specified may result in exposure to hazardous radiation.**

---

These instructions use the following points of reference, shown in Figure 8-8:

- Y axis is the up-and-down direction (height)
- X axis is the side-to-side direction
- Z axis is always the optical beam axis

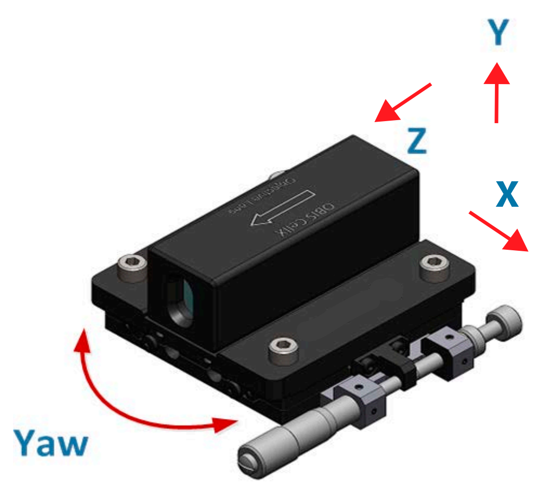



**Figure 8-8. Objective Lens and Motions for Adjustment**

### 8.1.6.1 Preparations for Collimation/Focus

Before the de-collimation procedure is begun, gather the necessary tools and equipment and make the following preparations:

- Any laser beam profiler (such as a slit or knife-edge type or CCD camera) with a measuring resolution of ≤5 µm can be used. See example in Figure 8-9.

- A beam attenuating tool (such as a reflective ND filter) is required to avoid damage to the beam profiler.

Either the beam profiler or the Objective Lens must offer adjustments on the Z-axis to be able to fine-tune the working distance. For the best alignment, one or both of these parts should be on X-Y translation stages as well.

If the X-Y translation stage is not available, users can make some rough X-Y-yaw adjustments with use of the oversized screw holes on the mounting plate for the objective lens.

### 8.1.6.2 Set Up the Beam Attenuator (Optional)

If a beam attenuating filter is to be used, do the following:

1. Set up the beam attenuating filter between the CellX and the objective lens. Be sure to tilt the filter slightly to direct any back reflection away. For more information, refer to 'Laser Back Reflection' (p. 253).

**WARNING!**
**LASER EMISSION STARTS NOW! *There is no shutter on the CellX unit.* The CellX system starts laser emission after power is applied.**

**Use precautions to avoid exposure of the eyes or skin to radiation from either a direct or reflected beam. Always wear appropriate safety glasses for the specific wavelengths. Refer to 'Laser Safety Hazards' (p. 7).**

2. Set the laser power to ON by toggling the switch on the power supply connected to the CellX unit.

   Select one laser beam to start alignment.

**NOTICE**

**It is recommended to start adjustments with either Channel 2 (typically 488 nm) or Channel 3 (typically 561 nm). Laser back-reflection is easier to see with either of these wavelengths.**

3. Set all other beams to OFF. Refer to the Coherent Connection software Help or User Manual instructions to use Coherent Connection software to set individual channels on and off.

### 8.1.6.3 Align the Beam Profiler to the CellX Beam

With objective lens removed, adjust the beam profiler's X and Y position so that the CellX beam hits the center or a reference position of the beam profiler.

### 8.1.6.4 Align Objective Lens to the CellX Beam

**WARNING!**

**Direct eye contact with the output beam from the laser can cause serious eye injury and possible blindness. Always wear appropriate safety glasses for the specific wavelengths. Use extreme caution even while wearing laser safety eyewear.**

Insert the objective lens in the beam path, and then do the following to get a correct alignment:

**WARNING!**

**Note that, if the reflected beam perfectly overlaps the input beam path, the laser can experience power instability.**

1. Find the back-reflected beam from the objective lens. The reflected beam should not overlap with the input beam.

   Refer to the example in Figure 8-9. The center spot is the input beam. The reflected beam is visible at the edge of the lens.

2. Rotate the yaw motion of the objective lens to adjust the reflected beam position to displace the X and Y position on the objective lens.

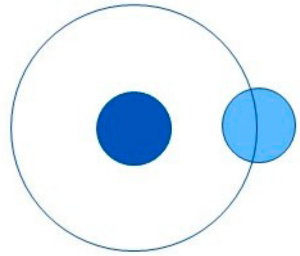


**Figure 8-9. Horizontal Tilt Point Alignment View on CellX Aperture - No Overlap**

3. Adjust the X and Y positions of the objective lens so that the focused beam hits the reference position on the beam profiler. This should be the same position that the CellX raw beam previously hit.

### 8.1.6.5 Adjust the Working Distance and CellX Collimation

1. Adjust the Z position (working distance) of the beam profiler to find the vertical focus; that is, to minimize the vertical beam size measured by beam profiler. The vertical beam size at focus is approximately:
   - With objective OL10-UV: 10 µm
   - With objective OL15-UV: 15 µm
2. Adjust the collimator Z-position internal to the CellX until the horizontal beam size reaches the desired value (for example, 60 µm for OL10-VIS and 90 µm for OL15-VIS).

   •The vertical beam size is now changed to a bigger value.
3. **Repeat steps 1 to 2** until the vertical beam size is minimized and the horizontal beam size reaches the desired value.
4. Adjust the laser output power level to nominal. This achieves the best stability level for the system.
5. Set this laser channel to OFF.

### 8.1.6.6 Adjust Other CellX Channels, Individually

One at a time, adjust other channels.

1. Set each wavelength to ON, one at a time, at nominal power level.

**CAUTION!**
**Do not adjust the working distance of the beam profiler!**

2. Adjust the internal Z-collimation/focus adjustment for each wavelength to make the vertical beam minimum in size. The horizontal beam size should automatically reach its specification range.
3. Finally, carefully lock down the collimators:

   Use a 5/64-in. hex torque driver, at the location highlighted in Figure 8-10. The recommended locking torque value is 6 to 12 in-oz (0.042 to 0.084 N-m).

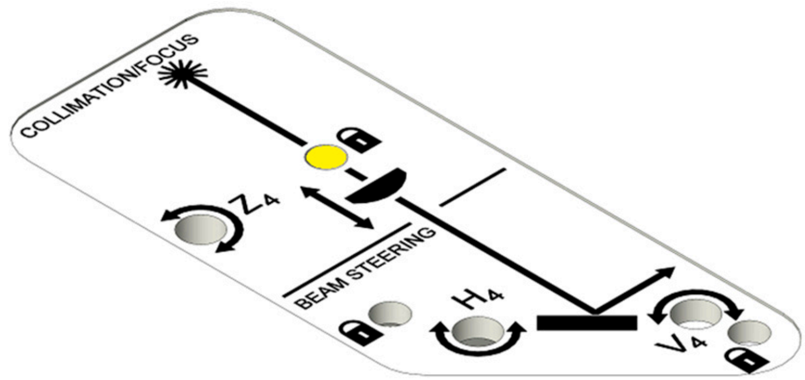



**Figure 8-10. Lock Down Collimators**

**CAUTION!**
**Locking down the collimators too tightly can affect the polarization extinction ratio of the laser beam.**

## 8.1.7 Align CellX Unit and Objective Lens to Target

The task is to align three objects:

- The CellX unit
- The objective lens
- The target (for flow cytometer applications, the target is a flow cell)

To accomplish this, first align the CellX beams to the target, then align the Objective Lens to the beam.

### 8.1.7.1 Set CellX Unit Power to ON and Prepare for Alignment

These steps assume that the power supply is connected to the CellX unit.

1. If power is not already set to ON, do so now with the switch on the power supply.

**WARNING!**
**LASER EMISSION STARTS NOW!** ***There is no shutter on the CellX unit.*** **The CellX system starts laser emission after power is applied.**

**Use precautions to avoid exposure of the eyes or skin to radiation from either a direct or reflected beam. Always wear appropriate safety glasses for the specific wavelengths. Refer to 'Laser Safety Hazards' (p. 7).**

2. For safety, set the power to <5 mW for laser alignment. Refer to the Coherent Connection software Help or User Manual about how to set the power level with use of the Coherent Connection software.
3. Select one laser beam to start alignment; any wavelength can be selected.

***NOTICE***
**It is recommended to start adjustments with use of either Channel 2 (488 nm) or Channel 3 (561 nm). Laser back-reflection is easier to see with either of these wavelengths.**

4. Set all other laser beams to OFF.
5. Loosen the locks on the internal beam pointing/steering adjustments for the CellX unit with a 5/64-in hex driver. The locations are highlighted in Figure 8-11:

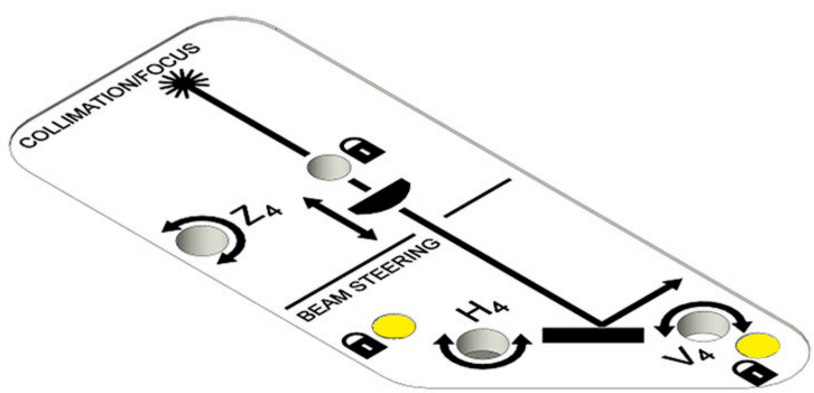



**Figure 8-11. Loosen Locks for Beam Adjustment**

### 8.1.7.2 Align CellX Beam to Target

Without any objective lens, adjust the position of either the CellX unit or the target (or both) so that the CellX beam hits the target.

Finding the back-reflected light from the target is a good way to know that the target is hit by the beam. The internal pointing/steering adjustments for the CellX unit can be used to fine-tune the beam path.

### 8.1.7.3 Align Objective Lens to the CellX Beam

***NOTICE***
**A magnifying lens or camera system can help with this alignment.**

Now the objective lens must be put in the beam path.

**WARNING!**
**Note that, if the reflected beam perfectly overlaps the input beam path, the laser can experience power instability.**

1. Find the back-reflected beam from the objective lens. Rotate the yaw motion of the objective lens so that the reflected beam does NOT overlap with the input beam path. Refer to example in Figure 8-9.

**WARNING!**
**Direct eye contact with the output beam from the laser may cause serious eye injury and possible blindness. Always wear appropriate safety glasses for the specific wavelengths.**

2. Adjust the X and Y position of the objective lens so that the focused beam hits the target on which the raw CellX beam previously hit.

***NOTICE***
**Fine-tune of the Z-position does not require it to be unlocked.**

3. Fine-tune the Z position (working distance) of the objective lens so that the vertical focus is at the target. Iteratively fine-tune the beam path with the internal X and Y pointing adjustments in the CellX unit, as needed. Refer to the alignment diagram in Figure 8-13. If the target is a flow cell, optimize this alignment by peaking the scattering signal.

4. Lock down the pointing beam adjustment. Refer to locations highlighted in Figure 8-12. Use a torque screwdriver with 5/64-in. hex bit to tighten the lock screws. Refer to 'Torque Notes Recommendations' (p. 198).

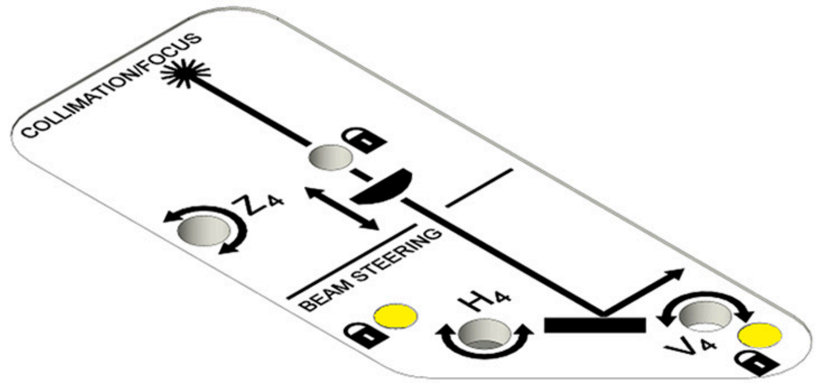



**Figure 8-12. Torque Locks for Beam Adjustment**

CellX pointing adjustments are locked to maximize stability.

***NOTICE***
**Lock of the adjustments results in a small amount of steering shift. An iterative lock-and-adjust method is needed to get correct alignment.**

To ease the alignment process, use a gradual and iterative lock-and-adjust method. Always start with locking at a medium torque value, as shown in Figure 8-13:

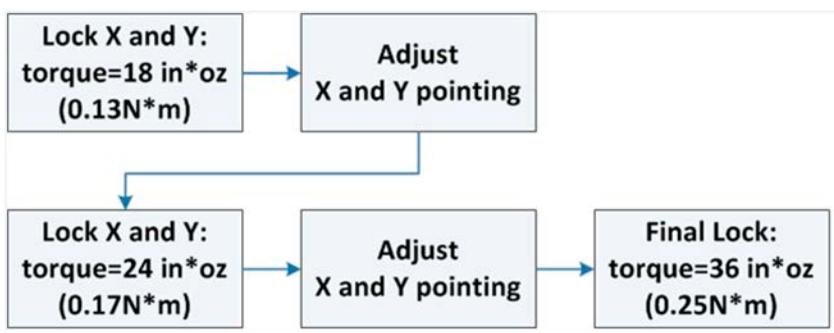



**Figure 8-13. Alignment Process Diagram**

### 8.1.7.4 Torque Notes Recommendations

- At larger torque values on the locks for the adjustments, the X and Y adjustments become harder to turn. Use an L-shaped hex key for this adjustment.

- Due to mechanical variation, some dichroic mounts may already be fully locked at 24 in-oz. If this happens, the locking steps can instead be done in increments such as 12 → 18 → 24 in-oz, then finished with the final lock torque of 36 in-oz.

- The recommended torque wrench to be used is the Mountz FGV-25z.

### 8.1.7.5 Partial Lock First Recommendations

- The locking shift can be difficult to estimate because it is dependent on the individual mount and any pre-bias of the lock screws. Partially locking first can be helpful, as it reduces the magnitude of the shift when locking and makes the locking shift estimation more reliable.

- The partial locking torque should be selected as high as possible, as long as the pointing adjustment is still smooth.12 in-oz is a good starting point, but can be adjusted by feel. **The goal is to still be able to adjust smoothly while the lock is partially engaged.** This can be done progressively, by increasing the lock pre-bias as the mount is adjusted into alignment.

### 8.1.7.6 Recommendations to Avoid Backlash and Crosstalk

- **Approach target from one direction**: In order to have a more accurate locking shift estimation, it is recommended to always approach the target position from *one* direction. If adjustment toward the opposite direction is needed, overshoot a little first, and then turn back toward the target.

- **Priority direction**: If the position accuracy in the horizontal direction is more important than the vertical direction, then adjust the horizontal direction last. If position accuracy in the vertical position is more important, adjust the vertical direction last. If the position accuracy of both directions are equally important, then any crosstalk shift needs to be estimated and pre-biased. Crosstalk shift can be from zero to a few microns.

### 8.1.8 Adjust Other Channels

Continue the process to adjust other wavelengths, one at a time.

1. Go to the next channel for the needed wavelength to adjust.

**CAUTION!**
**Do not adjust the working distance! Instead, adjust the internal pointing for each wavelength to get a peak signal.**

2. Lock down each of the adjustments as described in the previous section, 'Align CellX Unit and Objective Lens to Target' (p. 194).
3. Re-install the top cover and tighten the lid. Use the two screws removed earlier.


**Figure 8-14. Reinstall the Top Cover**

# 8.2 CellX for Microscopy Maintenance Procedures

## 8.2.1 Examine and Adjust Fine Fiber Alignment

### 8.2.1.1 Introduction and Purpose

This procedure is needed to examine, and if necessary, externally align and use fiber with CellX units This applies only to units designed for use with an external fiber assembly that takes an input beam size of 0.7 mm. The fiber is mounted and aligned with a micromanipulator, or fiber aligner. This allows the beam to be delivered through the fiber for microscopy applications.

The fiber launcher/aligner is an external accessory used to attach the fiber to the aperture of the CellX. It gives the ability to adjust and fine-tune the alignment of the laser output and the fiber to achieve optimized and efficient laser output. Highly sensitive adjustments allow for very discrete laser alignment.

CellX units that are fiber-ready for microscopy are delivered with a fiber launcher pre-installed and factory aligned. Compatible CellX for Microscopy lasers without the launcher pre-installed can have a launcher installed, but then require coarse beam alignment before fine alignment is done for the external fiber.

To install a fiber launcher to a compatible CellX unit, go to 'Install the Fiber Aligner' (p. 209).

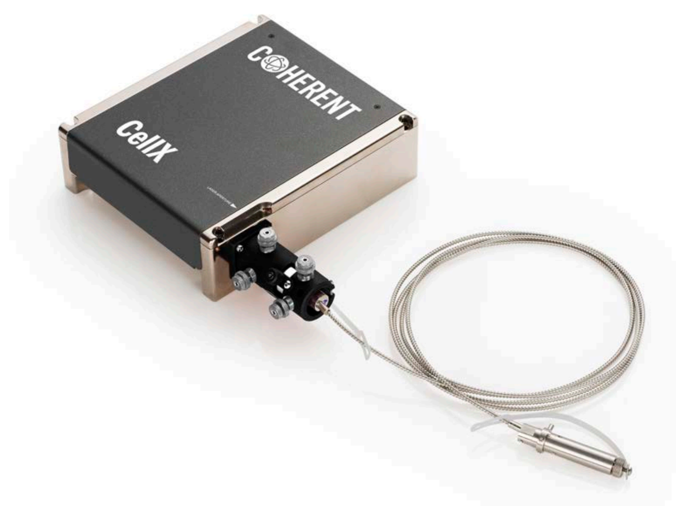



**Figure 8-15. External Fiber Configuration**

The procedures in this chapter apply to a launcher with the use of either FC/APC fiber or a fiber with collimated output. Refer to ’CellX Options for External Fiber for Microscopy’ (p. 61).

#### 8.2.1.2 Fine Fiber Alignment Procedure Overview

External and then internal beam alignment must be examined after installation of the fiber to the beam launcher/aligner. For fiber installation instructions, refer to the fiber install procedure in ’Installation’ (p. 77).

---

**CAUTION!**
**Use extreme caution to NOT over-adjust the knobs, which are highly sensitive. During shipment, alignment can shift, even though locked. Typically, the knobs are rotated less than 1/8th-turn to fine tune. Careless coarse knob rotation can result in a time-consuming search process to restore optimal alignment.**

---

**WARNING!**
**LASER RADIATION - The CellX laser system is an OEM component with CLASS 4 laser emission levels. Avoid eye or skin exposure to both DIRECT and SCATTERED radiation.The CellX laser system does not have a shutter. Always wear laser safety glasses when aligning the CellX unit.Use of controls or adjustments or performance of procedures other than those specified can result in exposure to hazardous radiation- Power on the CellX unit. Set the power level to 10 mW for all channels.**

---

**CAUTION!**
**Also, avoid back reflections when aligning the CellX unit. Back reflection of as little as 5% can damage the laser. Back reflection can also cause noise in the CellX system.**

---

**CAUTION!**

**The fiber must be kept free of contamination. Do not touch the fiber tip. The fiber tip must be inspected, and then cleaned, if necessary, during setup and before work is started. For instructions to clean the fiber, refer to ’Inspect and Clean the External Fiber’ (p. 220).**

**Figure 8-16. Fiber Launcher with Fiber Installed**

Figure 8-17 shows the location of the adjustment locks and knobs.

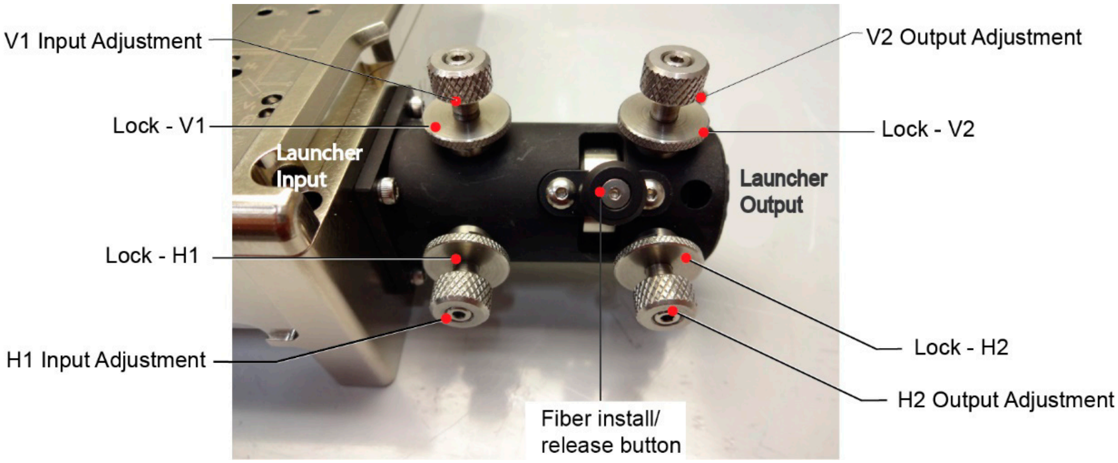



**Figure 8-17. Fiber Launcher Adjustments and Lock Locations**

**CAUTION!**
**The adjustments are highly sensitive. Adjustments with the knobs should be very slow and steady, not more than 1/8-turns, in order to find and stay within optimized ranges. If rotated too freely, the beam can be severely mis-aligned and require extensive time to get back to optimal alignment.**

### 8.2.1.3 Perform External Fiber Fine Alignment

1. Use the latest Coherent Connection (currently Coherent Connection 6) software to set laser emission to OFF.

**CAUTION!**
**Make sure that the power meter wavelength is set correctly.**

2. Prepare the power meter or measurement software to observe and measure the laser output.
3. Use the software for laser operation to set the 488 nm channel to ON (with 10 mW output power setting). Refer to the example in Figure 8-19. There should be some visible light coming out of the fiber.

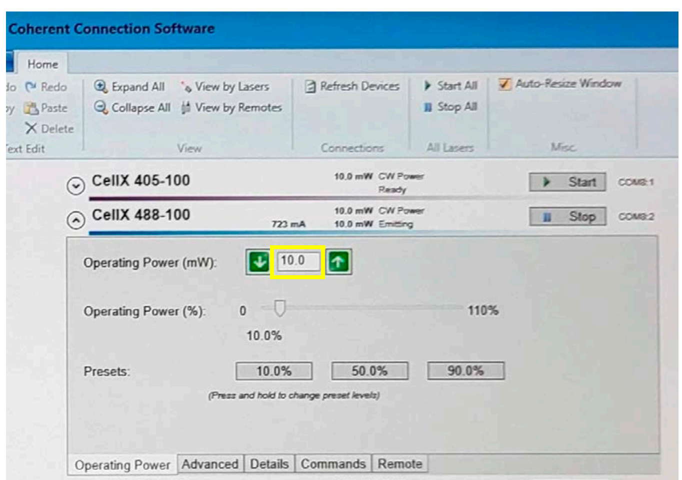



**Figure 8-18. Example Power Sensor and Laser Operation Software Screens**

4. If there is NO visible light, complete coarse alignment before the next steps are done. Refer to **'Perform Coarse Alignment with Align-**

**ment Tool' (p. 212)**. When coarse alignment is done, continue to the next step.

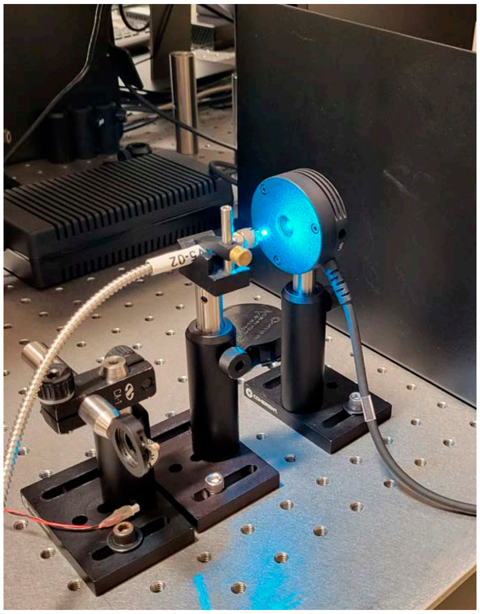


**Figure 8-19. Laser Light at Fiber Output End**

5. Rotate all four of the lock mechanisms counter-clockwise to unlock the adjustment knobs. Refer to Figure 8-20.

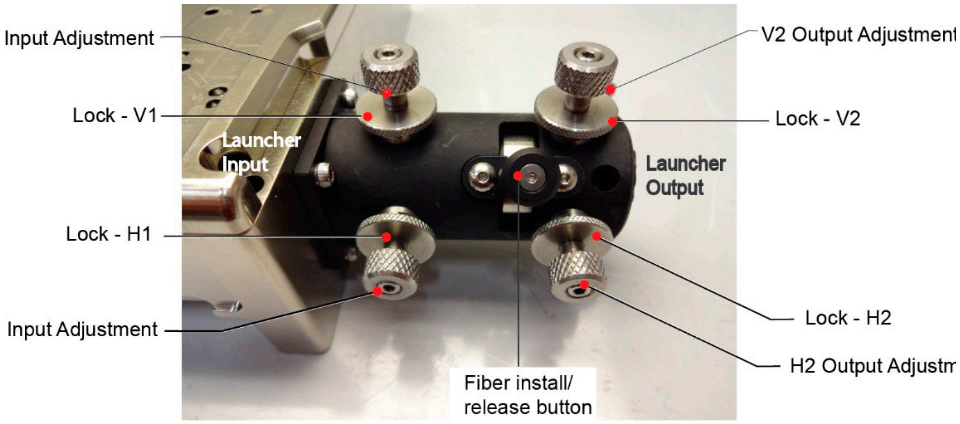



**Figure 8-20. Adjustment Controls for Input/Output**

---

**CAUTION!**
**The adjustments are highly sensitive. Adjustments with the knobs should be very slow and steady, not more than 1/8-turns, in order to find and stay within optimized ranges. If rotated too freely, the beam can become so misaligned that the laser output is not visible. This requires extensive search and time to get back to optimal alignment.**

---

6. Carefully adjust the knobs to get the optimized output power from the fiber. A 5/64-in hex wrench or driver is recommended for fine adjustment. There should be at least 6.5 to 8 mW of power shown on the meter when the power is optimized.The goal is to get the observed output power in the measurement software to be as high, or optimized as possible. the Refer to the example in Figure 8-21.

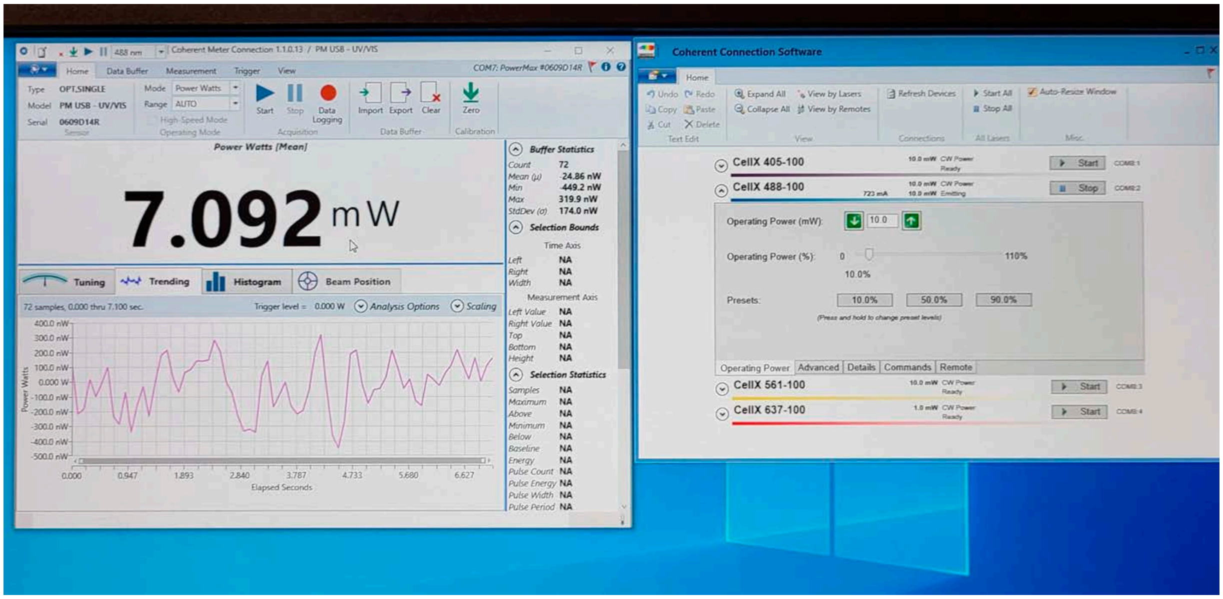



**Figure 8-21. Example Power Sensor and Laser Operation Software Screens**

7. To get a maximized power level, do the following:

   a.) Use the knobs to move the fiber launcher in horizontal (bottom H1 & H2) direction to get the maximized laser output. Refer to reference Figure 8-20. Rotate each knob slightly in the same direction and observe the power level in the measurement software. Refer Figure 8-22. If the level decreases, rotate the same knob other direction slightly. Alternate between knobs and 'walk' the beam to the **highest/maximum** power level.

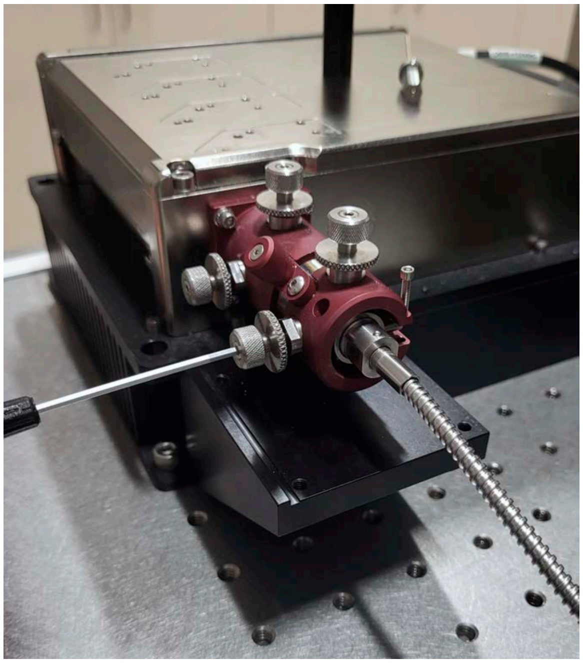


**Figure 8-22. Carefully Rotate Adjustment Knob**

b.) Use the knobs to move the fiber launcher in vertical (top V1 & V2) direction to get the maximized output. Refer to reference Figure 8-20. Rotate each knob slightly in the same direction and observe the power level in the measurement software. If the level decreases, rotate the other direction slightly. Alternate between knobs and 'walk' the beam to the **highest/maximum** power level.

c.) When the power level is maximized and turns of adjustment knobs cannot increase the power level, STOP.

**CAUTION!**
**Do NOT adjust the knobs for fiber alignment with the power level set to maximum for the laser, 100 mW. This could damage the fiber. The 100 mW power level can be used to observe how optimized the power output is, but adjustments must NEVER be made at maximum output power.**

8. Increase the 488 nm Channel 2 power to 20 mW in the software.

9. Repeat the adjustments in the steps above to get the optimized output power for the 488 nm channel.

---

***NOTICE***

**Z-adjustment of the internal beam is pre-set with units that ship with an external fiber and should not be performed. Only in rare situations where output power cannot be optimized to a correct level, can Z-adjust performed, with extreme care, for troubleshooting. Refer to ’CellX for Microscopy Only: Output Power Measured for Externally Aligned Fiber is Below Minimum Value’ (p. 236).**

---

If adjustment does not give an optimization of output measurement of at least 65% of the input power, troubleshooting can be performed. For example, at 10mW input power, the reading in the measurement software should be minimum 6.5mW or greater. Refer to ’CellX for Microscopy Only: Output Power Measured for Externally Aligned Fiber is Below Minimum Value’ (p. 236). For assistance, contact Coherent Product Support. Refer to ’Contact Product Support’ (p. 229).

10. Set the 488 nm channel to OFF.

11. Carefully rotate all four lock mechanisms clockwise to lock the knobs. Make sure that the adjustment knobs do not move, by observing the output power.

    No more fiber launcher adjustment is needed after the maximum coupling efficiency is achieved. After the 488 nm channel is optimized, the dichroic adjustments must be made for the remaining channels, on the CellX unit itself. Refer to ’Internal Beam Alignment’ (p. 183) for more information about dichroic adjustment and to Figure 8-24.

12. Adjust the coupling efficiency to the maximum for the next channel:

    a.) Use the software to set the 405 nm Channel 1 to ON.

    b.) Adjust the CellX dichroic mirror horizontally (H) and vertically (V) to maximize the coupling efficiency for Channel 1 (405 nm). Adjust at 10 mW first, then increase the power to 20 mW.

    Refer to Figure 8-24 for locations.

---

***NOTICE***

**The locks for these adjustments should not need to be used for minor adjustments. The locks can remain locked for minor H and V adjustments.**

---

If at any time in these steps, if adjustment does not give an optimization output reading of at least 65% of the input power, troubleshooting can be performed. For example, at 10mW input power, the reading in

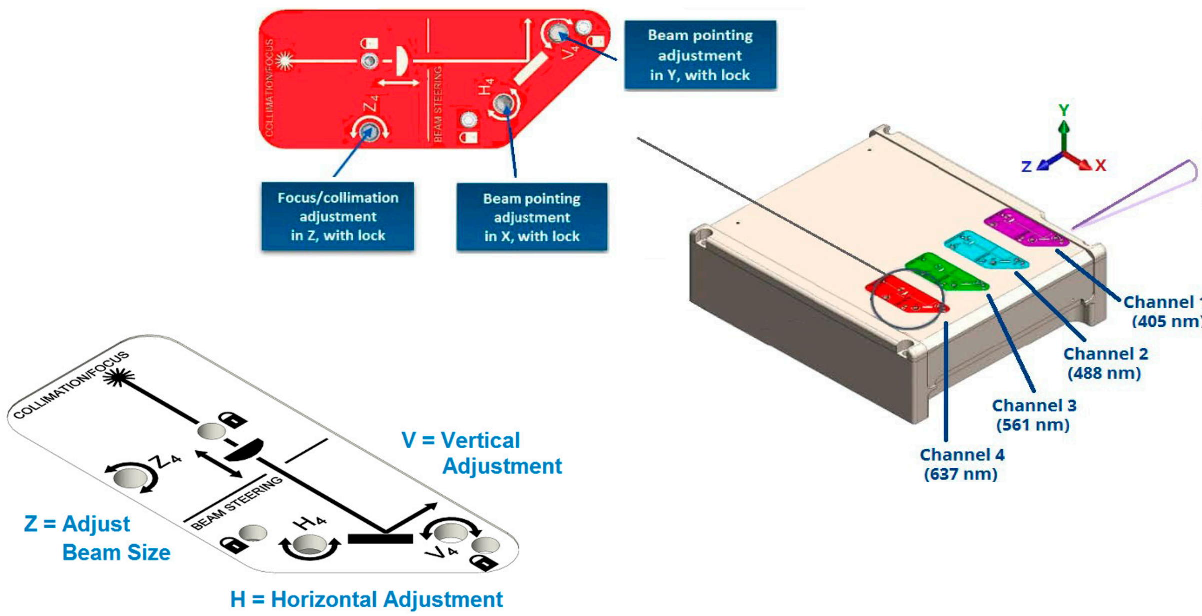
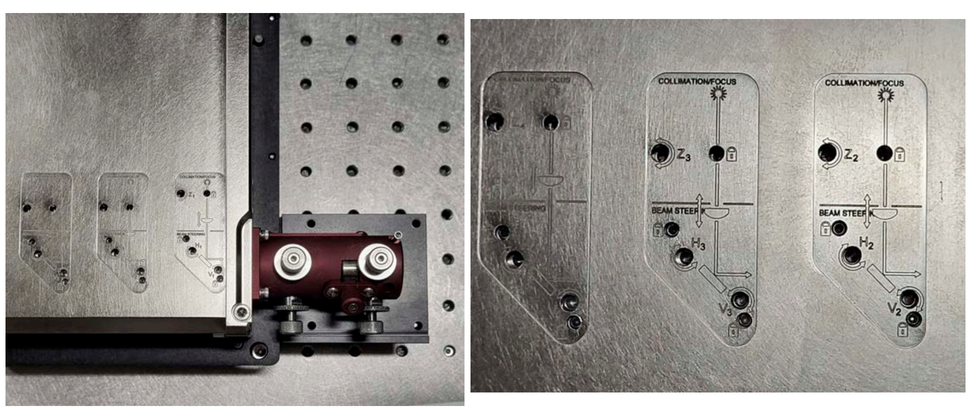



**Figure 8-23. Internal Beam Alignment Overview**

**Figure 8-24. Dichroic (V & H) Adjustment Locations**

the measurement software should be minimum 6.5mW or greater. Refer to ’CellX for Microscopy Only: Output Power Measured for Externally Aligned Fiber is Below Minimum Value’ (p. 236). For assistance, contact Coherent Product Support. Refer to ’Contact Product Support’ (p. 229).



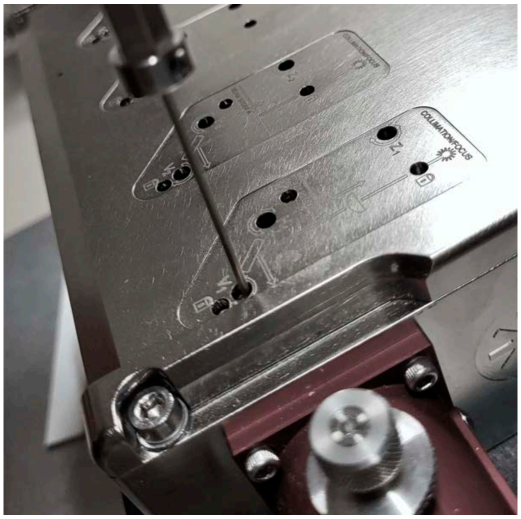


**Figure 8-25. Dichroic (V) Adjustment for 405 nm Channel**

c.) Adjust until a maximized power level is reached.

---

***NOTICE***

**If a large adjustment is needed, the mounts on the CellX should first be partially unlocked. The dichroic adjustment is very sensitive and usually with some crosstalk and backlash for both horizontal and vertical adjustment. The CellX dichroic mounts were partially locked (for 488 nm channel it was fully locked as the adjustment is not needed) to make the adjustment easier. Only small adjustment is needed - usually smaller than a quarter-turn.**

---

13. When the 405 nm is optimized, set the laser emission to OFF.
14. Continue to the 561 nm (Channel 3) and 637 nm (Channel 4). Set them to ON, to get the channels optimized, as was done for Channel 1, and to set them to OFF. Refer back to step 12.
15. Make sure that the locks on the launcher are rotated clockwise to lock all of the adjustment knobs.

## 8.2.2 Install the Fiber Aligner

This procedure must be completed if a fiber aligner (PN 2313364) is not yet installed on a compatible CellX for Microscopy laser system

For lasers that have a fiber launcher already installed. go to ’Install Fiber Assembly’ (p. 102).

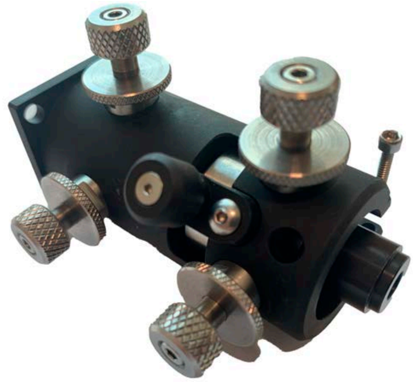


**Figure 8-26. Adjustable Fiber Aligner with Alignment Sleeve**

1. Make sure that the CellX laser system is set up on an appropriate surface or optical workbench with a heat sink. Refer to the instructions for setup and installation in 'Install CellX System Hardware' (p. 77), as necessary.
2. Locate the four socket-head mount screws (4-40, 0.25-in., P/N 7202-0404) for the launcher. No washers are needed.
3. Locate a 3/32-in. hex-head torque driver.


**Figure 8-27. Recommended Torque Driver**

4. Remove and read the CAUTION label on the beam launcher. The adjustment knobs are highly sensitive.


**Figure 8-28. Caution Label For Sensitive Adjustment**

5. Set the fiber launcher over the CellX aperture at the side of the unit. Make sure that it is aligned to the four mount screw holes. Refer to Figure 8-29.

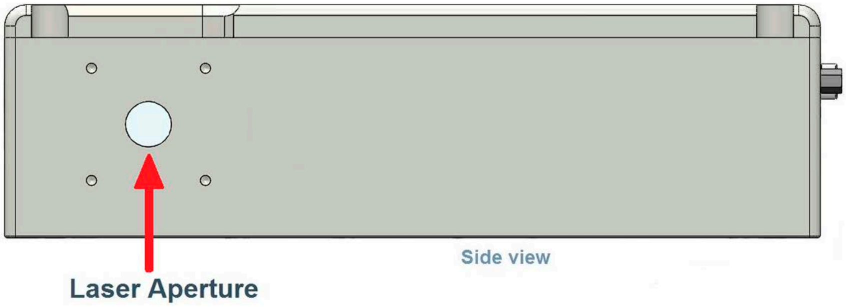



**Figure 8-29. Laser Aperture and Mount Location**

6. Attach the four screws lightly, hand-tight at first. Do not torque yet. Refer to Figure 8-30.

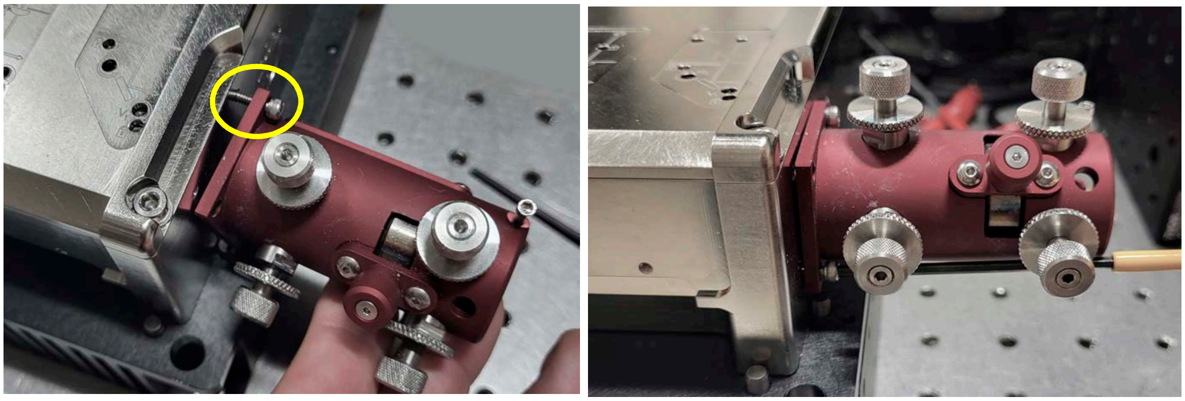


**Figure 8-30. Attach Four Screws Lightly**

**NOTICE**

**Coarse adjustment of the beam location must be done while the launcher is attached. This is done to make sure that the beam is not far out of alignment when the more precise beam alignment is done later. Otherwise, precise alignment is very difficult.**

7. Use the torque driver and, in an alternating 'star' pattern, torque the screws to 0.45 N-m (4 in-lb).


**Figure 8-31. CellX System with Fiber Launcher Attached**

8. To complete a step-wise torque process, go through a second 'star' pattern' to tighten again to 0.45 N-m (4 in-lb).
9. Use the alignment tube to perform coarse alignment. Follow the procedure in 'Perform Coarse Alignment with Alignment Tool' (p. 212).

### 8.2.3 Perform Coarse Alignment with Alignment Tool

**NOTICE**

**This procedure is only done with CellX lasers configured for microscopy applications.**

There are situations where a a basic coarse alignment of the beam output from the CellX for Microscopy must be done. For example, a beam launcher accessory is ordered to be installed on a CellX laser that does not have one. Also, in rare cases, a configuration of CellX with a fiber launcher can be mis-aligned during the shipment, and there is no beam delivered out of the fiber. This can happen even if the fiber is confirmed to be fully inserted in the launcher.

In these situations, the alignment tool/tube (PN 2313363) can be used for a basic coarse alignment. The tube has a small aperture on one end. Refer to Figure 8-32.

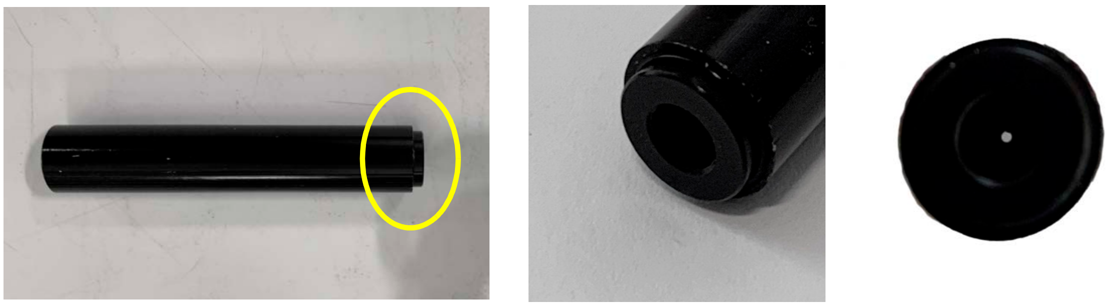


**Figure 8-32. Alignment Tube (Pinhole aperture side, with bevel, circled)**

---

**CAUTION!**

**The adjustments are highly sensitive. Adjustments with the knobs should be very slow and steady, not more than 1/8-turns, in order to find and stay within optimized ranges. If rotated too freely, the beam can become severely mis-aligned and require extensive search and time to get back to optimal alignment.**

---

Do the following:

1. Use the Coherent Connection software to set laser emission to OFF.
2. Make sure that the fiber is removed from the fiber launcher and that the protective cap is installed.

**Figure 8-33. Remove Fiber From Launcher and Install Cap**

3. Note the location of the install/release button. Refer to Figure 8-35.

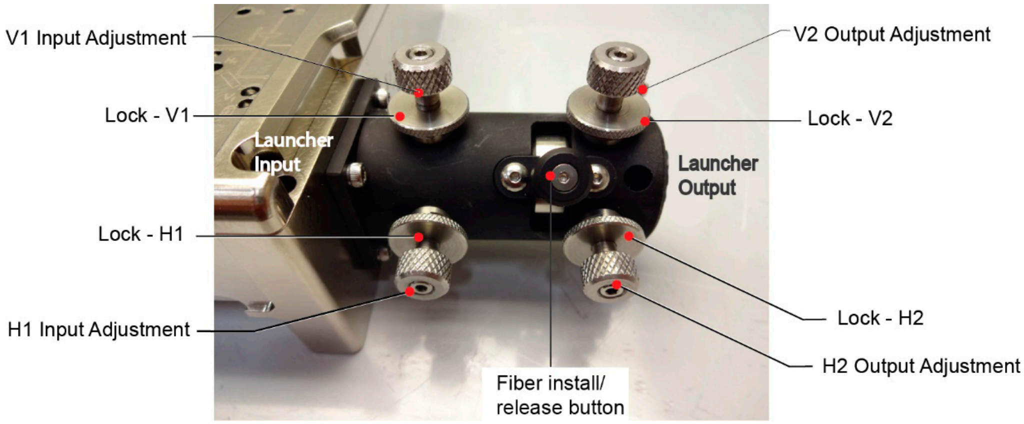
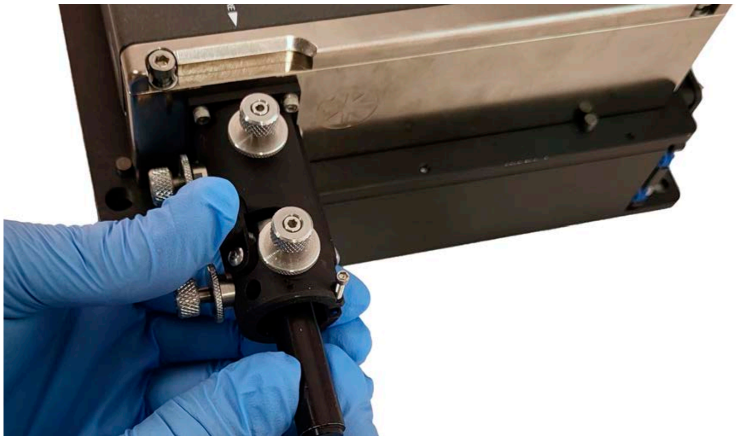



**Figure 8-34. Launcher Input / Output Adjustment Locations**

4. Push and hold the installation lock button and slide the alignment tool/tube into the launcher with the aperture (beveled) end of the tube,

with the pinhole, on the input (closest to laser) side of the launcher first. Refer to Figure 8-35.



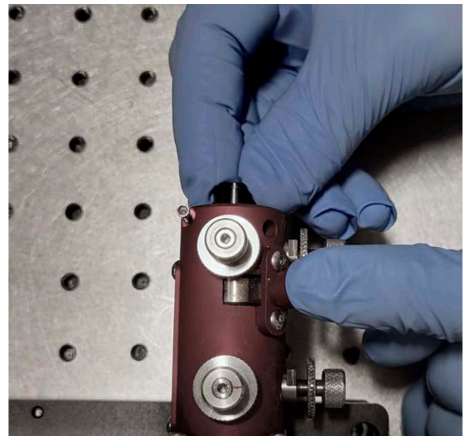


**Figure 8-35. Remove/Install Lock Button and Tool Partially Inserted**

5. Make sure that the tube is fully inserted, and then release the button. Refer to Figure 8-36.

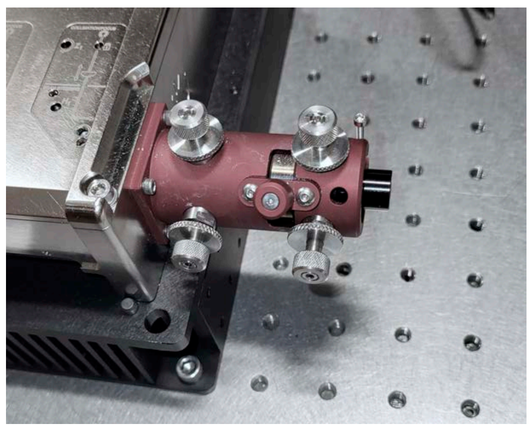


**Figure 8-36. Adjustment Tube Fully Inserted, Beveled Aperture End in First**

6. Use the Coherent Connection software to set the 488 nm beam to On at 10 mW power level.

7. Before examination and adjustment is done, it is recommended to put a temporary marking on the adjustment knobs to show their 'start'

position, for reference. This can be useful if adjustment must be reversed. Refer to Figure 8-37.

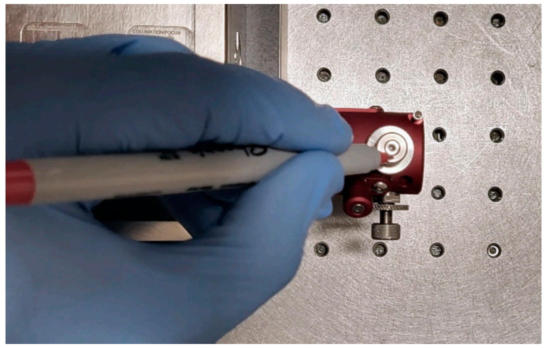


**Figure 8-37. Temporary Location Marking**

***NOTICE***

**Note that unlike the fine adjustment with fiber installed, the adjustment knobs are used differently for coarse beam alignment. The procedure in this section requires the adjustment of the V1/H1 knobs, and the V2/H2 knobs, alternately. When the tube/tool aperture is closer to the input side, adjust V1/H1. When the tube position is reversed, the aperture is near the output side. Then, V2/H2 is adjusted to make the beam centered on the aperture. Follow the instructions below, carefully for coarse adjustment.**

8. Align the beam with the tool:

   a.) Turn the lock mechanisms counter-clockwise to loosen the adjustment knobs. Refer to reference Figure 8-34.

b.) Adjust the two knobs (V1/H1) on the fiber launcher, on the input side. Make sure that the beam comes out from the center of the aperture. A 5/64-in. hex driver is recommended to improve control for small adjustments.

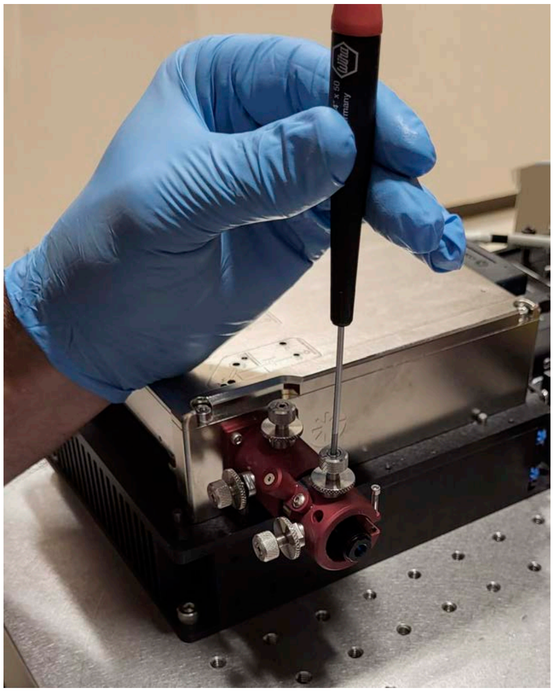


**Figure 8-38. Adjust Knob with Tool**

c.) Use a beam block or a similar method to view the location of the beam as it comes out of the aperture on the end of the tube. Make sure that it is in the center and that the beam is not clipped. Refer to Figure 8-39.

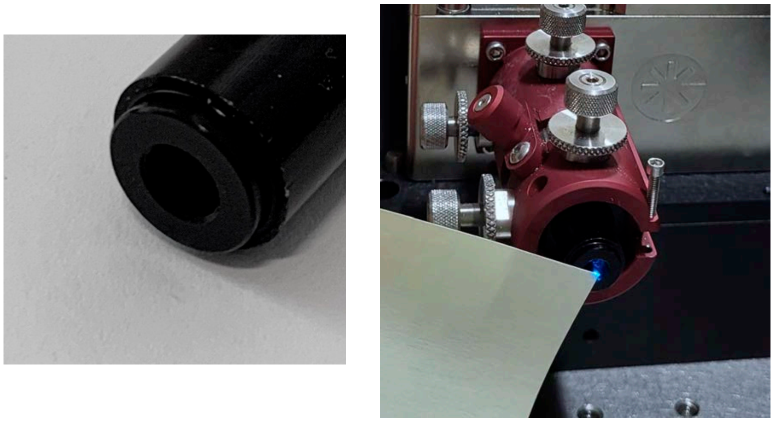


**Figure 8-39. Beam Aligned in Center of Alignment Tool/Aperture**

d.) Set the laser to OFF

e.) Push and hold the fiber release/hold button (refer to Refer to reference Figure 8-35), and remove the tube.

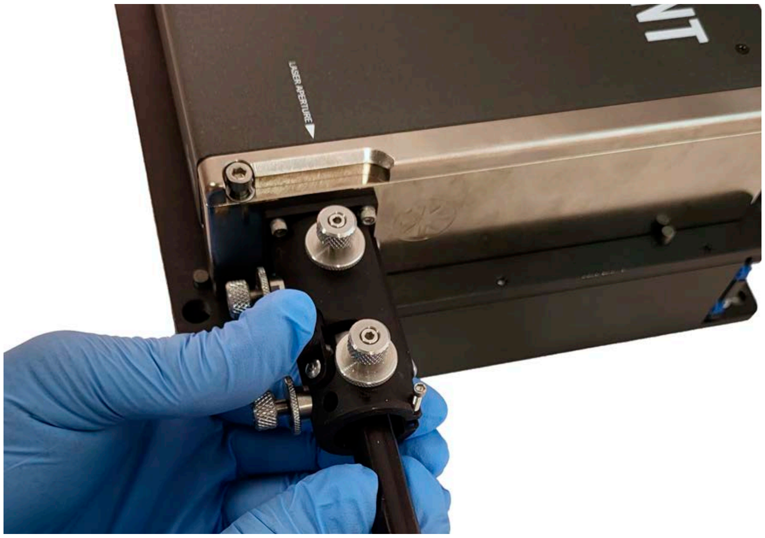


**Figure 8-40. Push Release/Hold Button and Remove Alignment Tube**

f.) Then, push and hold the release/hold button, and re-insert it with the opposite (aperture, pin-hole) end of the tube, into the output (farthest from the laser) side of the launcher first. Refer to Figure 8-41.


**Figure 8-41. Tube Inserted with Aperture (beveled) End in Last**

g.) Set the laser to ON.

h.) Adjust the two knobs (V2/H2) on the output side of the launcher. Make sure, visibly, that the beam is in the center of the aperture, as bright as possible, and it is not clipped.

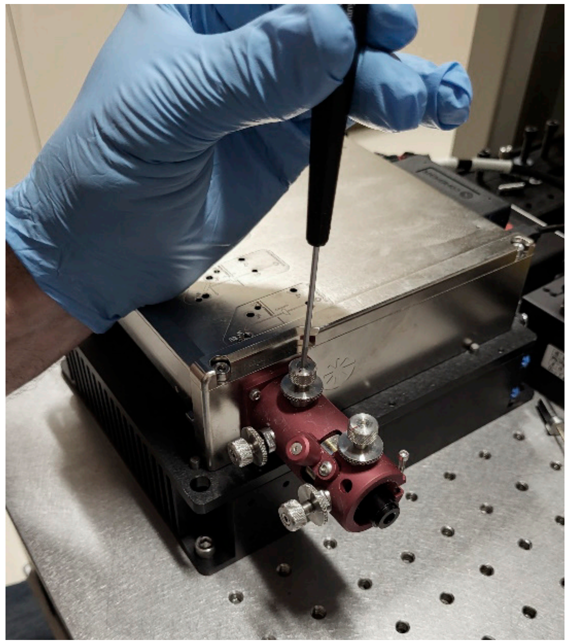


**Figure 8-42. Adjust Knob with Tool**

9. Repeat the input and output adjustment in this sub-steps above two to three times. This is done to align the launcher so that the beam goes through the center of the aperture if it is on the input or output side.

10. Push and hold the release/hold button and remove the alignment tool/tube.

**Figure 8-43. Remove Alignment Tool/Tube**

11. Install the fiber. Refer to the install fiber procedure in 'Install and Set Up Fiber for Microscopy' (p. 101).
12. Adjust the knobs on the output end on the fiber launcher, slightly, to get the visible light, aimed at a target or beam block, to a maximum.

*NOTICE*
**The light might be faint. It is recommended to set the ambient light in the room very low so that any light from the fiber is visible.**

13. If little or no light is visible, rotate the knobs until some light is seen. Then adjust the knobs slightly in order to get the brightest visible light on the target.
14. Complete the steps in the **'Perform External Fiber Fine Alignment' (p. 203)** section of this procedure. This provides the best laser coupling of all channels.

## 8.3 Inspect and Clean the External Fiber

This procedure applies to external fiber for CellX for Microscopy applications. Before this cleaning procedure is performed, inspect the APC fiber optic surface with a fiber scope to determine the extent to which the fiber might be damaged or contaminated.

*NOTICE*
**To prevent the introduction of dust, dirt, or potential damage to the fiber optic, only perform the cleaning procedure if the fiber optic surface shows imperfections.**

**CAUTION!**
**Follow all safety instructions when isopropyl or methanol is used for wet clean of the fiber tip. If safety instructions are not available, contact the vendor before completion of these procedures.**

**CAUTION!**
**Never touch the tip of the fiber connectors. Leave the protective cover on the fiber tip in the closed position as long as possible.**

**CAUTION!**
**Never use alcohol, methanol or wet cleaning without a way to make sure that it does not leave residue on the fiber tip.**

### 8.3.1 Necessary Materials and Equipment

The following materials are required to perform this procedure:

- Cleanroom-quality swabs made by ITW Texwipe part number TX759B
- Fresh spectroscopic-grade methanol or spectroscopic-grade isopropyl alcohol
- Fiber microscope (fiber scope), 200X total magnification [1]
- Non-powdered, non-coated Nitrile gloves

**CAUTION!**
**NEVER use acetone to clean the fiber! This can cause damage to the optic fiber.**

1. Customers who have purchased 200x microscopes can use those instead.

### 8.3.1.1 Fiber Scope

Use a fiber scope that supports the following:

A recommended fiber scope is the Thorlabs FS201 and FC/APC adapter. See Figure 8-44.


**Figure 8-44. Example Fiber scope and Adapter - Thorlabs FS201**

## 8.3.2 Fiber Evaluation Criteria

Figure 8-45 shows images as viewed through a fiber scope of different types of damage. Note that the views shown are the optical surface.

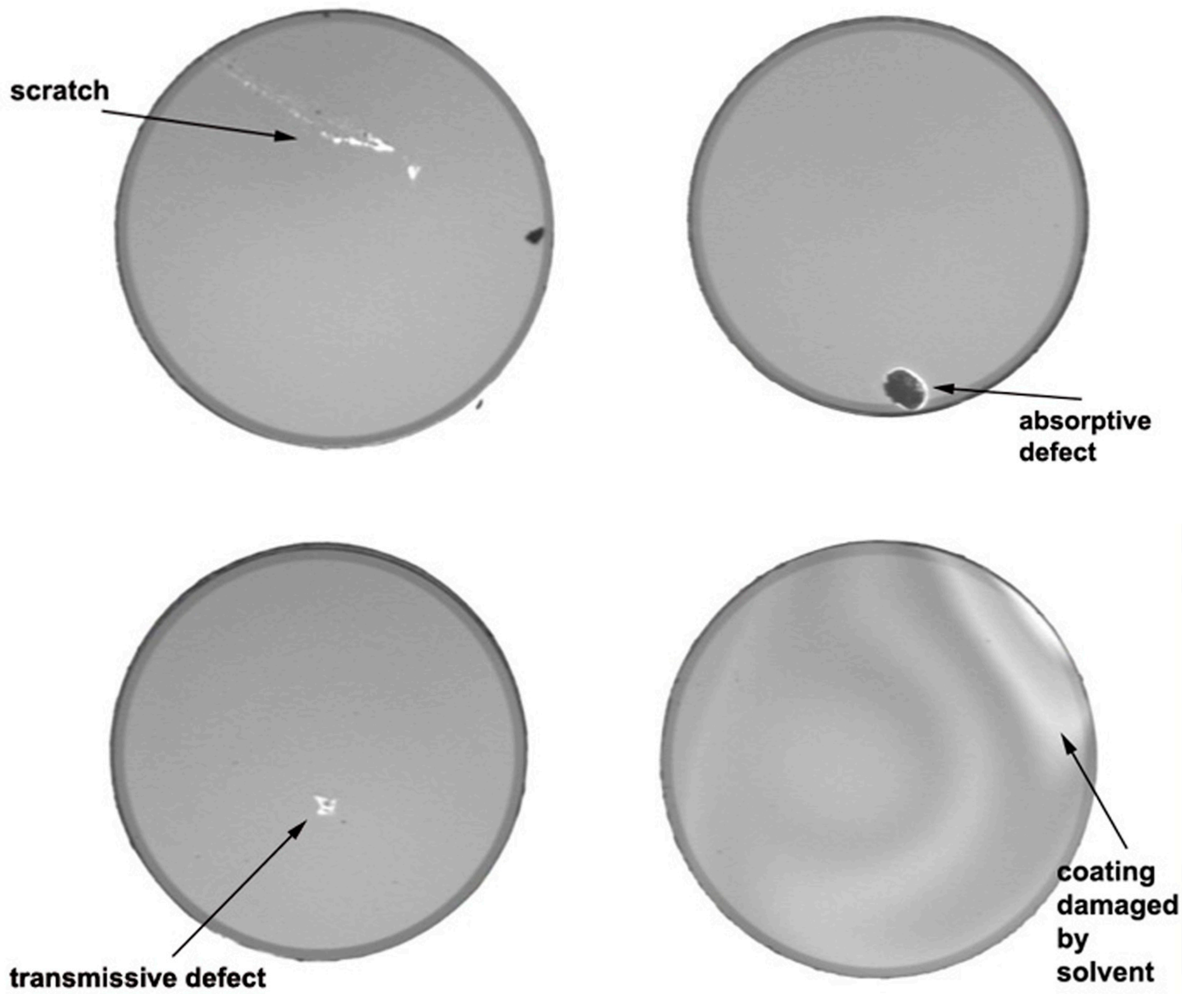



**Figure 8-45. Examples of Fiber Damage**

Figure 8-46 shows images of damage with contamination (left), then damage that is visible after contamination is cleaned (middle), and finally no damage after a polish (right).

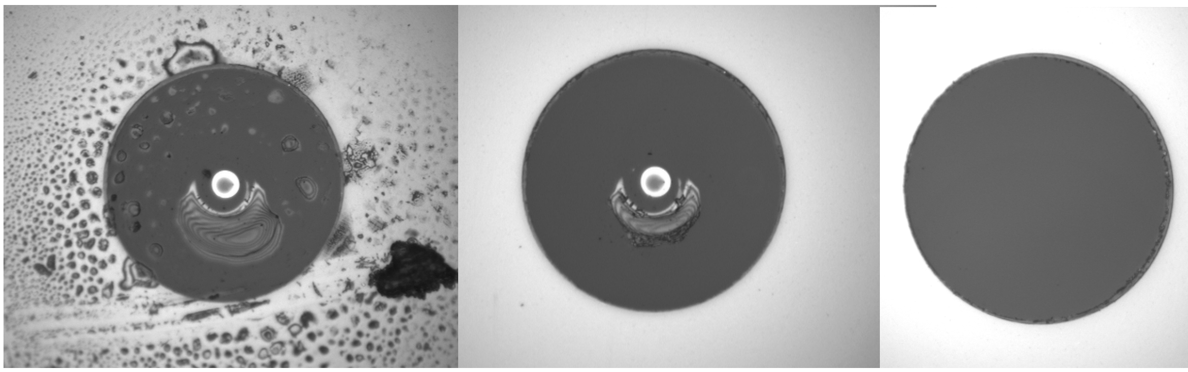


***Figure 8-46. Example of Contamination, Damage visible after Clean, and Polish Result***

### 8.3.3 Procedure For Fiber Inspection

Always wear latex gloves (or the equivalent) while any of the following procedures are performed. Dust, condensation, and oils from the hand can be transferred to the optical surface, which can lead to damage. If contaminants are visible on the outer wall of the nose, clean this surface first. See ’Clean the Fiber’ (p. 225).

1. Remove the protective cap from the fiber.
2. Tilt the fiber, as shown in Figure 8-47, and gently slide it into the adapter.


**Figure 8-47. Put Fiber in FC Adapter**

3. Inspect the fiber for defects: spots on coating, scratches, burns, contamination.

If the fiber surface complies with the acceptable guidelines, immediately install the fiber optic into the FAP or reinstall the protective cap.

### 8.3.4 Clean the Fiber

If contaminates are observed on the outer wall of the fiber nose, do the following to clean:

***NOTICE***
**Only optical grade isopropyl alcohol or methanol that is fresh and unexpired must be used. Otherwise, it can absorb moisture over time and cause problems.**

1. Use optical-grade methanol or isopropyl alcohol and a swab and insert the swab between the fiber tip and the shoulder. Rotate the swab inside the shoulder.
2. Halfway through the perimeter turn the swab around to use its other flat side.
3. Repeat, if necessary.

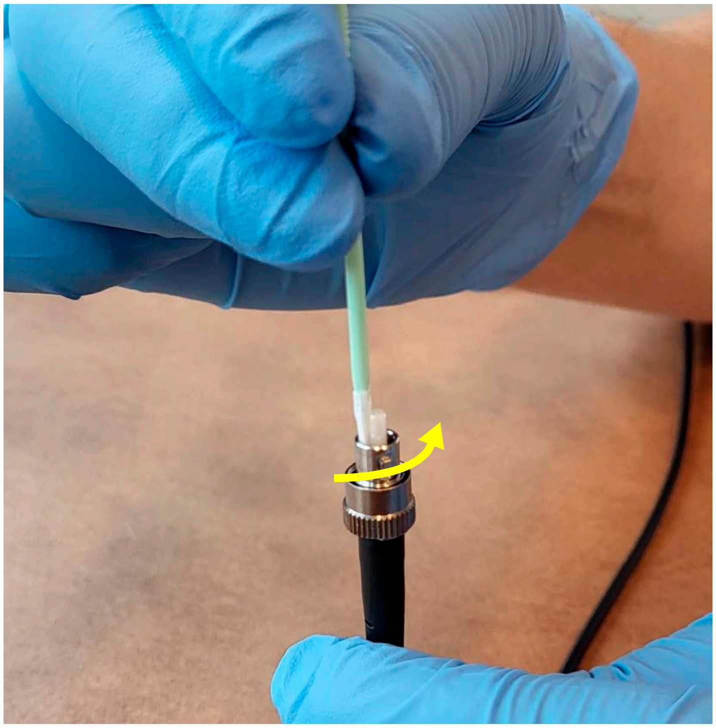


**Figure 8-48. Clean the Fiber Tip**

If contamination is observed on the fiber surface, do the following to clean:

1. Put two to three drops of methanol or isopropyl alcohol on the swab.
2. Vigorously shake off excess fluid from the swab.

**CAUTION!**
**Excess methanol on the fibers can cause potentially catastrophic damage to the fiber optic and the FAP.**

**CAUTION!**
**To prevent damage to the fiber, only the synthetic cloth on the swab should make contact with the fiber optic surface. Do not allow the plastic applicator to touch the fiber surface.**

***NOTICE***
**Use the swab to wipe in one direction. Do not rotate the swab as this can reintroduce contaminants.**

3. Hold the fiber surface vertically, and drag the swab once across the fiber optic surface. See Figure 8-49. **Do not** move the swab back and forth. **Do not** re-use the swab. Use a new, clean swab each time for the swipe.

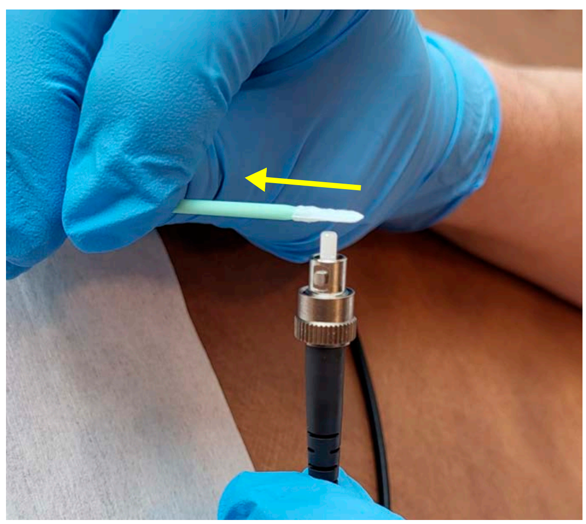


**Figure 8-49. Set the Swab in Position on the Fiber Optic Surface**

4. Re-examine the fiber with the fiber scope.
   - If the fiber surface complies with the acceptable guidelines, immediately re-install the fiber optic into the FAP.
   - If imperfections remain, the fiber optic must be replaced or returned to Coherent to be polished.
5. Reinstall the protective cap on the fiber tip.

# 9 Troubleshooting

## 9.1 Introduction

This section describes how to identify and correct any issues that can be encountered when work is done with the CellX Laser System.

***NOTICE***
**There are no user-serviceable components in the CellX laser system. DO NOT disassemble the enclosure. The laser system is designed to be operated as assembled.**
***The Warranty is void if the enclosure is disassembled!***

**CAUTION!**
**Take ESD precautions when handling and installing a laser. Refer to 'ESD Protection' (p. 18) for more information about ESD precautions.**

## 9.2 Contact Product Support

Coherent provides telephone and web-based technical assistance as a service to its customers and assumes no liability thereby for any injury or damage that can occur when such services are provided.

Under no circumstances do these support services affect the terms of any warranty agreement between Coherent and the buyer. Operation of any Coherent laser with any of its interlocks (or safety features) defeated is always at the operator's own risk.

***NOTICE***
***The Warranty is void if the enclosure is disassembled!***
**There are no user-serviceable components in the CellX laser system. DO NOT disassemble the enclosure. The laser system is designed to be operated as assembled.**

Should you experience any difficulties with the CellX laser system and need more assistance or technical information, contact Coherent Technical Support as described on in the front matter of this manual on page i.

Please be ready to provide the following information to the Support Engineer who responds to your request:

- Model or part number of the laser system
- Serial number of the laser system
- A description of the problem
- Any corrective steps that have been attempted.

## 9.3 Extended Warranty Service Options

Coherent offers extended service and warranty options through service agreements. Refer to 'Extended Warranty Service Options' (p. 237).

## 9.4 Troubleshooting Procedures

The following sections identify common issues that can occur.

If the steps described in the following sections do not resolve the issue, contact Coherent Support; see as described on in the front matter of this manual on page i.

**WARNING!**
**Follow all laser safety procedures when the output aperture on the laser is inspected.**

### 9.4.1 Issue: No Output Power from the Laser

If there is no output power from the CellX laser system, perform the steps in Table 9-1 in the order shown.

**Table 9-1. No Output Power from the Laser**

| Done | Steps |
|---|---|
| [ ] | Check that the to 115/220V AC power supply is connected to the CellX Laser System.<br>If the power supply is connected to the laser system through the connector on the Heat Sink, ensure that the connectors are properly seated. |
| [ ] | Turn the switch on the power supply OFF, then ON. |
| [ ] | Check that nothing is blocking the output aperture on the laser. |
| [ ] | Connect the CellX laser system to a workstation, power up the laser, and run Coherent Connection software. |
| [ ] | Check settings in software for **AutoStart**:<br>• Go to the **Advanced** tab and check the AutoStart setting.<br>• If “AUTOSTART=OFF”, change the setting to “AUTOSTART=ON”.<br>The laser begins emitting when the 12 volt power supply is turned on. |
| [ ] | Check settings in software for the **power level**:<br>• Go to the **Operating Power** tab and check the power level settings.<br>• Alternately, enter the remote command:<br>`SOUR:POW:LEV:IMM:AMPL?`<br>This should reply with the power level at which the laser is currently set to output. |
| [ ] | Check the settings for **’Laser on’ status**:<br>*In hardware:*<br>• Check the LED indicators on the CellX laser system.<br>*In software,* check the “laser on” status either:<br>• Through the Coherent Connection software, or<br>• Alternately, enter the remote command: `SOUR:AM:STAT?` |
| [ ] | Check the settings for **Operating Mode**:<br>• Go to the **Advanced** tab and check settings for the Operating Mode. For normal Continuous Wave (CW) operations, set ’CW Power’ mode.<br>• Alternately, enter the remote command:<br>`SOUR:AM:SOUR?`<br>The command replies with CWP (Continuous Wave Power). |
| [ ] | Check the settings for **fault Status LEDs**.<br>• *In hardware:* Check the state of the ’Next Steps’ (p. 110).<br>• *In software*: Enter the following remote command:<br>`SYST:FAUL?` |
| [ ] | • If operating in pulsed mode, make sure that the correct modulation signal is applied. |

If the steps described do not resolve the issue, contact Coherent Support for assistance (see ’Contact Product Support’ (p. 229)).

### 9.4.2 Issue: Laser Output Power Lower Than Expected

If the laser output power is lower than expected, perform the steps in Table 9-2 in the order shown.

**Table 9-2. Laser Output Power Lower Than Expected**

| Check | Steps |
|---|---|
| [ ] | On the power supply, turn the switch OFF, then ON. |
| [ ] | Check that nothing is blocking the output aperture on the laser.<br>***IMPORTANT! Follow all laser safety procedures when inspecting the output aperture on the laser***. |
| [ ] | Locate an **external power meter** that is both calibrated and appropriate for the output power level and wavelength of the lasers.<br>Verify the output power level of the CellX Laser System. |
| [ ] | Connect the CellX laser system to a workstation, power up the laser, and start the appropriate Coherent Connection software. |
| [ ] | Check settings in software for the **power level**:<br>• Go to the Operating Power tab and check the power level settings.<br>• Use the remote query:<br>**`SOUR:POW:LEV:IMM:AMPL?`**<br>This replies with the power level at which the laser is currently set to output. |
| [ ] | Check the settings for **Operating Mode**:<br>• Go to the Advanced tab and check settings for the Operating Mode.<br>OR<br>• For normal Continuous Wave (CW) operations, set 'CW Power' mode.<br>• Use the remote query:<br>**`SOUR:AM:SOUR?`**<br>The command should reply with CWP (Continuous Wave Power). |
| [ ] | Check the settings for **fault Status LEDs**.<br>• *In hardware:* Check the state of the 'Next Steps' (p. 110).<br>• *In software*: Go to the Main window and check the settings, or use the following remote query:<br>**`SYST:FAUL?`** |

If the steps described do not resolve the issue, contact Coherent Support for assistance. See 'Contact Product Support' (p. 229).

### 9.4.3 Issue: CellX Powered Up, Does Not Emit

If the CellX laser system is powered up but is not emitting and/or remains in Standby Mode, perform the steps in Table 9-3 in the order shown.

**Table 9-3. CellX Powered Up, Not Emitting**

| Check | Steps |
|---|---|
| [ ] | For models with the control board that has a keyswitch (refer to Figure 3-17), turn the keyswitch to the STANDBY position, then back to the ON position.<br>*See NOTES below.* |
| [ ] | The LED on the CellX Laser System should turn white and the laser begins emission after a 5-second delay. |
| [ ] | Ensure that the laser is not turned off through its software interface. To do so:<br>• Open the Coherent Connection software.<br>• Press the **Start** or **All Start** button. |

- If the keyswitch on the CellX Laser System is already in the ON position when the CellX Laser System is powered up, the keyswitch must be cycled to bring the laser out of STANDBY mode.

If the steps described do not resolve the issue, contact Coherent Support for assistance (see ’Contact Product Support’ (p. 229)).

### 9.4.4 Issue: LED Does Not Function

If the LED on the top cover of the CellX laser system is not functioning, perform the steps in Table 9-4 in the order shown

**Table 9-4. LED Not Functioning**

| Check | Steps |
|---|---|
| [ ] | Connect the CellX laser system to a workstation, power up the laser, and run Coherent Connection software. |
| [ ] | Go to the Preferences tab and check the settings for LED status. |
| [ ] | To confirm LED status, enter the following query:<br>**`SYSTem:INDicator:LASer?`**<br>A response of ON means that the LED is NOT disabled. |

If the steps described do not resolve the issue, contact Coherent Technical Support for assistance (see ’Pack and Ship Instructions’ (p. 239)).

## 9.4.5 Issue: Coherent Connection Software Cannot Access Lasers

If the Coherent Connection software does not access the CellX laser system, perform the steps in the order shown:

**Table 9-5. Software Cannot Access Lasers**

| Check | Steps |
|---|---|
| [ ] | Check both ends of the cable between the host workstation and the CellX laser system to ensure a snug connection:<br>• USB connection from the back of the CellX unit to the workstation<br>• RS-232 connection from the Control Board inserted into the CellX to the workstation |
| [ ] | Disconnect all other connections to the host workstation. Test the desired connection by itself. |
| [ ] | Restart the Coherent Connection software on the host workstation. |

If the steps described do not resolve the issue, contact Coherent Support for assistance (see 'Pack and Ship Instructions' (p. 239).

## 9.4.6 Issue: Base Plate Temperature Error

The maximum baseplate temperature should be 45°C for an CellX Laser System. See 'Heat Sink Options' (p. 32) for specifications.

***NOTICE***
**DO NOT use thermal grease or thermal compounds. The use of thermal grease or thermal compounds voids the warranty.**

If there is a base plate temperature error, and the CellX laser system is not functioning, perform the steps in Table 9-6 in the order shown.

**Table 9-6. Base Plate Temperature Error**

| Check | Steps |
|---|---|
| [ ] | Cycle the laser power OFF, then ON. |
| [ ] | Check the reported base plate temperature in the software. The maximum baseplate temperature should be 45°C for an CellX Laser System.<br>• Look at the Coherent Connection Details tab and make sure that the base plate temperature is being reported for each laser channel.<br>• Go to the Operating Power tab and check the power level settings.<br>• Use the remote command<br>**SOUR:TEMP:BAS?** |

**Table 9-6. Base Plate Temperature Error**

| Check | Steps |
|---|---|
| [ ] | Make sure that the CellX Laser System is mounted correctly to a properly-sized heat sink—refer to page 32. The laser and heat sink should have metal-to-metal contact. |
| [ ] | Make sure that the base plate is mounted to a heat sink that has a smooth surface. The mounting surface should be milled flat (within < 0.05 mm over the mounting surface). |
| [ ] | Make sure that the ambient temperature is not more than 45°C for the CellX Laser System. |
| [ ] | For fan cooled heat sinks, make sure fans operate and airflow is not obstructed. |

If the steps described do not resolve the issue, contact Coherent Support for assistance (see ’Contact Product Support’ (p. 229).

## 9.4.7 Issue: Error Message—Non-Existent Port

The error message shown in Figure 9-1 can display when the Coherent Connection software on a workstation tries to communicate with a device but:

- The device no longer responds.
- The device was not correctly disconnected from the workstation.
- The computer did not correctly release the device.

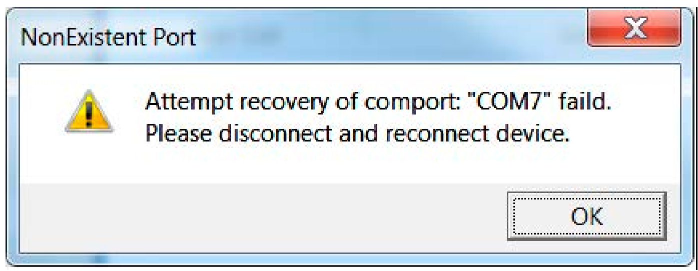



**Figure 9-1. Error Message: Non-Existent Port**

To correct this issue, perform the steps in Table 9.4.8 in the order shown:

## 9.4.8 CellX for Microscopy Only: Output Power Measured for Externally Aligned Fiber is Below Minimum Value

***NOTICE***
**Only in rare situations where external fiber output power cannot be optimized to a correct level, can Z-adjust be performed, with extreme care, for troubleshooting.**

**Table 9-7. Output Power for Externally Aligned Fiber Below Minimum**

| Check | Steps |
|---|---|
| [ ] | Make extremely light adjustments to the internal CellX optical Z-adjustment. Refer to 'Understand Internal Beam Adjustment Controls' (p. 188). Do not make large adjustments as this can affect X and Y adjustments and the collimated beam position. |

# 10 Extended Warranty Service Options

Coherent offers extended service and warranty options through service agreements, including the following.

**Coherent Productivity PLUS (PPlus)**: Extends the products warranty by an additional 12 Months and includes unlimited technical support. Extended warranty is available up to 15,000 hours total of operation or 5 years after standard warranty, whichever occurs first. Extended warranty must be purchased within the original warranty period or extension

**Coherent Advantage PLUS (APlus)**: Extended service provides expedited, 'quick turn' unit replacement during the standard warranty period or extension.

Under Advanced Replacement, the defective unit must be returned within the agreed time-frame. If the defective unit is sent back and it is No Problem Found (NPF), an evaluation fee may be charged and the customer will be billed for the replacement unit that was provided previously free of charge.

For more information, go to: www.coherent.com/support/service

# 11 Pack and Ship Instructions

This section provides information to help correctly pack and ship the products. This is needed if the product is sent back to Coherent for service or repair.

*NOTICE*
**Save the shipping box and packing materials after initial purchase. These materials are required to ship the laser system to any other location or return the CellX laser system to the factory.**

## 11.1 Components to Ship

The CellX laser system and available components and accessories are shown in Table 11-1. Depending on the order that was placed, these components may have arrived in separate boxes. See 'CellX System Configurations' (p. 247) for part numbers and contact information for Coherent.

**Table 11-1. CellX Components To Be Shipped**

| Item Description | Laser System | Developer's Kit | Accessories Kit |
|---|---|---|---|
| CellX Laser System | X | X | — |
| Fan-Cooled Heat Sink<br>Includes a Stage Platform Extension and hardware | — | X | — |
| Heat Sink, OEM Module | — | X | — |
| Objective Lens, OL10-UV 10 µm Focus | — | X | — |
| Objective Lens, OL15-UV 15 µm Focus | — | X | — |
| Bracket to Mount Objective Lens over Laser Exit Aperture | — | X | — |
| Low-Profile Translation Stage with Mount for Objective Lens | — | X | — |
| Power supply, 110/220V AC, 12V DC, IEC-320 | — | X | — |
| Power cord, USA to IEC-320 | — | X | — |
| Control Board, Adjustable Power | — | X | — |
| Control Board, Key-Switch, RS-232, Digital/Analog SMB (also referred to as a Breakout Board) | — | X | — |
| Control Board, 4 Analog Modulation Inputs, RS-232 | — | X | — |
| Interlock Plug, DB37 | — | X | X |

**Table 11-1. CellX Components To Be Shipped (Continued)**

| Item Description | Laser System | Developer’s Kit | Accessories Kit |
|---|---|---|---|
| USB cable, Type A to Type Mini-B (1.8 meters) | — | X | X |
| USB Flash Drive with Coherent Connection software, drivers, Data Sheet, and THE *CellX Operator’s Manual* | — | X | X |
| *CellX Installation & Quick Set-Up Guide* | X | X | — |
| Hardware and tools; see ’Standard CellX Accessory Kit’ (p. 248) | — | X | X |

## 11.2 Pack and Ship the Product

This section describes how to pack the CellX laser system and ship either to another location for your company or organization, or to return to Coherent, Corp.

To obtain service under this warranty, Customer must notify the Company of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service.

The Company shall, in its sole discretion, determine whether to perform warranty service at the Customer's facility, at the Company's facility, or at an authorized repair station.

If Customer is directed by the Company to ship the product to the Company or a repair station, Customer shall:

- Package the product (to protect from damage during shipping) as instructed in the next sections.
- Ship it to the address specified by the Company (see ’Ship the Returned Product’ (p. 245)).
  - Prepay shipping back to Coherent in conjunction with recalibration and recertification.
  - Coherent shall pay the cost of shipping the Product back to the Customer in conjunction with product failures within the first twelve (12) months of time of sale or during an extended 12-month warranty period.

A Returned Material Authorization number (RMA) assigned by the Company must be included on the outside of all shipping packages and containers. Items returned without an RMA number are subject to return to the sender. See ’Contact Product Support’ (p. 229) for a Return Material Authorization number.

### 11.2.1 Repack an OEM System

This section describes the factory-recommended repacking procedure for the base CellX laser system, with additional steps for CellX with Fiber configurations. Follow this procedure to ship the laser system to another location after initial installation or return it to the factory.

This is generally referred to as an OEM system, and includes ***only*** the CellX unit and hardware, as well as a printed copy of the *CellX Installation & Quick Set-Up Guide*. To pack the developer's kit, refer to 'Repack the Developer's Kit' (p. 244).

Figure 11-1 shows the box and packaging material qualified for shipping that is used for a single CellX laser system

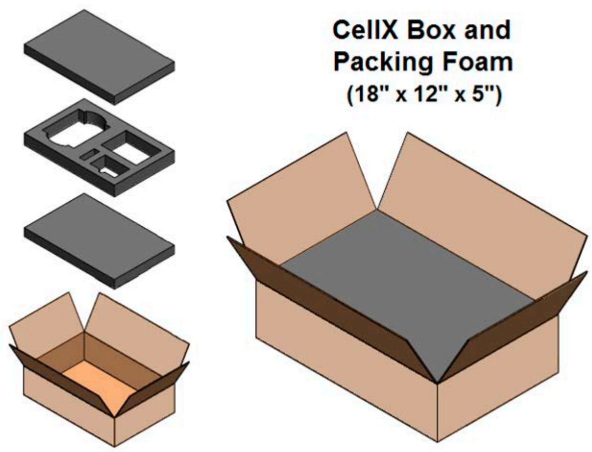



**Figure 11-1. Shipping Container – Single Base CellX (OEM)**

**WARNING!**
**Take precautions to prevent damage from Electrostatic Discharge (ESD) to the CellX laser system and any materials when packing the equipment.**

When using the following procedure, refer to Figure 11-1 to correctly set in position all components in the shipping box.

1. Set the lower layer of ESD foam in the box.
2. Put the layer of ESD foam with cut-outs on top of the lower layer of ESD foam in the box.

3. Insert the CellX laser system into the silver ESD bag, and use tape to close. Put the ESD bag inside the large cut-out on the second layer of ESD foam.

**Figure 11-2. Example ESD Foam Layer with Cutouts**

4. Put the interlock dongle in one of the cutouts.The example in Figure 11-2 shows a CellX with beam aligner configuration and interlock dongle in a bag and in the cutouts.

5. **If shipping to another location for your company or organization**:

   - Gather any screws and washers and insert them into the small pink poly bag. Add that to the small cut-out in the second layer of ESD foam.

   - Include the printed copy of the *CellX Installation & Quick Set-Up Guide* in the box.

6. For CellX with Fiber system, packaging is similar to as it is shown in Figure 11-1, but with an additional tray and foam layer on top for the fiber assembly. Do the following:
   - Put the fiber tray ESD foam layer over the layer with CellX and ESD bag.

**Figure 11-3. Fiber Tray ESD Foam Layer in Place**

   - Put the fiber, with fiber tray, into place on the ESD foam layer for the fiber. Include the printed copy of the *CellX Installation & Quick Set-Up Guide*.

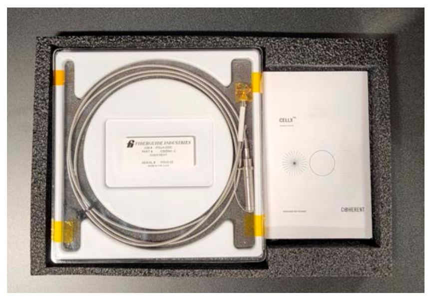


**Figure 11-4. Fiber Tray ESD Foam Layer in Place**

7. Put the top ESD foam layer over the last layer.

**Figure 11-5. Top ESD Foam Layer in Place**

8. Close the box and make it secure with tape.
9. If shipping to another country, prepare the necessary customs paperwork.
10. See 'Ship the Returned Product' (p. 245) for instructions and a return address.

## 11.2.2 Repack the Developer's Kit

This section describes how to repack the CellX Developer's Kit. If shipping ***only*** the CellX laser system to the destination, see instructions in the section above, See "Repack an OEM System" on page 241.

Figure 11-6 shows the box and packaging material qualified for shipping that is used for the CellX Developer's Kit. See 'Components in the Developer's Kit' (p. 248) for a list of all parts and accessories in the kit and a key to the locations in the pack material.

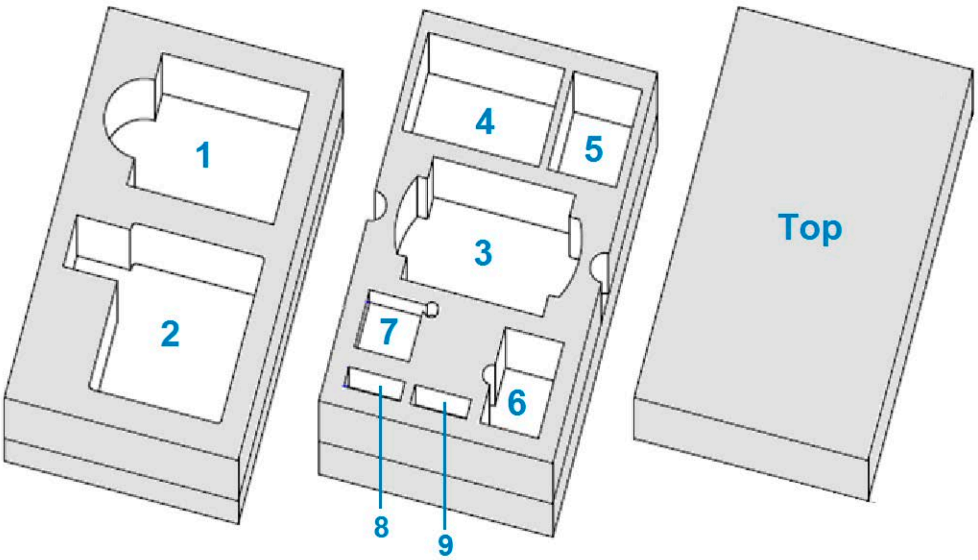



**Figure 11-6. Shipping Container – CellX Developer's Kit**

This box and packing materials have been designed to accommodate the components of the CellX Developer's Kit, as follows:

**Table 11-2. Key to Packing the Developer's Kit**

| Space | Component in the Developer's Kit |
|---|---|
| 1 | Power Supply |
| 2 | Heat Sink, Fan-Cooled with Stage Platform Extension |
| 3 | CellX Laser System |
| 4 | Accessories Kit |
| 5 | DB37 Interlock Plug and Control Boards |
| 6 | Heat Sink, OEM Module |
| 7 | Translation Stage |
| 8 and 9 | Objective Lens, either the 10 μm or 15 μm Focus |

Packaging materials include high-density ESD foam with cutouts for the various components, as well as silver ESD bags.

**WARNING!**
**Take precautions to prevent damage from Electrostatic Discharge (ESD) to the CellX laser system and its components when packing the equipment.**

When the following procedure is used, refer to Figure 11-6 to correctly put all components in position in the shipping box.

1. Set the lower layer of ESD foam into the box, with cut-outs facing up.
2. Put the **Power Supply** into the cut-out area marked #1 in Figure 11-6.
3. Put the **Fan-Cooled Heat-Sink** into the cut-out area in the ESD foam marked #2 in Figure 11-6.
4. Put the second layer of ESD foam on top of the first set, with cut-outs facing up.
5. Insert the **CellX laser system** into the silver ESD bag, and tape to close. Place the ESD bag into the cut-out area marked #3 in Figure 11-6.
6. Gather all tools, hardware, the flash drive, and the USB cable and insert them into the pink poly bag. Put this **Accessories Kit** into the cut-out area marked #4 in Figure 11-6.
7. Insert the **Interlock Plug and any Control Boards** into a silver ESD bag, and tape to close. Place the ESD bag into the cut-out area marked #5 in Figure 11-6.
8. Put the **OEM Heat Sink** into the cut-out area marked #6 in Figure 11-6.
9. Insert the **Translation Stage Accessory** into a silver ESD bag and tape to close. Put the ESD bag into the cut-out area marked #7 in Figure 11-6.
10. Insert the 10 µm focus **Objective Lens** into a silver ESD bag and tape to close
11. Insert the 15 µm focus **Objective Lens** into a silver ESD bag and tape to close.
12. Put these ESD bags into either cut-out area marked #8 or #9 in Figure 11-6.

### 11.2.3 Ship the Returned Product

To prepare a packed product for shipping:

1. To return **the system to Coherent** for service or warranty issues:
   - First contact Coherent Customer Service at 1–(800)–343–4912 to obtain a Return Material Authorization (RMA) number.
   - Ship ***only*** the CellX laser system. It is not necessary to return any hardware or printed material when returning the unit to Coherent.
2. Attach a tag or printed page to the product that includes the name and address of the owner, the person to contact, the serial number, and the RMA number you received from Coherent Customer Service. Pack this tag **inside** the box.
3. If available, use the original shipping and packaging materials, and pack the product.
4. Put the top protective layer of ESD foam in position in the shipping box.
5. Close the box and seal the shipping carton with shipping tape or an industrial stapler.
6. Add the RMA number received from Coherent Customer Service to the shipping label or close to the shipping label on the **outside** of the box.
7. If shipping to another country, prepare the necessary paperwork to ship to that country.
8. Ship the product to Coherent to the following address:

   Coherent, Corp.<br>
   Attn: RMA #<br>
   27650 SW 95th Ave.<br>
   Wilsonville, OR 97070<br>
   USA

# A Parts & Accessories

This section describes the parts and accessories available with an CellX laser system.

Contact Coherent as follows to order any CellX laser system, the Developer's Kit, parts, tools, and accessories:

- Call Coherent Technical Support Hotline at 1.800.367.7890 (or, outside of the USA, call 1.734.456.3100).
- Send an email to Customer.Support@Coherent.com.
- Contact a local Coherent service representative (see www.Coherent.com for a list of worldwide contacts).

## A.1 CellX System Configurations

Table A-1 shows the standard configurations of CellX laser systems that are available to order:

**Table A-1. CellX – Ordering Numbers**

| P/N | Description |
|---|---|
| 1323532 | CellX Laser System Developer's Kit.<br>Includes four 100 mW laser modules (405, 488, 561, 637 nm) in the unit, plus all components shown in Table A-2 and Table A-3. |
| 1318680 | CellX Laser System (405, 488, 637 nm).<br>Includes three 50 mW laser modules in the unit. |
| 1318681 | CellX Laser System (405, 488, 637 nm).<br>Includes three 100 mW laser modules in the unit. |
| 1318682 | CellX Laser System (405, 488, 561, 637 nm).<br>Includes four 50 mW laser modules in the unit. |
| 1318683 | CellX Laser System (405, 488, 561, 637 nm).<br>Includes four 100 mW laser modules in the unit. |
| 1424660 | Base CellX FR Laser 4x100mW 405,488,561,637 nm. Fiber Ready. **Fiber/Launcher Sold Separately** |
| 2309912 | CellX FR Laser 4x100mW 405,488,561,637 nm. Fiber Ready.<br>**Includes Fiber/Launcher for FC/APC Output** |
| 2309585 | CellX FR Laser 4x100mW 405,488,561,637 nm. Fiber Ready.<br>**Includes Fiber/Launcher for Collimated Output** |

Any components or accessories listed in Table A-2 and Table A-3 may be purchased separately for use with individual configurations of the CellX laser system.

## A.2 Components in the Developer's Kit

Table A-2 shows the parts and accessories included in the CellX Developer's Kit (P/N 1323532). The kit is intended for development purposes to experiment and to evaluate the different available components.

Each line item can also be ordered individually.

For descriptions and specifications about these components, see 'Description and Specifications' (p. 23).

**Table A-2. CellX Developer's Kit**

| P/N | Description |
|---|---|
| 1318683 | CellX Laser System–4x100mW (405, 488, 561, 637 nm) |
| 1321203 | Accessory Kit for CellX (Alignment Tools, Interlock Plug, USB Cable, Coherent Connection software, Operator's Manual) |
| 1365935 | Accessory, Objective Lens, OL10-UV 10 µm Focus, CellX |
| 1383130 | Accessory, Objective Lens, OL15-UV 15 µm Focus, CellX |
| 1321963 | Accessory, Mount, Front Aperture Objective Holder |
| 1321964 | Accessory, Low-Profile Translation Stage with Mount for Objective Lens |
| 1323285 | Heat Sink, Fan-Cooled with Stage Platform Extension for the CellX, and required hardware |
| 1315322 | Heat Sink, OEM Module |
| 1211389 | Power Supply, 110/220V AC, 12V DC, IEC-320 |
| 1299911 | Accessory, Control Board, Adjustable Power |
| 1298365 | Accessory, Control Board, Key-Switch, RS-232, Digital/Analog SMB |
| 1323597 | Accessory, Control Board, 4 Analog Modulation Inputs, RS-232 |

## A.3 Standard CellX Accessory Kit

Table A-3 shows the parts that are included in the Accessory Kit (P/N 1321203). These parts can also be ordered separately.

**Table A-3. Accessory Kit for CellX**

| P/N | Description |
|---|---|
| 1313160 | CellX Interlock Plug, DB37. (This connector jumpers the keyswitch and interlock pins.) |
| 1192185 | Wrench, Hex L-Key, 3mm x 2.5 in. L. |
| 5401-0081 | Wrench, Hex L-Key, 5/64 in., Short Arm. |
| 1321201 | Wrench, Hex L-Key, 0.05 in x 2.813 in. L. |
| 1321213 | Screwdriver, Phillips P0, 5.3 in. L. |
| 1059831 | Socket Head Screw (4 each), M4 x 50 mm L, Stainless Steel. Attaches the CellX system to the Heat Sink. |
| 7202-0410 | Socket Head Screw (2 each), 4-40 x 0.625” L, Stainless Steel. Attaches the Interlock Plug to the CellX system. |
| 7884-0800 | Washer (2 each), Flat, Nom ID .169 OD .304 Thick .032. Use with screws to attach the CellX to the Heat Sink. |
| 1108906 | USB Cable, Type A to Type Mini B, Detachable, 1.8 M. Connects the CellX system to a workstation and use Coherent Connection Software with the system. |
| 1213052 | USB Flash Drive. Contains the *Operator’s Manual*, Data Sheet, Coherent Connection software, and more |


**Figure A-1. CellX Accessory Kit Components**

# A.4 Accessories for Microscopy/Fiber Launch

Depending on the configuration ordered, the following are available accessories for use with CellX for Microscopy.

**Table A-4. CellX Freespace Laser and Accessories for Microscopy**

| P/N | Description |
|---|---|
| 2313508 | Fiber Assembly, FC/APC termination, 2m long |
| 2323509 | Fiber Assembly, Collimated termination, 2m long |
| 2313364 | Fiber Launcher with alignment sleeve/tool and mounting hardware (purchased separately) |
| 1315292 | Fan-cooled heat sink for microscopy (no stage platform extension). |

# A.5 Power Measurement

This section describes power measurement tools from Coherent that are recommended for use with the CellX laser system.

Coherent offers a variety of instruments for laser test and measurement. For more information about the products listed in this section, see the current Coherent *Laser Measurement and Control Product Catalog* or the Coherent website:

www.Coherent.com

## A.5.1 Power Sensor and Meter Combinations

For the most common diagnostics need—measuring the output power of the CellX—we recommend the following different types of power meters that work well with the family of OBIS and CellX laser products.

### A.5.1.1 Sensor with Meter Recommendations

The product combination shown in Figure A-2 are the recommended measurement tools for the CellX laser system.

This combination covers the entire range of wavelengths for lasers in the CellX unit at both 50 mW and 100 mW power levels:

- PS10 High-Sensitive Thermopile Sensor (P/N 1098350)
- FieldMaxII-TOP Laser Power and Energy Meter (P/N 1098580)

- FieldMaxII-TO Laser Power and Energy Meter (P/N 1098579)
- LabMax Touch Meter and Touch Meter Pro (P/N 1343658


**Figure A-2. Recommended Measurement Tools**

The PS10 is a thermally-stabilized, amplified thermopile power sensor with a broad spectral response, high sensitivity, and a large active area. It is designed for measurements in the 100 µW to 1 W region.

Coherent recommends the FieldMaxII-TOP/TO to go with the PS10. The FieldMaxII, affordable, versatile, easy-to-use digital meters, are designed for field service and production applications. This meter features an easy-to-read liquid crystal display (LCD) with a back light and direct button-driven commands for simple, no-hassle use.

The LabMax Touch and Touch Pro are laser power and energy meters with a 7-in. touchscreen LCD. They have trending, tuning, statistics, and data logging capabilities. They provide Ethernet, USB and RS232 PC interfaces, analog output, external trigger input/output and TTL output.

### A.5.1.2 PowerMax USB Options

As an alternative, the following product combinations can be used with the CellX laser system.

- PowerMax-USB UV/VIS Quantum Power Sensor (P/N 1168337) with post stand
- PowerMax-USB Wand UV/VIS Quantum Power Sensor (P/N 1212310)

Figure A-3 shows both of these options:

This sensor incorporates a Silicon photodiode for measurement of power from 5 µW to several hundred milliwatts.

**Figure A-3. PowerMax-USB Power Sensor Options**

A spectrally-calibrated ND2 filter is used to attenuate the laser beam, allowing for a higher average power measurement than is typically possible with a photodiode.

The sensor works with continuous wave (CW) as well as pulsed sources greater than 100 pulses per second (PPS).

- The standard UV/VIS sensor has a removable nose cone that can be used to reduce stray light, which is helpful when measuring on the low end of the power range.
- With its compact size and thin profile, the Wand UV/VIS fits into tight optical set-ups where a standard detector may not fit.

## A.6 Shop.Coherent (US Customers Only)

These accessories or product bundles can be ordered on the Shop.coherent website at: https://coherentinc.my.site.com/Coherent

Shop.coherent is the official e-commerce website for Coherent lasers, energy meters and sensors, fiber optics, and accessories. Available for US customers, the e-commerce service offers product search, product-specific filtering, and fast-and-easy checkout with prompt order and shipping confirmations.

# B Laser Back Reflection

This section describes laser back reflection, and describes how to prevent damage or noise to the CellX™ laser system caused by back reflection.

## B.1 What is Back Reflection?

***Back reflection*** (also referred to as ***retroreflection***) occurs when a part of the laser beam is sent back into the laser's exit aperture. Back reflection can be caused by any object in front of the laser and can result in instability, noise, or damage to the laser.

**WARNING!**
**Always wear correct laser safety eyewear and follow laser safety precautions when using the procedures described in this document.**

In a normal application the laser beam exits the beam aperture and none of the light from the laser is reflected back. Ideally 100% of the output power from the laser is used in the application and none of the light is scattered or sent back into the laser exit aperture.

See Figure B-1 for the location of the laser aperture for the output beam on the right side of the CellX laser system.

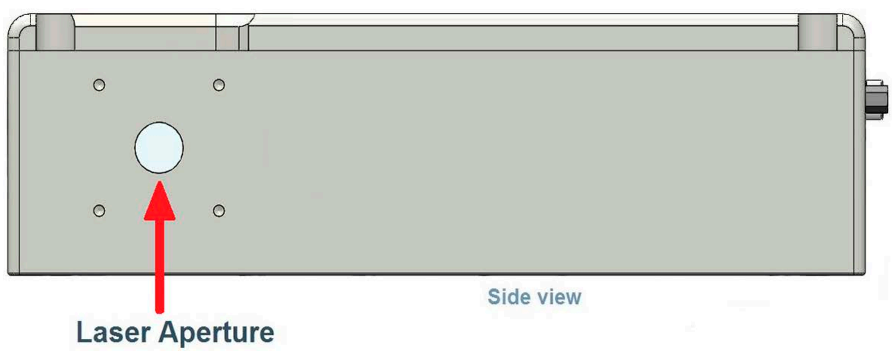



**Figure B-1. Location of Laser Aperture**

**WARNING!**
***There is no shutter on the CellX unit.*** **Avoid any possibility of viewing either a direct or reflected beam. Always wear appropriate safety glasses for the specific wavelengths.**

## B.2 Damage from Back Reflection

The amount of back reflection that can damage a laser diode changes from device to device. Sometimes a back reflection that is as low as 4% of the total beam power is sufficient to cause damage.

Damage from back reflection can be immediate, or it can be subtle and slowly decrease the service life of the laser.

Indications that back reflections are causing permanent damage to the laser diode include:

- No output power
- Low output power
- Over-current of the laser diode

Back reflection can also cause the output power noise (RMS noise and Peak-to-Peak noise) to increase if the reflection interferes with the laser cavity or light-loop.

Figure B-2 shows how a laser beam hits an object and reflects part of the beam back into the laser exit aperture.

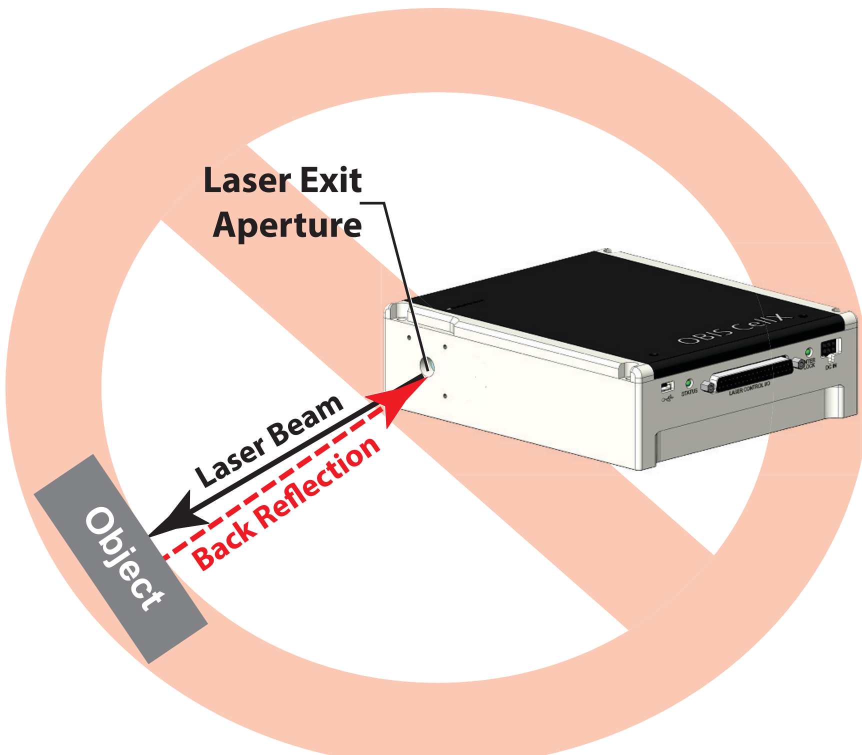



**Figure B-2. Laser Beam Reflects Back into Laser Aperture**

**CAUTION!**
**Avoid any condition where the laser beam—or any part of the laser beam—reflects back into the laser exit aperture.**

Coherent recommends that the laser light be reflected away from the laser exit aperture to a safe beam dump (absorber), as shown in Figure B-3.

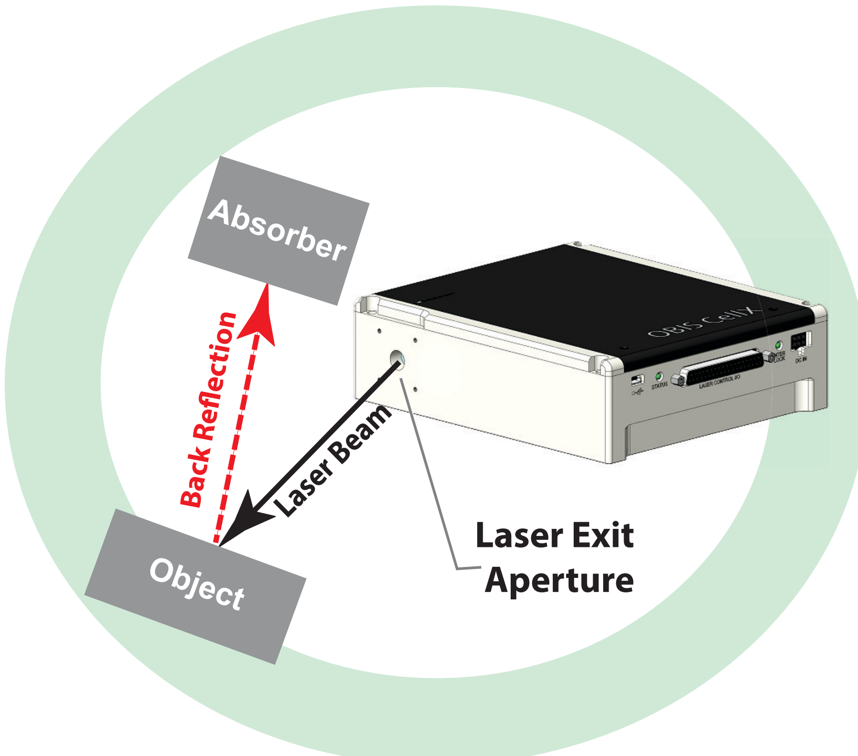



**Figure B-3. Deflect Laser Light Away from Laser Aperture**

## B.3 How to Prevent Back Reflection

The procedure that follows describes how to prevent a strong back reflection and possible damage to the laser:

1. Use the USB controls to set the power at 10% of the rated output power before unblocking the laser beam or enabling laser emission.
2. Do optical or laser alignment at this low output power to confirm there are no back reflections. Sources of back reflections include:
    - Fiber, fiber ferrule, or fiber connector
    - Optical filters that are not angled but are perpendicular to the beam

- Neutral Density Glass or Beam Attenuators that have a front surface reflection that can create a back reflection.
- Beam block at normal incidence that reflects power back into the laser
- Plano-concave or plano-convex lenses where the flat surface reflects back part of the beam
- Power measurement probes that use a reflective attenuator or have a surface that reflects the laser light.
- Mirrors or other shiny surfaces from mounts or other optical components in the beam path.

When measuring laser power with a power meter, always angle the power sensor so that the laser beam does not reflect back into the laser exit aperture.

To correctly measure laser power:

1. Take the measurement near the laser.
2. Move the power sensor to maximize the reading of the output power. ***DO NOT let this movement and alignment create a back reflection***.

In many cases an object is put in position in front of the laser as a beam block. Make sure the object is not reflective and does not create a back reflection to the laser.

If you cannot adjust your application to decrease the back reflection of the laser light into the laser's exit aperture, add an optical isolator to protect the laser. Although the optical isolator adds cost and requires additional space, it can be an appropriate safety factor to increase the life of the laser.

Be aware of every optical surface in front of the laser. All objects have the opportunity to create a back reflection. In many cases the front surface and the back surface of the optic are a source of back reflection. Figure B-4 shows a set-up that might cause back reflection damage.

With any optic or object, the angle of incident can impact the optics performance or function. Review the specifications for each optical element to understand how much angle is acceptable. The closer the object is to the laser, the more angle is needed to direct the back reflection away from the laser exit aperture. The farther the object is away from the laser, the less angle is needed to direct the back reflection away from the laser exit aperture.

The set-up shown in Figure B-5 is safer than the set-up in Figure B-4 because both objects are set at a slight angle to the laser. This change of angle sends the back reflection away from the laser exit aperture.

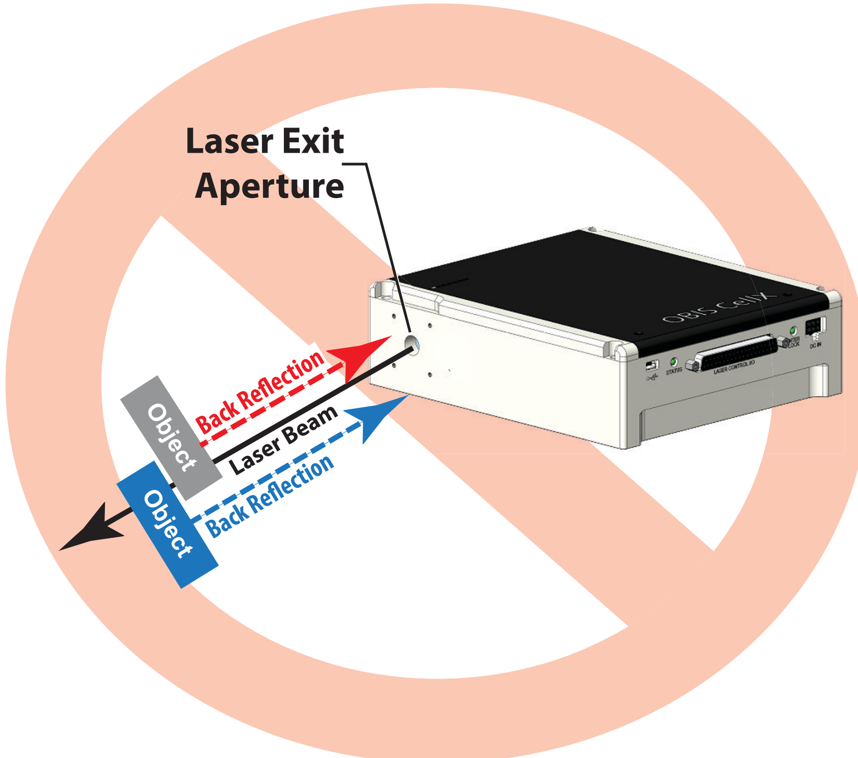



**Figure B-4. Set-Up that Can Cause Damage**

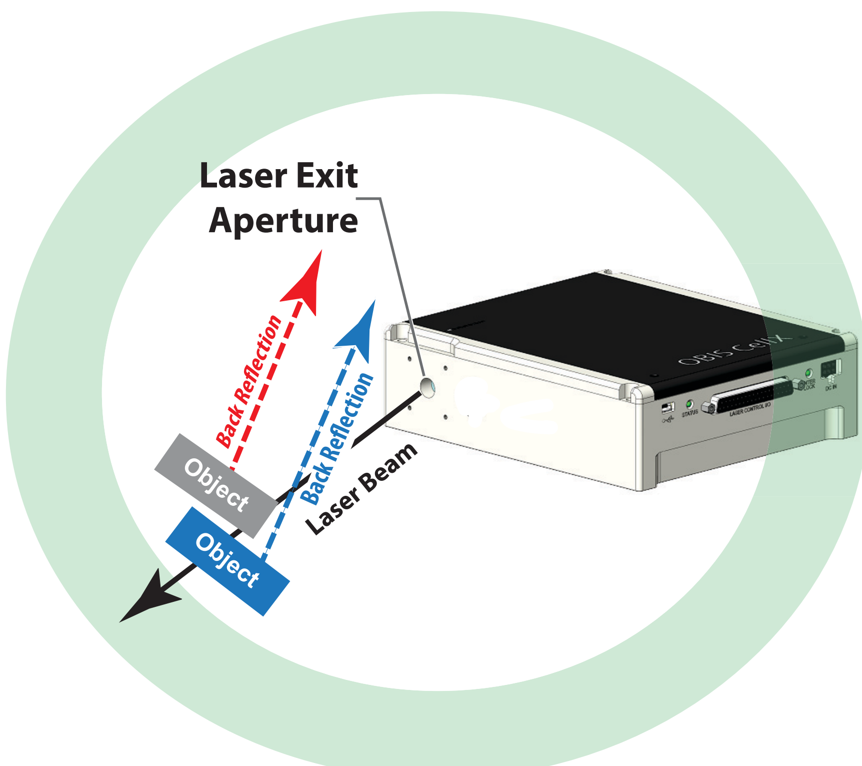



**Figure B-5. Direct Back Reflection Away from Aperture**

## B.4 Summary of Precautions

A laser can shows symptoms —such as low output power, no output power, over-current, or high noise. This indicates a possibility of back reflection to the laser.

To prevent damage, reduce noise, and increase the life of a laser:

- Look at the objects in front of the laser and make a note of which surfaces are a possible hazard for back reflections. Change the objects to be less reflective whenever possible. Adding Anti-Reflective (AR) coatings to optics and more diffuse surfaces to mounts can help.
- If possible, add an angle to the object so that the reflection does not enter the laser exit aperture.
- Take precautions when moving objects that can create a back reflection in front of the laser.
- *Decrease the power from any possible back reflections* by starting the laser at lower output power—for example, 10% output power.
- *Using correct safety precautions*, watch where the reflections from objects are returning to make sure the reflections are not at or near the laser exit aperture. Always use the appropriate eyewear protection.
- *Take extra precautions when using a laser power meter.* Consider how close the measurement is being taken to the laser and the angle at which the beam can reflect off the sensor so that it does not reflect back into the laser.
- *Add an optical isolator* to those applications with laser exit aperture back reflections that cannot be corrected changing the angle of optics.

# C Beam Alignment Properties and Considerations

## C.1 Overview

This section provides basic optics maintenance information to consider for alignment of the internal beam delivery system. In addition, it describes the properties of the beam,

The design of the CellX laser system includes individual, user-adjustable beam expansion telescopes for each wavelength, followed by dichroic mirrors. This allows users to make adjustments that combine the individual wavelengths into a single, collimated, and round multi-wavelength beam

This provides flexibility for cytometry applications. Users make specific separations of each individual wavelength to create patterns of laser stripes at the flow cell.

- **Focus Control**: Translation of the second telescope lens that adjusts the collimation to focus at the flow cell.
- **Tilt Adjustment**: Fine adjustment for the vertical and horizontal beam pointing, and therefore the beam position at the flow cell.

Standard configurations of the CellX laser system are shipped with all wavelengths aligned to be coaxial. CellX does not support top-hat beam shaping. In addition, the vertical and horizontal beam **position** at the laser exit aperture on the CellX unit are set at the factory prior to shipment.

## C.2 Objective Lens Use

An external objective lens assembly can reshape and focus the collimated, circular output beam from the CellX laser system into a focused, elliptical stripe with a Gaussian profile needed for a typical flow cytometry application.

Objective lens assemblies generate a Gaussian beam profile in both the vertical and horizontal axes. Within a certain range, the beam size aspect ratio of the major and minor axes can be increased through system adjustments.

See the CellX datasheet at http:// shop.coherent.com for a list of the optical performance specifications for different CellX Objective Lens accessories. In addition, see Figure 3-44 (p. 3-71) for examples of the nominal optical performance for the two objective lenses available with the CellX laser system.

## C.3 Understand Beam Diameter

This section provides a technical overview about the profile of a beam diameter.

The typical OBIS laser beam is close to an ideal Gaussian beam profile, where the peak intensity of the beam is at the center.

In Figure C-1, the intensity profile cutting through a laser beam is shown for the ideal case.

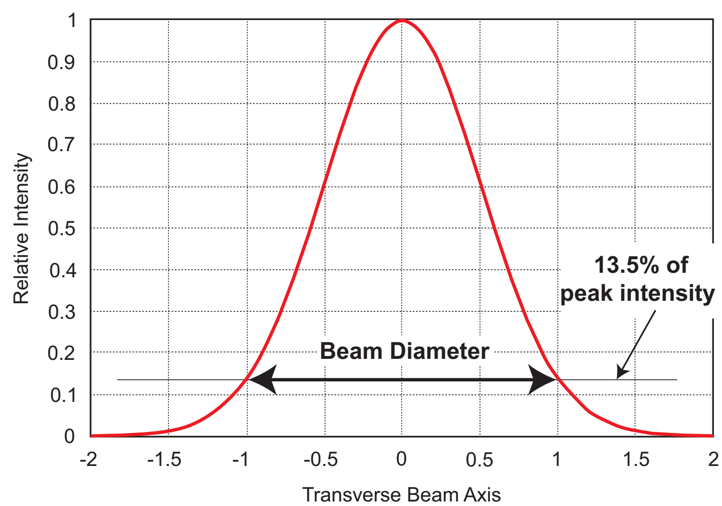



**Figure C-1. Gaussian Beam Profile**

For these beams, the beam diameter is defined as the width of the beam, where the intensity is 13.5% of the peak intensity. Based on the mathematical description of the beam profile, this is a good first approximation of beam diameter.

The goal is to select a clear aperture of optics through which the laser beam must travel. To allow at least 99% of the laser beam though an aperture, it should be at least 2 to 3 times the beam diameter at that point. In actual practice, the clear aperture to be selected should be several millimeters larger; this makes it easier to align the beam through the optic.

## C.4 Understand $M^2$ (M Squared) Factor

The actual laser beams differ somewhat from the ideal Gaussian profile shown earlier in Figure C-1. To handle the deviation from the ideal case, the factor $M^2$ or K has been developed.

For the ideal beam, the $M^2$ factor is 1 and the factor increases as the beam deviates more from ideal behavior.

For a beam with an $M^2$ factor of 1.2, the product of the beam diameter and divergence is 1.2 times larger than an ideal Gaussian beam. The $M^2$ factor basically relates to the factor by which the beam diameter is different from ideal. As shown in examples later in this section, this has practical use to determine the beam size at various locations in a beam delivery system. Note that the $M^2$ = 1/K and is also in common use.

## C.5 Understand Beam Propagation

As a laser beam propagates, or travels away from its narrowest point or beam waist, it increases in size in a very predictable fashion.

To calculate the beam size at a specific location, one must know the size of the beam waist and its location. Thus the beam diameter *D*, at a distance *Z* away from the beam waist, with a beam waist diameter of $D_0$ follows the equation:

$$D = \sqrt{D_o^2 + \Theta^2 Z^2}$$

The factor Θ is the beam divergence. The beam divergence depends on some basic properties of the beam, including the wavelength and the beam waist size $D_0$. The relationship for the beam divergence at full angle, then is:

$$\Theta = \frac{4\lambda M^2}{\pi D_o}$$

Often the beam divergence is a value included in the specifications of a laser. If a calculation is being made of the divergence, the units of the wavelength and the beam waist diameter must be the same.

## C.6 Understand Beam Focus

This section provides a technical overview about the Focus beam and how it relates to power density.

Most laser processing applications call for focus of the laser beam to a small spot so that the high-power density can accomplish the desired work.

To achieve the smallest spot size, the beam must be focused with a lens that transmits the laser wavelength.

The clear aperture for the diameter of the beam must be sized at a point using the guidelines covered in 'Optical Specifications' (p. 69).

The approximate spot size of the focused laser beam using a lens with focal length *f* is:

$$D_f = \frac{4f\lambda M^2}{\pi D_e}$$

Where:

$D_e$ is the beam diameter at the focusing lens

$D_f$ is the focused beam diameter

## C.7 Understand Rayleigh Range and Depth of Focus

It is important to have knowledge of the work range where the process functions correctly. The major issue is the acceptable range in the distance between a focusing lens and the work surface.

A convenient model for this is to calculate the Rayleigh range for the focused beam as an initial evaluation of the optical design. The Rayleigh range is the difference in distance between the beam waist location and the point at which the beam is 1.4 times larger.

$$Z_r = \frac{\pi D_o^2}{4\lambda M^2}$$

The beam waist diameter can be for a focused beam However, it could also be any other beam waist and the equation is still applicable.

It should be noted that reduction of the spot size reduces the **depth of focus** more rapidly than the **spot size** is reduced. Therefore, when reducing spot size, the process can become much more intolerant to variability in the distance between the focusing lens and the work piece.

The Rayleigh range provides a guide to the range of acceptable working distances. The actual value depends on the process, the equipment, and dynamics between the two factors.

## C.8 Understand Beam Expansion

As noted earlier, an increase in the beam diameter on a focusing lens can produce smaller focused spot size.

The other issue that beam expansion addresses is variation in the focused spot size on a gantry-based system. In these systems, the beam size on the focusing lens varies as the distance between the laser and the focusing lens is moved. This in turn causes the focused spot size to change as well as the distance to the beam waist.

Beam expansion reduces the change in the focused spot size and changes in focal point. The most simple beam expanders use two lenses with different focal lengths. See the example in Figure C-2.

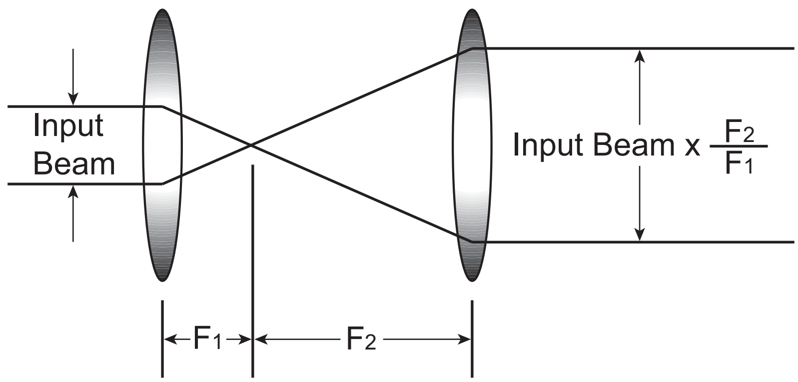



**Figure C-2. Simple Beam Expander**

The ratio of the focal lengths gives the magnification of the beam. Galilean beam expanders use a negative lens followed by a positive lens for expansion.

As an example, the simple beam expander in Figure C-3 shows the combination of 2.5-inch and 5-inch lenses to magnify the beam by a factor of two.

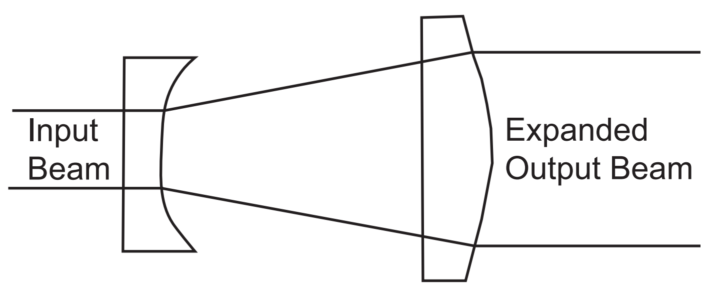



**Figure C-3. Galilean Beam Expander**

The proper separation of the two lenses is the sum of their focal lengths. Small adjustment of the separation is required to correct for the effect of the distance from the first lens to the beam waist.

As a general guideline for design, keep the ratio of the focal length divided by the beam diameter for each lens greater than 10 to minimize effects of aberration. The earlier guidelines about acceptable clear apertures and beam diameters are still applicable.

The beam expander can be used to adjust focus at the work surface. This is accomplished by setting the final objective lens to exactly its Back Focal Length (BFL) from the work surface (along the middle of the optical axis). The Back Focal Length is specified by the lens manufacturer. Focus is then done by adjustment of the spacing of the lenses in the beam expander.

# D Warranty

Coherent, Corp. warrants OBIS CellX Laser System 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.

OBIS CellX 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.

## D.1 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.

## D.2 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

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.

# Glossary

°C Degrees Centigrade or Celsius
°F Degrees Fahrenheit
Ω Ohm(s)
µ Micron(s)
µm Micrometer(s) = $10^{-6}$ meters
µrad Microradian(s) = $10^{-6}$ radians
µsec Microsecond(s) = $10^{-6}$ seconds
$1/e^2$ Beam diameter parameter = 0.13534

AC Alternating current
Address A unique one-byte identifier assigned to each device on the bus
Amp Ampere(s)
APC Angle physical contact
Application Protocol
A set of application defined commands and replies used to implement a system of cooperative devices

BSA Beam Shaping Accessory, also known as an Objective Lens
BNC Type of connector
Broadcast Message
Message sent by a master device and received by all connected slave devices
BUSMGMT
Message is a bus management message

CDRH Center for Devices and Radiological Health
cm Centimeter(s)
CW Continuous wave

DC Direct current
DDL Direct diode laser
Destination Address
Address of the recipient device for a message
DHCP Dynamic Host Configuration Protocol. A protocol that provides a means to dynamically allocate IP addresses to workstations on a local area network.
DLE Data link escape

EOM A two-byte sequence indicating the end of a message packet
ESD Electrostatic discharge
ETX End of message data

FC Fiber-connector
FP Fiber pigtail

g Gram(s) or earth's gravitational force (gravity)
GUI Graphical user interface

| | |
|---|---|
| HeNe | Helium neon |
| Hz | Hertz or cycles per second (frequency) (= 1/pulse period) |
| IEC | International Electrotechnical Commission |
| IR | Infrared (wavelength) |
| I/O | Input/output |
| kg | Kilogram(s) = $10^3$ grams |
| kHz | Kilohertz = $10^3$ hertz |
| kOhm | Kilohm(s) = $10^3$ ohms |
| LCD | Liquid crystal display |
| LED | Light emitting diode |
| LS version | OBIS Laser, based on optically pumped semiconductor laser (OPSL) technology |
| LX version | OBIS Laser, based on direct diode laser (DDL) technology |
| m | Meter(s) (length) |
| mA | Milliamp(s) = $10^{-3}$ Amperes |
| mAmp | Milliampere(s) |
| Master | Controlling device which manages bus direction, assigns device addresses, and generally the source for all application protocol command initiation |
| MHz | Megahertz = $10^6$ hertz |
| microscopy | The technical field of using microscopes to view samples & objects that cannot be seen with the unaided eye |
| mm | Millimeter(s) = $10^{-3}$ meters |
| mrad | Milliradian(s) = $10^{-3}$ radians (angle) |
| ms | Millisecond(s) = $10^{-3}$ seconds |
| mV | Millivolt(s) |
| MVP | Modulation and variable power |
| mW | Milliwatt(s) = $10^{-3}$ Watts (power) |
| NA | Numerical aperture |
| nm | Nanometer(s) = $10^{-9}$ meters (wavelength) |
| N·m | Newton meter |
| CellX laser system | A dedicated Coherent device that serves as a communication gateway to a single laser and provides a CDRH-compliant keyswitch and interlock capabilities. |
| OEM | Original equipment manufacturer |
| OPSL | Optically-pumped semiconductor laser |
| oz·in. | Ounce inches |
| PIP | Port Identification Pin, a signal pin located on the cable connecting the slave device to the CCB |
| PPS | Pulses per second |
| rms | Root mean square (effective value of a sinusoidal wave) |
| RMA | Return material authorization |

| | |
|---|---|
| SCPI | Standard commands for programmable instruments. This standard, developed by Hewlett-Packard, complements IEEE 488 and is promoted by the SCPI Consortium. |
| SDR | Shrunk delta ribbon. This connector type is used on the back panel of the OBIS Laser for the full-feature I/O cable. |
| Slave | Device which receives and interprets messages and responds as required |
| SOM | A two-byte sequence indicating the start of a message packet |
| Source Address | Address of the device transmitting a message |
| Standard Message | Message sent from the master device to a specific slave device address |
| SRCCCB | Message originated from CCB stack |
| SRCCONT | Message originated from master device (controller) |
| STX | Start of message data |
| System Protocol | A set of predefined bus management commands and responses used by CCB protocol stacks for set-up and management of the bus |
| TEC | Thermoelectric cooler |
| TEM | Transverse electromagnetic mode (cross-sectional laser beam mode) |
| TTL | Transistor-transistor logic |
| UART | Universal asynchronous receiver/transmitter |
| UFC | Ultra-flat contact |
| UV | Ultraviolet |
| V | Volt(s) |
| VAC | Volts, alternating current |
| VDC | Volts, direct current |
| W | Watt(s) (power) |
| WD | Working Distance |

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CellX™ Laser System Operator’s Manual

Part No. 1319147 Rev. AC

COHERENT

INNOVATIONS THAT RESONATE

Download software and manuals at https://www.Coherent.com/resources

*1319147 AC*

CellX™ Laser System Operator’s Manual

Part No. 1319147 Rev. AC