CUBE Laser System

Operator's Manual

COHERENT®
Superior Reliability & Performance

CUBE® LASER
OPERATOR'S MANUAL

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0 PREFACE

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.

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

Anyone setting up or operating a laser or working in an environment with working lasers must first read and understand how safety information is presented prior to beginning any tasks. See detailed information in the section, "Laser Safety & Compliance" (p. 13).

0.1 Safety Warnings

This section provides information about signal words and safety symbols that you need to know before you begin to use BeamView.NET in a laser environment.

0.1.1 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, as described in Table 0-1:

Table 0-1. Signal Words

SIGNAL WORD	DESCRIPTION
DANGER!	Indicates a hazardous situation that, if not avoided, WILL result in death or serious injury. This signal word is to be limited to the most extreme situations.
WARNING	Indicates a hazardous situation that, if not avoided, could result in death or serious injury.
CAUTION	Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.
NOTICE	Indicates information considered important, but not hazard-related. "NOTICE" may also be used when there is the risk of property damage.

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

0.1.2 Symbols

The signal words **DANGER**, **WARNING**, and **CAUTION** are always emphasized with a safety symbol that indicates a special hazard, regardless of the hazard level. The icons are intended to alert the operator as described in Table 0-2

Table 0-2. Safety Symbols

SYMBOL	DESCRIPTION
	Important notes or instructions for operation and maintenance.
	Danger of exposure to hazardous visible and invisible laser radiation.
	Dangerous voltages when working with other equipment may be of sufficient magnitude to constitute a risk of electric shock.
	Danger of susceptibility to Electro-Static Discharge (ESD).

0.2 Export Control Laws

It is the policy of Coherent, Inc. to comply strictly with export control laws of the United States of America (USA).

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

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

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

1 LASER SAFETY & COMPLIANCE

This section describes requirements for safety for persons setting up or operating the CUBE® Laser System:

You must review these laser safety sections thoroughly BEFORE operating the laser. Carefully follow all safety instructions presented throughout this manual.

This user information reported in this manual is in compliance with the following standards for Light-Emitting Products EN/IEC 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 Laser Safety Hazards

Laser beams are powerful enough to burn skin, clothing, or combustible materials, even at some distance. Laser beams can ignite volatile substances such as alcohol, gasoline, ether, and other solvents, and can damage light-sensitive elements in video cameras, photo-multipliers, and photodiodes.

Hazards associated with lasers generally fall into the following categories:

- Biological hazards from exposure to laser radiation that may 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!
Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

1.1.1 Optical Safety

Because of its special properties, laser light poses safety hazards not associated with light from conventional sources. The safe use of lasers requires that all laser users, and everyone near the laser system, are aware of the dangers involved. The safe use of the laser depends upon the user being familiar with the instrument and the properties of coherent, intense beams of light.

A laser produces optical power levels that are dangerous to the eyes and skin if exposed directly or indirectly. Operate all laser products only with proper eye and skin protection at all times.

DANGER!
Never view directly emitted or scattered radiation with unprotected eyes. Direct eye contact with the output beam from the laser will cause serious damage and possible blindness.

At all times, ensure 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.

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 beam-splitters. While weaker than the main beam, such beams may still be sufficiently intense to cause eye damage.

1.1.1.1 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 Section 4.4.4 of the ANSI Z136.1 standard. Other national safety requirements for other national or international standards include ACGIH, OSHA, and the section, "EN 207 Personal eye protection equipment - Filters and eye-protectors against laser radiation (laser eye-protectors)".

CAUTION!
Laser safety eyewear protects the user from accidental exposure to laser radiation by blocking light at the laser wavelengths. However, laser safety eyewear may also prevent the operator from seeing the beam or the beam spot. Exercise extreme caution even while wearing safety glasses.

Precautions include:

1. Never look directly into the laser light source or at scattered laser light from any reflective surface. Never sight down the beam into the source.
2. Maintain experimental setups at low heights to prevent inadvertent beam-eye encounter at eye level.

WARNING!
Laser safety glasses can present a hazard as well as a benefit; while they protect the eye from potentially damaging exposure, they block light at the laser wavelengths, which prevents the operator from seeing the beam. Therefore, use extreme caution even when using safety glasses.

3. As a precaution against accidental exposure to the output beam or its reflection, those using the system must wear laser safety glasses as required by the wavelength being generated.

1.1.1.2 Maximum Power Levels

The CUBE laser may emit VISIBLE and/or INVISIBLE LASER RADIATION over wavelengths of 375 nm to 730 nm from the aperture in the front of the laser. The potentially accessible emissions depend on the specific model.

Table 1-1 lists the maximum power levels.

Table 1-1. Maximum Power Levels for CUBE Lasers

MODEL	WAVELENGTH RANGE	MAXIMUM POWER
375 nm, 16 mW	370 nm – 380 nm	85 mW
405 nm, 50 mW	400 nm – 410 nm	160 mW
405 nm, 100 mW		
445 nm, 40 mW	440 nm – 450 nm	70 mW
488 nm, 50 mW	483 nm – 493 nm	80 mW
640 nm, 40 mW	635 nm – 642 nm	70 mW
640 nm, 100 mW	635 nm – 644 nm	160 mW
660 nm, 60 mW	652 nm – 665 nm	100 mW
660 nm, 100 mW		150 mW
685 nm, 40 mW	680 nm – 690 nm	80 mW
730 nm, 30 mW	720 nm – 740 nm	33 mW

Laser-to-laser tolerance: All lasers ±5 nm except CUBE 640-40 with 635 to 642 nm range, CUBE 640-100 with 635 to 644 nm range, CUBE 660 with 652 to 665 nm range, and CUBE 730 ±10 nm.

1.1.2 Laser Back Reflection

This section describes back reflection and tells how to prevent damage or noise caused by back reflection.

1.1.2.1 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 cavity through the aperture. Back reflection can be caused by any object in front of the laser (such as other equipment or even a wristwatch) and can result in instability, noise, or damage to the laser.

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.

The amount of back reflection that can damage a laser diode changes from device-to-device. Sometimes a back reflection as low as a few percentage 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 life of the laser.

Indications that there are back reflections to the laser that may cause permanent damage include:

- No output power
- Low output power
- Over-current of the laser diode

1.1.2.2 How to Prevent Back Reflection

The following procedure describes how to prevent a strong back reflection and possible damage to the laser:

1. Use the USB or RS-232 controls to set the power to minimum output power before opening the laser aperture.
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 cavity.

CAUTION!
DO NOT let movement and alignment create a back reflection.

In many cases an object is positioned 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 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 object 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.

- The closer the object is to the laser, the more angle is needed to direct the back reflection away from the laser aperture.
- The farther the object is away from the laser, the less angle is needed to direct the back reflection away from the laser aperture.

IMPORTANT!
The Coherent product Warranty does not cover damages to the laser caused by customer handling failure. Take precautions with initial set-up to avoid damage to the laser. Avoid any condition where any part of the laser beam reflects back into the laser exit aperture.

1.2 Summary of Precautions

Due to inherent safety hazards when using lasers, the user is advised to follow these precautions:

1. Observe all safety precautions listed in the Operator's Manual.
2. Limit access to the laser to qualified users who are familiar with laser safety practices and who are aware of the dangers involved.
3. Use the laser in an enclosed room. Laser light will remain collimated over long distances and therefore presents a potential hazard if not confined.
4. Post warning signs in the area of the laser beam to alert those present.
5. Advise everyone using the laser of these precautions. It is good practice to operate the laser in a room with controlled and restricted access.
6. Extreme caution must be exercised when using solvents in the area of the laser.
7. To avoid laser back reflection:
    - Take precautions when moving objects that can create a back reflection in front of the laser.
    - Review the objects in front of the laser and note 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 or beam shutters can help.

- If possible, add an angle to the object so that the reflection does not enter the laser cavity.
- Decrease the power from any possible back reflections by starting the laser at lower output power—for example 10% output power—before opening the laser shutter.
- ***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.
- 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 doesn't reflect back into the laser.
- A laser that shows low output power, no output power, over-current, or high noise, indicates a possibility that there is a back reflection into the laser.
- Add an optical isolator to those applications that have laser exit aperture back reflections that cannot be corrected by angling the optics.

1.2.1 Electrical Safety

The Coherent CUBE laser system does not contain hazardous voltages.

DO NOT disassemble the enclosure. There are no user serviceable components in the controller or laser head. All units are designed to be operated as assembled. ***The Warranty will be voided if either the laser head, the controller, or the cable is disassembled.***

CAUTION!
Electrostatic charges as high as 4000 volts easily collect on the human body and equipment and can discharge without detection.
Although the electronics features have input protection, permanent damage can occur on devices subjected to high-energy electrostatic discharges. You must take correct ESD precautions during installation and operation to prevent damage or performance degradation.

The most common ESD damage occurs when handling a device during installation or use. Take the necessary measures to protect the system from ESD.

Dry air and carpet also create a higher potential for ESD. Remember to take precautions or shielding not only for operations, but for demonstrations or trade show exhibitions.

Laser diode static sensitive parts or assemblies are bagged only in metalized shielding (shiny gray) bags. NEVER use pink anti-static bags, because they are a potential source of contamination that may impact laser lifetime!

1.3 Safety Features of the Laser

The CUBE laser system includes safety features for both the laser head and the Control Box, described in the following subsections.

CAUTION!
Use of controls, adjustments, or performance of procedures other than those specified in this manual, may result in hazardous radiation exposure.

1.3.1 Safety Features on the CUBE Laser Head

The safety features on the laser head include:

- Protective housing
- Manually-operated shutter

1.3.1.1 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 21CFR, Part 1040 Section 1040.10 (f)(1) and IEC 60825-1 Clause 6.2. This is except for the output beam, which is a Class IIIb laser. The protective housing should never be opened.

1.3.1.2 Shutter

The laser contains a manually-operated shutter at the beam exit aperture on the front of the laser head. When the shutter is fully closed, there is no laser radiation emitted from the laser.

1.3.2 Safety Features on the Control Box

The safety features on the control box for the CUBE laser system include:

- Key control
- Laser emission indicator on the control box
- Remote interlock
- (Optional) A secondary emission indicator

1.3.3 Key Control

The control box is provided with a keyswitch that prevents the generation of laser radiation when it is in the OFF position. Laser radiation may occur when the key is in the ON position.

You can remove the key when it is in the OFF position; the key is not removable when it is in the ON position.

The system cannot be operated when the key is removed [CFR 1040.10 (f)(4)/IEC 60825-1, Clause 6.6].

1.3.4 Laser Emission Indicators

The laser system control box provides a laser emission indicator, which is located on the front panel of the control box.

- When the control box indicator is illuminated, the laser should be considered dangerous; a laser beam may be created at any instant (via computer control, for example).
- When the control box LED indicator is not illuminated, laser radiation is not possible.

After the illumination of the control box indicator, there is a delay of at least five seconds in until actual laser emission.

CAUTION:
Take all appropriate actions to avoid direct and indirect exposure to radiation when working with lasers. See "Summary of Precautions" (p. 17) for a list of actions for working safely.

1.3.5 Secondary Emission Indicator (Optional)

The Coherent CUBE laser system includes the capability to add a secondary emission indicator. This indicator is sold as an optional accessory (P/N 1079150). The secondary emission indicator can be mounted remotely at a distance up to 5 meters (16 feet) from the laser system.

Figure 1-1. Secondary Emission Indicator

1.3.6 Remote Interlock

The control box is provided with a remote interlock circuit that, when open, prevents the generation of laser radiation. See Figure-1-2 for details about the interlock circuit configuration.

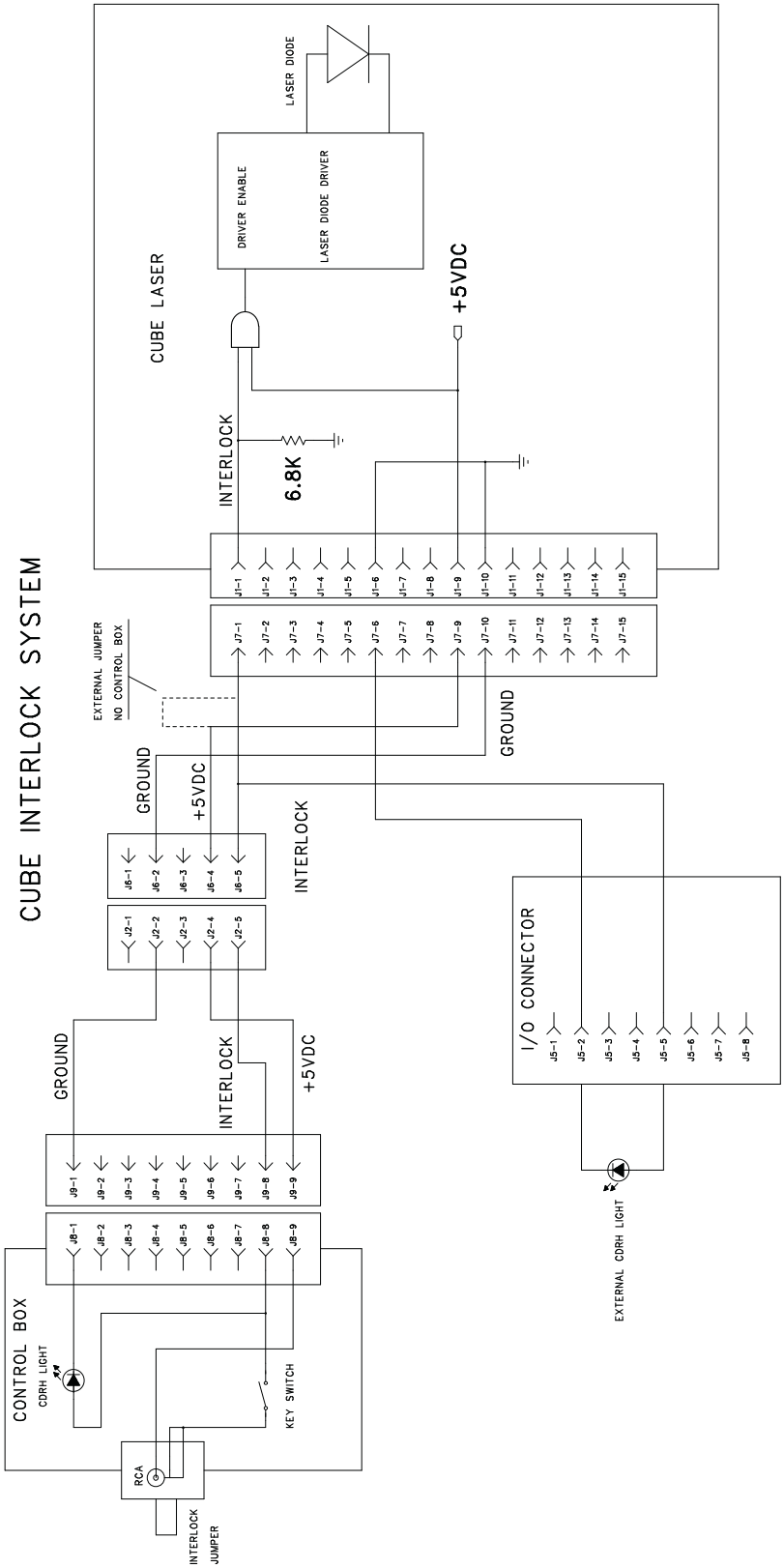


Figure 1-2. Interlock Diagram

1.4 Laser Classification and Compliance

This section describes the classification of the CUBE laser system, as well as compliance with various regulatory agencies.

1.4.1 Laser Emission and Classification

The Coherent CUBE laser system is classified by the United States National Center for Device and Radiological Health (CDRH) as a CLASS IIIb laser product. The CUBE laser emits VISIBLE and INVISIBLE LASER RADIATION of 370 nm to 740 nm wavelength from the aperture in the front of the laser head.

1.4.2 Regulatory Compliance

When used with the control box, Coherent CUBE laser systems comply with all of the requirements of CDRH (21CFR Subchapter J) and EN60825-1.

United States of America:

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

Europe:

The European Community requirements for product safety are specified in the Low Voltage Directive (LVD) (published in 2014/35/EU). The Low Voltage 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 IEC 60825-1 "Safety of Laser Products". Compliance of this laser with the European requirements is certified by the CE mark.

To comply with CDRH and EN60825-1 requirements, the CUBE family of products has been certified by an outside testing lab to be in compliance with the environmental and safety directives listed here:

EMI Standard for Emissions per:

EN55011:2007
Class A Radiated Emissions

EN55011:2007
Class A Conducted Emissions

EN61000-3-2:2006
Power Line Harmonics

EN61000-3-3:1995:A1:2001:A2:2005
Power Line Voltage Fluctuation and Flicker

EMC Standard for Immunity per:

EN61000-4-2:2003
Electrostatic Discharge – Performance Criteria B

EN61000-4-3:2006
Radiated Immunity – Performance Criteria A

EN61000-4-4:2004
Electrical Fast Transient Immunity – Performance Criteria B

EN61000-4-5:2004
Electrical Slow Transient Immunity – Performance Criteria B

EN61000-4-6:2003
Conducted RF Immunity – Performance Criteria A

EN61000-4-11:2004
Power Line Interruptions, Dips, and Dropouts – Performance Criteria B

Low Voltage Directive 73/23/EEC Tests per:

EN61010-1:2001
Safety Requirements Part 1: General Requirements

MD – Machinery Directive for Laser Devices Tests per:

EN60825-1:2001
Safety of Laser Products – Part 1: Equipment Classification Requirement and User's Guide

EN60825-2:2005
Safety of Laser Products – Part 2: Safety of Optical Fiber Communication Systems

EN60825-12:2004
Safety of Laser Products – Part 12: Safety of Free Space Optical Communication Systems Used for Transmission of Information
21CFR 1040.10

1.4.3 CDRH Accession Numbers

Table 1-2 lists CUBE part or item numbers, and their corresponding CDRH accession number.

Table 1-2. CUBE CDRH Accession Numbers

PART/ITEM NUMBER	ACCESSION NUMBER	PART/ITEM NUMBER	ACCESSION NUMBER
1069408	0420530-043	1112774	0420530-043
1069410	0420530-043	1116078	0420530-043
1069413	0420530-043	1117004	0420530-043
1069415	0420530-043	1118915	0420530-043
1069416	0420530-043	1128264	0420530-043
1069417	0420530-043	1130061	0420530-043
1069418	0420530-043	1139603	0420530-043
1094060	0420530-043	1139604	0420530-043
1099208	0420530-043	1142279	0420530-043
1106207	0420530-043	1149209	0420530-043

1.4.4 Safety and Compliance Labels

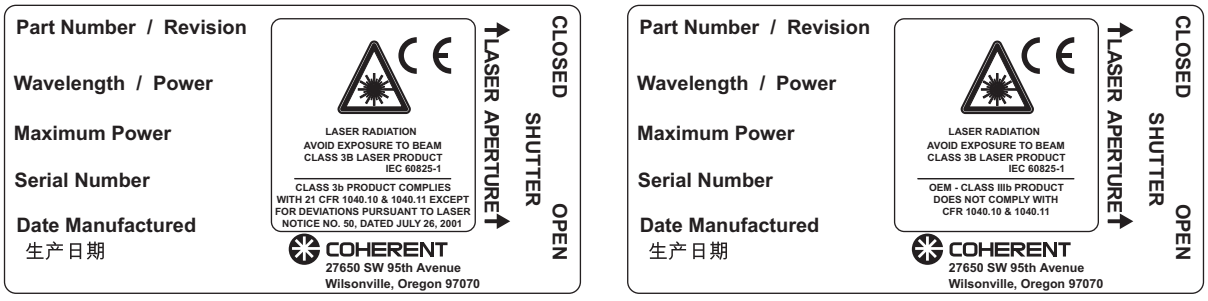
The laser housing includes labels for safety and compliance, described in this section.

1.4.4.1 Safety Labels

The location of the laser safety label for the CUBE laser system is shown in Figure-1-4:

Figure 1-3. Laser Safety Labels on the CUBE Laser

The label can be a Conforming or a Non-Conforming label, depending on usage:



Conforming Label

Nonconforming Label

Figure 1-4. Conforming and Non-Conforming Safety Labels

1.5 Environmental Compliance

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

1.5.1 EU REACH

REACH (Registration, Evaluation, Authorization and Restriction of Chemicals) is a European Union Commission (EUC) Regulation on chemicals and their safe use (EC 1907/2006) entered into force on 01 June, 2007.

Coherent products are “articles” as defined in REACH Article 3(3) and do not release substances under their normal use. Suppliers of articles must provide recipients with information on Substances of Very High Concern (SVHC) if those are present above a concentration limit of 0.1% on an article level. It is the duty of Coherent to communicate information about substances in articles, the delivered product(s), based on Coherent’s knowledge, may contain the listed chemical substance(s) included on the REACH Candidate List at this link:

https://edge.coherent.com/assets/pdf/reach_article_33_statement.pdf

The current Candidate List of SVHCs can be found on the ECHA website:

https://echa.europa.eu/home

Coherent will post information on SVHCs to our website as the information becomes available and assures its customers that our products are in full compliance the EU REACH requirement. For detailed information on SVHC and Coherent products, see https://www.coherent.com/company/environmental.

1.5.1.1 RoHS Compliance

The European Union RoHS Directive EN 50581:2012 restricts the use of certain hazardous substances in electrical and electronic equipment. Coherent is in compliance with this Directive and can provide RoHS certification upon request.

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

For Class B lasers:

Conformance to the EMC requirements is achieved through compliance with the harmonized standards EN55011:2009 for emission and ENC61000-6-2:2005 for immunity. Compliance of this laser with the EMC requirements is certified by the CE mark, displayed on the laser safety label.

1.5.2 China RoHS Compliance

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

This Regulation restricts the use of certain hazardous substances in electrical and electronic equipment. The China RoHS Regulation applies to the production, sale, and import of products into the Peoples Republic of China.

A label is attached to the laser housing or packaging to comply with the China RoHS (Restriction of Hazardous Substances) Directive. This label lists potentially hazardous substances that may be present in the CUBE laser system. An example of the label for the CUBE laser system is shown in Figure-1-5.

Figure 1-5. China RoHS Table of Restricted Hazardous Substances

The table shows that Lead (Pb) is present in the CUBE (due to the use of brass material) and that the environmental-friendly use period is 20 years (as indicated by the number "20" inside the circle).

The China RoHS directive also requires that the date of manufacture be displayed in Chinese characters on the product. This is accomplished on both the conforming/nonconforming labels for the CUBE laser system, as in Figure-1-6:

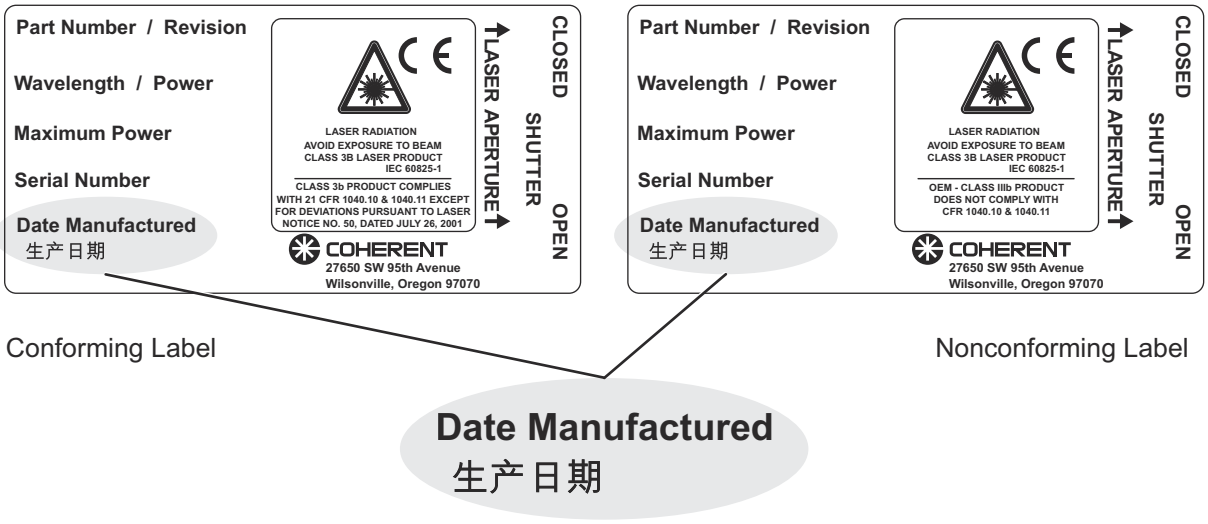


Figure 1-6. China RoHS Date of Manufacture

1.5.2.1 Waste Electrical and Electronic Equipment (WEEE, 2002)

The European Union Waste Electrical and Electronic Equipment (WEEE) Directive (2012/19/EU) is represented by a crossed-out garbage container label, shown in Figure-1-7:

Figure 1-7. Waste Electrical and Electronic Equipment Label

The purpose of this directive is to minimize the disposal of WEEE as unsorted municipal waste and to facilitate its separate collection. This crossed-out garbage container label is affixed to the cover of the CUBE.

The WEEE Directive applies to this product and any peripherals marked with this symbol. Do not dispose of these products as unsorted municipal waste. Contract the local distributor for procedures for recycling this equipment.

1.6 Sources of Additional Information

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

1.6.1 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

1.6.2 Publications and Guidelines

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

Safety of laser products - Part 14: A user's guide
IEC 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

1.6.3 Equipment and Training

Coherent Web Site
Laser Safety Page, Laser Safety Awareness Training Video
www.coherent.com

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

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

2 CUBE PRODUCT INTRODUCTION

This section describes the CUBE Laser System, lists features, describes each component in the system, and provides specifications and dimensions for the components of the system.

For installation instructions, see “Set Up and Installation” (p. 53). That section describes installation of a complete CUBE laser system.

For the various modes of operation, see “Operations” (p. 67).

Additional information is provided later in this book about computer control and commands, setting advanced features, using remote communications, and troubleshooting.

2.1 Features of the CUBE Laser System

The features of the CUBE Laser System include:

- Single transverse mode
- Thermoelectrically-cooled for extended life
- Compact package
- High-quality glass optics
- Digital modulation control
- Analog modulation control
- Circular or elliptical beams
- RS-232 and USB remote communication
- Coherent CUBE Connection software
- Shutter
- Control Box
- Heat Sink (optional)

2.2 System Description

The CUBE laser system combines the very latest semiconductor laser technology with proven high-quality diode laser system manufacturing techniques. This laser system is the most advanced compact full-feature laser system on the market today.

The CUBE laser system, shown in Figure-2-1, is a complete system with laser head, control box, power supply, and interface cables;. This system can be mounted to an optical table or breadboard with the appropriate heat sink capability. The CUBE laser system delivers power, stability, and performance in a small package and at an attractive price.

Figure 2-1. CUBE Laser System

Table 2-1 lists the components shipped with a complete CUBE laser system:

Table 2-1. Components of a CUBE Laser System

#	P/N	COMPONENT
1	Varies	CUBE Laser Head
2	1039966	CUBE Control Box
3	1072454	CUBE Power Supply, 6 VDC, 2.5A, Switched
4	1108063	Power Cord
5	1072166	CUBE Interface Cable (Quatro Digital Interface from the CUBE laser to the control box, I/O, RS-232, and power)
	1108906	USB Cable (see Figure-2-10)
	1147585	CUBE Quick Start Guide
	1079890	CD-ROM with CUBE Operator's Manual and Coherent CUBE Connection Software

The M4 screws and washers to mount the CUBE laser system are also included in the shipment, along with a Hex wrench.

In addition, the optional accessories listed in Table 2-2 to can be ordered for the CUBE laser system.

Table 2-2. Accessories for a CUBE Laser System

P/N	COMPONENT
1073840	CUBE Heat Sink with Fan
1116779	CUBE Right-Angle Heat Sink Mount
1079150	CUBE Secondary Emission Indicator Lamp
1040408	Non-Shorted RCA Plug
1103937	CUBE I/O Interface Cable, 8-Pin to Flying Leads NOTE: This cable is not included with the laser system and must be ordered separately. This optional I/O cable connects to the CUBE Interface Cable (Quatro Digital Interface, P/N 1072166.)
1415602	High-Speed USB-to-Serial RS-232 Adapter
1080090	Cable Extension to Extend Control Box or RS-232 M-F, DB-9 Cable

2.2.1 CUBE Laser Head

The CUBE laser head is a direct-diode laser.

Figure 2-2. CUBE Laser Head

The output beam of the diode is collimated by a high-aperture lens. Additionally, the beam is formed by a prism pair to achieve a round beam in the far field.

A thermoelectric cooler is integrated for stabilizing the diode laser. Excess heat is removed via the base plate of the laser.

The construction details of the CUBE laser head are shown schematically in Figure-2-3. The dimensions of the CUBE laser head are listed in “Dimensions: CUBE Laser Head” (p. 47).

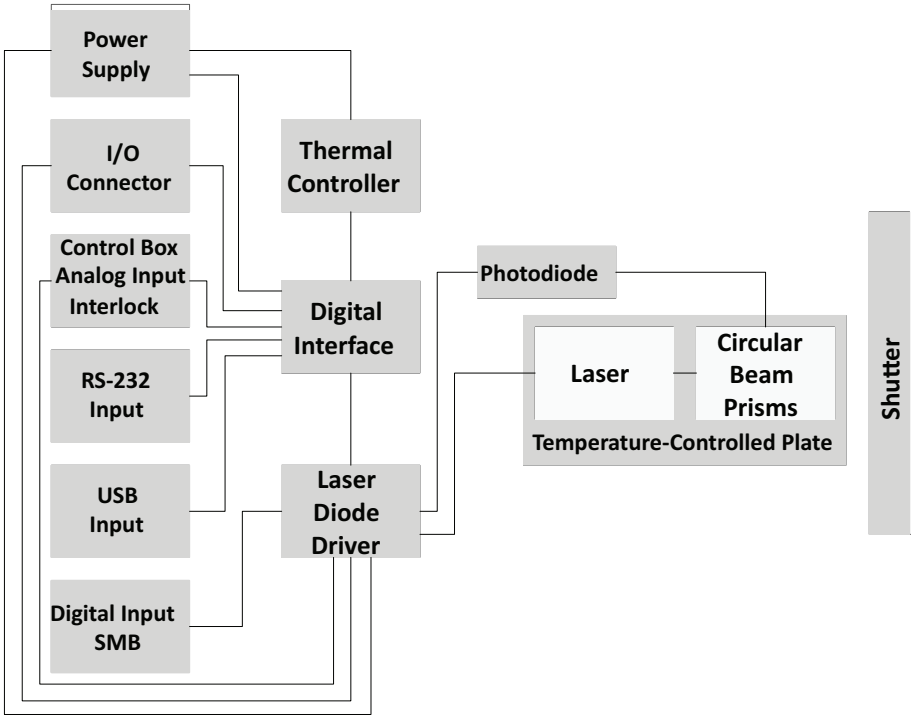


Figure 2-3. CUBE Laser Head Schematic

2.2.2 CUBE Control Box

When properly installed and operated, the CUBE Control Box allows the Class IIIb (CDRH)/Class 3B (IEC) laser system to conform to CDRH 21 CFR 1040 and IEC60825-1 requirements for a "conforming" system. The system is tested and certified at the factory to ensure that all of the safety features are operational. Bypassing or otherwise disabling these safety features invalidate the conformity to the CDRH and IEC regulations.

The CUBE Control Box, shown in Figure-2-4, is connected to the laser interlock. The keyswitch initiates or interrupt laser emission in the same fashion as the interlock.

Figure 2-4. CUBE Control Box with Keyswitch

The BNC connector provides access to the power control line for laser power control at analog modulation rates. Use the RCA rear connector in series with an external interlock.

Figure-2-5 shows the connectors at the bottom end of the CUBE Control Box.

- The Modulation connector is used for analog modulation.
- The LED indicator shows that the system is active and the interlock is closed.
- The keyswitch turns the laser ON or OFF. There is a 5-second delay at power ON.

Figure 2-5. Control Box Front Panel View

Figure-2-6 shows the connectors on the back panel of the CUBE Control Box.

- The 9-pin connector that attaches the CUBE Interface Cable to the Control Box
- The Interlock RCA jack

Figure 2-6. Control Box Back Panel View

2.2.2.1 Interface Cable

The CUBE laser system includes a full-function interface cable, shown in Figure-2-7, which can access all functions available in the Coherent CUBE system.

This CUBE Interface Cable (Quatro Digital Interface) is included with the CUBE laser system at no extra charge. This cable provides separate connectors from the CUBE laser to the control box, I/O, RS-232, and power.

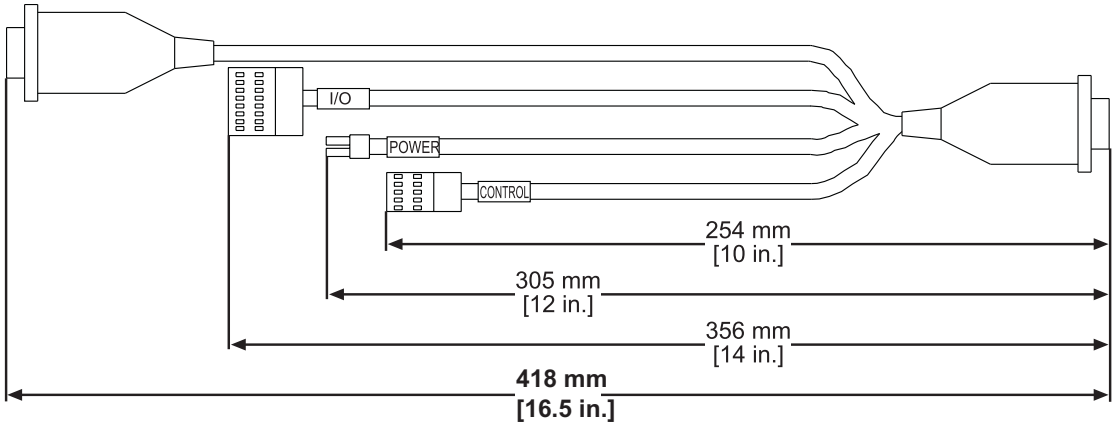


Figure 2-7. Interface Cable

The CUBE Interface Cable connects to the optional CUBE I/O Cable, 8-Pin to Flying Leads (P/N 1103937), which is not included with the laser system and which must be ordered separately.)

Figure-2-8 shows the signals for the interface cable.

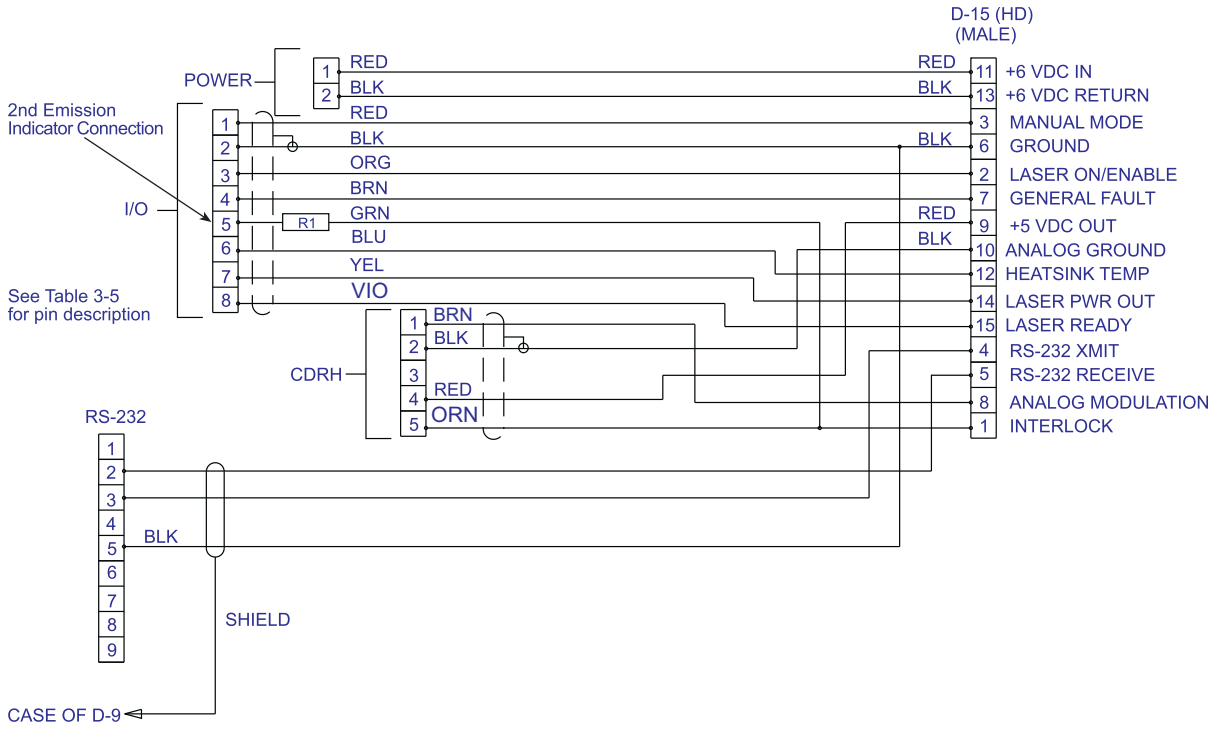


Figure 2-8. Interface Cable Description

Table 2-3 lists the pin-outs for the interface cable.

Table 2-3. Interface Cable Pin-Outs

PIN #	FUNCTION	DIRECTION	DESCRIPTION	DRIVE/LOAD
1	Interlock	Input	0 = Open, Ground (normal) 1 = Closed, TTL High	7 K ohm internally pulled down
2	Laser On (Enable)	Input	0 = Laser Off 1 = Laser On, TTL High	7 K ohm internally pulled up
3	Manual Mode	Input	0 = Computer Control 1 = Manual mode, + 5 VDC (normal)	7 K ohm internally pulled up
4	RS-232 Receive	Output	DE-9 Pin 3	Standard
5	RS-232 Transmit	Output	DE-9 Pin 2	Standard
6	Signal Ground (For use with all signal inputs except the analog modulation)	Input	DE-9 Pin 5	Ground
7	General Fault	Output	0 = No Faults 1 = Fault condition, +5 VDC	7 K ohm
8	Analog Modulation	Input	0 to + 5 VDC = Threshold – 100% Power Control	2 K ohm
9	+ 5 VDC Output	Output	Reference Output, + 5.0 VDC	100 mA Maximum Drive
10	Analog Modulation Ground	Output	Ground	Ground
11	Power Supply Input + 6 VDC	Input	4.8 V to 6.5 VDC Power Input	2.5 A
12	Over-Temperature Heat sink	Output	0 VDC = Base plate Temperature less than 40ºC + 2.5 VDC = Base plate Temperature between 40 and 50°C + 5 VDC = Base plate Temperature over 50°C	2 K ohm
13	Power Supply Ground	Input	Ground	Ground
14	Laser Power Out	Output	0 to + 2 VDC = 0 to 100% Laser Power	750 ohm
15	Laser Ready	Output	0 = Laser Not Ready 1 = Laser Ready, + 5 VDC	2 K ohm
Shell	Chassis Ground		Ground	Ground

2.2.2.2 Interlock

The control box can be connected to a remote switch to disable the system (in the event that a door or panel is opened). The interlock switch must be wired in series with the interlock RCA connector:

INTERLOCK:

Open = Laser OFF
Closed = Laser ON

When the interlock is returned to the closed position, a 5-second delay occurs before laser emission.

Table 2-4 lists specifications for the Interlock:

Table 2-4. Interlock Specifications

SYSTEM SPECIFICATIONS	VALUE
Interlock Control Input	
Maximum Bandwidth	7 Hz
Rise and Fall Time (10% to 90%)	< 1 µsec
Modulation Depth	Infinity, Complete On/Off
Input Impedance	7000 ohms

NOTICE!
The interlock is a fused + 5 VDC line. Do not ground the interlock or apply any outside power to the circuit.

2.2.3 Connectors on the Laser Head

Figure-2-9 shows the connectors on the CUBE laser:

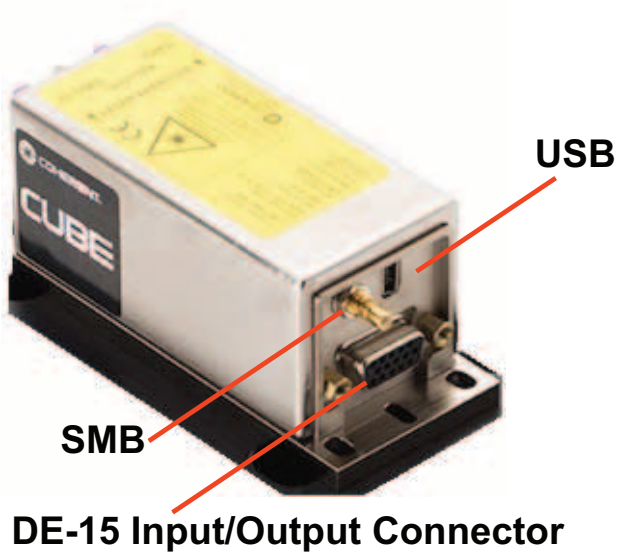


Figure 2-9. Connectors on the CUBE Laser Head

These include:

- SMB Digital Modulation Input
- DE-15 Input / Output Connector
- USB Connector

Each of these are described in the subsections that follow.

2.2.3.1 SMB Digital Modulation Input

Table 2-5 lists specifications for the SMB Digital Modulation Input:

Table 2-5. SMB Digital Modulation Input

SYSTEM SPECIFICATIONS	VALUE
Maximum Bandwidth	150 MHz
Except for CUBE 445nm and 488nm lasers	125 MHz
Rise and Fall Time (10% to 90%)	< 2 nsec
Except for the CUBE 445nm laser	Fall Time is < 3 nsec with 125 MHz Maximum Bandwidth
Modulation Depth (extinction ratio)	
At 0 Hz	> 1,000,000:1 (10^6:1)
At 150 MHz	> 250:1

- 50 ohm Input Impedance
- V Input Low < 0.8 V
- V Input High > 2.6 V
- Maximum Modulation Frequency

Refer to the CUBE Data Sheet for specifications applicable to each model.

2.2.3.2 DE-15 Input / Output Connector

Recommendations:

- Norcomp 979-009-020-121
- Norcomp 180-015-272-000

2.2.3.3 USB Connection

The CUBE USB cable, shown in Figure-2-10, is shipped with the CUBE laser system.

Figure 2-10. USB Cable

. The CUBE bandwidth provides:

- Standard Mini-USB connection
- USB 1.1 or 2.0 communication speed

IMPORTANT!
A USB connection is compatible ONLY with older 32-bit operating systems and IS NOT valid to interface with Windows 7 (64-bit) or Windows 10 operating systems.

All RS-232 commands and queries are available via a USB connection to the host computer. This connection is made using the High-Speed USB-to-Serial RS-232 Adapter (P/N 1415602), sold separately. See details in the section, "Computer Control" (p. 95).

2.2.4 CUBE Power Supply and Power Cord

The CUBE laser system includes a Power Supply (P/N 1072454), which has a power switch and Power On LED indicator. The Power Cord (P/N 1108063) is also included with the CUBE laser system, shown at the top of Figure-2-11.

Figure 2-11. CUBE Power Supply

The power supply requirements for the CUBE laser are:

4.8 VDC to 6.5 VDC 2.5 A

Table 2-6 lists the Power Supply Specifications for both input and output:

Table 2-6. Power Supply Specifications

INPUT	OUTPUT
Input Voltage: 90 to 264 VAC Input Current: < 0.5 A at 90 VAC input Input Frequency: 47 to 63 Hz	Output Voltage: 6 VDC Output Current: 2.5 A Rated Output Power: 15 W (max.) Output Regulation: ± 5% Line Voltage Regulation: ± 1% Typical Measured at Full Load

2.2.5 Coherent CUBE Connection Software

Each CUBE laser system includes Coherent CUBE Connection software for laser control in a graphical user interface (GUI) environment to a host computer.

Figure 2-12. Software CD

For installation instructions and a description of the user interface, see “Computer Control” (p. 95). Any required drivers for the CUBE laser are installed automatically during by the CUBE Connection software.

2.3 Accessories for CUBE Lasers

Table 2-7 lists accessories available for the CUBE laser system:

Table 2-7. Accessories for a CUBE Laser System

P/N	COMPONENT
1073840	CUBE Heat Sink with Fan
1116779	CUBE Right-Angle Heat Sink Mount
1415602	CUBE High-Speed USB-to-Serial RS-232 Adapter
1079150	CUBE Secondary Emission Lamp
1040408	Non-Shorted RCA Plug
1103937	CUBE I/O Cable, 8-pin to Flying Leads
1080090	Cable Extension to Extend Control Box or RS-232 M-F, DB-9 Cable

2.3.1 CUBE Heat Sink (Optional)

The mounting of any laser is important to extend the stability of the beam over time and temperature, and the heat sink provides proper thermal dissipation and mechanical positioning.

The optional CUBE Heat Sink from Coherent (P/N 1073840) is the result of significant design research and testing. The optional heat sink is available to ensure optimal heat sinking of the CUBE laser head, if not covered by OEM integration.

With the Coherent CUBE Heat Sink, shown in Figure-2-13, the safety shutter is easily accessible and the rear panel is unobstructed for access and connections.

Figure 2-13. CUBE Heat Sink (Optional)

NOTE:
This optional Coherent accessory is not required if the heat sink function is covered by OEM integration.

The optional CUBE Heat Sink accessory has sufficient cooling capacity for ambient temperatures to cool to a maximum ambient temperature of 50°C. The solid CUBE Heat Sink foundation is designed to maintain the specified system pointing stability.

The CUBE Heat Sink includes a fan that connects directly to the power supply, which is included with each system. English and metric mounting hardware is also included. See "Mount the Laser Head" (p. 54) for installation instructions.

2.3.1.1 Features of the CUBE Heat Sink

- 64 mm (2.5 in.) beam height
- Output beam centers on standard table 2.54 cm (1 in.) bolt pattern
- Metric and English bolt pattern
- Precision dowel pin laser positioning
- Integrated cooling fan
- Proven stable performance over time and temperature

- Safety shutter access
- Small footprint
- Rugged design

2.3.1.2 Packing List for the CUBE Heat Sink

The CUBE Heat Sink Accessory Kit is shown in Figure-2-14:

Figure 2-14. CUBE Heat Sink Accessory Kit

Table 2-8 lists the parts and accessories included with the CUBE Laser System:

Table 2-8. Packing List for the CUBE Heat Sink Accessory

ITEM DESCRIPTION	QUANTITY
Heat Sink	1
Fan Power Connector	1
1/4-20 Mounting Hardware	4
M6 Mounting Hardware	4
M4 Laser Mounting Hardware	4
Non-Metallic Flat Washers	4
3/16 Wrench	1
M6 Wrench	1

2.3.2 Heat Sink Specifications

It is imperative that the laser head be adequately heat sinked; otherwise, it will overheat and shut down. The Heat Sink Flatness requirement is < 0.05 mm over the entire mounting surface.

NOTE:
Heat dissipation varies with laser power levels.

Figure-2-15 shows the heat dissipation of the CUBE laser head for a given base plate temperature.

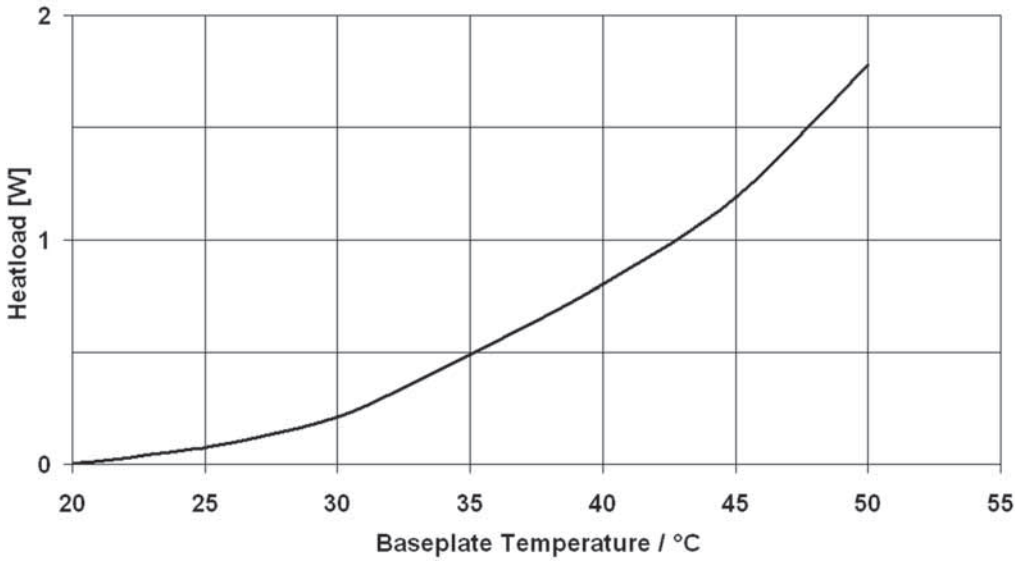


Figure 2-15. Thermal Dissipation of the CUBE Laser Head

The graph in Figure 2-16 (p. 2-42) allows determination of the heat sink thermal impedance requirement, based on the anticipated maximum ambient temperature of 40ºC. For example, if the maximum expected ambient temperature is 35°C, the heat sink thermal impedance needs to be 2.7ºC/Watt.

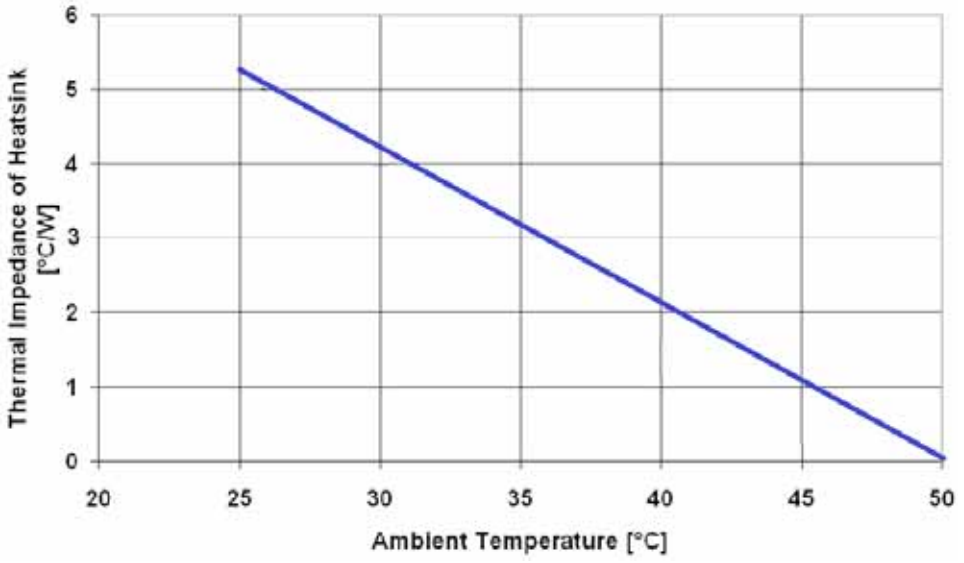


Figure 2-16. Estimated Heat Sink Requirements for an Ambient Temperature of 50ºC

If additional thermal conduction is required, the only recommended thermal conductance aids are pyrolytic graphite pads or thermal materials, such as Sil-Pad or Indium foil. Thermal compound or any flowable compound is not recommended.

IMPORTANT!
The use of flowable thermal compounds can reduce the normal lifetime of a laser *and will void the CUBE laser warranty*.

The mounting surface of the heat sink must be flat to ensure good thermal contact and avoid damage to the laser head. Many extruded heat sinks are warped and the mounting surface should be milled flat (within < 0.05 mm over the mounting surface).

2.3.3 CUBE Right-Angle Heat Sink Mount

The optional CUBE Right-Angle Heat Sink Mount (P/N 1116779) for the CUBE laser is available for applications that require the direction of the beam polarization to be rotated ninety degrees. The Right-Angle brackets act as a Heat Sink when mounting the CUBE laser.

The most common use of the CUBE Right-Angle Heat Sink Mount is to change the CUBE polarization from vertical to horizontal. The Right-Angle Heat Sink Mount allows the CUBE laser to be rotated 90º without a change in beam position (if mounted as shown in Figure-2-17).

Figure 2-17. Right-Angle Heat Sink Mount with CUBE Laser

2.3.3.1 Features of the CUBE Right-Angle Heat Sink Mount

The features of the CUBE Right-Angle Heat Sink Mount include:

- 19 mm (.75 in.) beam height is maintained
- CUBE laser mounting bolt pattern
- Heat sink included for heat dissipation
- Proven pointing performance over temperature and time
- Safety shutter access
- Small footprint
- Rugged design

2.3.3.2 Packing List for the CUBE Right-Angle Heat Sink Mount

Figure-2-18 shows the CUBE Right-Angle Heat Sink Mount kit. This includes mounting hardware (both tools and screws) for both standard and metric mounting.

Figure 2-18. Right-Angle Heat Sink Mount (Optional)

For installation instructions, see "Mount on a Right-Angle Heat Sink Mount (Optional)" (p. 56).

For dimensions, see "Dimensions: CUBE Right-Angle Heat Sink Mount" (p. 50).

Table 2-9 lists the items included with the CUBE Right-Angle Heat Sink Mount:

Table 2-9. Packing List for Right-Angle Heat Sink Mount

ITEM DESCRIPTION	QUANTITY
Right-Angle Heat Sink Mount	1
M4 x 16 mm Long Mounting Hardware	4
M4 Small Pattern Washers	4
Wrench, Hex key, 3 mm	1
Wrench, Hex key, 2.5 mm	1
Instruction Sheet, CUBE laser Right Angle Mount and Heat Sink (P/N 1144556)	1

2.3.4 CUBE I/O Interface Cable

The mating CUBE I/O Interface Cable, 8-pin to Flying Lead (P/N 1103937), is sold separately. This eight-pin I/O connector, shown in Figure-2-19, is provided for access to the laser control and status pins.

Figure 2-19. CUBE I/O Interface Cable

Use Table 2-10 to determine the functions required for your application.

Table 2-10. CUBE I/O Interface Cable

PIN	COLOR	FUNCTION	DIRECTION	RANGE	DESCRIPTION
1	Red	Manual Mode	Input	TTL - 0, TTL - 1	Default + 5 V for Manual mode (Auto-Start). Connect to ground for computer-start mode.
2	Black	Ground	Input	N/A	Ground
3	Orange	Laser On/Enable	Input	TTL - 0, TTL - 1	Default + 5 V for Laser is Enabled. Connect to ground to disable laser output.
4	Brown	General Fault	Output	N/A	Default: zero volts for no faults. Output + 5 V if a fault condition exists. Example: Base plate over-temperature
5	Green	2nd Emission Lamp	Output	TTL - 0, TTL - 1	Default: zero volts for interlock open and laser off. Output 5 V when laser enabled. Second emission lamp accessory sold separately
6	Blue	Heat Sink Temperature	Output	0 V, 2.5 V, 5 V	Laser Base Plate Temperature output signal • 0 VDC = Temperature less than 40°C • + 2.5 VDC = Temperature between 40°C and 50°C • + 5 VDC = Temperature over 50°C
7	Yellow	Laser Power Output	Output	0 to 2 V	Laser Power output signal. Voltage proportional to laser power. Zero to + 2 V represents zero to 100% Laser Output Power
8	White	Laser Ready	Output	TTL - 0, TTL - 1	Default: Zero volts - laser not ready. Output + 5 V when the laser is ready.

2.4 Operating Specifications

Table 2-11 lists the operating specifications for the CUBE Laser System.

Table 2-11. Operating Specifications

OPERATING CONDITION	VALUE
Laser Head Operating Voltage	+4.8 to 6.5 VDC
Laser Head Operating Current	<2.5 Amps
Baseplate Temperature Range (Non-condensing with laser diode TEC at set point of 22°C.)	+10° to 50°C (50° to 122°F)
Maximum Heat Dissipation of Head (W) (baseplate at 50°C)	13° W
Storage Temperature	–20° to 60°C (–4° to 140°F)

Table 2-12 lists the recommended storage temperature for CUBE lasers:

Table 2-12. Storage Specifications

STORAGE CONDITION	VALUE
Storage Temperature	–20° to 60°C (–4° to 140°F)

For current information, refer to the CUBE data sheet on the Coherent website at

https://www.coherent.com/lasers/laser/cube-lasers

2.4.1 Temperature and Humidity

The CUBE laser system includes an active thermoelectric cooler to maintain the diode and optics at 22°C.

The humidity and ambient temperature around the laser needs to be considered to prevent condensation on the diode and optics. The diode set temperature is 22ºC.

CAUTION!
Dew points above 22ºC (shaded in pale blue) might cause condensation.

Table 2-13 contains boxes representing the dew point numbers.

Table 2-13. 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
41	41	39	38	37	36	35	34	33	32	29	28	27	24	22	19	17	13	8	3
38	38	37	36	35	34	33	32	30	29	27	26	24	22	19	17	14	11	7	0
35	35	34	33	32	31	30	29	27	26	24	23	21	19	17	15	12	9	4	0
32	32	31	31	29	28	27	26	24	23	22	20	18	17	15	12	9	6	2	0
29	29	28	27	27	26	24	23	22	21	19	18	16	14	12	10	7	3	0	
27	27	26	25	24	23	22	21	19	18	17	15	13	12	10	7	4	2	0	
24	24	23	22	21	20	19	18	17	16	14	13	11	9	7	5	2	0		
21	21	20	19	18	17	16	15	14	13	12	10	8	7	4	3	0			

2.5 Dimensions

This section provides dimensions for the following components:

- CUBE Laser Head
- CUBE Control Box
- CUBE Power Supply
- CUBE Heat Sink (optional)
- CUBE Right-Angle Heat Sink Mount (optional)

2.5.1 Dimensions: CUBE Laser Head

Figure-2-20 shows the dimensions for the CUBE laser head.

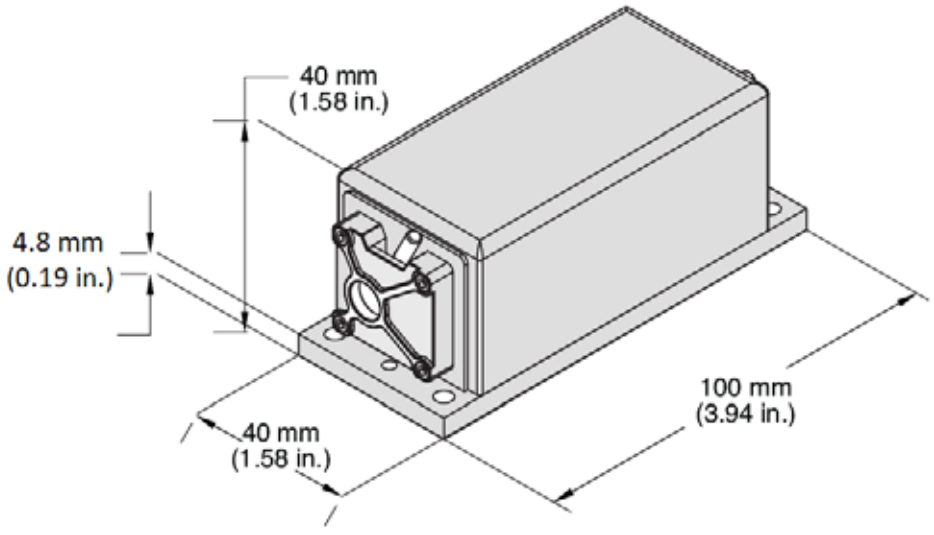


Figure 2-20. Dimensions — CUBE Laser Head

Dimensions for the front and back ends of the laser are shown in Figure-2-21, along with connectors and the laser aperture:

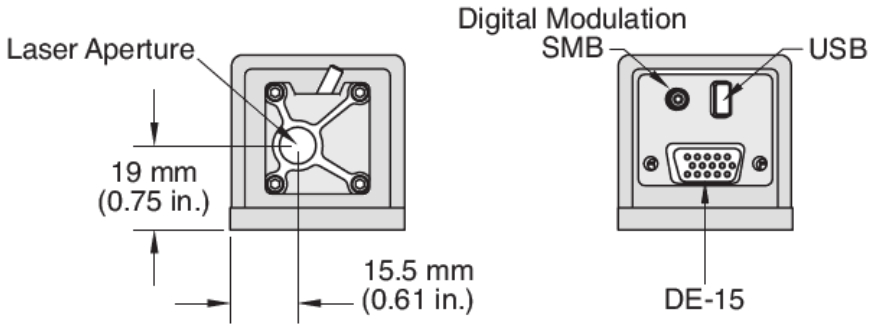


Figure 2-21. Dimensions — CUBE Laser Head End Views

2.5.2 Dimensions: CUBE Control Box

Figure-2-22 shows the dimensions for the control box to the CUBE laser system. Notice that the green LED emission indicator shows that system is active and the interlock is closed.

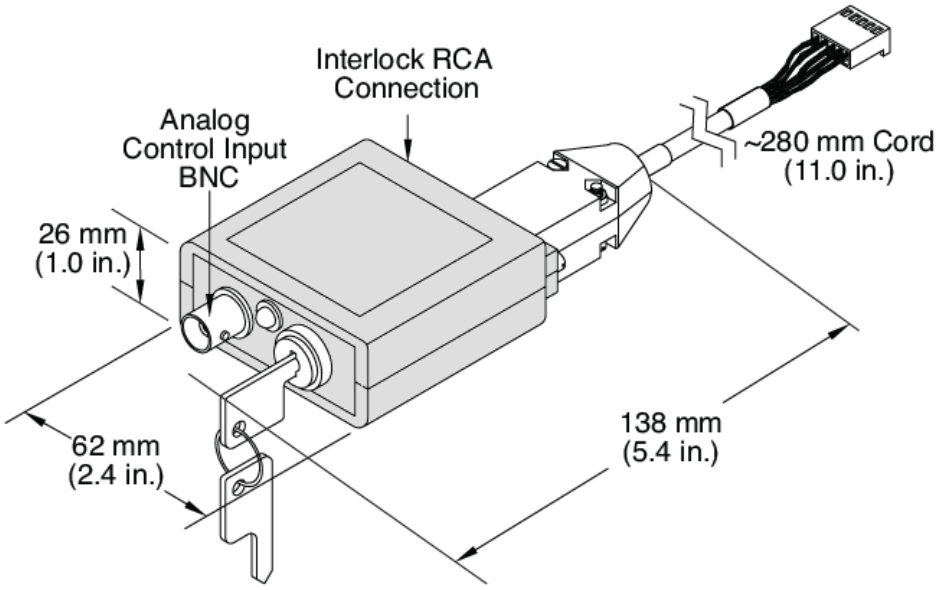


Figure 2-22. Dimensions — CUBE Control Box

2.5.3 Dimensions: CUBE Power Supply

Figure-2-23 shows the dimensions for the power supply to the CUBE laser system.

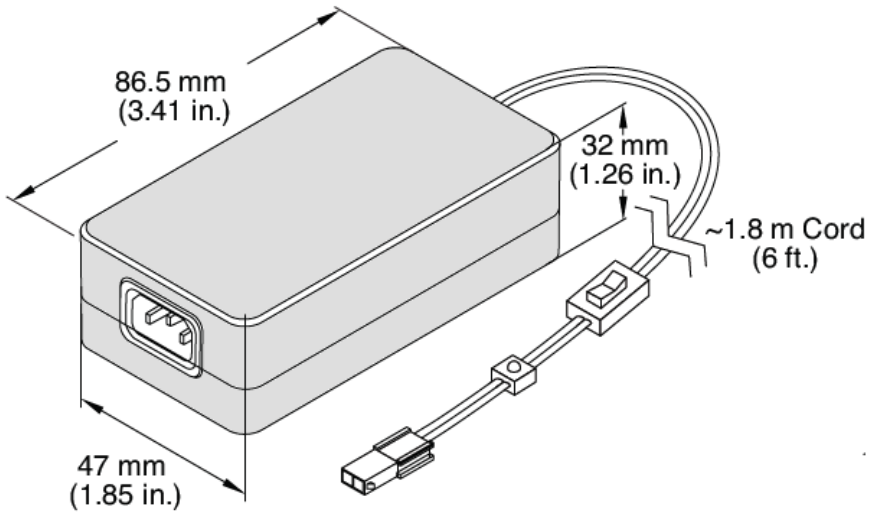


Figure 2-23. Dimensions — CUBE Power Supply

2.5.4 Dimensions: CUBE Optional Heat Sink

Figure-2-24 shows the dimensions for the optional Coherent Heat Sink for the CUBE laser head.

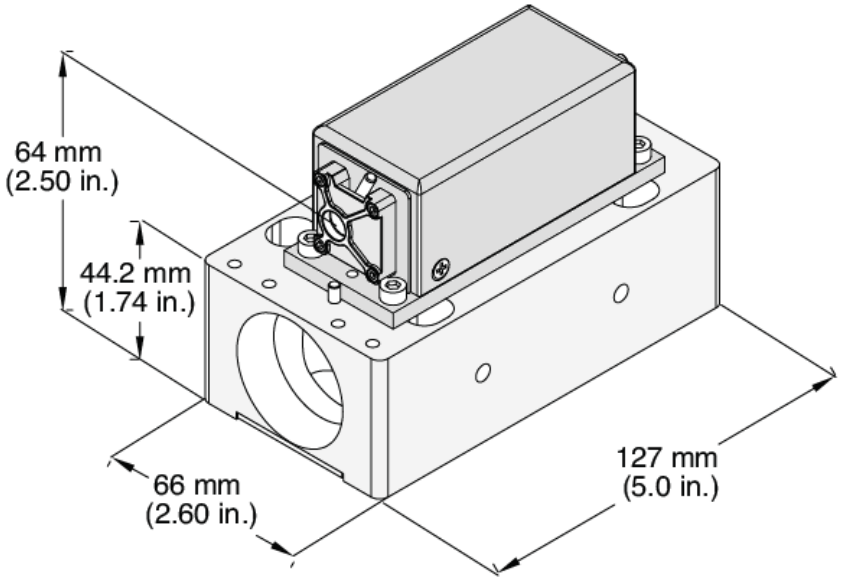


Figure 2-24. Dimensions — Optional CUBE Heat Sink

Figure-2-25 shows the mounting holes on the optional Heat Sink:

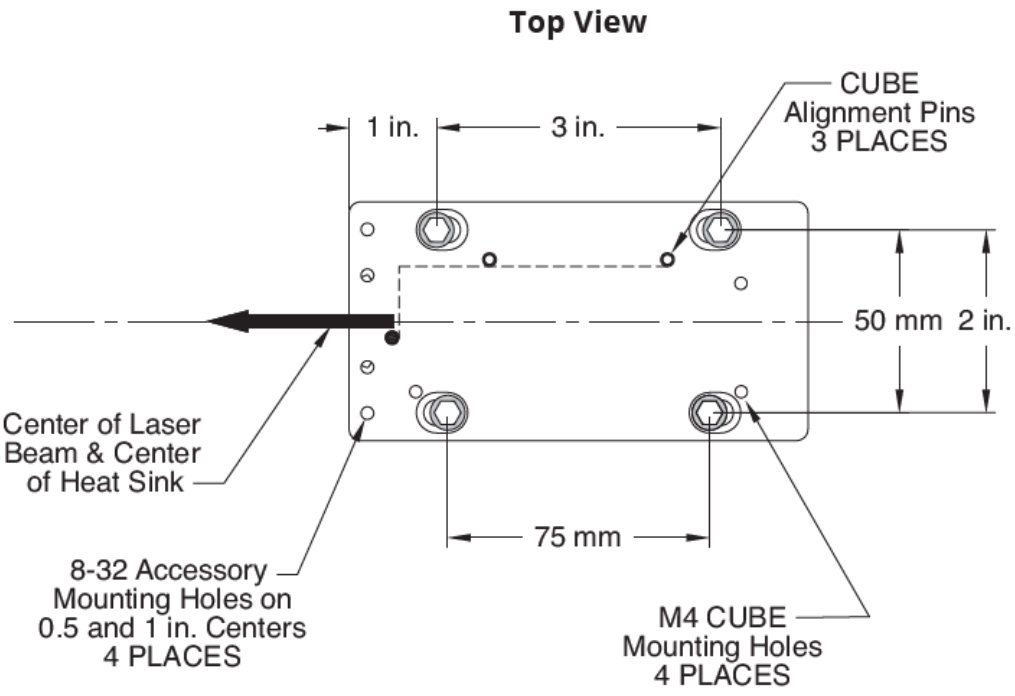


Figure 2-25. Mounting Holes — Optional CUBE Heat Sink

NOTICE!
Mounting holes on the Coherent Heat Sink can be used to mount the heat sink onto either standard or metric holes on optical or breadboard patterns.

2.5.5 Dimensions: CUBE Right-Angle Heat Sink Mount

Figure-2-26 shows dimensions for the optional CUBE Right-Angle Heat Sink Mount for the CUBE laser.

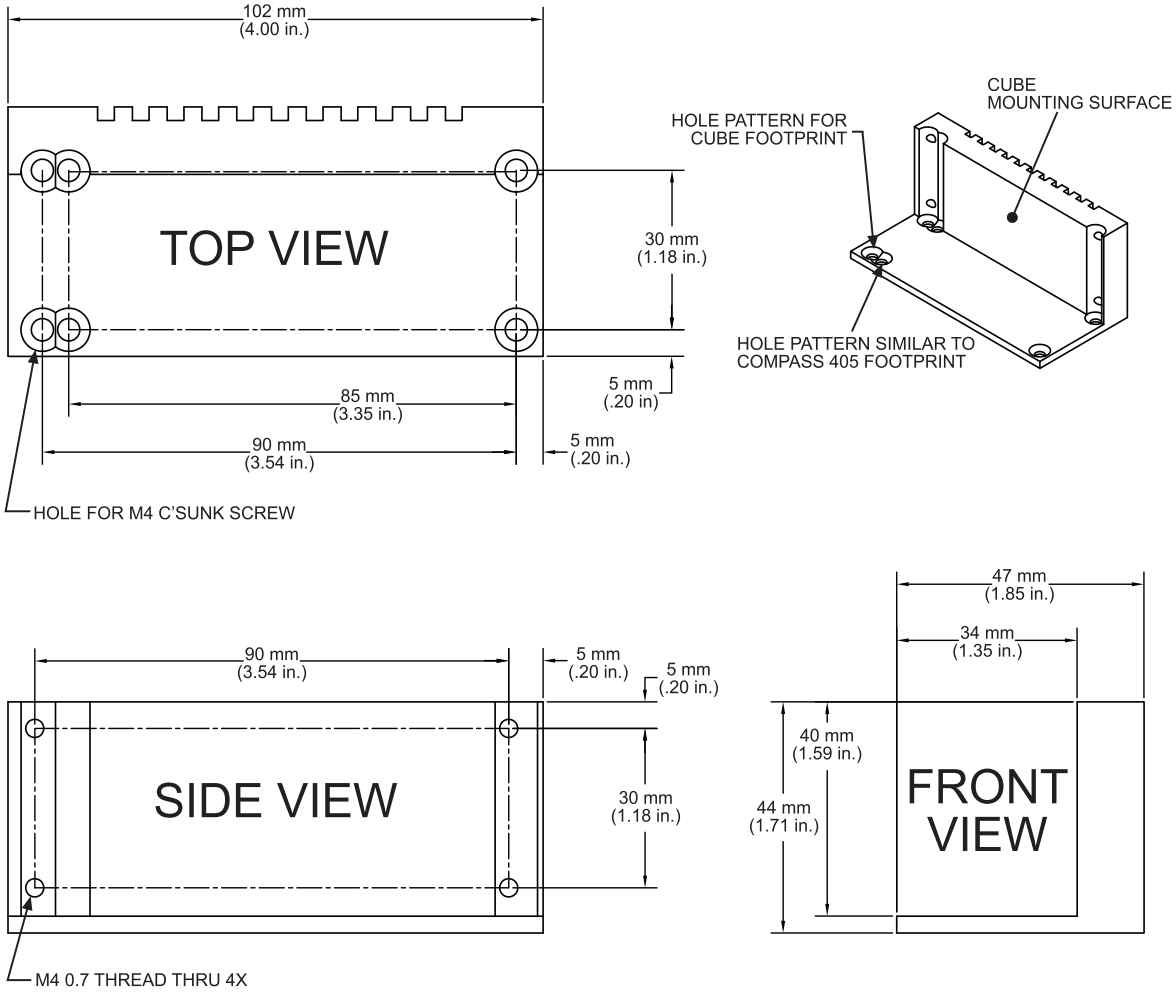


Figure 2-26. Dimensions: Right-Angle Heat Sink Mount

3 SET UP AND INSTALLATION

This section describes how to set up and install a CUBE laser system, including how to mount the laser, attach power, connect various cables, and so on.

CAUTION!
The CUBE Laser System is a Class IIIb laser product. Depending on the specific laser model, the laser will emit either VISIBLE OR INVISIBLE LASER RADIATION of 375–730 nm wavelengths from the aperture in the front of the laser head.

Read the safety information and precautions in “Laser Safety & Compliance” (p. 13) prior to installation.

3.1 Receiving and Inspection

Before you begin, gather all components and tools to be used. Also inspect the product that was received before starting installation and set-up.

Inspect shipping boxes for signs of rough handling or damage and indicate any such signs on the bill of loading. Report any damage immediately to the shipping carrier and to Coherent Order Administration Department at +1-(800)-367-7890 (outside the US: +1-(408)-764-4557, or to an authorized Coherent representative.

NOTICE!
After unpacking the system, save the shipping boxes for later potential shipments—refer to “Service & Support” (p. 121) for shipping instructions.

Table 3-1 lists the items shipped with a CUBE Laser System:

Table 3-1. Packing List for CUBE Laser System

P/N	COMPONENT	QTY
Varies	CUBE Laser Head	1
1039966	CUBE Control Box	1
1072454	CUBE Power Supply, 6 VDC, 2.5A, Switched	1
1108063	Power Cord, North America	1
1072166	CUBE Interface Cable (Quatro Digital Interface included at no extra charge that provides an interface from the CUBE laser to the control box, I/O, RS-232, and power)	1
1108906	USB Cable	1
1147585	CUBE Quick Start Guide	1
1079890	CD-ROM with CUBE Operator’s Manual and Coherent CUBE Connection Software	1
Included	Modified M4 Mounting Screws (4 each), M4 Small Pattern Washer (4 each), and small Hex wrench (1 each)	

3.2 Installation Steps

The steps required for installation vary, depending on whether or not you want computer control of the laser. For information about set-up for computer control, see "Computer Control" (p. 95). This section summarizes the steps to install the CUBE laser system.

NOTICE!
Take appropriate ESD precautions when handling and installing the laser. Refer to "Electrical Safety" (p. 18) for a complete description of precautions.

For a typical installation of the CUBE laser system:

1. Mount the CUBE laser on either the optional CUBE Heat Sink, the Right-Angle Heat Sink Mount, or a mounting surface capable of providing adequate thermal dissipation. For requirements, see "CUBE Heat Sink (Optional)" (p. 40).
2. Connect the Interface cable to the laser head.
3. Connect the Control Box to the interface cable. Ensure the keyswitch is in the OFF position.
4. Connect the power supply.
5. Turn power ON.
6. Turn the keyswitch on the control box to the ON position.Laser emission starts in approximately 5 seconds.
7. Move the laser shutter to the OPEN position, as indicated on the label at the top of the laser head.

3.3 Mount the Laser Head

Installation options include:

- Install the CUBE laser head onto an OEM heat sink mount that meets the flatness requirements for thermal management of the CUBE laser system.
- Mount the CUBE laser head with the Coherent CUBE Heat Sink directly to an optical table or breadboard.

NOTE:
The CUBE Heat Sink from Coherent is an optional accessory that is not provided with the laser system and must be ordered separately.

Depending on the space available and desired position of the laser in a customer-designed installation, another mounting alternative is to attach the CUBE laser using the Coherent Right-Angle Heat Sink Mount.

Each of these installation options are described in the sections that follow.

3.3.1 Mount on the CUBE Heat Sink (Optional Accessory)

To mount the CUBE laser head with the optional CUBE Heat Sink from Coherent to an optical table or breadboard, follow the mounting procedure described in this section. Instructions are provided for connections required for various modes of operation.

NOTICE!
The mounting surface of the Heat Sink must be flat to ensure good thermal contact and avoid damage to the laser head. Many extruded Heat Sinks are warped and the mounting surface should be milled flat (within < 0.05 mm over the mounting surface).

1. Place the CUBE laser on either the optional CUBE Heat Sink or a mounting surface capable of providing adequate thermal dissipation. Direct contact between laser and heat sink is recommended.

   If additional thermal conduction is required, the only recommended thermal conductance aids are pyrolytic graphite pads or thermal materials, such as Sil-Pad or Indium foil. Thermal compound or any flowable compound is **not** recommended. Refer to “CUBE Heat Sink (Optional)” (p. 40) for Heat Sink requirements.

NOTICE!
The use of flowable thermal compounds can reduce the normal lifetime of a laser *and will void the CUBE laser warranty*.

2. Secure the Coherent Heat Sink (P/N 1073840) to the proposed laser location. Ensure the ends of the Heat Sink remain unobstructed for proper air flow.

   Secure the CUBE laser head to the Heat Sink with the M4 screws shipped with the system (M4 x 10 mm with small pattern washer).

NOTICE!
The laser system includes modified M4 mounting hardware. Standard M4 socket head screws do not provide sufficient clearance for mounting holes.

3. Tighten the screws in a diagonal pattern to ensure optimum pointing stability. Torque the mounting screws to 23 N·m (32 oz·in.) in the sequence of 1-2-3-4, shown in Figure-3-1.
4. Use the same diagonal pattern for the final torque setting of 1 N·m (142 oz·in.)
5. If fan operation is required, connect the fan to the CUBE power supply with the cable provided with the Heat Sink. The fan cable will allow power to be supplied to the Heat Sink fan and the CUBE simultaneously.
6. Proceed with normal laser operation.

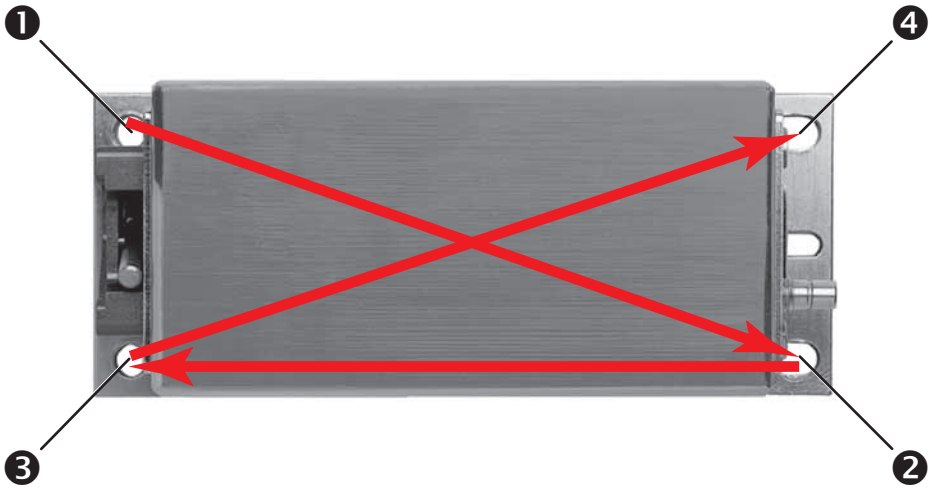


Figure 3-1. Torque and Tightening Pattern (CUBE Laser to Heat Sink)

3.3.2 Mount on a Right-Angle Heat Sink Mount (Optional)

As an alternative to using the optional CUBE Heat Sink from Coherent, instead attach the CUBE laser to a Right-Angle Heat Sink Mount. The mounting diagram is shown in Figure-3-2.

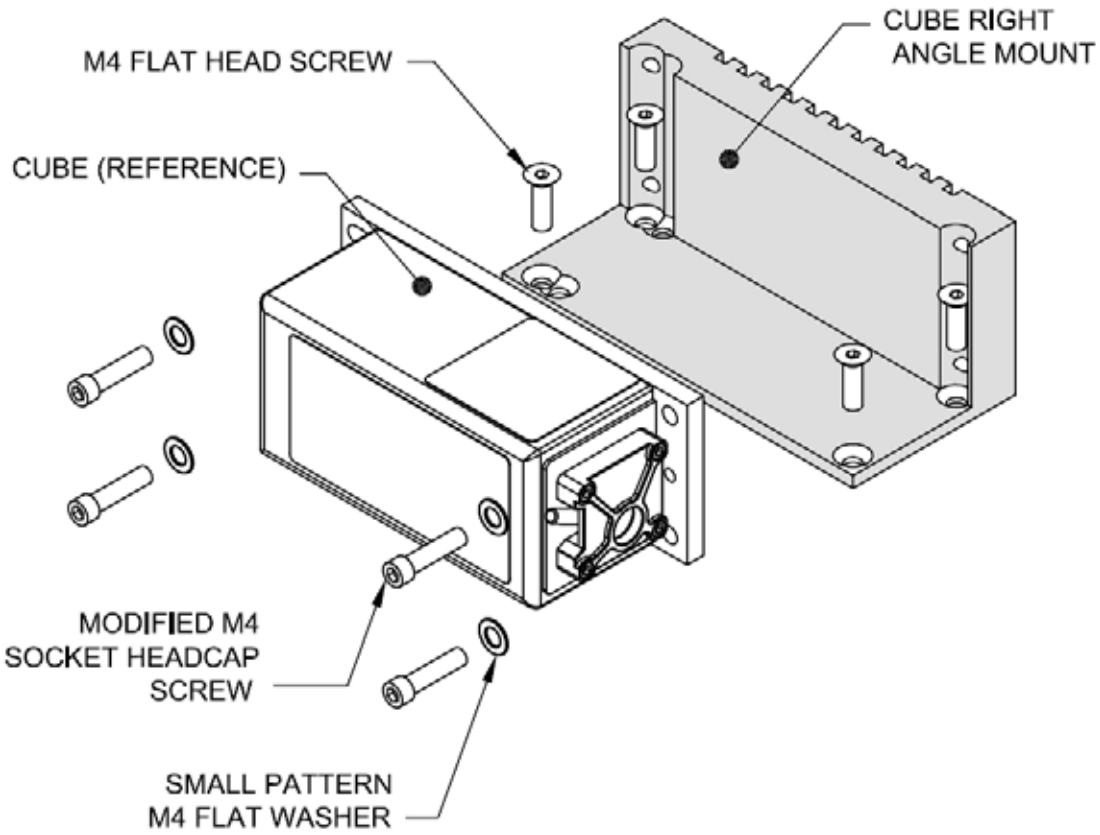


Figure 3-2. Right-Angle Heat Sink Mount Mounting Diagram

1. Attach the CUBE laser to the Right-Angle Heat Sink Mount using the provided four small pattern flat washers and modified M4 socket head cap screws. Mount the CUBE laser to the Right-Angle Heat Sink Mount as shown in Figure-3-2:

Figure 3-3. Tighten Mounting Screws

2. Torque the screws to 36 inch ounces in the same diagonal pattern shown earlier in Figure-3-1.

3.3.3 Connect the Interface Cable to the Laser

Connect the serial interface cable (with the DE-15 pin connector) to the CUBE laser, as shown in Figure-3-4.

Figure 3-4. Connect the Serial Interface Cable to the Laser

Tighten the connector shell screws to ensure reliable system operation.

3.3.4 Connect Power

The power cable 2-pin connector mates to the supplied CUBE power supply. The connector is keyed to ensure correct polarity when plugged into the power supply.

CAUTION!
Failure to connect the power cable 2-pin connector correctly may cause internal damage and will void the warranty.

1. Connect the power supply.
   - Use care to connect the tabbed ends in the correct alignment, as shown in Figure-3-5.

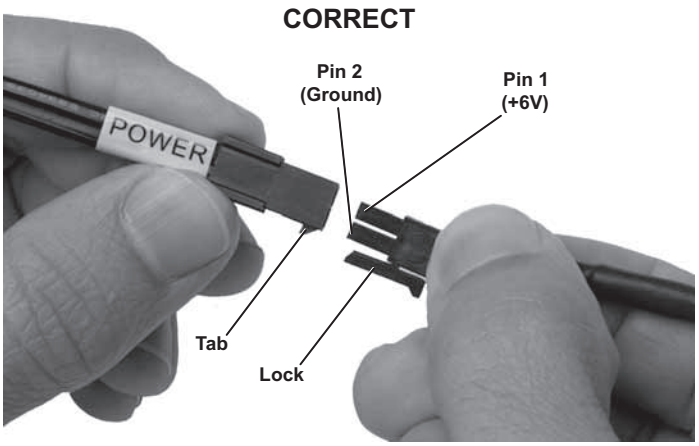


Figure 3-5. Correct Way to Connect 2-Pin Power Cable

   - Figure-3-6 shows the WRONG way to connect the power cable.

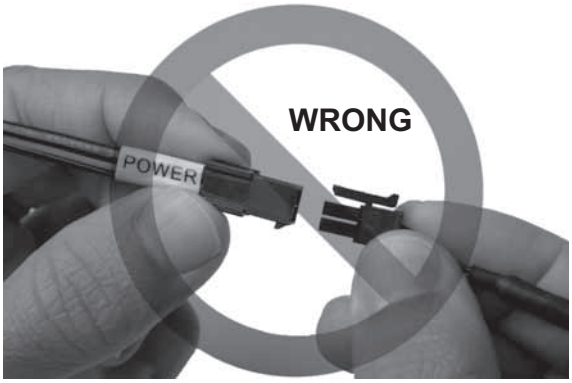


Figure 3-6. Wrong Way to Connect 2-Pin Power Cable

3.3.5 Connect the Control Box to the Laser

1. Connect the 5-pin I/O cable of the Control Box cable to the CUBE Interface Cable, as shown in Figure-3-7.

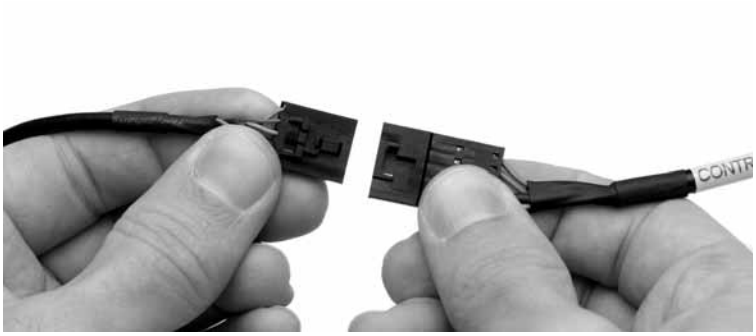


Figure 3-7. Connect the Control Box

2. Confirm that the keyswitch on the Control Box is in the OFF position, as shown in Figure-3-8.

Figure 3-8. Control Box Keyswitch

3. Close the interlock with the supplied shorted RCA plug or connect the interlock to a remote interlock switch.

CAUTION!
The interlock is a fused + 5 VDC signal line. Do not connect to a ground circuit or the internal fuse may blow.

Figure-3-9 shows where to connect the Interlock to the Control Box.

4. Apply power to the laser using the power supply rocker switch.
5. Turn the Control Box keyswitch to the ON position to initiate laser emission.

Figure 3-9. Control Box Interlock Connection

NOTICE!
The CUBE laser system is shipped in CW Manual mode with a 5-second CDRH-required delay. The laser emission is active approximately five (5) seconds after the keyswitch is set to the ON position.

If computer control is not desired, the CUBE laser system starts without additional hardware or configuration settings. If computer control is desired, see "Computer Control" (p. 95).

The CUBE laser system uses the following connections, shown in Figure-3-10, plus a choice of Heat Sink.

Figure 3-10. CUBE Laser System Set-Up

Table 3-2 lists the components shipped with a complete CUBE laser system:

Table 3-2. Components of a CUBE Laser System

#	P/N	COMPONENT
1	Varies	CUBE Laser Head
2	1039966	CUBE Control Box
3	1072454	CUBE Power Supply, 6 VDC, 2.5A, Switched
4	1108063	Power Cord
5	1072166	CUBE Interface Cable (Quatro Digital Interface from the CUBE laser to the control box, I/O, RS-232, and power)
	1108906	USB Cable (see Figure-3-12)
	1147585	CUBE Quick Start Guide
	1079890	CD-ROM with CUBE Operator's Manual and Coherent CUBE Connection Software

Note that the Quatro Cable connects to an optional CUBE I/O Interface Cable, with 8-Pin to Flying Leads (P/N 1103937), which is not included with the laser system and must be ordered separately.

See "Operations" (p. 67) for additional details about connections for Analog and Digital Modulation.

3.4 Connect Laser to Computer

The CUBE laser system can control laser power or other parameters remotely using CUBE Connection software installed on a host computer or laptop.

- For details about installing and using the CUBE Connection software, see "Coherent CUBE Connection Software" (p. 77). This section includes installation instructions for the software, which is shipped with the CUBE laser system. You can also download the software from the Coherent website at:

  https://www.coherent.com/lasers/laser/cube-lasers

- For a list of computer controls and queries for both Continuous Wave (CW) and Pulsed operations, also see "Computer Control" (p. 95).

All remote computer settings are stored each time the system is powered down. Use the "?S" query to display a complete list of current settings.

NOTICE!
A null-modem cable will not operate the CUBE laser system. The CUBE is a DCE device and requires a standard serial cable.

Before communications can take place, you must set up a physical connection.

For connection with Windows 10 and Windows 7 (64-bit) an RS-232 connection is required. Coherent offers an optional High-Speed USB-to-Serial RS-232 Adapter (P/N 1415602), shown in Figure-3-11.

Figure 3-11. Connect Optional RS-232 Interface Cable

For connection with a 32-bit operating system, a USB connection can be used. This USB cable, shown in Figure-3-12, is included with the CUBE Laser System.

Figure 3-12. USB Cable

Each of these connections are described in the sections that follow.

3.4.1 RS-232 Connection

To enable RS-232 communications between the CUBE laser and a 64-bit host computer, a physical connection must be made to be able to utilizes the pin-outs on the RS-232 connector.

To do so, connect the serial interface cable to the optional CUBE High-Speed USB-to-Serial RS-232 Adapter (P/N 1415602). This optional adapter, shown in Figure-3-11, is available from Coherent and is sold separately.

This Adapter allows connection of a serial RS-232 device (CUBE laser) to a host computer with a USB Type-A port. A 3-foot detachable USB Type-A Male to USB Type-B Male cable is included. This connector is compatible with operating systems for Windows XP, Windows 7, and Windows 10.

3.4.1.1 RS-232 Input Pins

Table 3-3 and Table 3-4 list the input pins from the RS-232 connector to the computer.

You can connect directly to the CUBE DE-15 connector or the CUBE interface cable DE-9 connector. Note the differences for a DE-9 interface cable or a DE-15 interface cable.

Table 3-3. **DE-9 INTERFACE CABLE CONNECTOR**

PIN NUMBER	DESCRIPTION
2	RS-232 Transmit
3	RS-232 Receive
5	Ground

Table 3-4. **DE-15 LASER CONNECTOR**

PIN NUMBER	DESCRIPTION
4	RS-232 Transmit
5	RS-232 Receive
6	Ground

3.4.1.2 RS-232 Communication Settings

Table 3-5 lists the settings for the RS-232 connector.

Table 3-5. RS-232 Communication Settings

SETTING	VALUE
Baud	19200
Parity	None
Data Bits	8
Stop Bits	1
Flow Control	None

3.4.2 USB Connection

Each CUBE laser system includes Coherent CUBE Connection software for USB laser control in a graphical user interface (GUI) environment.

IMPORTANT!
A direct USB connection between the laser and a host computer is compatible ONLY with older 32-bit operating systems.
A USB connection IS NOT valid for interfacing with Windows 7 (64-bit) or Windows 10 operating systems.

This can be resolved using the optional High-Speed USB-to-Serial RS-232 Adapter (P/N 1415602), described next. Using this adapter, all RS-232 commands and queries are available via a USB connection to the host computer.

3.4.3 Factory Defaults

Table 3-6 lists the factory default settings.

Table 3-6. Factory Default Settings

SETTING	DESCRIPTION
>=1	Command prompt on
CDRH=1	5-second emission delay active
DST=22	Diode set temperature is 22ºC
E=1	Echo on
P= <Nominal Laser Power>	Output power set to nominal
CW=1	CW laser emission
ANA=0	External analog connector power control
EXT=0	External power control off

3.4.4 Connect the Laser for Remote Control

Before you make a connection for remote control, set up the CUBE laser system as follows This assumes you have already downloaded and installed software.

1. Mount the CUBE laser on either the optional CUBE Heat Sink, the Right-Angle Heat Sink Mount, or a mounting surface capable of providing adequate thermal dissipation.
2. Connect the Interface cable to the laser head.
3. Connect the Control Box to the interface cable. Ensure the keyswitch is in the OFF position.
4. Connect the power supply.
5. Select the appropriate cable for remote control:
   - If using an older host computer with 32-bit operating system, connect a USB cable.
   - For 64-bit systems, connect an RS-232 cable to the computer shown in Figure-3-13.

Figure 3-13. Optional USB-to-Serial RS-232 Adapter

6. Install the Coherent CUBE Connection software.
7. Turn power ON.
8. Open the Coherent CUBE Connection program. The Home Screen launches.
9. Turn the keyswitch on the control box to the ON position. Laser emission starts in approximately 5 seconds.

The laser starts in Continuous Wave (CW) mode at full power.

For Digital modulation, after remote communication is established, use the “CW=0” command to set Pulse operation mode. When Pulse mode is active, the laser modulation is controlled by the TTL input through the SMB connector.

For more information about using commands to control the amplitude of the pulse output, see “Computer Control” (p. 95).

4 OPERATIONS

The CUBE Laser System operates in a variety of laser emission modes.

- Continuous Wave (Manual mode | CW operations)
- Pulsed operation (Analog modulation)
- Digital control (Digital modulation)
- Mixed modulation (also referred to as Pulsed Mode with Digital Control using both Digital and Analog modulation)

Table 4-1 lists performance characteristics of the various modulation methods.

Table 4-1. Control Input Performance Characteristics

SYSTEM SPECIFICATIONS	VALUE
Digital Modulation Maximum Bandwidth Rise and Fall Time (10 to 90%) Modulation Depth at 0 Hz Modulation Depth at 150 MHz Input Impedance	 150 MHz [a] < 2 nsec [b] > 1,000,000:1 (10^6:1) > 250:1 50 ohms
Analog Modulation Maximum Bandwidth Rise and Fall Time (10 to 90%) Modulation Depth Input Impedance	 350 KHz [c] < 1 µsec > 10,000:1 2000 ohms
Laser Enable Control Input Maximum Bandwidth Rise and Fall Time (10 to 90%) Modulation Depth Input Impedance	 130 KHz <1 µsec Infinity, Complete On/Off 7000 ohms
Interlock Control Input Maximum Bandwidth Rise and Fall Time (10 to 90%) Modulation Depth Input Impedance	 7 Hz < 1 µsec Infinity, Complete On/Off 7000 ohms

a. For CUBE 445-40C and CUBE 488-50C: The Maximum Bandwidth for Digital Modulation is 125 MHz.
b. Only on CUBE 445: Fall Time < 3 nsec with 125 MHz maximum bandwidth. Actual performance values are listed in the data sheet for a specific CUBE laser wavelength and power.
c. For CUBE 375: The Maximum Bandwidth for Analog Modulation is 705 kHz.

IMPORTANT!
Refer to the CUBE Laser data sheet for specifications about each CUBE laser, including maximum bandwidth, rise and fall times, and other details to consider for your installation.

The CUBE Laser System controls the output power with an external DC voltage source. The modulated output must be controlled with external analog or digital signals. Modulation signals are connected to the back of the CUBE laser through the SMB connector.

NOTICE!
The CUBE laser system is delivered in CW Power mode. Operating in other modes requires USB or RS-232 remote control from a computer running either Coherent CUBE Connection software or a terminal program. See "Computer Control" (p. 95) for more information.

The CUBE laser system includes complete remote communication and control via RS-232 or USB connection. See "Computer Control" (p. 95) for more information.

4.1 Before You Begin

Normal operation assumes that the following initial configuration steps have been taken, do the system is set up and ready to use:

1. The CUBE laser system has been mounted to a proper Heat Sink and torque specifications. Refer to "Set Up and Installation" (p. 53) for Heat Sink and torque requirements.
2. The interface cable has been connected to the laser, power supply, and Control Box.
3. The main power switch on the power supply is in the OFF ("0") position.
4. The keyswitch on the Control Box is in the OFF position.
5. The laser has been connected to the power supply.
6. The power supply has been connected to electrical power.

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. For more information, see "Laser Back Reflection" (p. 16).

4.2 Continuous Wave (CW) Operation

CUBE lasers have a closed light loop circuit, internal to the laser, that operates the laser in a Constant Power mode. This operating mode is called CW:Power.

NOTICE!
The CUBE laser system is shipped in CW Manual mode with a CDRH delay. Laser emission occurs approximately five seconds after the keyswitch is set to the ON position.

A normal DC type voltage input provides direct CW power control. A typical start-up sequence includes:

1. Toggle the power switch for the laser to the ON position. The Status LED on the laser flashes green at 2.5 Hz, which shows that the laser is in warm-up mode.
2. Wait until the Status LED on the laser turns blue. The laser completes its warm-up mode and goes into STANDBY mode.
3. Turn the Control Box keyswitch to the ON position to initiate laser emission. The Status LED on the laser turns white and remains white when the laser emission is ON.
4. After safe laser beam control is ensured, move the laser shutter to the OPEN position, as indicated on the laser top label. Take appropriate safety measures to avoid exposure to direct or reflected laser radiation.

The factory default system configuration—and the steps above—allow for computer control without additional configuration settings.

For information about remote control of the laser, including a list of computer controls and queries, see “Computer Control” (p. 95).

4.3 Analog Modulation (Pulsed) Control

The CUBE laser system provides the capability to control the output power with an external voltage source.

CUBE lasers offer Analog modulation that allow the laser output power to track an analog input voltage. Analog modulation can be used with a DC voltage source to change the output power. Also sine wave, triangle wave or any arbitrary waveform can be used to control the laser power by tracking the input voltage.

The Control Box BNC connector controls laser power with an analog input proportional to the laser output. Figure-4-1 shows the BNC connector for analog modulation on the Control Box:

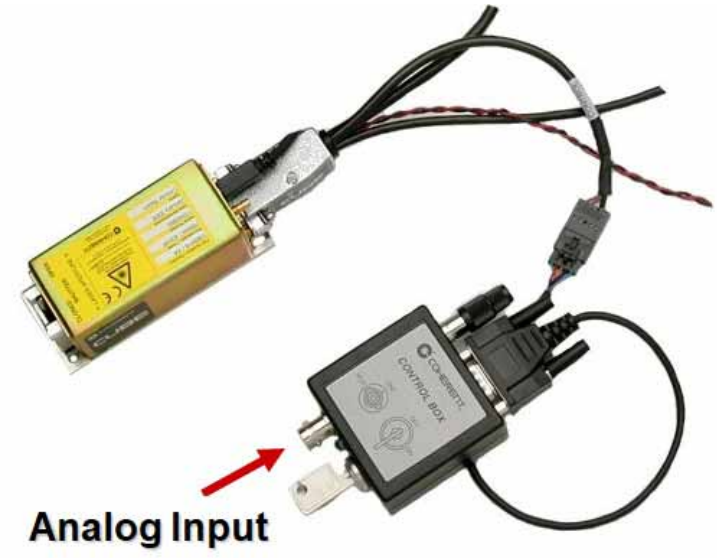


Figure 4-1. Connection for Analog Modulation

For actual wavelength and power performance values, refer to the CUBE laser data sheet for specifications. For example, the laser can be modulated at 150 MHz with a continuously changing amplitude up to 350 KHz. For actual wavelength and power performance values, refer to the data sheet for your specific laser.

Figure-4-2 shows typical waveforms under Pulsed Operation (Analog modulation). In this example, the analog signal is a 0 to 5V, 50 kHz, square wave.

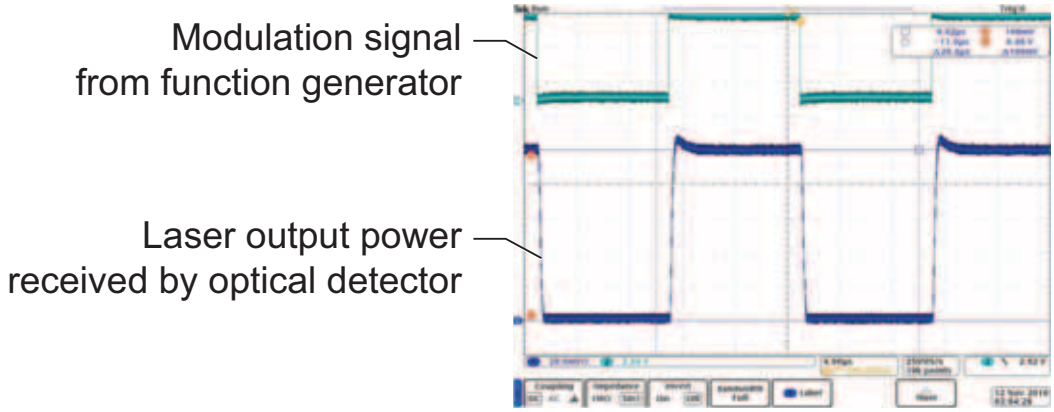


Figure 4-2. Waveforms for Pulsed Operation (Analog Modulation)

NOTICE:
You must send the EXT=1 command through RS-232 or USB for the Analog Power control to be active.

Table 4-2 lists the input connections for Analog Modulation (BNC input on the Control Box).

Table 4-2. Analog Modulation Input Connections

ANALOG MODULATION		
BNC CONNECTOR	**RANGE**	**DESCRIPTION**
+VDC	0 to 5V	Analog Input (+) Maximum Bandwidth
GND	N/A	Analog Input (–) Ground for Analog Input

The Analog Control can change the output power at a maximum bandwidth. See the data sheet for your specific laser for details about maximum bandwidth and other specifications. The external analog input provides the capability to vary the output power from minimum to 100%.

The Analog modulation input voltage is controlled from 0 to 5 volts. At 0 volts, the laser is at minimum output power. With 5 volts input, the laser is at 110% of its rated output power, as shown in the graph in Figure-4-3.

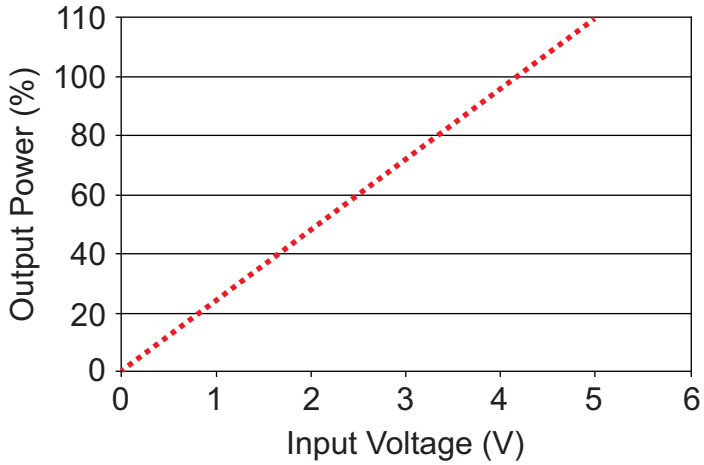


Figure 4-3. Analog Modulation: Power vs. Input Voltage

NOTICE:
For Analog Power Control to be active, you must send the EXT=1 command using host communications through Coherent CUBE Connection or a host computer terminal program while connected through the RS-232 connection using a RS-232 to USB adapter (sold separately).

The CUBE laser system provides a complete set of input and output controls through the DE-15 connector. For a complete list of connector functions, refer to Table 2-3, “Interface Cable Pin-Outs,” on page 35.

4.3.0.1 Constant Power (Light Regulation) Mode

The Constant Power mode uses a sample of the laser output power to control the laser diode current and establish a light output power level by this feedback. The computer sets the maximum laser output power by varying the reference voltage to the light feedback error amplifier. Analog modulation operates the same way by varying the reference voltage from the maximum set by the computer. See Figure-4-4.

To access the analog modulation input, connect to the BNC on the front of the Control Box.

The Constant Power mode has the advantage of compensating for aging in the diode by sampling the light output level directly and always driving the necessary current through the laser diode to maintain the power level. Another advantage is that light output verses modulation input voltage is forced to be linear and directly proportional.

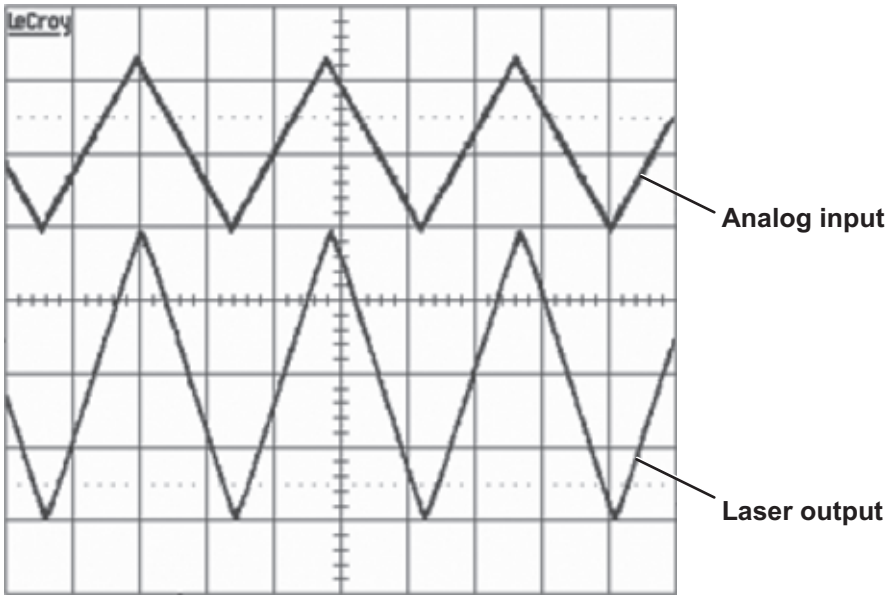


Figure 4-4. Example: CUBE Analog Modulation in Constant Power (CW) Mode

4.3.0.2 Analog Modulation (Constant Current) Mode

The Analog Modulation mode sets the laser diode drive to a constant current value. The amount of current drive is adjusted to a level necessary to produce the set output power level.

The digital modulation input is used to turn the output power on and off, with ON being a TTL high input. The computer sets the output power level to the proper value at the time the mode is entered, or by the user issuing a "CAL" command.

In this mode, the analog modulation operates to decrease the operating current proportional the input voltage. The effect of this input voltage on the power output is dependent upon the laser diode slope of current verses power. See Figure-4-5.

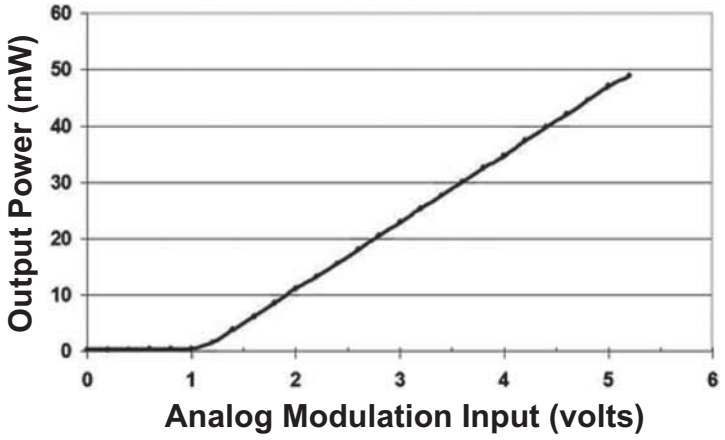


Figure 4-5. Example: CUBE Analog Modulation in Pulse Mode

The level at which the light output reaches a minimum is also dependent upon the diode and will vary from diode to diode. To assure that a given maximum output power is available, a "CAL=" command should be issued on a regular schedule to compensate for laser diode aging.

4.4 Digital Modulation

For applications requiring a laser to turn ON and OFF in Digital mode, CUBE lasers offer Digital modulation. CUBE lasers can be modulated in the Digital mode from minimum power to the Set Power.

Table 4-3 lists the Digital Modulation input connections:

Table 4-3. Digital Modulation Input Connections

DIGITAL MODULATION		
PIN NUMBER	**RANGE**	**DESCRIPTION**
Center	< 0.8 V	TTL Low Signal = Laser Threshold Power
	> 2.6 V	TTL High Signal = Nominal or Stored Laser Power
Outside		SMB Connector Ground

For Digital Modulation, connect the external pulse source to the SMB connector on the back panel of the CUBE laser, as shown in Figure-4-6. The laser SMB connector has an input impedance of 50 ohm.

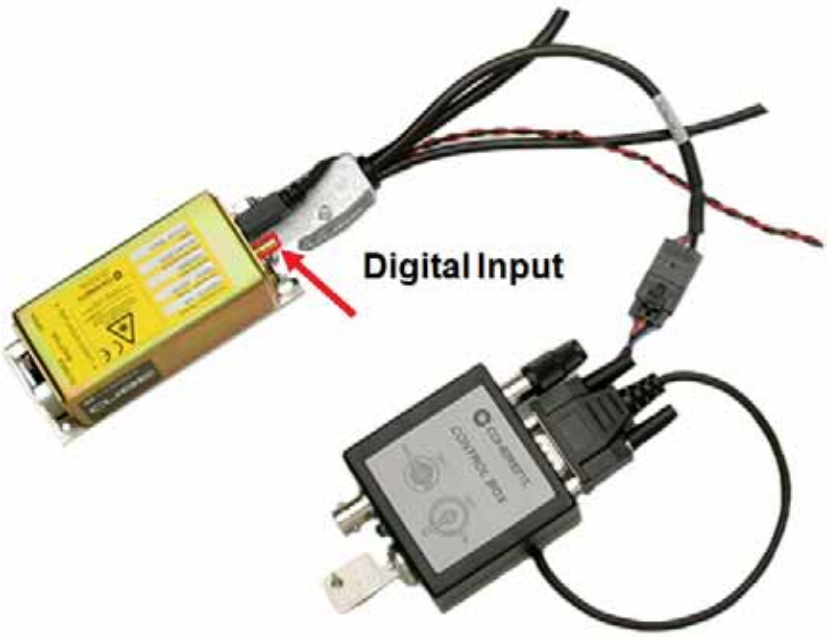


Figure 4-6. Connection for Digital Modulation

When operating in Digital Modulation mode at the Digital SMB input, the voltage input signal needs a minimum 30 mA drive current capability into 50 ohms. Computer I/O DAQ products frequently do not provide an output drive/source current level that can drive a 50 ohm load.

In such instances, use an additional line driver intended for use with I/O hardware with TTL/CMOS outputs to provide the 50 ohm Digital Modulation drive current requirement.

Typical Waveforms and rise/fall time under Digital modulation are shown in Figure-4-7.

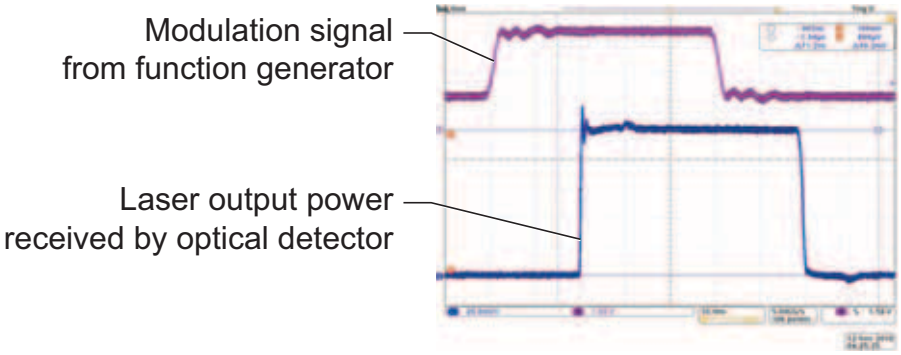


Figure 4-7. Digital Modulation Timing Diagrams

In the example shown, the digital signal is 1.1 to 3.3 Volts, 10 MHz, square wave

The TTL levels must be maintained for a minimum of 2.5 ns. The logic of the laser head electronics is "active high," which means that the TTL high level is equal to laser ON.

In such instances, use an additional line driver intended for use with I/O hardware with TTL/CMOS outputs to provide the 50 ohm Digital Modulation drive current requirement.

1. Connect the laser as shown in "Set Up and Installation" (p. 53).
2. Connect a signal generator cable (impedance Z = 50 Ω) between the laser head and the DC voltage source (maximum frequency depends on specifications for each model of the CUBE laser).

   The Digital modulation voltage signal has to be TTL-level (V Low < 0.8 V and V High > 2.6 V) with an impedance of 50 Ω.

   Use the "CAL" command to control the amplitude of the pulse output. Enter a power <value> in mW, using the following command for example: "CAL=<value>".

NOTICE!
Based on differences between optical Rise Time and Fall Time—combined with the associated delay difference between the digital input and optical output—150 MHz modulation is not achievable with a 50-50 duty cycle. Refer to the CUBE laser data sheet for specifications.

3. Adjust the duty cycle as needed to achieve maximum optical pulse amplitude at the desired modulation frequency.

4.5 Mixed Modulation Mode

The CUBE laser system has two operating modes: CW (constant power) and Pulse (constant current). The Pulse mode offers advantages of both digital and analog inputs. In many applications, these laser features can help replace external modulation controls to save cost and space. The CUBE Laser System can be modulated by both analog and digital signals at the same time.

The Laser can be operated with Mixed Modulation to vary the laser output power with a analog signal and a digital signal to turn the laser ON and OFF. The advantage of Mixed Modulation mode is to control the laser power separately from switching the laser from ON to OFF.

An example of mixed modulation is shown in Figure-4-8. In this example, the analog signal is a 0 to 5 VDC, 1 kHz triangle wave and the digital signal is a 1.1. to 3.3 Volts, 30 kHz, square wave.

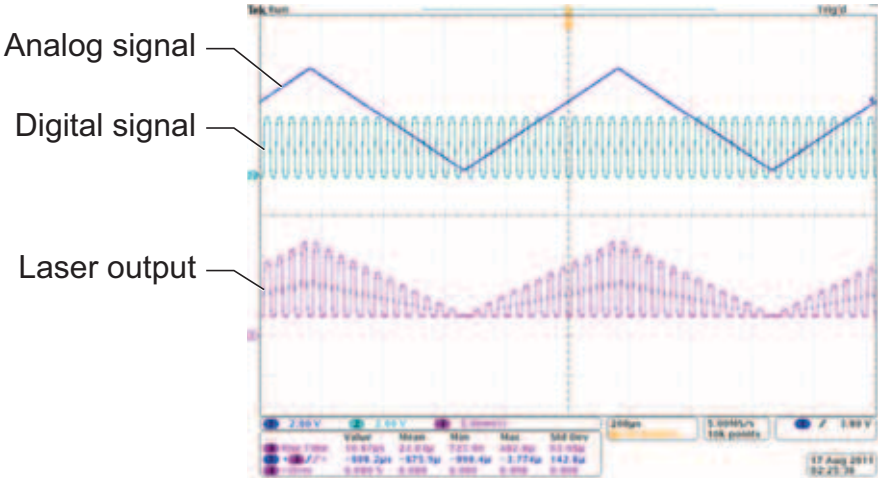


Figure 4-8. Waveforms for Mixed Modulation

When setting up the system to use Pulsed operations in Mixed modulation mode, connect the external pulse source to the SMB input connector for Digital On/Off operation as shown in Figure-4-9. This laser SMB connector provides digital TTL input laser control.

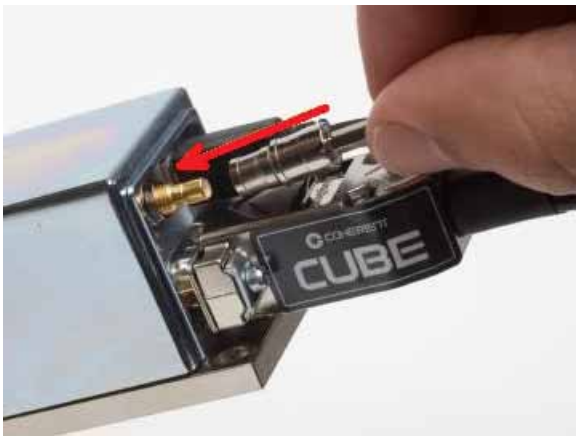


Figure 4-9. Digital Modulation (Pulsel) Connection

NOTICE!
The SMB input connector is a 50 Ω input impedance. The digital input requires a TTL high for laser on and TTL low for laser off, with a drive/source current level > 30 mA.

NOTICE:
The Control Box BNC connector has an input impedance of 2.2 K ohm.

The Control Box BNC connector can be used to control the amplitude of the digital modulation output. For example, the analog input can be combined with the digital input to control the amplitude of the high frequency modulation signal at the 350 KHz rate. See the data sheet for specifications about each CUBE laser.

4.5.0.1 Replacing External Modulation System with the CUBE

The equivalent of a Laser operating through an AOM can be achieved by using the CUBE Laser in Pulse mode.

The ON-OFF control line connects to the Digital modulation input (SMB connector, 50 ohm input) and the output level control line connects to the Analog modulation input (CUBE DE-15 connector). This arrangement allows the output power level to be controlled by the Analog input voltage and be turned ON-OFF by the Digital modulation input voltage (TTL High is ON).

The "CAL=" command sets the maximum output power when the Analog modulation is at + 5 VDC and the Digital modulation is set to TTL high. The rise and fall times for the Digital modulation input are less than 2 ns with a maximum bandwidth of greater than 150 MHz. Refer to the CUBE Laser data sheet for specifications for your laser.

5 COHERENT CUBE CONNECTION SOFTWARE

The Coherent CUBE Connection software provides simple graphical access to the Coherent CUBE system.

This software is shipped on a CD with the CUBE laser system. However, because many of today's host computers and laptops are no longer equipped with a CD drive as standard equipment, you can also download the current software from the Coherent website:

https://www.coherent.com/lasers/laser/cube-lasers

This software displays variable settings, and allows to you set binary functions with the click of a mouse.

The CUBE Connection software generally operates intuitively. The limits of adjustable parameters and operation of binary functions are described in the section, "Computer Control" (p. 95).

Th CUBE Connection software offers a terminal window to enter standard RS-232 commands as text for program development purposes. CUBE RS-232 command protocol requires capital letters for each command or query.

5.0.1 Software Installation

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

To download the latest version of the Coherent CUBE Connection software:

1. Go to the Coherent website and search for "CUBE".

   https://www.coherent.com/lasers/laser/cube-lasers

2. On the product page, scroll to the bottom and select the icon for CUBE Connection:
3. Click the icon to either Open or Save the ZIP file.

Using this software, you can control laser power or other parameters directly through an RS-232 connection or, for 32-bit operating systems, a USB connection.

The Coherent CUBE Connection software CD contains the software and USB drivers necessary to operate the CUBE remotely via USB

To start the software installation process:

1. Place the Coherent CUBE Connection software CD into the computer CD drive. The software installation process automatically starts. The installation process automatically loads the necessary USB drivers.
2. The installation dialog box shown in Figure-5-1 welcomes the user and provides brief copyright information. Click "Next" to continue installation.

Figure 5-1. Software Installation — Welcome Screen

3. The installation dialog box shown in Figure-5-2 displays the Software License Agreement. Review the contents.

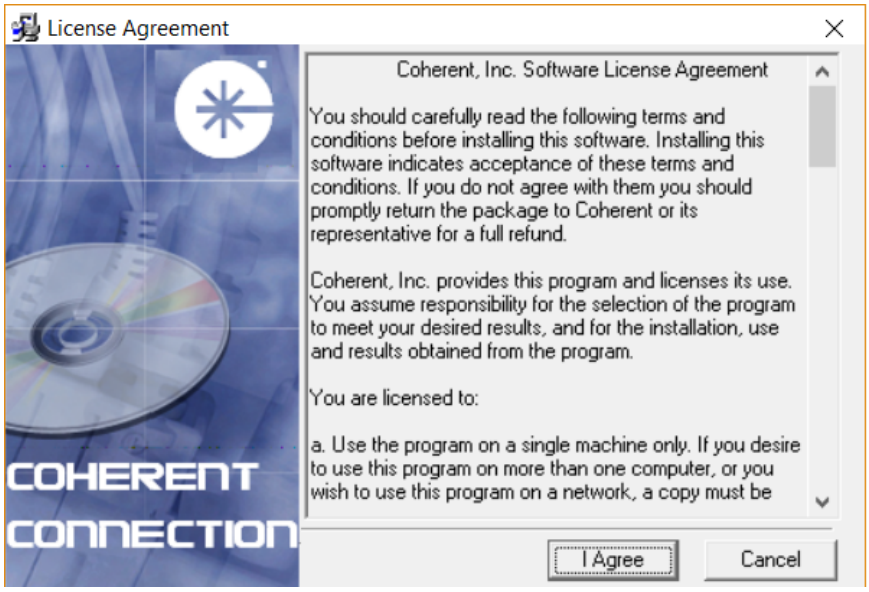


Figure 5-2. Software Installation — Software License

4. Scroll down to read all terms and conditions, then click “I Agree” as shown in Figure-5-3 to continue the installation.

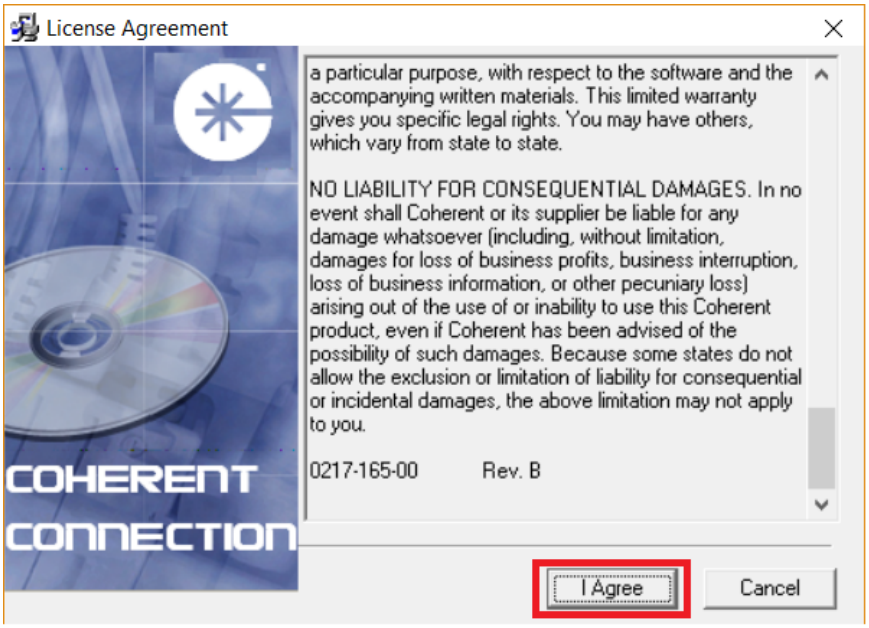


Figure 5-3. Software Installation — Software License Agreement

5. The installation dialog box shown in Figure-5-4 displays the default location for the Coherent CUBE Connection software installation. Click “Next” to continue the installation or click “Browse” to select a different location in which to install the software.

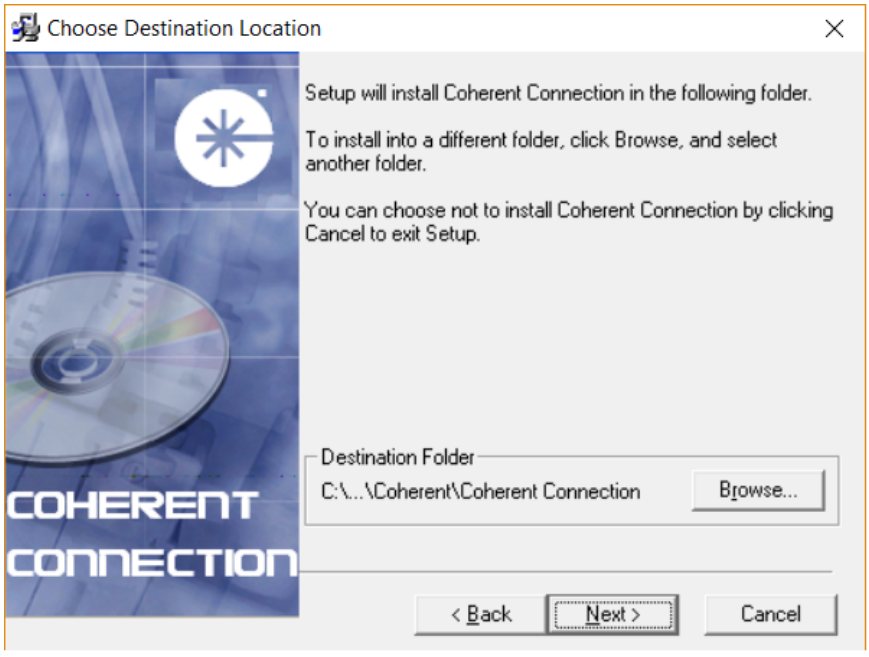


Figure 5-4. Software Installation — Directory for Installation

6. The installation dialog box shown in Figure-5-5 displays the program manager designation for the Coherent CUBE Connection software. The text is displayed when you click "Start" then "Programs" in Windows.

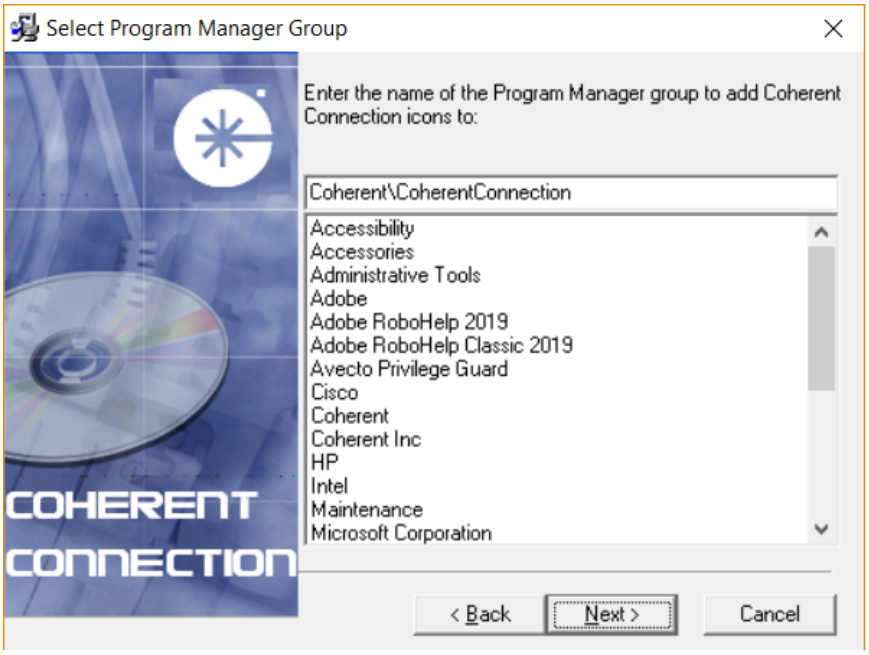


Figure 5-5. Software Installation — Select Icons to Display

One selection you may want to install for ease of use is the Coherent icon, listed in Figure-5-6.

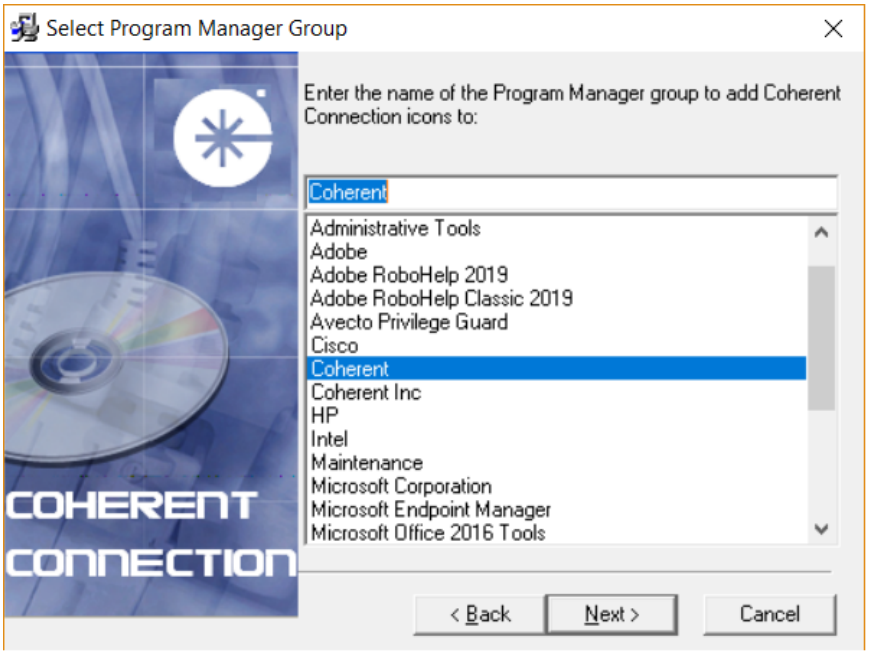


Figure 5-6. Software Installation — Example of Icon Selected

7. The installation dialog box shown in Figure-5-7 completes the settings associated with the software installation. Click the “Back” button to change any settings. Click the “Next” button to install the software in the selected location.

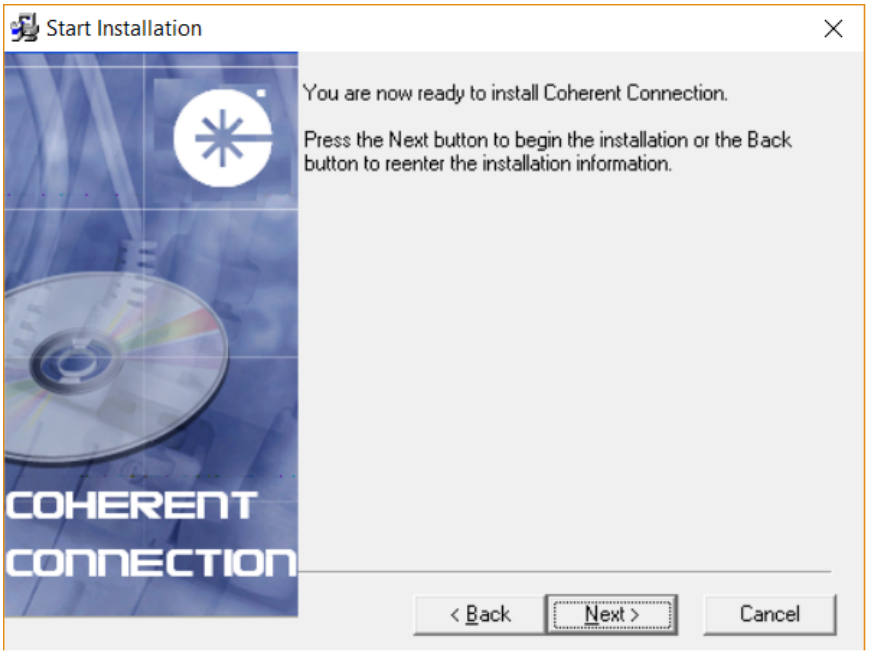


Figure 5-7. Software Installation — Settings Selected

8. The installation dialog box shown in Figure-5-8 displays the progress of the software installation.

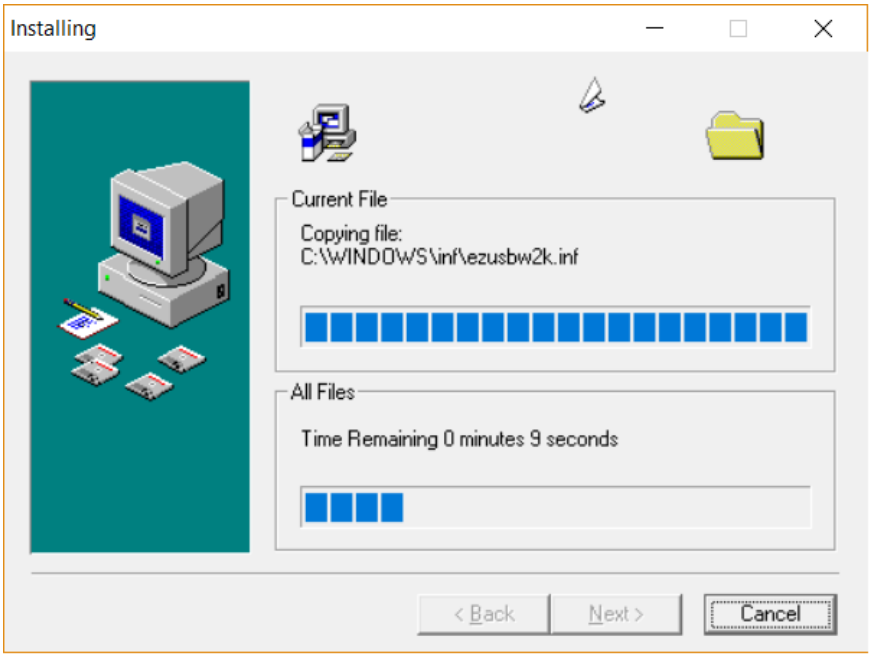


Figure 5-8. Software Installation — Progress Bar

9. The installation dialog box shown in Figure-5-9 confirms the successful installation of the Coherent CUBE Connection software.

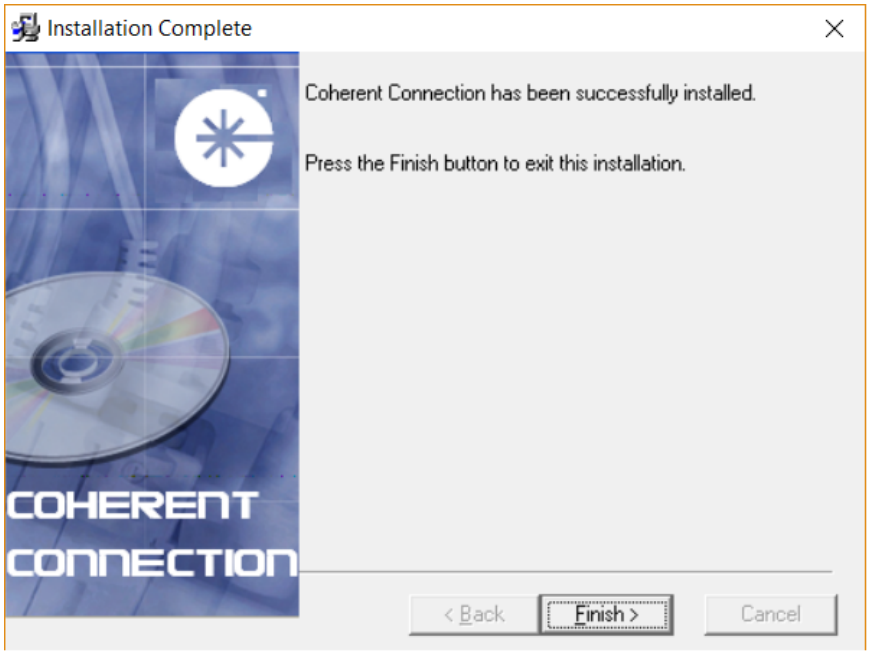


Figure 5-9. Software Installation — Software Installed Successfully

10. Click the "OK" button shown in Figure-5-10 to restart the computer and register the Coherent CUBE Connection files and USB drivers.

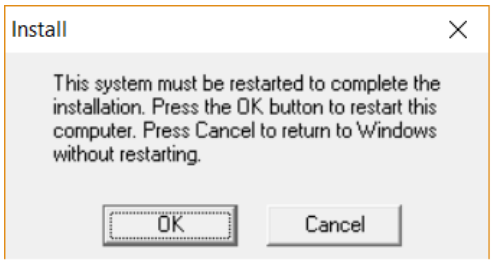


Figure 5-10. Software Installation — System Restart

11. When the computer restart is complete, a Coherent CUBE Connection shortcut icon is displayed on the computer desktop. Double-click on the icon to start the Coherent CUBE Connection program.

The Coherent CUBE Connection software installation is complete.

The next sections describe the tool bar and the user interface for the Coherent CUBE Connection software.

5.1 Coherent CUBE Connection Tool Bar

The Coherent CUBE Connection Tool Bar provides quick access to the screens and functions.

- Menu access to the Open, Save, and Print functions is located in the File menu.
- Menu access to Coherent CUBE Connection screens is located in the View menu.

5.1.1 Open Button

 The Open button displays a standard Windows Open dialog. The default file type is .cfg, representing a Configuration file. The Configuration file is used to store and recall all Coherent CUBE Connection settings.

5.1.2 Save Button

 The Save button displays a standard Windows Save dialog. Enter a desired file name and click “Save” to store all current Coherent CUBE Connection settings to a .cfg file. Use the “Open” button to restore these settings later.

5.1.3 Print Button

 The Print button provides the capability to print Configuration files or the active Coherent CUBE Connection window. Select the type of print function and then click “OK” to print on the selected printer.

5.1.4 Home Button

 The Home button switches to the Home screen. Review the Home screen for additional detail associated with screen functions.

5.1.5 Settings Button

 The Settings button switches to the Settings screen. Review the Settings screen for additional detail associated with screen functions.

5.1.6 Information Button

 The Information button switches to the Information screen. Review the Information screen for additional detail associated with screen functions.

5.1.7 Terminal Button

 The Terminal button switches to the Terminal screen. Review the Terminal screen for additional detail associated with screen functions.

5.1.8 System Status

The System Status displays at the bottom of all Coherent CUBE Connection screens. The status indicates normal operation or fault condition. If a fault condition is indicated, check the Fault Screen for the specific fault. If a fault has the capability to reduce laser diode life, laser emission is interrupted until the fault is resolved.

5.2 CUBE Connection User Interface

This section describes the interface for the Coherent CUBE Connection software.

5.2.1 Home Screen

The Home screen shown in Figure-5-11 displays common information associated with the laser operation. The Current gauge is displayed or hidden with a check box on the Setting screen. Specific faults are displayed on the Fault screen.

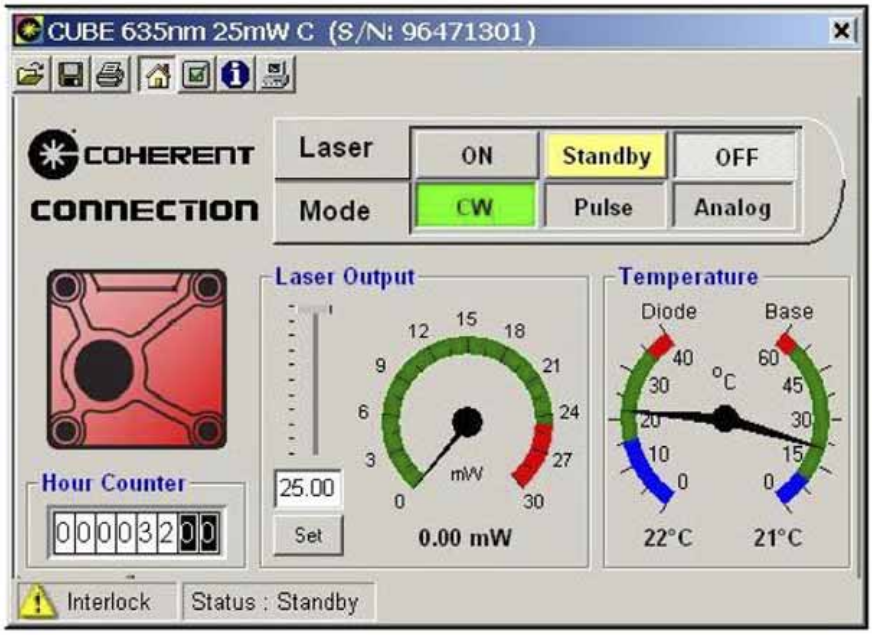


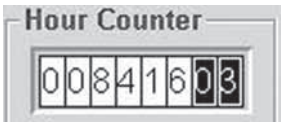
Figure 5-11. CUBE Home Screen

5.2.2 Wavelength Icon

The displayed icon color indicates the wavelength of the laser connected to the Coherent CUBE Connection software. The values listed do not indicate the exact laser wavelength. The specific diode wavelength is shown on the system serial number label.

5.2.3 Hour Counter

The Hour Counter screen displays the current hours of laser diode operation. The counter increments when laser emission is active.



When the laser is in Standby, the counter does not increment. If the laser diode is replaced, the hour counter represents the hours of the installed diode.

5.2.4 Laser Emission Status

The Laser Emission Status screen indicates the current state of laser output and system status. The central indicator also shows Standby, CDRH Delay, and System Faults. The ON and OFF buttons are used to toggle laser emission.

5.2.5 Laser Mode Status

The Laser Mode Status indicators display the current output status for the CUBE.

NOTICE!
If lower power CW is observed, ensure both the Pulse and Analog are displayed in a disabled condition.

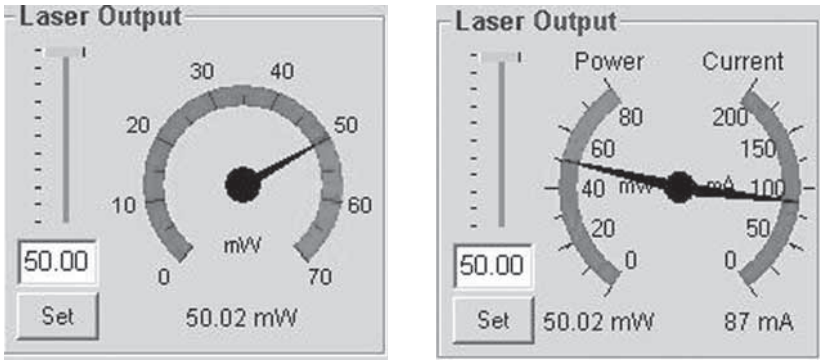
- When the Pulse is active, the laser output is controlled by an external digital signal to the back panel SMB connection.
- When the Analog is active, the laser output is controlled by an external voltage source input to the Control Box BNC connector.

NOTICE!
When the Pulse is active, the laser runs at threshold power. A laser running at threshold power can be interpreted as a CW laser problem.

Click the CW indicator to restore normal CW power levels. Laser modulation is controlled by a TTL digital signal through the SMB connector.

5.2.6 Laser Output Indicator

The laser output indicator is a relative display of laser output power. Coherent recommends using one of the external laser power meters—listed in "Power Meters and Sensors" (p. 115)—for precision measurement of laser output power.



Laser output power can be changed by using either of the following methods:

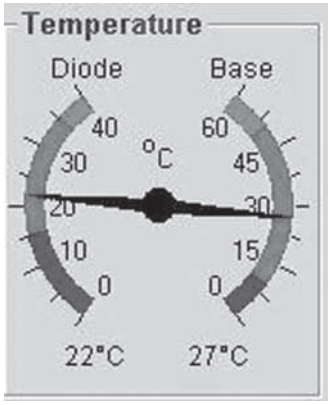
- Entering a value and then clicking the Set button.
- Dragging the slider and then clicking Set.

Add a relative laser current display by checking the Show combination Power/Current gauge on the Home Screen box on the Settings screen. The displayed current should be considered a relative value.

The Green to Red transition indicates maximum laser power.

5.2.7 Temperature Display

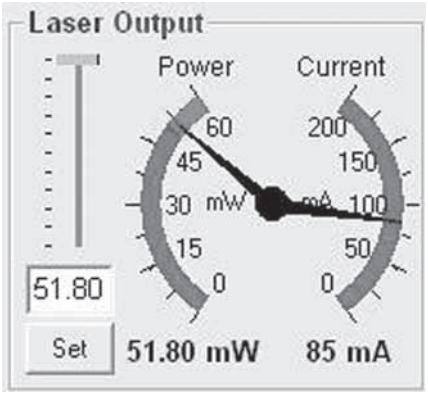
The temperature display shows a combination of the current diode and base plate temperature.



The diode temperature represents the measured diode temperature and not the set temperature. Use the Settings screen to change the diode temperature. The Red to Green transition represents maximum diode and base plate temperature.

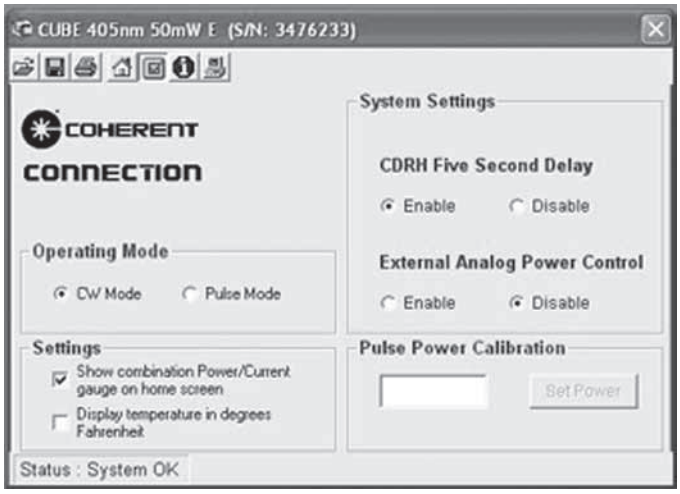
Double-click the Temperature gauge to display values in Fahrenheit. Double-click again to return values to Celsius.

Double-click the Power Gauge to display laser current. Double-click again to return the display to power only.



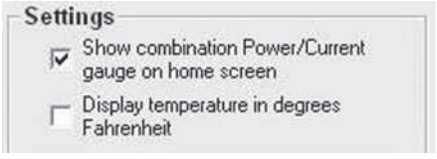
5.2.8 Settings Screen

The Settings screen is used to change various system and display parameters. All settings displayed on the Settings screen are stored when the application is closed. Laser-specific settings are stored in the laser when the laser is powered down.



5.2.9 Settings

The Settings section contains check boxes used to set Home screen display options and the laser status when exiting Sleep mode.



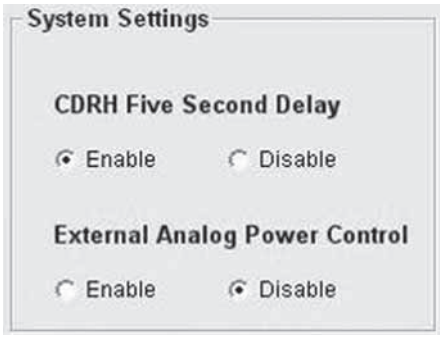
Use the first check box to show or omit the current display, in combination with the power display on the Home screen.

Use the second check box to set the units for the diode and base plate temperature display on the Home screen. If the box is not checked, degrees Celsius is displayed on the Home screen.

If the third check box is checked, the previous laser emission status is restored when the system exits Sleep mode. If the box is not checked, laser emission is automatically restored when the system exits Sleep mode.

5.2.10 System Settings

The System Settings section is used to control the CDRH delay and External Analog power control status for the connected CUBE laser.



CDRH Five-Second Delay

To maintain compliance with CDRH regulations, the system is shipped with the CDRH delay active. The CDRH Five-Second Delay radio buttons are used to toggle emission delay status.

- When the Enable button is selected, a five-second delay is applied each time laser emission is interrupted. These interruptions include an open interlock and fault conditions.
- When the Disable button is selected, laser emission are immediately restored.

External Analog Power Control

The External Analog Power Control radio button is used to set the state of power control.

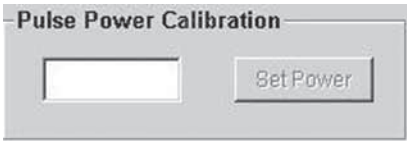
- When the External Analog Power Control is enabled, the laser output power is directly controlled by the Analog signal input through the Control Box BNC connector.
- When the External Analog Power Control is disabled, the laser output power is controlled by the Coherent CUBE Connection software.

5.2.11 Pulse Power Calibration

The Pulse Power Calibration function sets the amplitude of the digital laser pulses. This function is only available in Pulse mode.

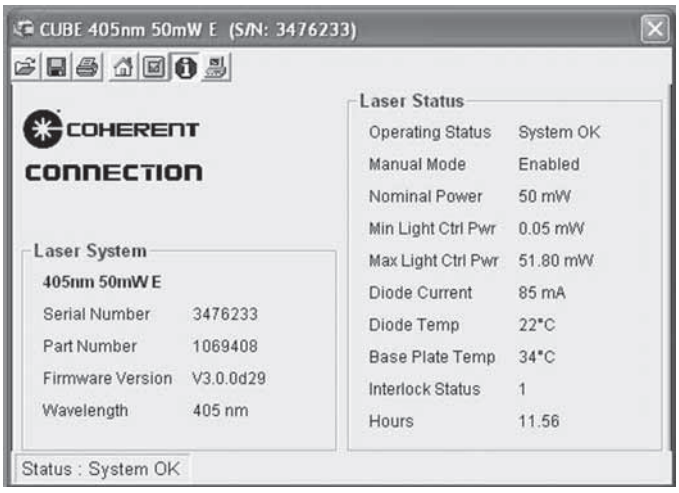
Secondary control of the pulse amplitude is available though a voltage input to the Control Box BNC, with the External Analog Power Control active.

To change the amplitude of the digital laser pulses, enter a laser power value and click Set Power.



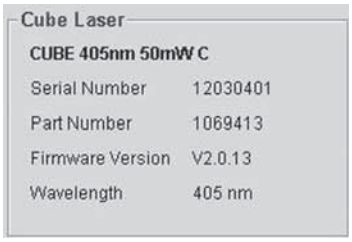
5.2.12 Information Screen

The Information screen displays system information and current performance parameters.



5.2.13 CUBE Laser Information

The CUBE Laser information section contains static information associated with the selected laser. The model name, serial number, part number, and nominal wavelength are read from the selected laser EEPROM. The displayed wavelength is a nominal value. The exact wavelength is shown on the system serial number label.



5.2.14 CUBE Laser Status

The CUBE Laser Status section lists of operating parameters. The information shown below represents a typical 405 nm system.

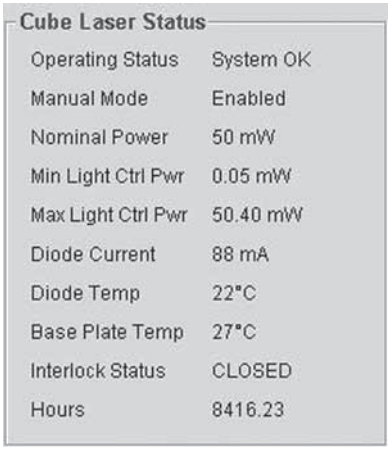


Table 5-1 lists the operating parameters.

Table 5-1. Operating Parameters

PARAMETER	DESCRIPTION
Operating Status	Operating Status displays the Standby, Fault, or Ready condition of the system.
Manual Mode	Manual mode represents the Start-up mode for the selected system. When Manual mode is active, laser emission is automatic, following diode temperature stabilization and CDRH delay condition. When Manual mode is disabled, the Laser On button on the Home screen must be clicked to initiate laser emission. Manual mode is controlled by the state of pin 3 on the DE-15 or pin 1 on the I/O connector. No connection to this pin defaults to Manual mode (Auto-start). When this pin is pulled low, laser emission must be initiated with computer control.
Nominal Power	Nominal Power represents the normal laser output power. Refer to **Max Light Ctrl Pwr**, below, for the maximum laser output power available.
Min Light Ctrl Pwr	Minimum Light Control Power represents the laser threshold output power. The value listed corresponds to the laser output power when the system is running in Pulse mode without a digital input to the SMB connector.

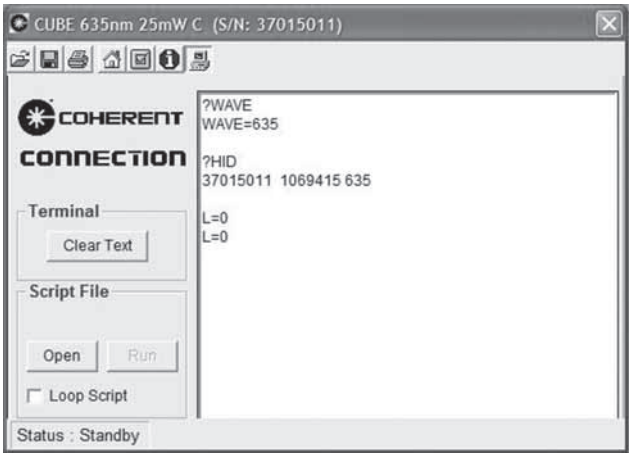
Table 5-1. Operating Parameters (continued)

PARAMETER	DESCRIPTION
Max Light Ctrl Pwr	Maximum Light Control Power represents the maximum power setting available.
Diode Current	Diode Current displays the relative laser diode current. This is an indirect measurement and is not considered absolute. Use this parameter as a tool to observe changes in diode current.
Diode Temp	Diode Temperature is the measured diode temperature. This value is updated continuously.
Base Plate Temp	Base Plate Temperature is updated continuously. If the base plate temperature exceeds 50ºC, the software protects the diode by interrupting laser emission. When the temperature returns below 50ºC, laser emission is automatically restored.
Interlock Status	Interlock Status is updated continuously. When the Control Box key is in the On position, the status displays as closed. If the key is switched to the Off position, the status displays as open.
Hours	The Hours Counter displays the current hours of laser diode operation. The counter increments when laser emission is active. When the laser is in Standby, the counter does not increment. If the laser diode is replaced, the hour counter represents the hours of the installed diode.

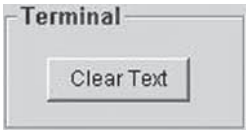
5.2.15 Terminal Screen

The Terminal screen is used to send individual commands or scripts to the CUBE through an RS-232 connection to an RS-232 to USB Adapter (accessory sold separately).

Review the RS-232 commands and queries for a complete list of items available through the Terminal screen.

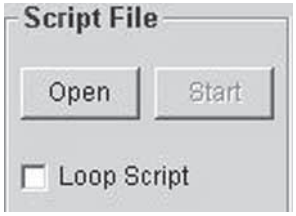


The Clear Text button clears all information displayed in the Terminal window.



5.2.16 Script File

The Open button displays a standard Windows Open dialog. To load a Script file into the Terminal window, select the desired file and click Open. Then click the Start button to execute the displayed script. Checking the Loop Script box will continually run the display script.



6 ADVANCED PROCEDURES

This section describes the following advanced features of the CUBE laser system:

- Change the state of the CDRH-required delay
- Set non-lasing conditions for intermittent use of the CUBE laser system

6.1 CDRH Feature

The Coherent CUBE is shipped as a CDRH-compliant laser system. The CDRH-required delay of approximately five seconds occurs between a laser ready condition and emission of laser light. This delay allows the user to take appropriate safety precautions prior to laser emission.

After the system is running, the CDRH-required delay is not applied each time the laser emission is remotely toggled on and off.

The CDRH setting is stored in memory.

6.1.1 Disable CDRH Procedure

The ability to change the state of the CDRH-required delay requires remote communication to the Coherent CUBE laser system via RS-232.

WARNING!
This operation defeats the safety controls required by the appropriate regulatory agencies. With the use of these commands, the customer assumes all responsibility for safety and proper compliance to CDRH 21 CFR 1040 and IEC60825-1.

See “Computer Control” (p. 95) for commands to establish remote communication with the CUBE laser system.

- To defeat the CDRH-required delay, use the “CDRH=0” command.

  The current CDRH-required delay state can be interrogated by the computer with the “?CDRH” query.

- To restore the CDRH-required delay, use the “CDRH=1” command.

6.2 System Standby and Sleep Mode

For users requiring intermittent use of the CUBE laser system, two levels of non-lasing conditions are offered:

- The "Standby" condition represents the Thermoelectric Cooler (TEC), maintaining constant diode temperature with the laser diode off.
- A "Sleep Mode" condition includes a laser-OFF condition with no TEC temperature control.

Laser output can be immediately initiated in a "Standby" condition. When the system is in Sleep mode, it requires a warm-up cycle (not to exceed five minutes) prior to laser emission.

- Standby Condition: `L=0 T=1`
- Sleep Mode: `L=0 T=0`

See "Computer Control" (p. 95)" for additional computer control information about the "L" and "T" conditions.

7 COMPUTER CONTROL

Almost any operation that can be performed or controlled using the keyboard with the CUBE Connection software can be done using remote control commands.

The CUBE laser system includes complete remote control capability through an RS-232 serial interface (when using a 64-bit operating system) or a USB connection (when using an older 32-bit operating system).

Using the Remote feature generally requires both hardware and software (a terminal program that supports the RS-232 protocol). For set-up instructions, see “Connect the Laser for Remote Control” (p. 64) for details about setting up the physical connection.

7.1 Manual Control

The CUBE is shipped in Manual mode. All of the RS-232 commands and queries are still available in Manual mode. Defeating Manual mode allows exclusive computer control, locking out the control cable and I/O cable controls.

NOTICE:
To defeat the Manual mode, insert a jumper between pins 1 and 2 on the interface cable I/O connector.

All remote computer settings are stored each time the system is powered down. Use the “?S” query to display a complete list of current settings.

7.2 Continuous Wave (CW) Commands and Queries

The CUBE command prompt provides feedback associated with the current system status and the command or query entered.

Refer to the “?F” query in Table 7-1, “RS-232 CW Commands and Queries,” on page 96 for a complete list of values returned with the command prompt.

Syntax:

`Command=<value>`

A CUBE command is used to change a present setting. The syntax used for CUBE commands is the command followed by an equal sign and a value. No spaces are used between the command, equal sign, and the value.

`?Query`

A CUBE query is defined by a question mark (“?”) prior to the query. The current state of CUBE commands can be displayed with a “?” prior to the command. Use the “?S” query to display a complete list of current settings.

Use the "?S" query to display a list of current settings.

?F - The ?F query

Returns the fault status as a decimal value representing the sum of all current faults. If there is no fault in the system, it returns a value of zero.

?FF - The ?FF query

Returns the fault status in a 16-bit binary format representing the sum of all faults. The table below shows the decimal equivalent. If there is no fault in the system, it returns a value of 0000 0000 0000 0000 or [0].

?FL - The ?FL query

Returns the fault status as text and lists all the current faults. If there is no fault in the system, it returns the text message "System OK."

?H query

Displays a list of the commands and the associated descriptions.

Table 7-1 lists commands and queries for RS-232. See Table 7-4, "Fault Codes," on page 104 for fault codes.

Table 7-1. RS-232 CW Commands and Queries

COMMAND	FUNCTION	RANGE	DESCRIPTION
>	***Prompt ON-OFF	0, 1	Turns the command prompt on or off. This setting is stored into memory so that it remains the same even after a power on/off cycle.
CDRH	***5 Sec. Delay ON-OFF	0, 1	Toggles the CDRH five-second emission delay on and off.
?BT	*Base Plate Temp	0 to 55	Returns (in degrees Celsius) the present base plate temperature. The hardware resolution for this measurement is 0.06ºC.
?C	*Laser Diode Current	0 to 255	Returns (in milliamps) the present operating current of the laser diode. The hardware resolution for this measurement is 0.1 mA.
CLS	**Clear Screen	N/A	Clears text from a serial communication screen.
?DST	Diode Set Temp.	15 to 35	Returns (in degrees Celsius) the present set temperature of the laser diode. The hardware resolution for this measurement is 0.029ºC.
?DT	*Diode Present Temp.	15 to 35	Returns (in degrees Celsius) the present measured temperature of the laser diode.
E	**Echo ON-OFF	N/A	Sets or reads the Echo Off feature. This feature turns character echo on or off on a serial communication terminal and is useful if a computer script/program—rather than a person—is controlling the laser.
?F	*Fault Number		Returns the present system status as a decimal value corresponding to the binary system status. Review the ?F table for a complete list of error conditions.
?FF	*Fault Binary Code		Checks for faults in the system and returns a two-byte result. No system fault returns 0000 0000 0000 0000—see Table 7-4, "Fault Codes," on page 104.

Table 7-1. RS-232 CW Commands and Queries (continued)

COMMAND	FUNCTION	RANGE	DESCRIPTION
?FL	*Fault List		Checks for faults in the system and returns an ASCII result. No system fault returns “System OK”—see Table 7-4, “Fault Codes,” on page 104.
?HH	*Usage Hours Head	0 to 100000	Returns the present head hours with a resolution of one second. The head hours are tracked in one-minute intervals when the system is powered down and restored.
?HID	*Head ID Value	N/A	Returns (as a comma-delimited string) the head serial number, head type, and nominal wavelength.
L	***Laser ON-OFF	0, 1	Sets the laser status. Setting L=1 enables the laser On. TEC servo MUST be ON (T=1) to set L=1. Setting L=0 turns off the laser output.
?LT	Laser Type	N/A	When OP=2 operating mode is active, this query returns Sapphire laser types. Review the Sapphire manual for additional information.
OP	***Operating Protocol	1,2,3	Determines the response format for commands and queries. OP=1 returns data in the format described in the CUBE manual. OP=2 returns data to match responses from Coherent Sapphire lasers. OP=3 returns data to match responses from Coherent Compass 405 lasers. Review Coherent Sapphire and Compass 405 manuals for detailed response information.
P	***Laser power	0, MAXLP	Sets (in mW) the laser power. The range of P values is based on the minimum laser threshold power (?MINLP) and the maximum laser power (?MAXLP).
?PSH	Power Hours	0/100000	Returns the present Laser Hours.
?PST	Computer Temperature	N/A	Returns the present computer temperature in OP=2 operating mode.
?SP	*Set Power Out	0,MAXLP	Returns (in mW) the present laser power setting. This value represents the last value entered with the P command.
?SS	TEC	0,1	Returns TE status 1=ON, 0=OFF.
?SV ?SVH	*Software Version	N/A	Reads the CUBE firmware version.
?STA	*Operating Status #	N/A	Returns an integer value representing the present CUBE system operating status. 1: Warm Up 2: Standby 3: Laser ON 4: Error 5: System Halted (Fatal Error)
?M	*Manual Mode	0,1	Returns the status of the Manual mode control DE-15 pin 3. The Manual mode pin normally floats high with no connection. When this pin is tied to ground, all laser operations require computer control.
?MINLP	*Min. Light Cont. Pwr.	N/A	Returns (in mW) the minimum power available in CW light control mode.
?MAXLP	*Max. Light Cont. Pwr.	N/A	Returns (in mW) the maximum laser power available in CW light control mode.

Table 7-1. RS-232 CW Commands and Queries (continued)

COMMAND	FUNCTION	RANGE	DESCRIPTION
?NOMP	*Nominal Laser Pwr.	N/A	Returns (in mW) the nominal CW laser output power.
?WAVE	*Laser Wavelength	N/A	Returns the laser operating wavelength, based on a diode temperature of 25 degrees Celsius.
?INT, ?LCK ?K	*Interlock Status	0,1	The ?INT or ?LCK query returns the status of the interlock DE-15 pin 1 status. A value of 1 corresponds to a closed status and a value of 0 corresponds to an open status.
?PVPS	*Protocol Version	N/A	Reads the software protocol version. If the CUBE firmware is embedded into a process, this query can be used to check for changes in command structure. If the firmware version changes without changes to the command structure, the this query returns the same value for separate firmware versions.
T	***Turns TE ON	0,1	Reads or sets the TEC status. Setting T=1 enables the temperature control of the laser diode. Setting T=0 disables the temperature control.
CW	***CW or Pulse Mode	0,1	Switches the operating mode from CW (CW=1) to Pulse (CW=0). If Pulse mode is set, the laser runs at the threshold power if no voltage is present at the digital pulse input connector.
ANA	***Analog Control Mode	0,1	Switches the Laser Diode parameter controlled by the external analog signal from current (ANA=1) to power (ANA= 0). In CW mode, the CUBE is always in light-regulation, so the ANA value will remain zero (0).
EXT	***Ext. Analog Laser Pwr. Control	0,1	Commands either the power or current to be set by the external analog modulation input. Querying this command returns the command status: EXT=1 for external or EXT=0 for internal. The external connector is located at laser pin 8 on the DE-15 connector.

7.3 Pulsed Commands and Queries

The CUBE command prompt provides feedback associated with the current system status and the command or query entered.

Syntax:

`Command=<value>`

A CUBE command is used to change a present setting. The syntax used for CUBE commands is the command followed by an equal sign and a value. No spaces are used between the command, equal sign, and the value. For example, use the "CAL" command to control the amplitude of the pulse output. Enter a power <value> in mW, using the following syntax: "CAL=<value>".

?Query

A CUBE query is defined by a ? prior to the query. The current state of CUBE commands can be displayed with a ? prior to the command. Use the "?S" query to display a complete list of current settings.

Refer to the "?F" query for a complete list of values returned with the command prompt.

?F - The ?F query

Returns the fault status as a decimal value representing the sum of all current faults. If there is no fault in the system, it returns a value of zero.

?FF - The ?FF query

Returns the fault status in a 16-bit binary format representing the sum of all faults. Table 7-4, "Fault Codes," on page 104 shows the decimal equivalent. If there is no fault in the system, it returns a value of 0000 0000 0000 0000 or [0].

?FL - The ?FL query

Returns the fault status as text and lists all the current faults. If there is no fault in the system, it returns the text message "System OK."

Table 7-2 lists the Pulsed RS-232 commands and queries.

Table 7-2. Pulsed RS-232 Commands and Queries

COMMAND	FUNCTION	RANGE	DESCRIPTION
>	***Prompt ON-OFF	0, 1	Turns the command prompt on or off. This setting is stored in memory so that it remains the same, even after a power on/off cycle.
CDRH	***5 Sec. Delay ON-OFF	0, 1	Toggles the CDRH five-second emission delay on and off.
?BT	*Base Plate Temp	0 to 55	Returns (in degrees Celsius) the present base plate temperature. The hardware resolution for this measurement is 0.06ºC.
?C	*Laser Diode Current	0 to 255	Returns (in milliamps) the present operating current of the laser diode. The hardware resolution for this measurement is 0.1 mA.
CLS	**Clear Screen	N/A	Clears text from a serial communication screen.
?DST	Diode Set Temp.	15 to 35	Returns (in degrees Celsius) the present set temperature of the laser diode. The hardware resolution for this measurement is 0.029ºC.
?DT	*Diode Present Temp.	15 to 35	Returns (in degrees Celsius) the present measured temperature of the laser diode.
E	**Echo ON-OFF	N/A	Sets or reads the Echo Off feature. This feature turns character echo on or off on a serial communication terminal and is useful if a computer script/program—rather than a person—is controlling the laser.
?F	*Fault Number	See Table 7-4, "Fault Codes," on page 104.	Returns the present system status as a decimal value corresponding to the binary system status. Review the ?F table for a complete list of error conditions.

Table 7-2. Pulsed RS-232 Commands and Queries (continued)

COMMAND	FUNCTION	RANGE	DESCRIPTION
?FF	*Fault Binary Code	See Table 7-4, "Fault Codes," on page 104.	Checks for faults in the system and returns a two-byte result. No system fault returns 0000 0000 0000 0000—see Table 7-4, "Fault Codes," on page 104.
?FL	*Fault List	See Table 7-4, "Fault Codes," on page 104.	Checks for faults in the system and returns an ASCII result. No system fault returns "System OK"—see Table 7-4, "Fault Codes," on page 104.
?HH	*Usage Hours Head	0 to 100000	Returns the present head hours with a resolution of one second. The head hours are tracked in one-minute intervals when the system is powered down and restored.
?HID	*Head ID Value	N/A	Returns (as a comma-delimited string) the head serial number, head type, and nominal wavelength.
L	***Laser ON-OFF	0, 1	Set the laser status. Setting L=1 enables the laser ON. TEC servo MUST be ON (T=1) to set L=1. Setting L=0 turns off the laser output.
LT	Laser Type	N/A	When OP=2 operating mode is active, this query returns Sapphire laser types. Review the Sapphire manual for additional information.
OP	***Operating Protocol	1,2,3	Determines the response format for commands and queries. OP=1 returns data in the format described in the CUBE manual. OP=2 returns data to match responses from Coherent Sapphire lasers. OP=3 returns data to match responses from Coherent Compass 405 lasers. Review Coherent Sapphire and Compass 405 manuals for detailed response information.
P	***Laser power	0, MAXLP	Sets (in mW) laser power. The range of P values is based on the minimum laser threshold power (?MINLP) and the maximum laser power (?MAXLP).
?PSH	Power Hours	0 to 100000	Returns the present Laser Hours.
?PST	Computer Temperature	N/A	Returns present computer temperature in OP=2 operating mode.
?SP	*Set Power Out	0, MAXLP	Returns (in mW) the present laser power setting. This value represents the last value entered with the P command.
?SS	TEC	0,1	Returns TE status: 1=ON, 0=OFF
?SV ?SVH	*Software Version	N/A	Reads the CUBE firmware version.
?STA	*Operating Status #	N/A	Returns an integer value representing the present CUBE system operating status. 1: Warm Up 2: Standby 3: Laser ON 4: Error 5: System Halted (Fatal Error)

Table 7-2. Pulsed RS-232 Commands and Queries (continued)

COMMAND	FUNCTION	RANGE	DESCRIPTION
?M	*Manual Mode	0, 1	Returns the status of the Manual mode control DE-15 pin 3. The Manual mode pin normally floats high with no connection. When this pin is tied to ground, all laser operations require computer control.
?MINLP	*Min. Light Cont. Pwr.	N/A	Returns (in mW) the minimum power available in CW light control mode.
?MAXLP	*Max. Light Cont. Pwr.	N/A	Returns (in mw) the maximum laser power available in CW light control mode.
?NOMP	*Nominal Laser Pwr.	N/A	Returns (in mw) the nominal CW laser output power.
?WAVE	*Laser Wavelength	N/A	Returns the laser operating wavelength, based on a diode temperature of 25ºC.
?INT, ?LCK ?K	*Interlock Status	0,1	The ?INT or ?LCK query returns the status of the interlock DE-15 pin 1 status. A value of 1 corresponds to a closed status and a value of 0 corresponds to an open status.
?PVPS	*Protocol Version	N/A	Reads the software protocol version. If the CUBE firmware is embedded into a process, this query can be used to check for changes in the command structure. If the firmware version changes without changes to the command structure, this query returns the same value for separate firmware versions.
T	***Turns TE ON	0, 1	Reads or sets the TEC status. Setting T=1 enables the temperature control of the laser diode. Setting T=0 disables the temperature control.
CW	***CW or Pulse Mode	0, 1	Switches the operating mode from CW (CW=1) to pulse (CW=0). If pulse mode is set, the laser runs at the threshold power if no voltage is present at the digital pulse input connector.
ANA	***Analog Control Mode	0, 1	Switches the Laser Diode parameter controlled by the external analog signal from current (ANA=1) to power (ANA=0). In CW mode, the CUBE is always in light-regulation, so the ANA value will remain zero (0).
EXT	***Ext. Analog Laser Pwr. Control	0,1	Commands either the power or current to be set by the external Analog Modulation input. A query of this command returns the command status: EXT=1 for external EXT=0 for internal. The external connector is located at the laser pin 8 on the DE-15 connector.
CAL	***Cal. Laser Power in Pulse	Threshold - MAXLP	Sets the calibration of the laser output power in Pulse mode by closing the light feedback loop and adjusting the current to bring the power back to a specified set level. Enter a value for the CAL command to set the amplitude of a digital pulse to a specified level.

7.4 Using a Terminal Program

This section describes in general how to use a terminal program with the CUBE laser system.

IMPORTANT!
The drivers for the CUBE laser do not work with a Windows 10 operating system. The only way to communicate is to enable communication on the serial port.

1. Switch the CUBE laser OFF.
2. Connect the CUBE to the computer through the RS-232 port. A high-speed RS-232 to USB adapter is recommended if host computer does not have a serial connector.
3. Open a terminal program and create a file name for the new connection.
4. Select the appropriate COM port on the computer and follow the recommended terminal program menu settings shown here.

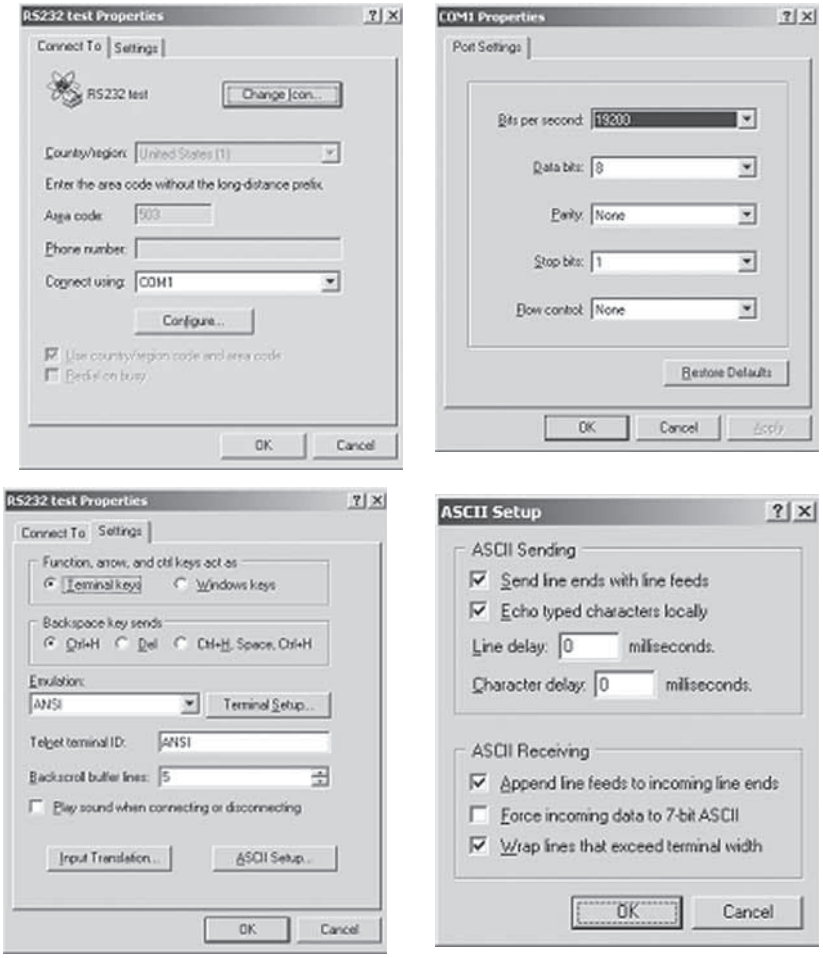
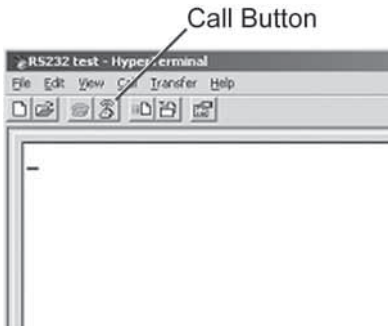
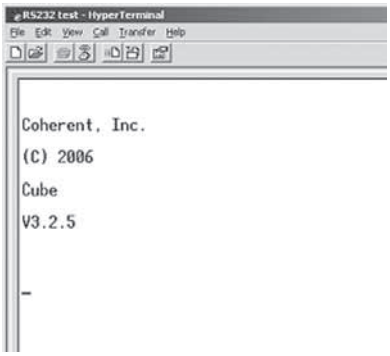


Table 7-3. Terminal Program Settings

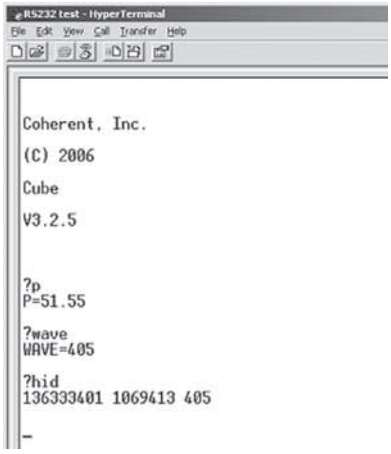
5. Go to the terminal program main window and activate the connection by pressing the Call button.



6. Switch the CUBE laser ON. If a proper connection is established, it will automatically reply to the terminal program with the information shown here.



7. Commands described in other sections of this manual can be used to communicate with the laser. In the following example, a few query commands are used to check the power level, wavelength, and the serial number of the laser.



7.5 Faults

Faults display on the Status bar. Specific information displays when a temperature fault—including Base Plate and Diode Temperature—is present. Other faults display with a Fault indicator. To obtain details for other faults, use the Terminal screen and enter ?F.

For steps to resolve issues, go to the section about "Troubleshooting" (p. 107).

7.5.1 Fault Codes

Table 7-4 lists the fault codes that may be displayed.

Table 7-4. Fault Codes

?F/?FF ERROR VALUE	DESCRIPTION/?FL	CAUSE	POSSIBLE SOLUTION
0	System OK		
1	Bad Command	Syntax error associated with the command	Review and correct the command syntax
2	Bad Data	Entered data is out of range or there is a syntax error associated with the data	Review the range of entered data or correct the syntax
4	EEPROM Checksum Error	Error associated with the system EEPROM	Reboot the laser system—contact Coherent Technical Support if the problem persists
8	Base Plate Temperature	Base plate temperature is greater than 50ºC	Improve Heat Sink to reduce the base plate temperature.
16	Laser Diode Temperature	Difference between the diode set temperature and the measured diode temperature is greater than 5ºC	Improve Heat Sink to reduce the diode temperature
32	Interlock Fault	Interlock is open	Close the Interlock connection
64	I2C Error	Processor-to-hardware communication error	Reboot the laser system—contact Coherent Technical Support if the problem persists
128	Value out of Range	Command entered correctly with a value that is excessive or deficient for the command	Review the range of entered data and correct, as necessary
256	nc		
512	nc		
1024	Flash Reset	Internal error caused a reset condition for all present settings	Enter the desired values for all system parameters
2048	Over Current	Laser current exceeded 120% of the new system current—result of diode degradation over time	Contact Coherent Technical Support

Table 7-4. Fault Codes (continued)

?F/?FF ERROR VALUE	DESCRIPTION/?FL	CAUSE	POSSIBLE SOLUTION
4096	Reset Clock	Internal error caused system clock reset	
8192	System Time Out	Command is not acknowledged by the processor	Contact Coherent Technical Support if the problem persists
16384	Buffer Overflow	Excessive number of commands is issued—typical command response time is 250 msec.	Space commands by 250 msec
32768	Fatal Error	Processor error	Reboot the laser system—contact Coherent Technical Support if the problem persists

7.6 CUBE OEM Tools (Active X Controls)

To aid in the development of an OEM application, Coherent provides a custom ActiveX control. This ActiveX control interfaces with any CUBE laser.

This control provides a development environment with a set of tools. These tools enable the programmer to quickly and efficiently communicate with the CUBE laser.

TABLEXREF lists the CUBE OEM Tools ActiveX controls for the following methods, properties, and events:

Table 7-5. Active X Controls

CONTROL	CUBE INTERFACE
Methods	CUBEStart CUBESendData
Properties	CUBEAdded CUBERemoved CUBECount
Events	CUBEDeviceFound CUBEDeviceRemoved
Command Set	CommandSet

Refer to the installation location for the Coherent CUBE Connection software for detailed information about these items.

- The default location is C:\Program Files\Coherent\Coherent Connection.
- Open the file "**`CUBEOCX.hlp`**".

8 TROUBLESHOOTING

This section describes steps to take if there are issues with laser operation.

NOTICE!
Take appropriate ESD precautions when handling and installing a laser. Refer to "Electrical Safety" (p. 18) for a description of ESD precautions.

If you experience problems with the CUBE laser system, see the procedures on the following pages. If you are not successful in solving the problem or need further assistance, either contact Coherent Technical Support (in the US: 1.800.367.7890), or a worldwide local Coherent service representative (see www.Coherent.com for worldwide contacts).

Table 8-1 lists possible issues and a link to the associated checklist.

Table 8-1. Troubleshooting Procedures

ISSUE	SEE…
No USB Communication	Checklist 1 (p. 107)
Interlock Fault	Checklist 2 (p. 108)
No Laser Emission at Start-up	Checklist 3 (p. 108)
System Shuts Down (RS-232 Control)	Checklist 4a (p. 109)
System Shuts Down (Analog Control and Manual Mode)	Checklist 4b (p. 109)
Low Power (RS-232 Control)	Checklist 5a (p. 110)
Low Power (Manual Mode)	Checklist 5b (p. 110)
Excessive Scattered Light (All Operating Modes)	Checklist 6 (p. 111)
Output Power Not Stable (All Operating Modes)	Checklist 7 (p. 111)
Beam Noise Out of Spec (All Operating Modes)	Checklist 8 (p. 111)
No RS-232 Communication	Checklist 9 (p. 112)
Transverse Mode is Not TEM_{oo}	Checklist 10 (p. 112)
Base Plate Over Temperature	Checklist 11 (p. 112)

8.1 Checklist 1: No USB Communication

[ ] Verify Operating System is 32-bit, Win 7 or Win XP. If not, the USB connection to a Host Computer Cannot be used.

[ ] Verify RS-232 connection is made to a recommended RS-232 to USB Adapter prior to connecting USB cable end of adapter to Host Computer.

[ ] Confirm RS-2322 settings (baud rate, etc.) are set properly. See RS-232 control section.

[ ] Contact Coherent Technical Support.

8.2 Checklist 2: Interlock Fault

If an interlock fault is suspected, execute the following steps.

[ ] Cycle DC power OFF/ON.

[ ] Verify the supply voltage is between 4.8 and 6.5 VDC.

[ ] Connect a computer and send the "?LCK" or "?INT" query. If a value of 0 is returned, check all interlock connections.

[ ] If the interlock connections are verified to be closed and the "?INT" or "?LCK" query return a 0 (Open) condition, contact Coherent Technical Support.

8.3 Checklist 3: No Laser Emission at Start-up

Laser emission should be present within 5 minutes of start-up.

[ ] Cycle DC power OFF/ON.

[ ] Verify that the shutter is in the OPEN position.

[ ] Ensure the DE-15 connector is properly secured with locking screws.

[ ] Verify the supply voltage is between 4.8 and 6.5 VDC.

[ ] Use a computer to send "?LCK" or "?INT". If the response is 0, check all interlock connections.

[ ] Send the L=1 command. If laser emission is not detected, contact Coherent Technical Support.

[ ] Check for proper heat sinking of the laser head. Use the "?BT" query to ensure the base plate temperature is less than 50°C.

[ ] Issue the "?F" command

[ ] If fault #8 or #16 is returned, ensure the ambient temperature is less than 40°C and the base plate temperature is less than 50°C.

[ ] If fault #4 is returned, contact Coherent Technical Support for information on restoring factory calibration settings.

[ ] If fault #32 is returned, verify all system interlocks are closed.

[ ] If fault #64 or #32768 is returned, the system has experienced a serious problem. Contact Coherent Technical Support.

8.4 Checklist 4a: System Shuts Down (RS-232 Control)

[ ] Check for proper heat sinking of the laser head—refer to “Checklist 11: Base Plate Over Temperature” (p. 112).

[ ] Check for proper grounding of the laser head (the laser head cover must be at earth ground).

[ ] Issue the “?F” command

[ ] If fault #8 or #16 is returned, ensure the ambient temperature is less than 40°C and the base plate temperature is less than 50°C.

[ ] If fault #4 is returned, contact Coherent Technical Support for information on restoring factory calibration settings.

[ ] If fault #32 is returned, verify all system interlocks are closed.

[ ] If fault #64 or #32768 is returned, the system has experienced a serious problem. Contact Coherent Technical Support.

8.5 Checklist 4b: System Shuts Down (Analog Control and Manual Mode)

[ ] Check for proper grounding of the laser head (the head cover must be at earth ground potential).

[ ] Verify the power supply is providing a voltage between 4.8 and 6.5 VDC.

[ ] Measure the base plate temperature. If it exceeds 50ºC, check for proper laser head heat sinking—refer to “Checklist 11: Base Plate Over Temperature” (p. 112).

[ ] If using external interlocks, verify all external interlocks are closed.

[ ] Contact Coherent Technical Support.

8.6 Checklist 5a: Low Power (RS-232 Control)

Measure power only with a calibrated power meter prior to any external optics, or use the "?P" command to obtain output power.

[ ] If the system does not achieve the specified maximum power level, use the "?SP" and "?MAXLP" queries to ensure the output power is set to a maximum (MAXLP).

[ ] Make sure the output window is clean.

[ ] Use the ?P RS-232 query to check current laser power. If the returned value does not represent the expected laser power, use P=<value> to set the desired laser power.

[ ] If system does not respond to the "?P" command, verify proper RS-232 set up.

[ ] If the value returned by ?P differs from the set power by more than 1.5 mW, contact Coherent Technical Support.

[ ] Use the ?CW query to check for Pulse mode. If CW=0, and no voltage is present on the SMB connector, the laser output will represent threshold. The threshold output is normally in the microwatt range.

[ ] Use the ?EXT query to check for active external analog power control. If ?EXT returns a value of 1, laser power is reduced. Enter EXT=0 to ensure normal power levels.

8.7 Checklist 5b: Low Power (Manual Mode)

Make sure laser power is measured by a calibrated power meter, prior to external optics.

In Manual mode, the CUBE allows for computer control and queries. Refer to "Checklist 4a: System Shuts Down (RS-232 Control)" (p. 109) for appropriate computer connections and settings.

[ ] Verify the output window is clean.

[ ] If using the Control Box for external power control, verify the expected voltage to the BNC connector.

[ ] If the system does not achieve the specified maximum power level, use the "?SP" and "?MAXLP" queries to ensure the output power is set to a maximum (MAXLP).

[ ] Verify the proper RS-232 command is issued. For example, issue the P=10 command. The "?P" query or external power measurement should result in 10 mW (?P=10 mW).

[ ] If the system does not respond to the "?P" command, verify proper RS-232 set up.

[ ] If "?P" response indicates low power, contact Coherent Technical Support.

8.8 Checklist 6: Excessive Scattered Light (All Operating Modes)

[ ] Observe the output beam prior to hitting any external optics. If the output beam is OK, clean the external optics.

[ ] Verify the output window is clean.

[ ] Contact Coherent Technical Support.

8.9 Checklist 7: Output Power Not Stable (All Operating Modes)

[ ] Measure power only with a calibrated power meter prior to any external optics.

[ ] Allow the system to warm up for at least 5 minutes.

[ ] Verify the output window is clean.

[ ] Verify all cable connections are secure.

[ ] Measure base plate temperature over a 5-minute period. If the base plate temperature is not stable, check for proper heat dissipation—refer to “Checklist 11: Base Plate Over Temperature” (p. 112).

[ ] If using the Control Box for laser power control, verify a stable input voltage to the BNC connector.

[ ] Contact Coherent Technical Support.

8.10 Checklist 8: Beam Noise Out of Spec (All Operating Modes)

[ ] Make sure beam noise is measured prior to any external optics.

[ ] Verify the output window is clean.

[ ] Check for proper heat sinking.

[ ] Verify there is no vibrations at the laser.

[ ] Check for proper grounding of the laser cover.

[ ] Contact Coherent Technical Support.

8.11 Checklist 9: No RS-232 Communication

[ ] Verify all connections are secure.

[ ] Verify RS-232 setting (baud rate, etc.) See RS-232 control section.

[ ] Ensure the communication cable is not a Null-modem.

[ ] Verify cable length does not exceed 5 m (16.4ft).

[ ] Use a second computer to exclude a defective RS-232 port at the controlling computer.

[ ] Contact Coherent Technical Support.

8.12 Checklist 10: Transverse Mode is Not TEMoo

[ ] Make sure the beam is observed prior to external optics. If the beam quality is correct, clean the external optics.

[ ] Verify the output window is clean.

[ ] Contact Coherent Technical Support.

8.13 Checklist 11: Base Plate Over Temperature

[ ] Verify the proper size of the heat sink—refer to "CUBE Heat Sink (Optional)" (p. 40) for more information.

[ ] Verify proper operation of the Heat Sink (that is, if a fan is used to cool the Heat Sink, make sure it is operating properly.)

[ ] Verify the Heat Sink compound, if used, is applied evenly between the laser head and the Heat Sink.

[ ] Verify the surface of the Heat Sink contacting the laser head is flat.

[ ] Verify the ambient temperature does not exceed 50ºC.

A PARTS LIST

This section describes the parts shipped with the CUBE laser system.

The following parts can be ordered by contacting Coherent Technical Support:

- By email: customer.support@coherent.com
- Visit our website: www.Coherent.com
  and search for a Coherent service representative for your local area.
- By phone: 1-(800)-367-7890 or 1-(408)-764-4557 outside the U.S.

When communicating with Coherent Technical Support, be prepared to provide the model and serial number of the Laser Head to the Support Engineer responding to your request. You can locate the date of manufacturing for your laser system on the label with the serial number.

- Effective January 1, 2007, the CUBE Laser System was released as RoHS-compliant.
- If your laser system was purchased prior to January 1, 2007, contact Coherent Technical Support to determine if the items listed in Table A-1 are the appropriate part numbers for your laser system.

A.1 Parts in the CUBE Laser System

Table A-1 lists the parts included with the CUBE laser system:

Table A-1. Parts List for CUBE Laser System

P/N	COMPONENT	QTY
See CUBE data sheet	CUBE Laser Head	1
1039966	CUBE Control Box	1
1072454	CUBE Power Supply, 6 VDC, 2.5A, Switched	1
1108063	Power Cord, North America	1
1072166	CUBE Interface Cable (Quatro Digital Interface) included at no extra charge. This cable provides connectors from the CUBE laser to the control box, I/O, RS-232, and power. (NOTE The cable connects to the optional CUBE I/O Cable, 8-Pin to Flying Leads, P/N 1103937, not included with the laser system and which must be ordered separately.)	1
1108906	USB Cable	1
1147585	CUBE Quick Start Guide	1
1079890	CD-ROM with CUBE Operator's Manual and Coherent CUBE Connection Software	1
Included	Modified M4 Mounting Screws (4 each), M4 Small Pattern Washer (4 each), and small Hex wrench (1 each)	

A.2 Optional Accessories (Order Separately)

Optional Accessories for the CUBE laser system are listed in Table A-2.

NOTE:
These accessories are not shipped with the CUBE Laser System and must be ordered separately.

Table A-2. Accessories for the CUBE Laser System

P/N	DESCRIPTION
1073840	CUBE Heat Sink with Fan
1116779	CUBE Right-Angle Heat Sink Mount
1079150	CUBE Secondary Emission Indicator Lamp
1040408	Non-Shorted RCA Plug
1103937	CUBE I/O Interface Cable, 8-Pin to Flying Leads (This optional cable connects to the CUBE Quatro Digital Interface Cable, P/N 1072166. That cable is included with the CUBE Laser System.)
1415602	High-Speed USB-to-Serial RS-232 Adapter
1080090	Cable Extension to Extend Control Box or RS-232 M-F, DB-9 Cable

B Power Meters and Sensors

For the most common diagnostics—measuring the output power of the CUBE laser system—Coherent offers a variety of instruments for laser test and measurement that cover that entire wavelength range.

This section describes power meters and sensors that are an ideal fit for the CUBE product family, including:

- For Cube lasers with a meter:
  - FieldMaxII-TO Laser Power Meter
  - PS10 sensor
- For Cube lasers in installations that want a meter integrated into the sensor:
  - USB PowerMax UV/VIS Power Sensor
    or USB PowerMax UV/VIS Wand
  - USB/RS PS10Q sensor (USB or RS)
  - USB PS10 sensor

For more detailed information and product data sheets, visit the Coherent website:

https://www.coherent.com/measurement-control/measurement/powermax-usb-sensors

B.1 Meter: FieldMaxII–TO

The FieldMaxII–TO is an affordable and versatile digital meter that is designed for ease-of-use in field service and production applications. The meter supports on-board analysis of mean, minimum, maximum, and standard deviation statistics.

Coherent recommends a FieldMaxII-TO digital power and energy meter for use with the PS10 sensor. Figure B-1 shows the FieldMaxII-TO Laser Power Meter (P/N 1098579):

Figure B-1. FieldMaxII–TO Meter (Power Only)

The FieldMaxII-TO Laser Power Meter measures power from nW to kW, and pulse energy from nJ to J at up to 300 pps. The Measurement Range is dependent on the sensor (refer to the sensor specifications for details).

A FieldMaxII–TO meter features:

- A large, easy-to-read back-lit LCD display
- An intuitive user interface offering button-driven control for simple operation.
- Area function for density measurements (J/cm2 or W/cm2)
- the FieldMaxII USB interface to use with the FieldMaxII PC software provided by Coherent
- Simulated analog-like movement for laser tuning
- LabVIEW instrument driver; simple LabVIEW examples are provided for basic functionality of the meter
- Compatible with Windows 7, 8, and 10 operating systems (32-bit and 64-bit)

The FieldMaxII PC software supports trend charting, tuning, statistics, and logging data to a file.

Multiple meters can be run on a single PC. This can be useful for final test and burn-in applications.

For more advanced interface and full operation in automation, refer to the LabMax-Pro SSIM Meter User's Manual.

For more information about products, go to the Coherent website:

https://www.coherent.com/measurement-control/measurement/fieldmaxii-to

B.2 PowerMax Sensors

Coherent PowerMax-USB sensors provide plug-and-play laser power measurement directly on a PC without the need for additional electronic instrumentation.

For more information, see the Coherent website:

https://www.coherent.com/measurement-control/measurement/high-sensitivity-thermopile-sensors-to-2w-rohs

This section describes a variety of PowerMax sensors that support the CUBE Laser System.

B.2.1 PS10 Sensor

The PS10 model sensors (P/N 1098350) are thermally stabilized, amplified thermopile power sensors with a broad spectral response, high sensitivity, and a large active area. These sensors are ideal for measuring laser diodes, HeNe and HeCd lasers, and small ion lasers.

The PS10 model includes a light tube mounted to the front of the housing, which minimizes the effects of background radiation and narrows the field of view. Alternatively, the light tube can be removed and replaced by a fiber adapter accessory.

The PS10 sensor shown, in FIG, is a low-power thermopile sensor with 10 uW resolution (10mm aperture).

Figure B-2. PS10 Thermopile Sensor

Features of the PS10 sensor include:

- Thermally stabilized design for low power sensitivity
- Noise equivalent power down to 3 µW
- Spectrally flat; good for broadband light sources
- Wavelength Range: 300 to 2100 nm

B.2.2 USB Sensors

The measurement circuitry typically found in a standalone meter has been reduced in size to extent that it can now fit inside a USB connector. The circuitry and USB connector have been adapted into a ‘PowerMax-USB’ cable that can be integrated to most Coherent power sensors, providing accurate power measurements of all types of CW and pulsed sources from the UV to Far IR.

Table B-1 lists the Coherent sensors and lists the part number for each.

Table B-1. Thermopile Sensor Product Description

PRODUCT/DESCRIPTION	P/N
USB PS10 High-Sensitivity Thermopile Sensor	P/N 1174260 (USB)
USB PowerMax UV/VIS Power Sensor or USB PowerMax UV/VIS Wand	P/N 1168337 P/N 1212310
USB/RS PS10Q Sensor (USB or RS)	P/N 1287077 (USB) P/N 1288992 (RS)

Each of these are described in the subsections that follow.

B.2.2.1 USB PS10 Sensor

The USB PS10 High-Sensitivity Thermopile Sensor (PN 1174260) is USB-enabled, low-power thermopile sensor with 3 uW NEP (10 mm aperture) (RoHS).

This Laser Measurement device provides direct USB 2.0 connection to a PC, with measurement resolution down to 10 µW and a wide spectral range.

The PS10 model includes a light tube mounted to the front of the housing, which minimizes the effects of background radiation. The light tube can be removed and replaced by FC or SMA fiber connectors.

Figure B-3 shows the USB PS10 Sensor

Figure B-3. USB PS10 Sensor

Features of the USB PS10 Sensor include:

- Thermally stabilized design for low power sensitivity
- Noise equivalent power down to 3 µW
- Spectrally flat; good for broadband light sources

B.2.2.2 PowerMax-USB UV/VIS Sensors

There are two models available for the PowerMax-USB UV/VIS sensors:

- PowerMax-USB UV/VIS Quantum Power Sensors (P/N 1168337)
  USB-enabled, Low power optical sensor with 100 nW NEP with ND2 filter (10 mm aperture) (RoHS)
- PowerMax-USB UV/VIS Wand (P/N 1299161)
  PowerMax USB Wand UV/VIS Quantum Power Sensor, Metal Enclosure

Figure B-4 shows the PowerMax-USB UV/VIS Quantum Power Sensor and the PowerMax-USB UV/VIS Wand:

Features of the UV/VIS sensors include:

- Large 8 mm and 10 mm apertures
- High-sensitivity Silicon photodiode
- Low power measurements down to 5 µW (wavelength dependent)
- Spectral response from 325 nm to 1065 nm

Figure B-4. PowerMax-USB UV/VIS Sensor and Wand

The PowerMax-USB UV/VIS Quantum sensors incorporate a Silicon photodiode, for measurement of power from 5 µW to several hundred milliwatts. The measurable power varies significantly by wavelength.

B.2.2.3 USB/RS PS10Q Sensor

There are two models available for the PS10Q Sensor:

- PS10Q Sensor (P/N 1287077) — for USB
- PS10Q Sensor (P/N 1288992) — for RS

Where optimum stability is required, the PS10Q includes a wedged quartz window, for applications from 0.3 to 2.0 µm. The quartz window more effectively eliminates thermal background radiation and the effects of air currents.

Features of the USB PS10Q Sensor include:

- Thermally stabilized designs
- Power measurement from 100 µW to 1 W
- 10 µW resolution
- 10 mm and 19 mm apertures
- Direct USB and RS-232 interfaces
- FC and SMA fiber adapters
- RoHS compliant

C SERVICE & SUPPORT

This section provides information about:

- How to contact Technical Support
- How to obtain service
- Product shipping instructions

C.1 Technical Support

Coherent provides telephone and web-based technical assistance as a service to its customers and assumes no liability for any injury or damage that can occur at the same time with such services.

Operation of any Coherent laser with any of its interlocks (or safety features) defeated is always at the operator's own risk. Under no circumstances do these support services affect the terms of any Warranty agreement between Coherent and the buyer.

Be prepared to provide the following information to the Product Support Engineer responding to your request:

- Model or part number of your unit
- Laser head serial number
- A description of the problem
- Any corrective steps you may have attempted

C.1.1 Support in the USA and North America

Should you experience any difficulties with your laser or need product or technical information, contact Coherent as follows:

- By email: customer.support@coherent.com
- Visit our website: www.Coherent.com

Should you need further assistance, please contact Coherent Technical Support:

- By phone: 1-(800)-367-7890 or 1-(408)-764-4557 outside the U.S.

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 calls will be quickly returned the next business day.

C.1.2 International Support

If you are located outside the U.S., visit www.Coherent.com for technical assistance, or contact your local Service Representative directly:

- Germany: +49–6071–968–0
- Japan: +813–5635–8680

On the Coherent website, you can also view contact information (telephone numbers and addresses) for Service Representatives worldwide.

C.2 Obtaining Service

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 "Product Shipping Instructions" next.
- Ship it to the address specified by the Company, with shipping prepaid. 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.

C.3 Product Shipping Instructions

You must include a Returned Material Authorization number (RMA) assigned by the Company on the outside of all shipping packages and containers. Items returned without an RMA number are subject to return to the sender. Detailed instructions to prepare a product for shipping are provided in the next section.

To prepare a product for shipping to Coherent:

1. Contact Customer Service for a Return Material Authorization number.
2. Attach a tag 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. Wrap the product with polyethylene sheeting or equivalent material.
4. Using the original shipping and packaging materials, pack the product.
5. Seal the shipping carton with shipping tape or an industrial stapler.
6. Add the RMA number you received from Coherent Customer Service to the shipping label on the outside of the box. Ship the product to the following address:

   Coherent, Inc.
   Attn: RMA #
   27650 SW 95th Ave.
   Wilsonville, OR 97070 USA

D WARRANTY

Coherent, Inc. warrants OBIS Laser Systems to the original purchaser (the Buyer) only; that the laser system that is the subject of this sale, (a) conforms to Coherent's published specifications, and (b) is free from defects in materials and workmanship.

Laser systems are warranted to conform to Coherent's published specifications and to be free from defects in materials and workmanship as specified in the sales or service contract. 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.

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

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
Automatic Send Data Control	An optional hardware feature that is useful to control enable/disable of transmit enable line of RS-485 transceiver
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.
CCB	Coherent Connection Bus, a RS-485 communication bus
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 computers 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
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
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
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)
Nm	Newton meter (torque)
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 488.2 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)

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1079231

CUBE Laser System Operator's Manual

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