

Cobolt Odin™ Series

Compact | Tunable | Mid-IR OPOs

3264 nm

3431 nm

4500 nm



HÜBNER Photonics



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1. Introduction

The Cobolt Odin™ Series is an ultra-compact and industrial-grade mid-IR source based on a fully contained temperature tunable Optical Parametric Oscillator (OPO) with integrated pump laser. Periodically poled nonlinear optical crystals are used for efficient and spectrally flexible generation of mid-IR emission. The lasers are manufactured using Cobolt's proprietary HTCure™ technology and packaged in a compact and sealed laser head, offering a size, robustness and reliability never before achieved for this kind of laser source.

The Cobolt Odin™ Series lasers provide up to 80 mW average output power at a centre wavelength freely selectable over the range of 2-4.5 μm through tailoring of the nonlinear crystal. The lasers can be tuned in wavelength over tens of nanometers via temperature adjustments. The emission is generated in nanosecond pulses (< 5 ns) at high pulse repetition rate (10 kHz) and very low pulse-to-pulse jitter.

The combination of compact format, high level of robustness, spectral flexibility and low power consumption makes the Cobolt Odin™ Series lasers ideal light sources for a large variety of industrial and scientific applications related to molecular spectroscopy. They are suitable for integration into analytical instrumentation for fast, accurate and sensitive gas detection used in environmental monitoring applications as well as for control and limitation of pollution emissions in petrochemical, automotive and energy production industries.

2. Safety

2.1. General

Cobolt Odin™ series are Class IIIB (CDRH), Class 3B (IEC) laser products that emit less than 500 mW of radiation in the Mid-IR spectrum. Residual emissions from the pump diode, the pump laser and the OPO cavity are contained within the laser head housing via filtering optics. The residual emission does not exceed laser Class 1.



Eye and skin exposure to direct or reflected laser light is hazardous and may be extremely harmful. Always wear eye protection appropriate to the beam wavelength and intensity. Laser radiation may pose a risk of igniting flammable materials and in event of ignition gasses and fumes may be generated. All equipment used in close proximity to the laser beam should be suitably fire resistant and the facility should be properly ventilated. It is advised to perform a risk assessment for the facility and equipment prior to using the laser. In the case of integration into a larger system, laser safety compliance must be evaluated on the end product.

The device must be handled by skilled personnel experienced with lasers, in a laboratory environment and with access to adequate laser safety equipment. The laser head clearly displays a yellow warning label that shows the location of the laser beam aperture. This label must be visible unless the laser beam is totally enclosed.

The table below describes the nominal lasers operation parameters.

Product	Average Power (mW)	Pulse Duration (ns)	Pulse Repetition Rate (kHz)	Pulse Energy (µJ)
Cobolt Odin™ 3.0-4.5 µm	> 80	< 5	> 7 / > 10	> 11 / >8

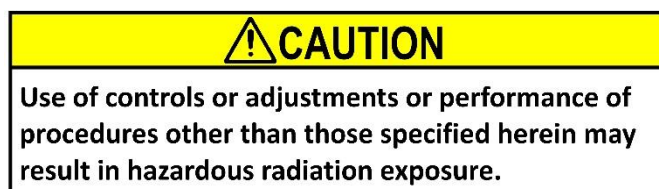
The table below describes the maximum energy density in J/cm² used for safety calculations and the appropriate level of eye protection in terms of optical density (OD) for each product line.

Product	Laser Class	Warning Label Power (mW)	Max Pulse (µJ)*	Max Energy Density (J/m²)**	Eye Protection Requirement***
Cobolt Odin™ 3.0-4.5 µm	IIIB	150	21	27	> OD 2 / I,R L1

* Max Pulse (µJ) = Warning Label Power (W) ÷ Repetition Rate at bottom tolerance (Hz)

** Max Energy Density (J/cm²) = Warning Label Pulse (J) ÷ Beam Area at bottom tolerance (cm²)

*** Eye protection (OD) = Log10(60825-1 Emission Limit : Class 1 (µJ) ÷ Max Pulse (µJ)), rounded up to the next integer/See EN 207



2.2. Safety features

The laser is equipped with all required safety features as described in the laser safety standard 60825-1. Disabling any safety features negate the CE/CDRH compliance of this product.

Remote Interlock Connector

The remote interlock connector is a connector which permits the connection of external controls placed apart from other components of the laser product. When the terminals of the connector are open-circuited, emission is interrupted and no radiation will be accessible. The remote interlock connector permits easy addition of an external interlock in laser installation. See section 4.3 for a detailed description of the remote interlock circuit and operation.

Manual Shutter (Beam Stop)

The laser head is equipped with a manual shutter, which functions as the beam stop, capable of preventing human access to laser radiation. The aperture location and the open and close positions of the shutter are indicated on the top surface of the laser head.

Key Control

The CDRH compliant model comes with a key-switch on the Controller which must be connected for the laser to operate. When the key is in the OFF position, the laser is prevented from emitting. The key must be actively turned to the ON position each time the laser is powered on. When the key is removed from the system laser radiation is not accessible.

Laser Radiation Emission Warning

The Controller incorporates information LEDs which display whether power is connected, the laser is on, or a fault has occurred. The "ON" LED is illuminated whenever the device is emitting or could emit light. See section 3.4 for details on the controller. The emission warning indicators are also visible in the Cobolt Monitor™ software, see section 9 for details on the control software.

2.3. Equipment Safety

Always install all power supplies used in the laser system to properly grounded power outlets. The laser head and controller must be mounted on a common ground plane, such as an optical table. Cobolt lasers contain a laser diode which is sensitive to electrostatic discharge (ESD).

2.4. Warning and Identification Labels

The upper face of the laser head contains a yellow label with laser safety warning and classification information, the wavelength and maximum power of the unit. It also shows the location of the laser beam from the aperture and indicates the open and close positions of the manual shutter. This label must be visible unless the laser beam is totally enclosed. A silver label showing information about the laser model, manufacturer date and location, and the power supply voltage and current, is located on the laser head. Lasers shipped to customers in the USA also contain a label of CDRH compliance.

Manufacturer Identification Labels

Cobolt Odin™ 80
3431 nm
 3431-05-71-0080-800
 S/N: **1234**
 Made in Sweden, 12-2015
 Input: VDC = 15 V, I_{MAX} = 4.2 A **OEM LASER DEVICE**
 Cobolt AB, Vretenvägen 13
 SE-171 54 Solna, Sweden

OEM Label

Cobolt Odin™ 80
XXXX nm
 XXXX-05-72-0080-700
 S/N: **12345**
 Made in Sweden, 05-2020
 Input: VDC = 15 V, I_{MAX} = 6 A **CE UK CA**
 Cobolt AB, Vretenvägen 13
 SE-171 54 Solna, Sweden

CE marking for CDRH models only



Aperture Warning Labels



Complies with 21 CFR 1040.10 and 1040.11
 except for deviations pursuant to
 Laser Notice No. 50, dated June 24, 2007

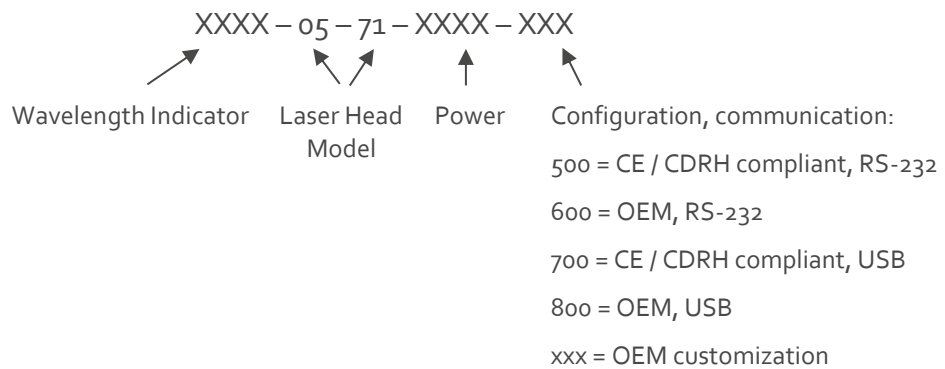
Laser Notice No. 50 Label
 CDRH models shipped to USA

3. Overview

Cobolt Odin Series laser systems consist of four main parts: the laser head, the Controller, the Cable and the Power Supply (not shown). The cable provided should always be used to connect the laser head with the Controller. Always install the laser system to a properly grounded power outlet.

3.1. Model number

Cobolt lasers are sold in two configurations: CDRH and OEM, described in section 3.2. The model numbers are composed as described below.



3.2. Configuration

3.2.1. CDRH Compliant

The CDRH compliant system is supplied with a key switch on the Controller, which must be connected, along with a remote interlock connector. Once power is supplied, laser radiation starts when the key is turned from the OFF position to the ON position. The status of operation can be monitored via LEDs on the Controller. Setting the key to its OFF position puts the laser in stand-by mode. **The CDRH model is CE compliant.**

The standard CDRH model consists of:

- Laser head
- Controller with key switch
- Keys
- 1(m) Controller Cable
- 15V/4.2A power supply unit

3.2.2. OEM

The OEM system is supplied **without** a key switch on the controller. Connecting the power supply to the controller initiates an automatic start-up sequence. If the remote interlock is connected, laser radiation will start automatically as soon as power is supplied and internal temperatures are stabilized.

The OEM model consists of:

- Laser head
- Controller
- Controller Cable
- 15V/4.2A power supply unit

3.3. Laser Head

The Laser Head contains a passively Q-switched diode-pumped solid-state nanosecond pulsed laser cavity, an integrated Optical Parametric Oscillator (OPO), beam shaping optics and thermoelectric coolers (TEC). The Laser Head also contains an optical feed-back loop which measures the average power of the output radiation and a pulse monitoring feed-back loop that measured the repetition rate of the pump laser. The beam shaping optics to provide a collimated, circular beam.

The Laser Head gets electrical power and control signals from the Controller via a 26-pin cable. The Laser Head has a manual shutter, a manufacturer’s identification label and a laser hazard and classification label. In addition, the Laser Head features an SMA connector for direct monitoring of pulse parameters and delivering a trigger-out signal from the measured pump OPO pulse.

3.4. Controller

The Controller supplies driving current and control signals to the laser head. All Laser Heads are delivered with a controller. The operation set points are specific to each Laser Head and have been fixed during manufacturing. The operation set points are stored in the laser head so the controller can be interchanged or replaced.

The status of the laser operation is given via LED indicators:

- | | | |
|-------------|----------------|---|
| <i>POW</i> | (green light) | Power is supplied. |
| <i>ON</i> | (orange light) | Laser light is on in constant current mode. |
| <i>LOCK</i> | (orange light) | Laser light is on and the output power has been locked to set point.
The laser is operating according to specifications. |
| <i>ERR</i> | (red light) | An error has occurred. No laser light. |

When power is supplied to the Controller, regardless of on/off state, the temperature control elements are operating to reach set point values. The Controller includes a remote interlock connector, pin 1-2 according to Section 4.3. The operation of the laser can be controlled and monitored via the data port that supports either USB or RS-232 commands. See Section 8.4 for further details. RS-232 controllers may also be delivered with a RS-232 to USB adaptor.

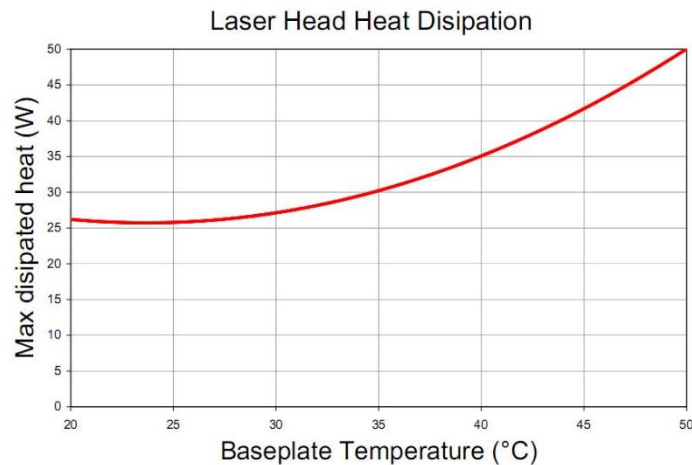
3.5. Controller Cable

The controller cable connects the laser head to the Controller. The standard (CE compliant) cable length is 1 m long. The cable has a minimum bending radius 8 cm. When connected care should be taken not to bend or break any of the 26 pins.

3.6. Thermal Management

To ensure operation within given specifications and for the warranty to be valid, the Laser Head must be attached to a heat sink providing a thermal resistance of <0.2 K/W. This value is the difference between the maximum allowed Laser Head base plate temperature (50°C) and the maximum specified ambient temperature at the air-heatsink interface (40°C), divided by the maximum power dissipated from the laser (~ 50 W for the highest power models at high ambient temperatures). The mounting surface should be flat (within ± 0.05 mm over mounting surface). It is recommended to use a thermal heat compound between the Laser Head and the heat sink to provide good thermal contact. The Cobolt 'HS-04 Laser Head Heatsink with fans' meets these requirements, see www.cobolt.se for more information on heat sinks.

For assistance in thermal management and system integration, please contact Cobolt's technical support.



Heat Sink Requirements and typical maximum heat dissipation for Cobolt Odin Series.

3.7. Power Supply Requirements

An appropriate Power Supply Unit (PSU) is supplied by Cobolt with the laser and must be plugged into a properly grounded standard power outlet. The output from this PSU is 15 VDC/4.2 A. The power supply accepts 100 – 240 V AC and 50-60 Hz. Ripple and noise 1% peak-peak max, 20 MHz bandwidth. The accepted voltage range is 11 V - 28 VDC; full performance is only guaranteed at 15 VDC/4.2 A.

4. System Description

The information presented here is believed to be accurate and is subject to change without notice. The specifications contained herein cannot be guaranteed outside of normal operational conditions. Specifications are guaranteed at 100% of nominal power.

4.1. Specification

4.1.1. Optical Specifications

Product Name	Cobolt Odin™			
Center wavelength ¹	3264 ± 4 nm		4330 ± 4 nm	
	3431 ± 4 nm			
Spectral Bandwidth	< 1.5 nm		< 2.8 nm	
Wavelength tuning range	± 25 nm		± 20 nm	
Wavelength resolution	< 0.007 nm			
Average output power	> 80 mW		> 60 mW	
Long term power stability (8hrs, ±3°C) ²	< 3 %			
Repetition rate ³	> 10 kHz	> 7 kHz	> 10 kHz	> 7 kHz
Pulse energy	> 7 µJ	> 10 µJ	> 7 µJ	> 10 µJ
Pulse duration	3-5 ns			
Pulse-to-pulse Jitter	< 1 µs			
Beam divergence (full angle, 1/e ²)	< 8 mrad			
Beam diameter at aperture (1/e ²)	1.7 ± 0.5 mm			
Polarization extinction ratio	> 100:1, vertical			
Beam symmetry at aperture	> 0.90 : 1			
Long-term repetition rate stability (8 hours, ±3 °C)	< 3 %			
Beam position accuracy	< 0.5 mm			
Beam angle accuracy	< 5 mrad			

All specifications given above are valid at nominal output.

1. The wavelength is specified in air. Other center wavelengths from 2-5µm available upon request.
2. Average power stability measured at a fixed wavelength. Power may vary during tuning.
3. The repetition rate can be chosen at time of purchase in combination with any available wavelength.

4.1.2. Operation and Environmental Specifications

Power supply	15 VDC, 4.2 A. (11-28 VDC accepted)
System power consumption (Laser Head + Controller)	< 63 W (typical ~30 W)
Maximum heat dissipation of Laser Head	< 50 W (typical ~20 W)
Maximum Laser Head baseplate temperature	50°C
Warm-up time, from OFF	< 5 min
Ambient temperature, operation	10 – 40 °C
Ambient temperature, storage	-10°C to +60 °C
Humidity	0-60 % RH non-condensing
Ambient Air pressure	950-1050 mbar
Heat sink thermal resistance, Laser Head	< 0.2 K/W

4.1.3. Electrical Interfaces

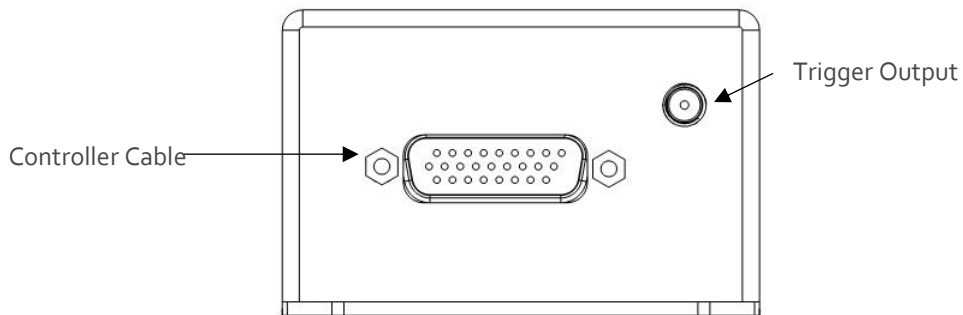
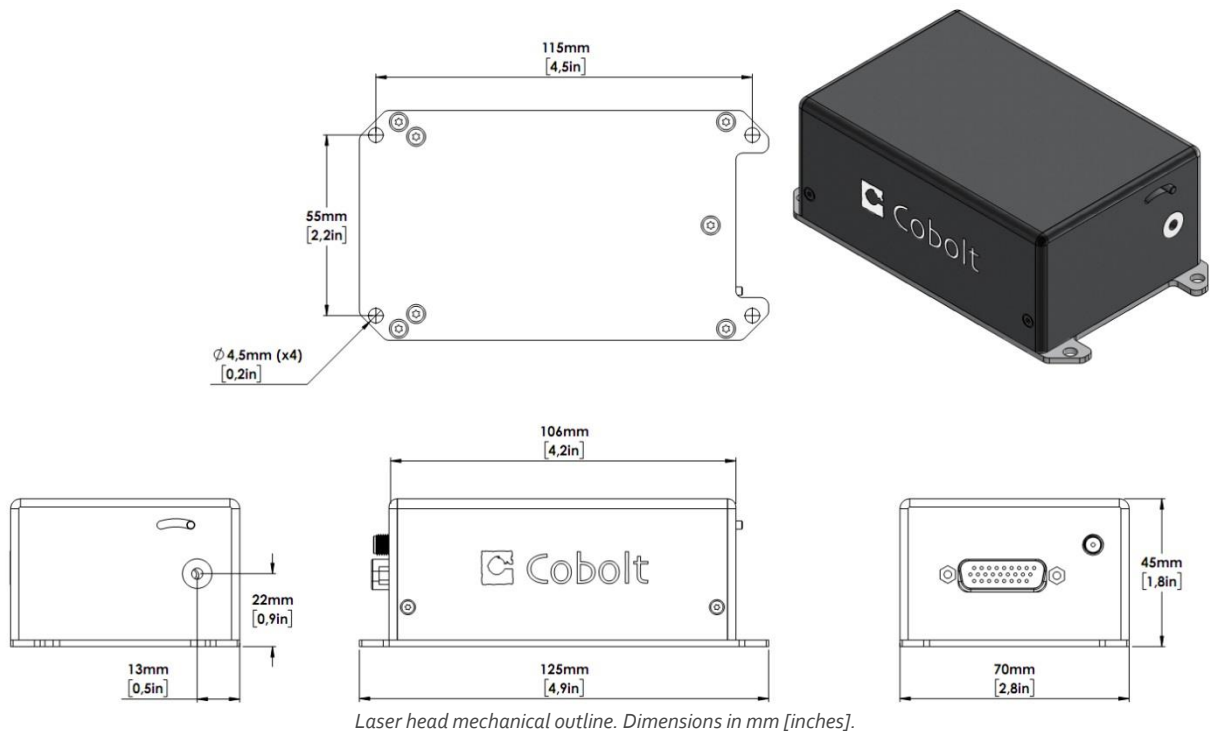
Interfaces	Connector	Function
Input power	Kycon KPJX-45, 4-pin	Power supply to Controller
Laser Head to Controller	HD-sub 26-pin, male	Connection to Laser Head
Controller to Laser Head	HD-sub 26-pin, female	Connection to Controller
Data port	USB-type mini B	Control and monitoring via control commands
Remote interlock & Analog signals	Molex 90130-3206	Analog input 5 – 12 V => Laser ON Analog input <2.7 V => Laser OFF
Trigger output	SMA Female	Output signal from pulse monitor

4.1.4. Mechanical Interfaces

Dimensions:	
Laser Head	125x70x45 mm (4.9x2.8x1.8 inches)
Controller	190x72x28 mm (7.5x2.8x1.1 inches)
PSU dimensions	115x50x35 mm (4.6x2x1.4 inches)
Fixation holes, Laser Head	∅ = 4x 4.5mm ; 115mm x 55mm
Fixation holes, Controller	∅ = 4x 6.4mm ; 178mm x 51mm
Cable (Laser Head – Controller)	1 m length, >8 cm bending radius
Laser Head weight	0.6 kg

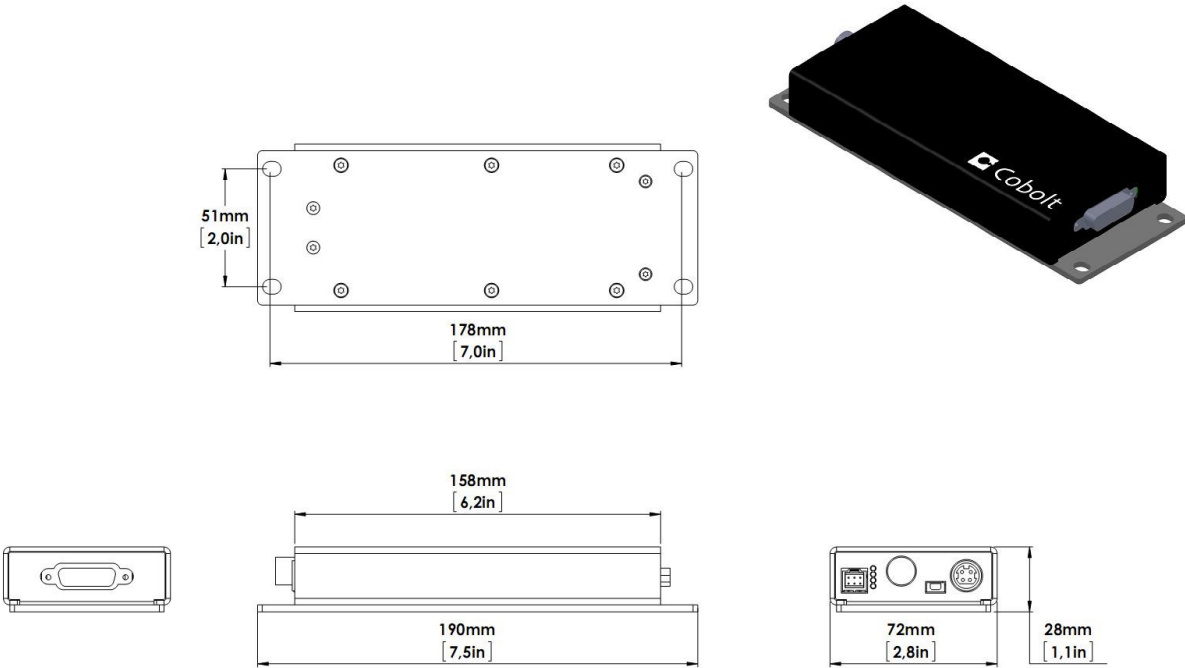
4.2. Mechanical Drawings

4.2.1. Laser Head

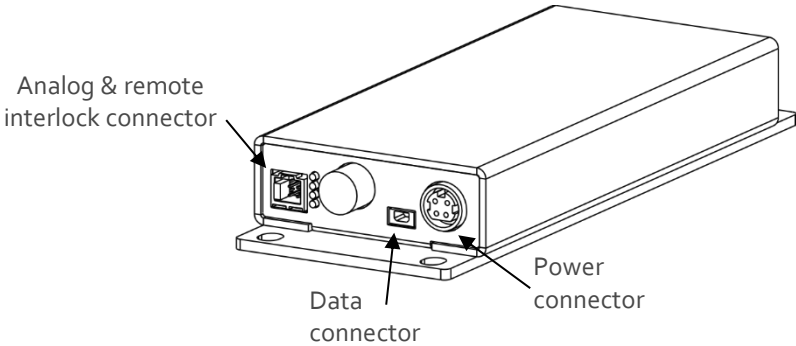


Connector location Laser Head

4.2.2. Controller



Controller mechanical outline. Dimensions in mm [inches].



Connector location Controller

4.3. Remote Interlock Connector

The remote interlock connector is located at pin 1 and 2 of the Molex connector on the Controller. The connector can be short-circuited with an interlock jumper (included at delivery) for operation of the laser. To use the remote interlock connector with an external switch, connect a pin 1 and 2 on a Molex plug. After the remote interlock connector has been opened the laser will need to be reset by disconnecting from and then reconnecting to the power supply in order to start again. Alternatively, it can be re-started using a special sequence of commands, see Section 8.4 for further details. The signal level is between 0V and +5V with a pull up resistor, and the current required to ground the remote interlock connector is 5 mA. The time delay in the hardware is <1ms, but after filtering by the firmware the reaction time is extended to < 20ms.

4.4. Direct ON/OFF control

The Direct On/Off Control feature enables turning the laser ON/OFF using a 5-12 VDC signal. After having configured the Controller for Direct Control operation (factory set or by executing @cobasdr 1), the laser can only start-up when 5-12V VDC (max 12.5 VDC) is applied to pin 3 on the analog connector with 0 VDC on pin 2 as reference. Shifting the signal to 0 VDC on pin 3 will turn the laser off and put the laser in stand-by mode (status LED:s is POW and not flashing).

This function is not available for CDRH compliant models.

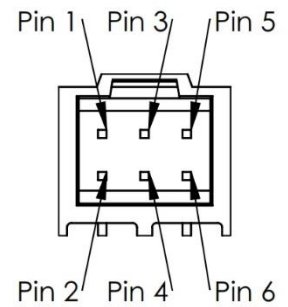
! Note: This input only controls the on/off state of the laser and cannot be used to modulate the power output.

4.5. Pin assignment

4.5.1. Analog connector & Remote interlock connector

Manufacturer Molex 90130-3206, mates with 90143-0006.

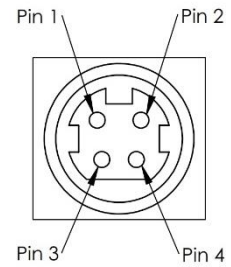
Pin	Function
1	Remote Interlock (connect to pin 2 for enable)
2	0 V - GND
3	Remote On/Off (+5V Input)
4	TST (Internal Cobolt use only)
5	LED "Laser on" (5V)
6	LED "Error" (5V)



4.5.2. Power connector

Kycon KPJX-4S, mates with Kycon KPPX-4P. Grounded shield.

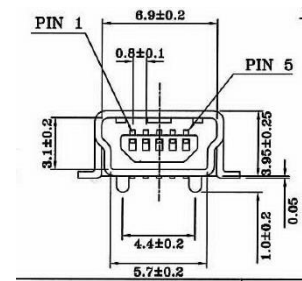
Pin	Function
1	0 V
2	+11-28 VDC
3	0 V
4	+11-28 VDC



4.5.3. Data connector

Connector USB-type, manufacturer Hsuan Mao C8320-05BFDSBo, mates with connector mini-B.

Pin	Function
1	+5 V
2	D-
3	D+
4	Not connected
5	0 V (GND)



5. Operating Instructions

As standard, all lasers are delivered with the Controller set in Auto-start mode. As soon as power is supplied to the Controller the temperature control elements are operating to reach set-point values and the laser emission will start, unless the key-switch is enabled (CDRH model).

5.1. Installation start-up operation

1. Mount the laser head on a suitable heat sink (see Section 3.5).
2. Ensure that the remote interlock jumper is connected.
3. Connect the laser head to the Controller with the Cable and fasten screws at both ends.
4. Connect the 15 VDC power supply to the mains outlet and then to the Controller.
5. The laser now goes through the following auto-start sequence:
 - Temperature stabilization (1-2 min). Status LEDs: POW flashing, then POW goes on.
 - Turn key switch to start the laser. Status LEDs: ON goes on (CDRH model only)
 - The laser starts (light is emitted) in a constant warm-up current constant for 60 sec. Status LEDs: ON goes on.
 - The laser locks to pre-set output power (<2 min) and operates according to specifications. Status LEDs: LOCK goes on.

! Note: If the power does not match the power as stated on the test sheet see Section 12: Service for more information.

5.2. Shutdown procedure operation

1. Turn the key switch to OFF first (CDRH models only).
2. Disconnect PSU from mains outlet.
3. Disconnect Controller from PSU.

6. Operating modes

Cobolt Odin™ series lasers are delivered in constant power mode. CDRH/CE compliant models may be used in constant power, constant current and burst mode only.

6.1.1. Constant current

The pump laser diode delivers a constant current. The constant repetition rate loop is inactive when this mode is selected. The actual repetition rate will still be displayed in the GUI.

6.1.2. Constant Power

The average power is monitored internally and a feed-back loop assures that a constant average output power is delivered by making small adjustments to the laser diode current. Note that the constant power monitor is wavelength dependent. The displayed power measurement is only valid at the center wavelength. It is recommended to use the constant power mode only when additional power stability is desired and operating the OPO at a constant wavelength. Tuning the wavelength while in constant power mode, will result in a change in output power due to this wavelength dependence.

6.1.3. Burst mode

In burst mode, the laser diode current is modulated which allows in bursts of pulses to be emitted repeatedly. The "On-Time" sets the time (in ms) where the laser diode current is set to "I-High", and the "Off-time" sets the time (in ms) where the laser diode current is set to "I-Low".

The burst mode can be used in numerous ways, but a typical use would be to set the "I-Low" just below the laser threshold and the "I-High" at a laser diode current giving desired output power. The result would be an on/off modulation of the laser set by the On/Off-times where a burst of pulses is emitted during the On-time. The pulse repetition rate is dependent on the laser diode current and consequently the number of pulses emitted in the On-state is dependent on both the "On-time" and "I-High".

As an example, if the pulse repetition rate at the set "I-High" is 7 kHz and the On-time is 7ms, there will be a burst of approximately 49 pulses during the On-time.

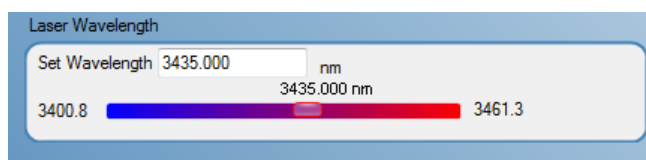
6.1.4. Constant repetition rate (OEM only)

The pulse repetition rate is monitored internally and a feed-back loop assures that a constant repetition rate is delivered by making small adjustments of laser diode current. Using the lasers in constant repetition rate mode is not compliant with the EMC/EMI 61326 standard for immunity to radiated electromagnetic fields according to IEC 61000-4-3 and thereby negates the CE compliance.

7. Wavelength tuning

Cobolt Odin™ features a filtering technique which significantly narrows the bandwidth of the emitted light resulting in the spectral bandwidth specified above. Additionally, the wavelength of the emitted light can be tuned with high repeatability and stability.

Tuning is done in the GUI by selecting “more” and then setting the desired wavelength. Equivalently, the 'swl' command can be used.



The wavelength tuning is continuous within three to four overlapping wavelength ranges of about 22nm each, together covering the total tuning range stated in the specification. The wavelength is controlled by adjusting the temperature settings of the TECs inside the laser head.

The TEC temperatures displayed in the GUI will turn from red to green when the target temperatures have been reached and the OPO has reached its target wavelength. It will take several additional seconds before the temperature has stabilized to within the $\pm 0.01^{\circ}\text{C}$ required for the specified stability performance. The specified bandwidth and wavelength stability are applicable only after the temperatures have stabilized.

Tuning time is proportional to the wavelength step taken, with additional time when going from one wavelength range to another. During the tuning time, the wavelength, the shape of the spectrum and the bandwidth may not be as stated in the specification. A tuning step spanning the entire tuning range typically takes less than a minute. For applications in which the shape of the spectrum and the bandwidth should be maintained during tuning it is recommended to tune the wavelength incrementally in small steps rather than setting the final wavelength directly.

Each unit is calibrated at the operating conditions stated in the test protocol prior to shipment. Operating the device under other conditions may affect the absolute calibration, but the repeatability and stability is maintained. The wavelength calibration is affected by a change in the OPOs operating current. Consequently changing the repetition rate, average power or operating the device in burst mode will affect the absolute wavelength calibration. As a rule of thumb, the wavelength shift is $\sim 1\text{pm}/\text{mA}$.

Note that the set wavelength refers to the wavelength in dry air at 1 atm and 288) where the refractive index in the mid-IR range is 1.000273.

8. Operation via data port

8.1. Handshaking

Under no circumstances does the Controller initiate communication; it only transmits characters in response to a message. Every message to the Controller generates a response, either a numerical value or the acknowledgment string "OK". In the event that the Controller receives a message that it cannot interpret, it responds: "Syntax error:" followed by the complete command string (minus the termination character) that caused the error. Every Controller response is terminated by a carriage return (ASCII 13) and a full stop is used with floating numbers.

8.2. RS232 configured controllers

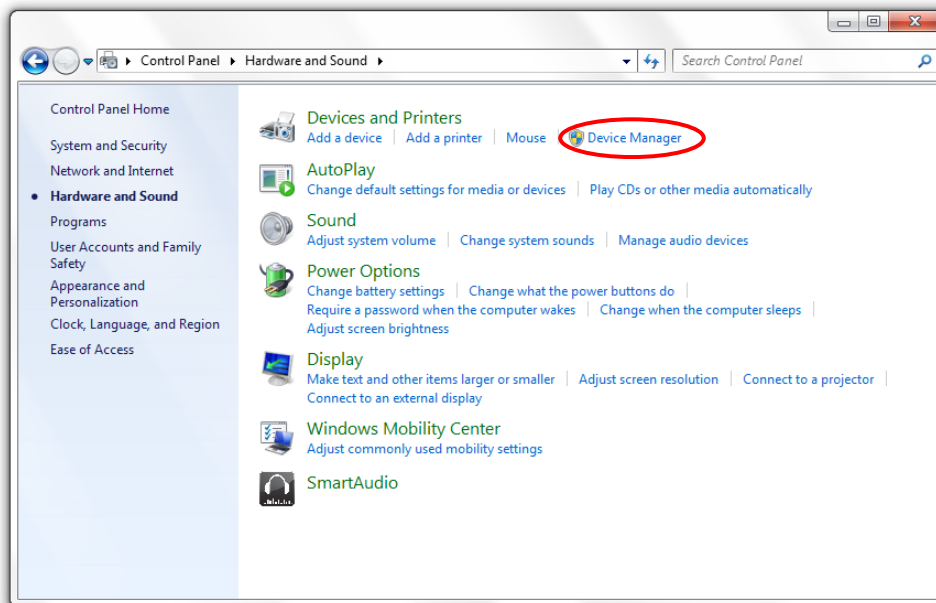
To communicate with the laser, a communication cable is supplied. Each Controller is shipped from the factory with a fixed baud rate (115200). The other serial port parameters are: 8 data bits, 1 stop bit and no parity. Hardware flow control is not supported. Each command to the Controller must be terminated by a carriage return. All commands are case-sensitive. Leading and trailing white space is ignored, but command arguments must be delimited by a single space character (ASCII 32).

8.3. USB configured controllers

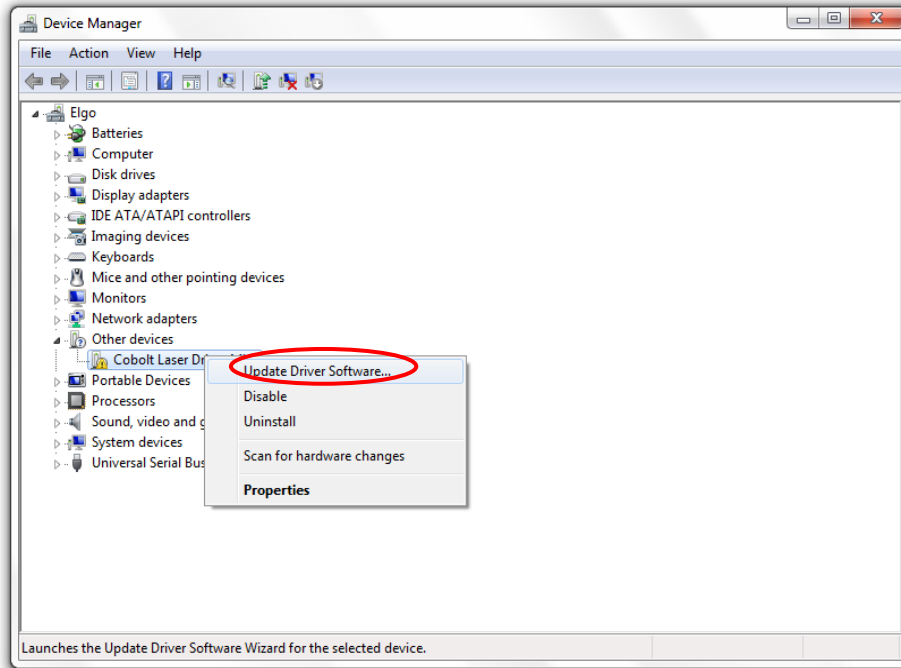
The USB configured controllers requires a driver for communication with a computer. The USB driver must be installed and can be downloaded from the Cobolt website (www.cobolt.se). When installed, a virtual COM port will be created to communicate with the Controller.

To install the USB driver in Windows 7 follow these instructions:

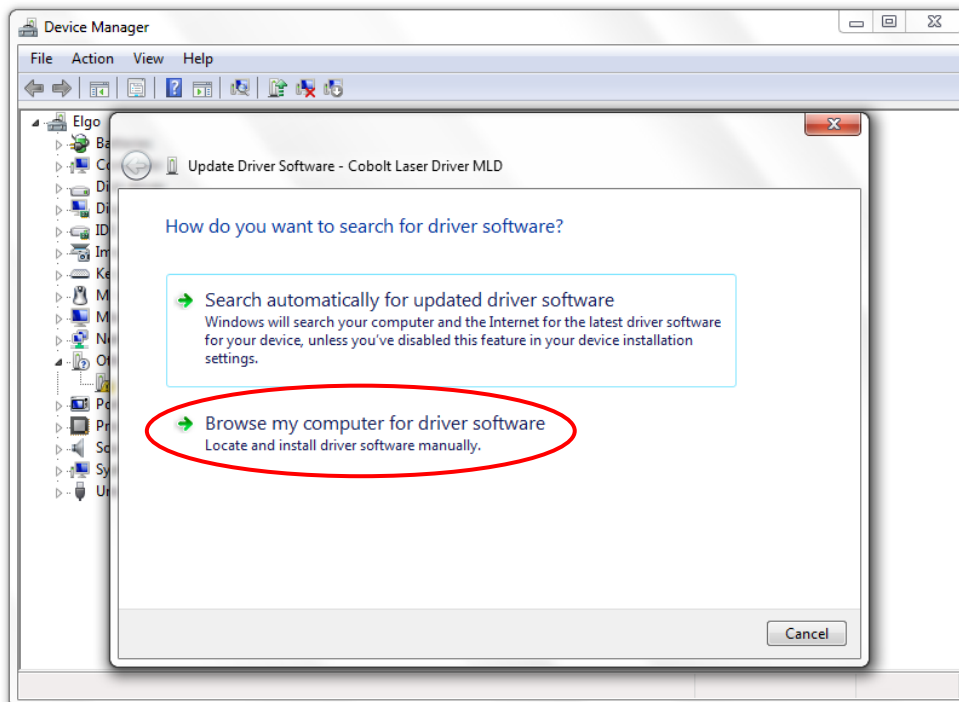
1. Go to the **Control Panel** and choose **Hardware and Sound**.



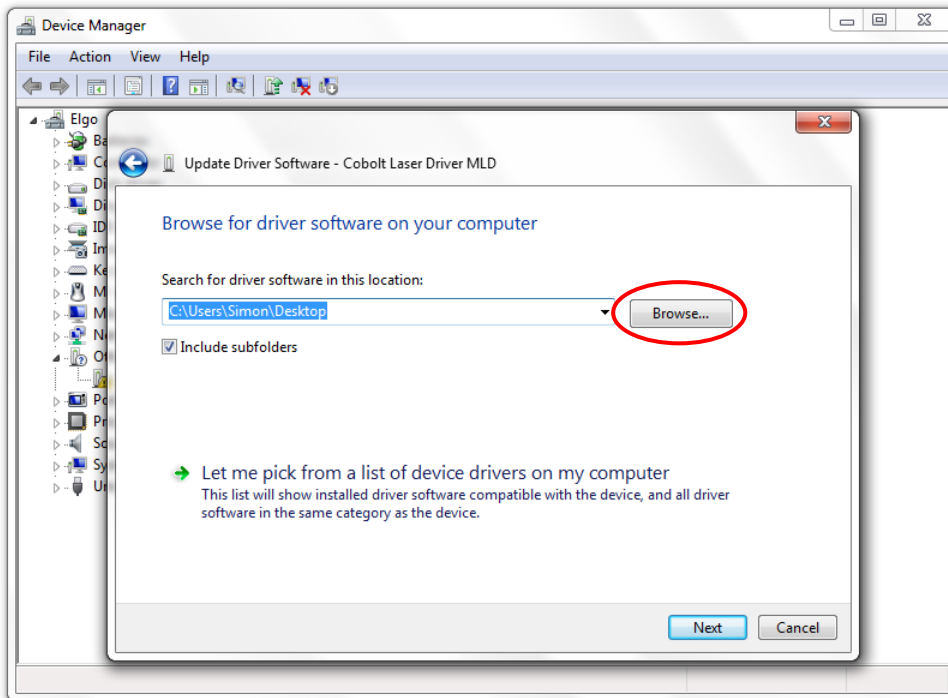
2. Under the **Devices and Printers** section, choose **Device Manager**.
3. Under **Other devices**, find the device called **Cobolt Laser Driver MLD/DPL**. Right-click it and chose **Update Driver Software**.



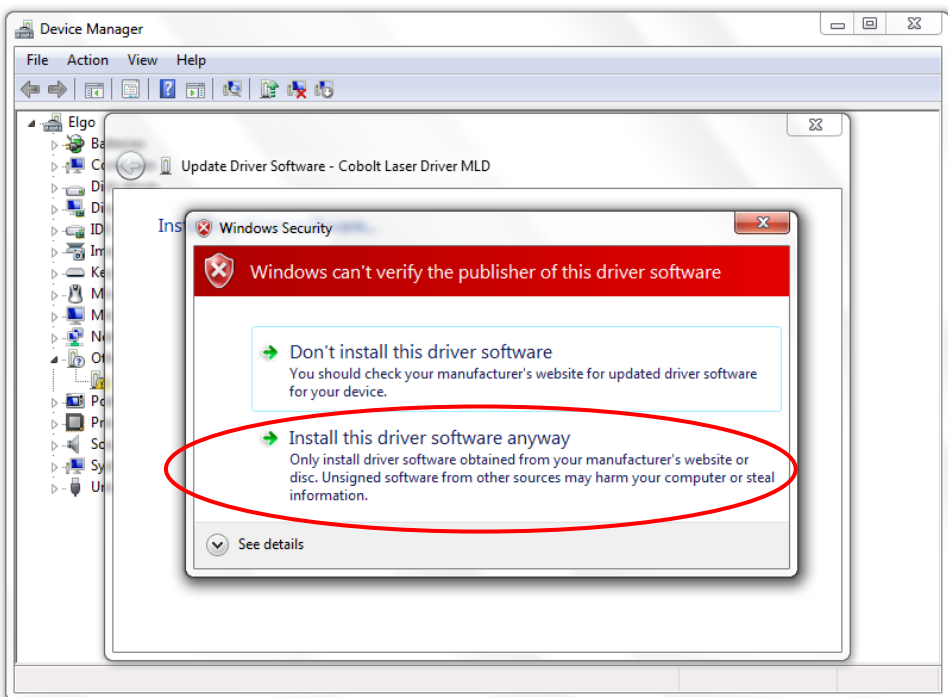
4. On the next screen chose the **Browse my computer for driver software** option.



5. Click **browse**, and find folder on your computer where the USB driver is stored.



6. Windows security may warn you that the publisher of the driver is unverified. Choose **Install this driver software anyway**.



7. The installation should now be complete.

8.4. Communication commands

The laser is delivered with the Controller set in Auto-start mode (see section 5.1 for Auto-start sequence description). For system integration the Auto-start sequence can be disabled and the following commands can be used to control the laser (NOTE some commands require Auto-start to be disabled but others will work when Auto-start is active). As long as power is supplied to the Controller the temperature control elements are always operating to reach set-point values and the laser will be idle waiting for the next command. All arguments are in lower case and separated by a space (ASCII 32).

Command	Function	Argument	Returned value
hrs?	Get laser head operating hours		Float
ilk?	Get interlock state		0 = OK, 1 = interlock open
@cobas	Enable/disable autostart (OEM models)	0 = disable, 1 = enable	
@cobas?	Get autostart enable state		0 = disabled, 1 = enabled
l?	Get laser ON/OFF state		0 = OFF, 1 = ON
l1	Laser ON Requires autostart disabled. Use this command for manual ON (OEM models).		
lo	Laser OFF Use this command for manual OFF (OEM models).		
p?	Get set output power		Float (W)
p	Set output power	Float (W) (e.g. p 0.050 for 50 mW)	
pa?	Read output power		Float (W)
i?	Get drive current		Float (A)
slc	Set drive current	Float (A)	
leds?	Status of 4 LEDs		Int [0:15] Bit 0 = "POWER ON" Bit 1 = "LASER ON" Bit 2 = "LASER LOCK" Bit 3 = "ERROR" 1 = LED on 0 = LED off
f?	Get operating fault		0 = no fault 1 = temperature error 3 = open interlock 4 = constant power fault
cf	Clear fault		
@cobasdr	Enable/disable direct control See sect 4.4 for description	0 = disable, 1 = enable	
@cobasdr?	Get direct control enable state		0 = disabled 1 = enabled
sn?	Get serial number		32-bit unsigned integer
@cob1	Laser ON after interlock Forces the laser into Autostart without checking if autostart is enabled (OEM models).		

swl	Set wavelength	Float (nm) (e.g. swl 3435.142)	
gwl?	Get wavelength		Float (nm)
rlf?	Read laser rep-rate		Float (kHz)
glf?	Get laser rep-rate		Float (kHz)
slf	Set laser rep-rate	Float (kHz)	
ebm	Enable burst mode		
ecc	Enable constant current mode		
ecr	Enable constant repetition rate mode		
ecp	Enable constant power mode		
sihigh	Set high-level (on-level) current used in burst mode	Float (A)	
silow	Set low-level (off-level) current used in burst mode	Float (A)	
stlon	Set on-time used in burst mode	Integer (ms)	
stloff	Set off-time used in burst mode	Integer (ms)	

For re-starting the laser with commands after having opened the remote interlock switch, execute "cf" for clear fault followed by "@cob1" to restart the laser. This command forces the laser into Auto-start enabled so Auto-start must be disabled if this is the required set up. On CDRH models the key switch is the only way to re-start.

9. Cobolt Monitor™ Software

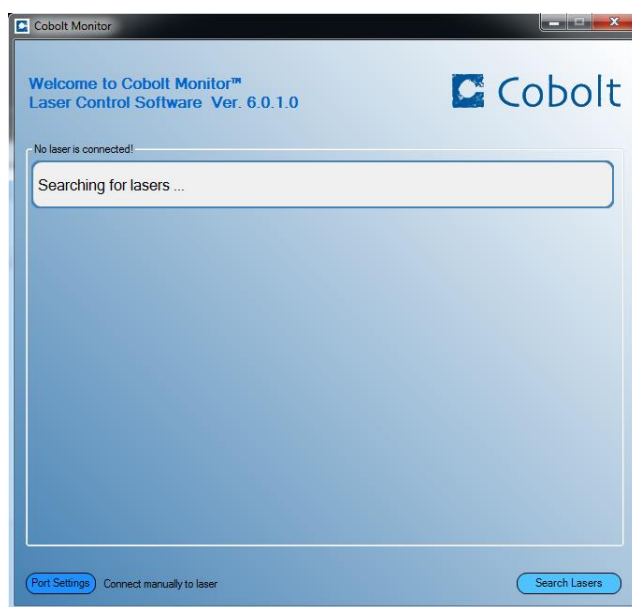
The Cobolt Monitor™ software provides a graphical way to monitor the laser performance and to change power, operation mode and other settings. The software can connect to the laser either via RS-232 port or via USB, depending on the type of controller. The USB driver must be installed manually and can be downloaded from the Cobolt website (www.cobolt.se), see section 8.3. Cobolt Monitor™ has been tested with operative systems Windows XP, Windows Vista, Windows 7 and Windows 8. Microsoft .NET 2.0 is required to run the Cobolt Monitor™ software. Most computers with operative systems Windows XP, Windows Vista, Windows 7 and Windows 8 have this included as standard.

9.1. Installation

Download the latest version of the Cobolt Monitor™ software from www.cobolt.se. The Cobolt Monitor™ software is a stand-alone executable, the executable file is packaged with other files needed to run the program in a .zip file. Save the .zip file any storage device, and extract all files. The folder created after extracting the files can be placed on any storage device and Cobolt Monitor™ can be run from there. All files and folders contained in the .zip file must be present for the program to function properly.

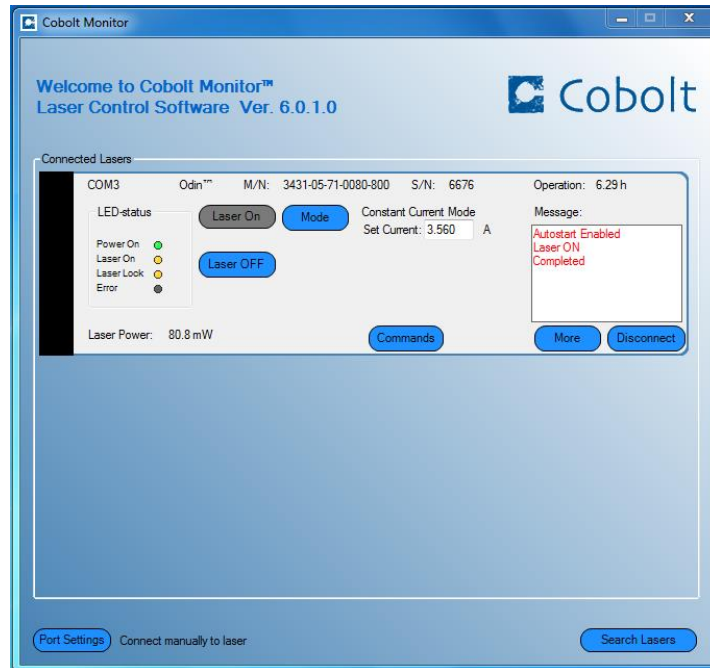
9.2. Software instructions

The software automatically searches for Cobolt devices every 5 seconds and automatically connects the laser if detected. The software can identify USB connected lasers as well as RS232 connected lasers.



The first Cobolt Monitor™ window that appears in the Cobolt Monitor software.

Once the laser is connected it can be controlled from the box dedicated for the laser. The interface, found in the following figure, is intended for typical user cases. Only the relevant information is presented on this level, displaying only the status the laser is in and relevant choices to make. Here follows a short description of how to use the Cobolt Monitor™ software on this level.



Laser successfully connected.

Laser ON – Turns the laser ON. If the laser is in autostart mode this is equivalent to “restart”.

Laser OFF – Turns the laser OFF.

Mode – Gives a choice of operational modes possible to choose for the laser model. Cobolt Odin™ Series Constant Power, Constant Current, Burst Mode and Constant Repetition Rate (OEM only) operation can be chosen. Only relevant choices are presented to the mode of operation chosen.

Commands – opens a command communications window to send commands directly to the laser controller.

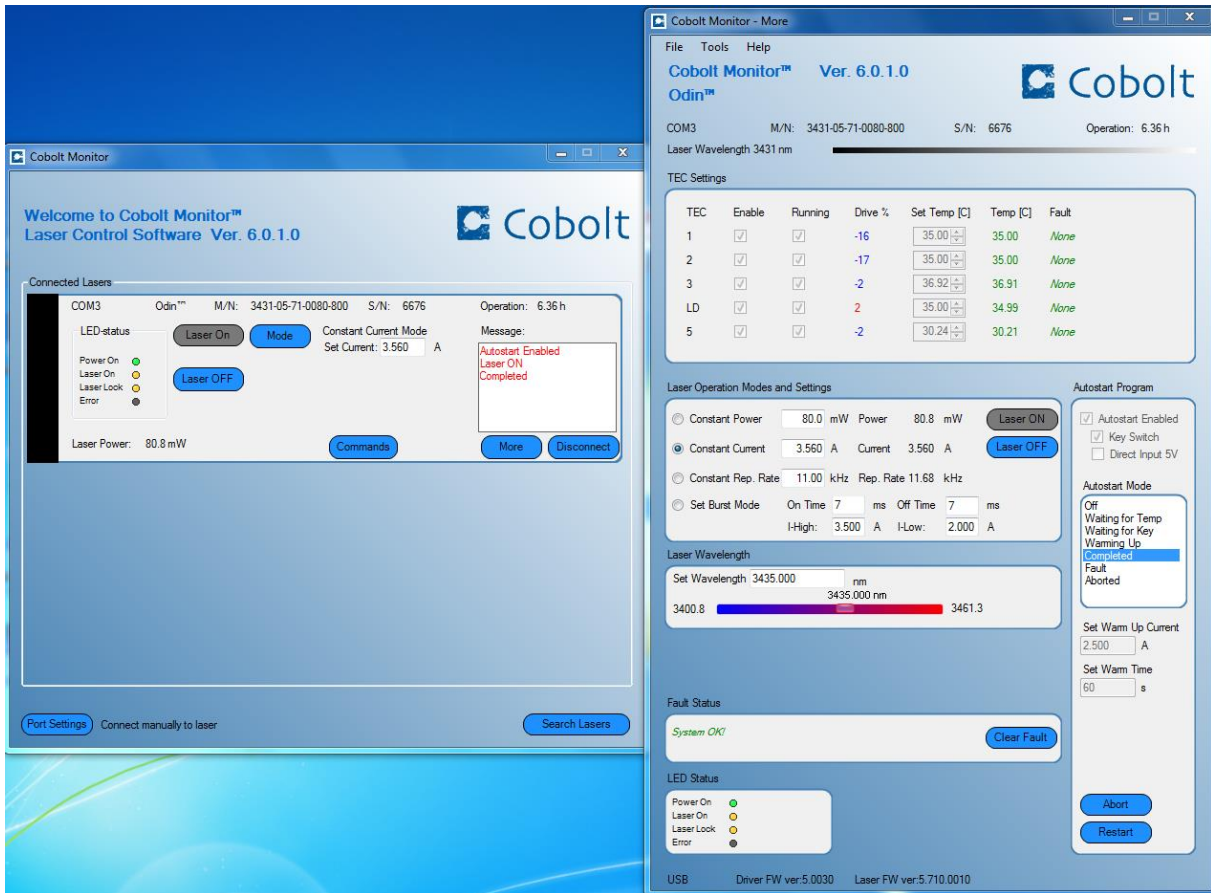
Message – highlights important information of the laser status to the user.

Disconnect – allows the user to disconnect from the Cobolt Monitor™ software in a controlled way.

! Note: The communication cable should not be removed when the software is in connect state. The communication within the controller may then malfunction and this might require a power restart of the driver. To disconnect the laser click “Disconnect” or close Cobolt Monitor™ completely. It is also possible to disconnect by powering the laser OFF. In this case Cobolt Monitor™ will automatically close the window for that laser.

Clear Fault - is displayed in the event of a fault. The user can deal with the cause of the fault and then press “Clear Fault” and then restart the laser by clicking “Laser ON”. Example: if the remote interlock loop is open the user must make sure the loop is closed again before issuing a “Clear Fault” followed by “Laser On”.

More –an additional Cobolt Monitor™ window will open containing more detailed information of that laser’s status.



Cobolt Monitor™ software expanded to for more detailed monitoring.

TEC Settings – shows the running status and the fault status for the laser’s internal thermoelectric coolers (TEC).

Laser Operation Mode and Settings - displays the set laser power. The user can switch between operation modes. Likewise, there are boxes to set the power, current, burst mode, repetition rate levels. See section 6 for more information on operation modes

Autostart Program - displays whether the laser is in CDRH or OEM mode and displays the current laser operational status. 5V direct input is set here, see section 4.4. There are also buttons to “abort” the autostart sequence or to “restart” the laser after a fault.

! Note Specifications are only guaranteed in constant power mode, at 100% of nominal power.

Fault Status – displays ERROR messages. In the event of an ERROR, the laser action is stopped. When the reason for the ERROR event is understood and the problem is addressed the fault status can be cleared with “Clear Fault”. If the Autostart Program is enabled, click restart to restart the laser.

LED Status - displays the LEDs that are currently illuminated on the Controller, see section 3.4. These are displayed even if the laser is in OEM mode.

10. Troubleshooting

In the unlikely case of a problem occurring, use the table below to help identify the error. Some faults can be fixed remotely. Back reflections into the laser cavity can cause instability. In case of a sudden voltage drop the laser will turn itself off and restart. If it is in CDRH configuration it will require that the key is turned on again. Contact Cobolt support or your local representative to identify corrective action.

<u>LEDs</u>	<u>Status</u>		<u>Explanation</u>	<u>Action</u>
	off	flashing		
POW	x		Mains power off	Check connections
POW		x	Temperatures not stabilized	Check if heatsink is sufficient
LOCK		x	Laser cannot lock in constant power, current limit has been reached	Check for back reflections. Contact the factory.
ERROR		on	Error in laser parameters	If lights at start-up check cable connections, if lights >5s after start-up contact the factory.

11. Warranty and Maintenance

Cobolt provides a warranty of 12 months with unlimited number of operation hours. The laser systems are designed for modular repair or replacement in the event that the laser head or Controller malfunctions. Warranty is invalid if the laser system is operated outside of the specific limits and conditions as outlined in this document.

The Cobolt lasers are contained in sealed enclosures and should not be opened for any reason. Disassembly of any part of the system (including the cable) means the system no longer complies with the EMC standards will void the warranty. All laser parameters are set at the factory, and there are no adjustments required. Maintenance is limited to wiping dirt off the enclosures and cleaning the aperture.

12. Service

Due to accuracy tolerances, calibration differences and allowed power drift there may be discrepancies between the Cobolt measurement of the optical output power and the customer measurement equipment. If the output power deviates from the reported value please contact your local Cobolt representative for an online re-calibration. If the laser does not function, do not attempt to open any of the units, or the warranty will be voided. Contact your local Cobolt representative for consultancy and to request an RMA number (see back cover for contact information). If an RMA number is issued and the laser needs to be shipped back to Cobolt or your local representative, please pack the complete system for shipment using the original package or equivalent. Ensure the unit is free from thermal paste before packing. The warranty covers repair or replacing the unit at the option of Cobolt.

13. Compliance (CDRH models only)

The CDRH model lasers (-5/700) are designed and manufactured to comply with the EC Low Voltage Directive and the EC EMC Directive in the CDRH-compliant configuration of laser head, controller, key, 1m controller cable and Cobolt-supplied power supplies. All equipment must be mounted on a common ground plane, such as an optical table. The equipment might not conform to the EC directives if any part of the supplied equipment is replaced with a part not supplied by Cobolt or if the equipment is not properly grounded. Disabling any of the safety features nullifies the CE compliance and the laser safety standard.



The following harmonized and limits standards have been applied:

Electrical Safety	EN 61010-1, IEC-61010-1, UL 61010-1 (Limited Energy System) UK S.I. 2016 No. 1101 : The Electrical Equipment (Safety) Regulations 2016
Laser Safety/Class	IEC-60825-1 FDA / CDRH : Complies with 21 CFR 1040.10 and 1040.11 except for conformance with IEC 60825-1 Ed. 3, as described in Laser Notice No. 56, dated May 8, 2019.
EMC	IEC 61326-1 EN 55011 Electromagnetic Emission , Class A Electromagnetic Immunity – Table 1 Requirements EN 61000-4-2 Electrostatic Discharge ±4 kV contact discharge and ±2 kV, ±4 kV, ±8 kV air discharge EN 61000-4-3 Radiated electromagnetic fields 80 – 1000 MHz, 3 V/m with 80 % AM @ 1 kHz 1.4 – 2.0 GHz, 3 V/m with 80 % AM @ 1 kHz EN 61000-4-4 Fast transient / Burst AC Power input port ±2,0 kV EN 61000-4-5 Surge AC Power input port ±0,5 kV, ±1,0 kV, ±2,0 kV Com. Mode AC Power input port, ±0,5 kV, ±1,0 kV Diff. Mode EN 61000-4-6 Conducted Immunity 3 V with 80 % AM @ 1 kHz EN 61000-4-11 Dips and Interruptions 50 Hz and 60 Hz. Test voltages: 100 V and 230 V UK S.I. 2016 No. 1091 : Electromagnetic Compatibility Regulations 2016 FCC 47 CFR - Part 15 (2009): Subpart B, Class A
RoHS	EU Directive 2011/65/EU, EU 2015/863 and amendment EU 2017/2102 UK S.I. 2012 No. 3032

Contact your sales representative for a copy of the full Declaration of Conformity.

14. Disclaimer

Cobolt will assume no responsibility for damage incurred by faulty customer equipment, such as measurement equipment, cables etc, used in conjunction with Cobolt lasers. Cobolt makes no warranty of any kind with regard to the information contained in this guide, included but not limited to, implied warranties of merchantability and suitability for a particular purpose. Cobolt shall not be liable for errors contained herein nor for incidental or consequential damages from the furnishing of this information. No part in this manual may be copied, reproduced, recorded, transmitted, or translated without the express written permission by Cobolt.



Our Locations

Cobolt AB

(Sales in Norway, Sweden, Finland and Denmark)

Solna, Sweden

Phone: +46 8 545 912 30

Fax: +46 8 545 912 31

E-mail: info@coboltlasers.com

HÜBNER GmbH & Co. KG

(Sales in Germany, Switzerland and Austria)

Kassel, Germany

Phone: +49 6251 770 6686

Fax: +49 6251 860 9917

E-mail: photonics@hubner-germany.com

HÜBNER Photonics Inc.

(Sales in USA, Canada and Mexico)

San Jose, California, USA

Phone: +1 (408) 708 4351

Fax: +1 (408) 490 2774

E-mail: info.usa@hubner-photonics.com

HÜBNER Photonics UK

(Sales in UK and Ireland)

Derby, Great Britain

Phone: +44 2380 438701

E-mail: info.uk@hubner-photonics.com

www.hubner-photonics.com

Australia

Warsash Scientific Pty Ltd

www.warsash.com.au

Benelux

Laser 2000 Benelux CV

www.laser2000.nl

Brazil

Photonics Instrumentos

www.photonics.com.br

China

DynaSense Photonics Co. Ltd.

www.dyna-sense.com

Estonia, Latvia and Lithuania

Optek Ltd

www.optek.lv

France

Optoprim

www.optoprim.com

India

Spectral Instrument System

www.spectralinstruments.com

Israel

Lahat Technologies Ltd

www.lahat.co.il

Italy

Crisel Instruments

www.crisel-instruments.com

Japan

Kantum Electronics Co Ltd

www.kantum.co.jp

Pneum Co, Ltd Japan

www.pneum.co.jp

Poland

Amecam

www.amecam.pl

Russia and Belarus

Azimuth Photonics

www.azimp.ru

Russia and Belarus

Azimuth Photonics

www.azimp.ru

South Korea

BM Laser Solutions Co., Ltd

www.bmlaser.co.kr

SM Tech

www.lasersystem.co.kr

Singapore, Malaysia and Thailand

Wavelength Opto-Electronic

www.wavelength-tech.com

Spain and Portugal

Laser Technology SI

www.laser-technology.com

Taiwan

Tayhwa Technology Co Ltd

www.tayhwa.com.tw

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