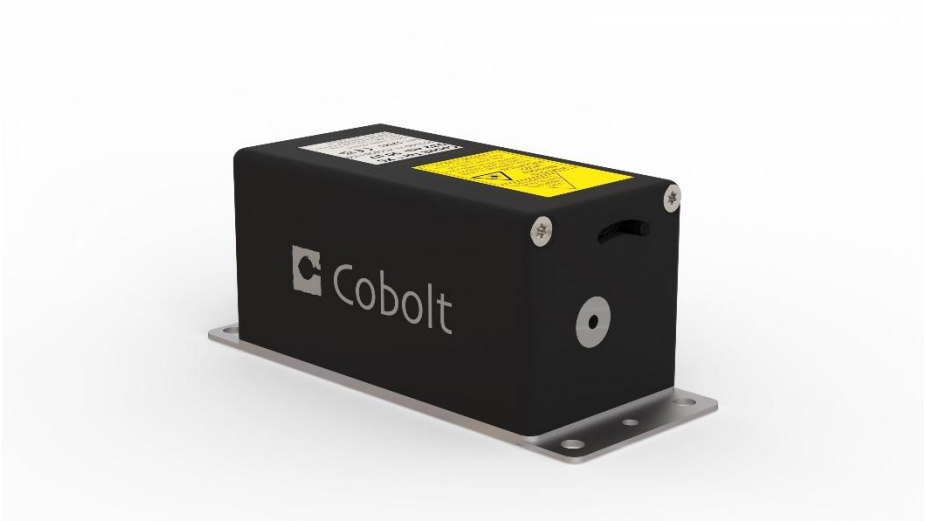
Cobolt Tor™ XS

Ultra-compact | Triggerable | Q-switched laser

532 nm
1064 nm



HÜBNER Photonics

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1. Introduction

The Cobolt Tor™ XS lasers are high-performance triggerable Q-switched diode-pumped lasers that come in an ultra-compact design with fully integrated electronics. The advanced integrated drive electronics allows for control of the laser using either integrated functionalities or by using an external signal connected to the SMB connector on the backside of the laser. This makes it possible to trigger optical pulses on demand for various applications. The pulse properties remain constant at all repetition rates.

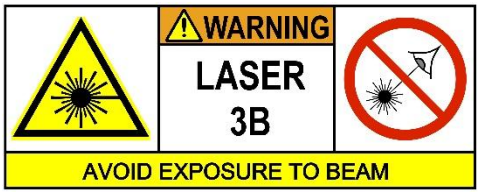
The lasers are manufactured using Cobolt's proprietary HTCure™ technology and packaged into a sealed laser head, offering an outstanding level of robustness and reliability and making these lasers highly suitable for OEM integration into demanding environments.

The combination of ultra-compact format, high level of robustness, high average power and pulse energy performance make the Cobolt Tor™ XS lasers ideal light sources for a large variety of industrial and scientific applications including LIDAR, hand-held LIBS and photoacoustic microscopy.

2. Safety

2.1. General

Cobolt Tor™ XS lasers are Class 3B (IEC) laser products that emit laser radiation in the Visible and Near Infrared (IR) spectrum. Residual emissions from the pump diode are contained within the laser head housing via filtering optics. The residual emission does not exceed Laser Class 1.



Symbols in the manual

WARNING – LASER RADIATION This symbol is used to call attention to important laser safety information

WARNING – STATIC MAGNETIC FIELD This symbol is used to call attention to important magnetic field safety information

CAUTION – GENERAL This symbol is used to call attention to important general operator and equipment safety information

NOTICE – GENERAL This symbol is used to call attention to best practices when using the equipment and does not indicate a hazard.

2.2. Accessible Emission

The table below describes the irradiance in W/cm² and appropriate level of eye protection in terms of optical density (OD) for each laser product. Be sure to consider the wavelength and power levels when selecting eye protection.

CAUTION Always wear the appropriate eye protection for the specified wavelengths. Verify the accessible emission wavelengths and power levels on the warning label before operating.

Product	Laser Class	Warning Label Power (mW)	Max Pulse (µJ)	Max Energy Density (mJ/cm²)	Eye Protection Requirement
Cobolt Tor™ XS 532 nm	3B / III	200	200	76	> OD 5 / I,R LB 6
Cobolt Tor™ XS 1064 nm	3B / III	300	300	153	> OD 5 / I,R LB 6

The equations below describe how to use the nominal output power (mW) and the minimum beam area to calculate the irradiance (kW/cm²) and how to use the Warning label (Max) power (W) and the Accessible Emission Limit (AEL) (W) per laser safety standard IEC 60825-1:2014 to calculate the required optical density (OD) for eye protection per wavelength.

$$\text{Irradiance}\left(\frac{\text{kW}}{\text{cm}^2}\right) = \frac{110\ \%\ \text{of Nominal Laser Power (kW)}}{\text{Beam area at bottom tolerance (cm}^2\text{)}}$$

$$\text{Require Attenuation of Laser Safety Glasses (OD)} = \log_{10}\left\{\frac{\text{Warning Label Power (W)}}{60825-1\ \text{Laser Class 1 AEL (W)}}\right\}$$

2.3. Beam Hazards

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. Class 4 laser radiation may ignite flammable materials and combustible gases in the beam path, and, in event of ignition, 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.

WARNING Remove all watches, rings, and other reflective jewelry before working with lasers. Always wear the appropriate eye protection from the wavelengths integrated into the system. Verify the accessible emission wavelength and power before operating. **Never look directly into a laser beam.**

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. If the laser does not function, do not attempt to open any of the units, or the warranty will be voided. Call or e-mail your local HÜBNER Photonics representative for consultancy and to request a case number.

2.4. Safety features

The laser is equipped with all required safety features as described in the laser safety standard 60825-1. Disabling any safety features negates the CE/CDRH compliance of this product. If any part of the delivered equipment is replaced with a part not supplied by Cobolt, or if the equipment is not properly grounded, then system may not conform to the CE / CDRH compliance standards listed in section 12 : Compliance (CDRH models only). Disabling any of the safety features nullifies the CE marking and violates the laser safety standard.

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 6.4 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 and 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 Key control box incorporates information LEDs, which display whether the power is connected and the laser is on, or if a fault has occurred. The "ON" LED is illuminated whenever the device is emitting or could emit light. The emission warning indicators are also visible in the Cobolt Monitor™ software. See section 4, for details on the control software.

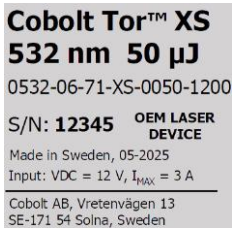
2.5. Equipment Safety

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).

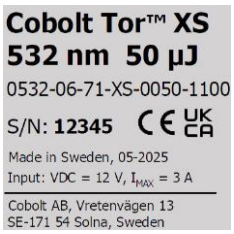
2.6. Warning and Identification Labels

The upper face of the laser head contains a yellow label with laser safety warning and classification information, the wavelength, maximum pulse energy 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 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

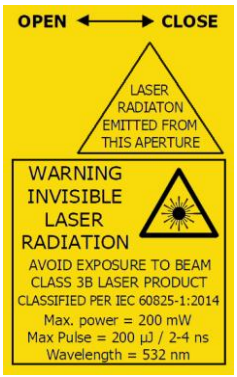


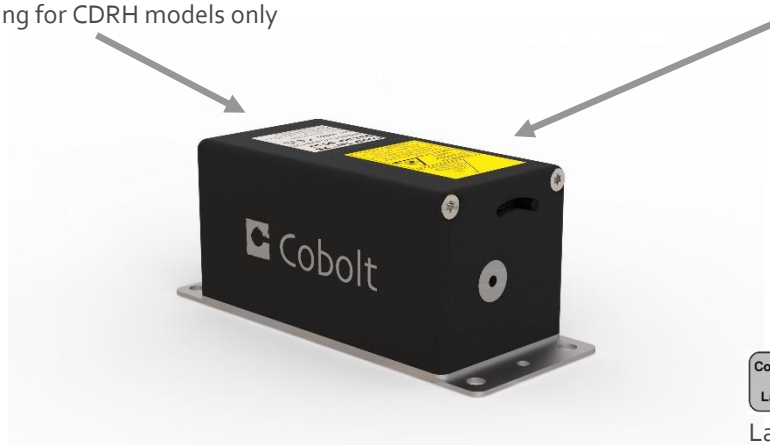
OEM Label

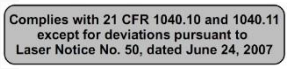


CE marking for CDRH models only

Aperture Warning Label







Laser Notice No. 50 Label

CDRH models shipped to USA

3. Quick Start Guide

3.1. Mounting and connecting the laser

1. Mount the laser on a heat sink or suitable flat surface that provides adequate heat dissipation and connection to ground. Use the four holes on the laser's base plate to secure it.

2. Attach the 14-pin molex cable to CONTROL socket on the laser head.

3. Attach the 15-pin D-SUB cable to the LASER HEAD socket on the key control box.

4. Insert the interlock plug into the connector on the key control box (or verify that it is in place).

5. Connect the supplied 12V power supply unit to the 12V socket on the laser head and plug it in to the mains.

6. To start the laser, turn the key on the Control Box clockwise to the ON position. If it is already in the ON position, turn it to OFF and then ON again. Light will be emitted as soon as the key is turned. The white 'Laser ON' Led will be illuminated.

7. The laser will start up in constant rep. rate mode at the nominal repetition rate. The system requires up to three minutes to stabilize thermally.

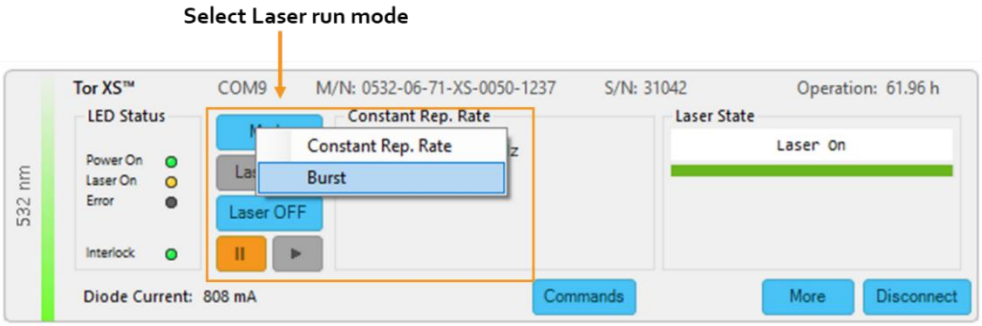
NOTICE If the performance does not match the performance as stated on the test sheet see section 12: Service for more information.

3.2. Controlling emission

All Cobolt Tor™ XS lasers are available with emission controls for Constant Rep. Rate or Burst mode operation. In this section the different ways to control the emission of each laser will be introduced. For command controls of the functions described see section 4.5 : Command list. This section gives more details about the controlling emission via the control software interface.

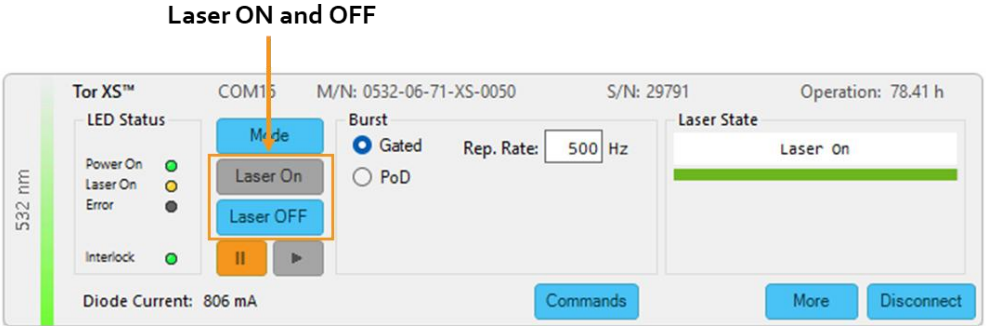
Laser Run Modes

The lasers are delivered in Constant Rep. Rate run mode. To prepare the laser for external controls the user must first select the Burst run mode. Selecting the laser run mode can be done in the Cobolt Monitor™ software, or via the command 'LASer:RUNMode XXX', where XXX is the run mode name : ConstantRepRate or Burst.



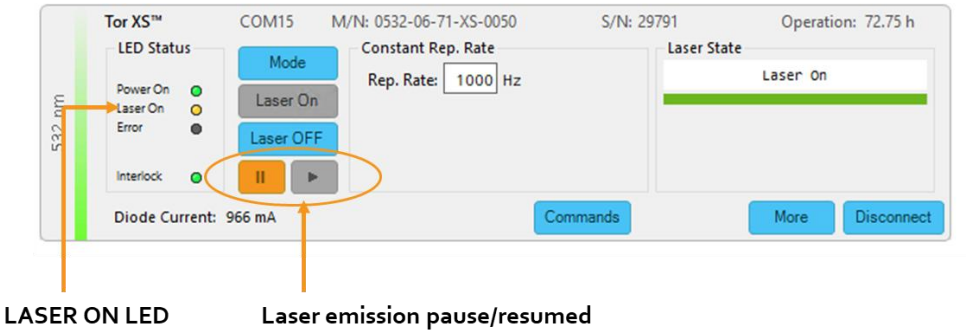
Laser ON and Laser OFF Button

The Laser ON and Laser OFF buttons can be used to stop and start emission regardless of the laser run mode (constant rep. rate and burst mode). Access to the Laser ON and Laser OFF buttons is available in the summary level of the user interface as well as the 'More' window. Turning the laser ON and OFF can be done in the Cobolt Monitor™ software, or via the command 'STARt' and 'STOP'. These functions return the laser to the 'Stand by' state, which requires toggling of the key to resume emission for CDRH compliant systems.



Pause or Resume Emission

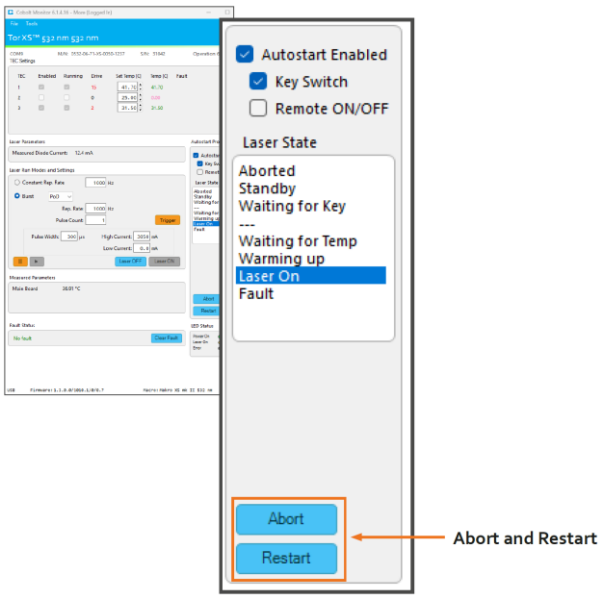
Use the Pause and Play buttons to pause and resume emission. Access to the Pause and Play buttons is available in the summary level of the user interface as well as the 'More' window. Pausing and resuming emission can be done in the Cobolt Monitor™ software, or via the command 'LASer:PAUSed X' where X is 1 for 'Paused' and 0 for 'Un-paused' or 'Resumed'. The laser is considered 'ON' when the emission is paused.



DANGER – Pausing the laser radiation does not make it inaccessible and will not prevent emission in a fail-safe way. Laser ON warning indicators will be illuminated as the lasers are considered armed for operation. Treat the system accordingly and observe all safety precautions.

RESTART and ABORT Button

The 'Restart' button will start the complete Autostart sequence including temperature stabilization and warm up. The 'Abort' button cancels the Autostart sequence and places the entire device in the 'Aborted' state, the laser is OFF and the temperature controls are not running. The key switch is required to restart the device when in CDRH mode. Aborting and restarting the laser can be done in the Cobolt Monitor™ software, or via the command to the command 'AUTOstart:RESTart', the abort button corresponds to the system command 'AUTOstart:ABORt'.



3.3. Shutting down the laser

1. Turn the key switch to OFF first (CDRH models only).
2. Disconnect PSU from mains outlet.
3. Disconnect laser from PSU.
4. Disconnect laser head from Key control box (only required for shipping).

4. Operation via data port

4.1. Data port connections

There are three ways to connect a Cobolt Tor™ XS Series laser to a data port. Avoid communicating via multiple interfaces simultaneously. The data connections are located as follows:

- Mini-USB connection on the laser head for USB communication. The USB cable is provided.
- 9-pin D-SUB connection on the key control box (CDRH model) allows for RS-232 communication
- For OEM Integration, the 14-pin Molex connection on the laser head can be used to connect to RS-232 communication. See section 6.4 for the pin assignment. The Molex - RS-232 cable is not standard and is not available from HÜBNER Photonics.

4.2. Remote Interface Configuration

USB communication

When using a Cobolt laser with Windows 10 or Windows 11, the USB device is automatically detected, and the USB driver installed. The computer will recognize the device as a virtual serial port and assign a COM port.

The USB identification string contains the following information:

- COM Port number
- Cobolt Vendor ID: 0x25DC
- Product ID: 0x03F2
- Laser serial number

When using the Cobolt laser with a Windows 8 or earlier (e.g Windows 7, Vista, XP) it is necessary to install the Cobolt signed USB driver. Please refer to the HÜBNER Photonics website https://hubner-photonics.com/ .

RS-232 communication

To communicate with a laser, a PC needs to have a serial port. Alternatively, an RS-232-to-USB converter can be used. The serial port settings are listed below.

Establishing serial port communication

Serial communication can be established with the laser using the following configuration:

- Baud rate: 115200
- No parity
- Termination for commands: CR
- Termination for answers: CR + LF
- Byte size: 8 bits
- 1 stop bit

Once the serial port is opened, the laser will not initiate communication under any circumstances, the laser will only transmit a response to each command. Responses maybe be a numerical value, a string or the acknowledgment string 'OK'. If the system receives a command that it cannot interpret, it responds with 'Syntax error'.

4.3. Cobolt Monitor Software

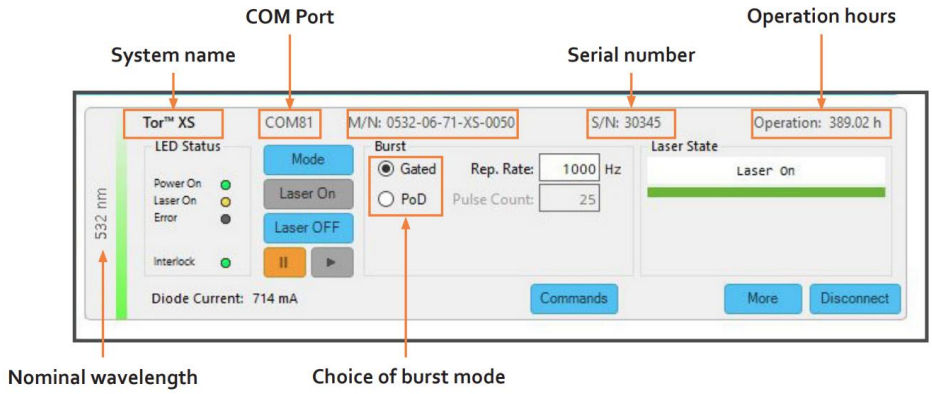
The Cobolt Monitor™ software provides a graphical interface to monitor the laser performance and to control laser operation. Cobolt Monitor™ has been tested with operating systems Windows 11 and Windows 10. Microsoft .NET 4.7.2 is required to run the Cobolt Monitor™ software. Most computers with Windows operating systems have this included as standard. When using versions of Windows older than Windows 10, a USB driver may be required.

Installation

Download the latest version of the Cobolt Monitor™ software from https://hubner-photonics.com/ . 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 to 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.

Connecting with Cobolt Monitor™ Software

Once the lasers are connected, each laser will be displayed in the Cobolt Monitor™ Software as shown below. Each laser can be controlled individually in the summary box. Only the most critical information is displayed on this level.



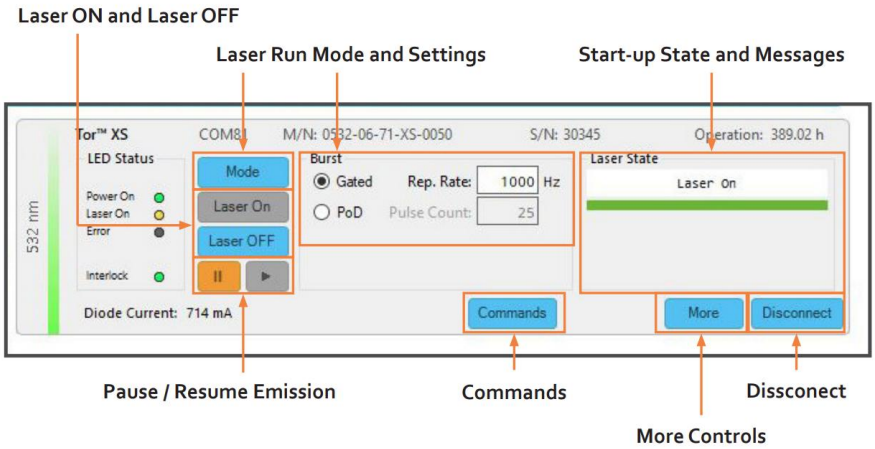
Laser displayed in Cobolt Monitor™.

COM port Displays the COM port to which the laser is connected.

System name Product description including the model family, Cobolt Tor™ XS, and the nominal wavelength. The system name will be searchable when performing system integration.

M/N Displays the laser model number. See section 5.1:Model number for details.

S/N Displays the laser serial number.



Laser displayed in Cobolt Monitor™.

Laser ON Turns the laser ON. If the laser is in Autostart mode, this is equivalent to 'Restart'.

Laser OFF Turns the laser OFF.

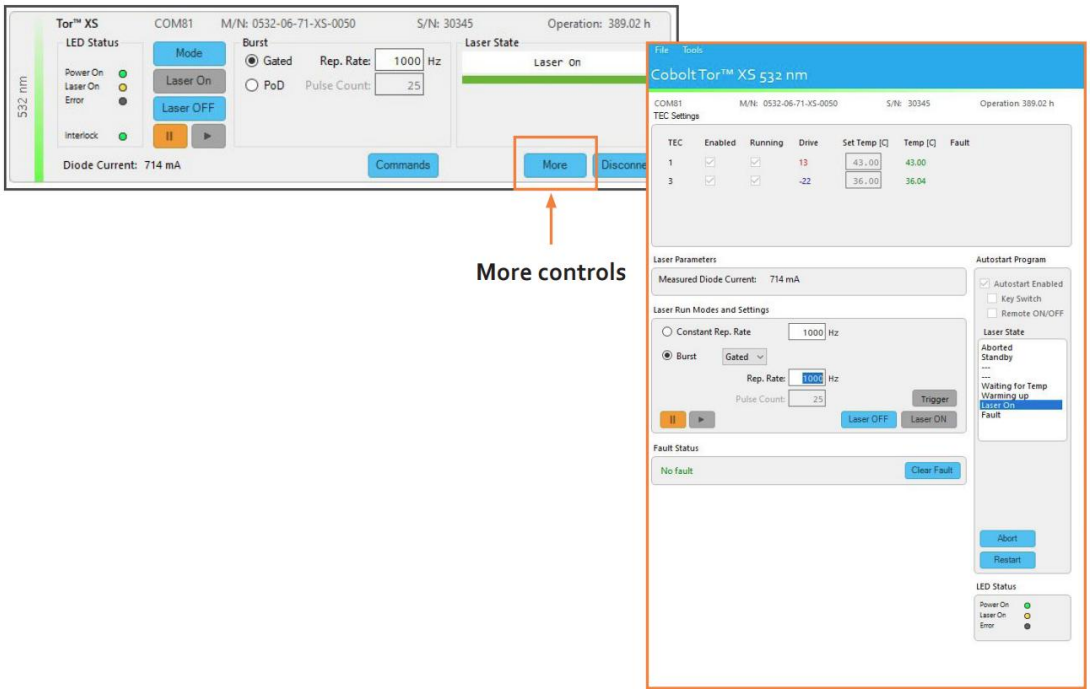
Pause / Resume Temporarily pauses emission, laser remains armed and is considered 'ON'.

Mode Choose the laser run mode. Click the button to see the drop-down menu and select: Constant RepRate or Burst.

Commands Opens a command communications window to send commands directly to the laser.

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

More An additional Cobolt Monitor™ window will open containing more detailed information of that laser's status and operational settings.



TEC Settings Shows the running status and the fault status for the laser's internal thermoelectric coolers (TECs). The temperature settings may be different depending on the laser run mode.

Laser Parameters Displays the operating current of the laser

Laser Run Mode and Settings

The user can switch between Constant Repetition Rate (Rep. Rate) mode and Burst mode. Within Burst mode there is a function for Gated pulse train or Pulse on Demand (PoD).

Input fields for settings such as the constant repetition rate settings and burst mode settings, including the repetition rate in burst mode and number of pulses per trigger in PoD mode.

Autostart Program

Displays whether the laser is CDRH (key switch enabled) or OEM (key switch disabled) configured and displays the current laser state. There are also buttons to 'Abort' the Autostart sequence or to 'Restart' the laser after a fault.

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.

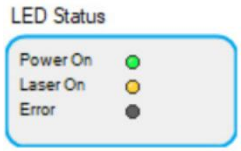
Clear Fault Is displayed in the event of a fault. The user can resolve the cause of the fault and then press 'Clear Fault' and then restart the laser by clicking 'Laser ON'. Example: if the remote

interlock loop is open the user must make sure the loop is closed again before issuing a 'Clear Fault' followed by 'Laser On' or clear the fault and restart by toggling the key switch.

LED Status

Displays the LEDs that are currently illuminated on the key control box. The LEDs are displayed in Cobolt Monitor even if the laser is in OEM mode without a key control box.

POWER	Green	Power is supplied.
ON	Yellow	Laser emission is possible.
ERROR	Red	An error has occurred.



4.4. Command Syntax

The Cobolt laser command syntax listed in this section shows all commands as a mixture of upper- and lower-case letters. The upper-case letters indicate the abbreviated spelling for the command. The commands are not case sensitive. For shorter program lines, the abbreviated form is beneficial whereas the program readability greatly benefits from the long form.

Triangle brackets (< >) indicate that a value must be specified for the enclosed parameter. The square brackets ([ ]) indicate that part of the command is optional. Query commands must be followed by a question mark '?'. The response for each command is listed in the tables in the next section. If no response is listed, the laser will acknowledge the command with the response string 'OK'.

Arguments of a command must be delimited single space character (ASCII 32). Arguments are not case sensitive and can be abbreviated in the same way as commands.

Examples:

- The command 'LASer:ConstantRepRate:REPRate:SETPoint' can be abbreviated to : 'LAS:CRR:REPR:SETP?' or 'las:crr:repr:setp?'
- The command 'TEC2:TEMPerature:reading?' queries the temperature reading of TEC number 2 whereas 'TEC:TEMP?' queries the temperature reading of TEC number 1.
- The command 'LASer:RUNMode BURst' can be abbreviated to 'LAS:RUNM BUR' or 'las:runm bur'

To get started using a Cobolt laser with a program written C++ or Python, please refer to our example codes at the HÜBNER Photonics GitHub: https://github.com/cobolt-lasers.

4.5. Command list

Below is a list of available commands. The name of the command links to the appropriate section with details of the function, arguments and returns. Alternately, browse to the appropriate page for these details.

System Commands	**See pg. 22**
*IDN?	
SYSTem:MODel:NUMber	
SYSTem:SERial:NUMber	
LASer:HOURs	
AUTOstart:ENAbled	
KEYswitch:ENAbled	
KEYswitch[:state]	
REMote:ENAbled	
REMote[:state]	

INTerlock[:state]	
TEC<x>:ENAbled	
TEC<x>:TEMPerature:SETPoint	
TEC<x>:TEMPerature[:reading]	
STATe	
FAULt[:name]	
FAULt:STATe	
FAULt:CLEar	
Emission control and laser status	**See pg. 23**
AUTOstart:RESTart	
AUTOstart:ABORt	
STARt	
STOP	
LASer:PAUSed	
LASer:RUNMode	
LASer:CURRent[:reading]	
Constant Rep. Rate mode	**See pg. 24**
LASer:ConstantRepRate:REPRate:SETPoint	
Burst mode	**See pg. 24**
LASer:BURst:TRIGer:MODE	
LASer:BURst:TRIGer:SOURce	
LASer:BURst:REPRate:SETPoint	
LASer:BURst:PULSe:COUNt:SETPoint	
LASer:BURst:TRIGer:SOURce	
Burst mode: Command trigger	**See pg. 24**
!e	
!d	
!t	
!f	
!n	

4.6. Command Descriptions

Commands to query system information including identification, configuration, state, and fault information.

System Commands

Command description	Argument	Return (data type) [units]
*IDN? Returns an identifier string of the laser	**Query Only**	(string)
SYSTem:MODel:NUMber Returns the factory set laser model number.	**Query only**	(string)
SYSTem:SERial:NUMber Returns the factory set laser model number.	**Query only**	(string)
LASer:HOURs Returns the number of operation hours of the system.	**Query only**	(string)
AUTOstart:ENAbled Returns the Autostart enabled state.	**Query only**	0 : Disabled 1 : Enabled
KEYswitch:ENAbled Returns the key switch enabled state.	**Query only**	0 : Disabled 1 : Enabled
KEYswitch[:state] Returns the key switch position.	**Query only**	0 : OFF 1 : ON
REMote:ENAbled Returns the remote ON OFF enabled state.	0 : Disabled 1 : Enabled	0 : Disabled 1 : Enabled
REMote[:state] Returns the remote ON OFF signal, if 5V is present on the appropriate pin or not	**Query only**	0 : No input signal 1 : 5 V is present
INTerlock[:state] Returns the interlock circuit state. If the interlock circuit is open or closed.	**Query only**	0 : Open 1 : Closed
TEC<x>:ENAbled Returns the enabled state of TEC x. <x> is either 1 [default], 2, 3	**Query only**	0 : Disabled 1 : Enabled
TEC<x>:TEMPerature:SETPoint Returns the set point temperature at TEC <x>. <x> is either 1 [default], 2, 3	**Query only**	(float) [°C]
TEC<x>:TEMPerature[:reading] Returns the measured temperature at TEC <x> <x> is either 1 [default], 2, 3	**Query only**	(float) [°C]

STATe Returns the state of the laser within the startup sequence. If Autostart is not enabled the return will not contain 'autostart_'	**Query only**	AutostartAborted AutostartStandby AutostartWaitingForKeyOn AutostartWaitingForRemote AutostartWaitingForTecs AutostartWarmingUp AutostartLaserOn Aborted Standby LaserOn Fault
FAULt[:name] Returns the fault description (short version)	**Query only**	(string)
FAULt:STATe Returns the fault state	**Query only**	0 : No fault 1 : Fault present
FAULt:CLEar Clears the fault message and allows the laser to be restarted.		

Emission control and laser status

Command description	Argument	Return (data type)
AUTOstart:RESTart Restarts the Autostart program, through waiting for TECs, warmup and to the completed state.		
AUTOstart:ABORt Aborts the Autostart sequence. Stops all function including laser drive current and temperature controls.		
STARt Starts the Autostart sequence and results in laser emission once the 'Laser ON' state is reached, regardless of the Autostart enabled state.		
STOP Stops the laser emission and will set the laser in the 'Standby' state		
LASer:PAUSed Pause and resume emission without changing the state or operating mode of the laser, no external signal required.	0 : Resume emission 1 : Pause emission	0 : Emission resumed 1 : Emission paused
LASer:RUNMode Sets / returns the run mode for the laser.	ConstantRepRate BURst	ConstantRepRate BURst
LASer:CURRent[:reading] Returns the measured current delivered to the laser diode.	**Query only**	(float) [mA]

Constant Rep. Rate mode

Command description	Argument	Return (data type)
LASer:ConstantRepRate:REPRate:SETPoint Sets / Returns the constant rep. rate mode set point. The input range is limited at the factory.	(float) [Hz]	(float) [Hz]

Burst mode

Command description	Argument	Return (data type)
LASer:BURst:TRIGer:MODE Sets / returns the burst trigger mode, either Gated or POD (see section 7.2).	GATed POD	GATed POD
LASer:BURst:TRIGer:SOURce Sets / returns the trigger source for the burst mode, either an external TTL signal or Commands	EXTernal (default) COMmand	EXTernal (default) COMmand
LASer:BURst:REPRate:SETPoint Sets / returns burst mode pulse repetition rate	(float) [Hz]	(float) [Hz]
LASer:BURst:PULSe:COUNt:SETPoint Sets / returns the number or pulses in ach burst in the POD burst mode	(integer)	(integer)

Burst mode: Command trigger

In power modulation mode it is possible to use commands as the modulator, in place of external modulation signals. In this mode commands are sent from the computer to turn on and off the laser emission, as well as setting the power level of the emission.

Command description	Argument	Return (data type)
LASer:BURst:TRIGer:SOURce Sets the active trigger signal (external TTL or computer commands)	EXTernal (default) COMmand	EXTernal (default) COMmand
!e Activate emission in the GATed burst mode		No response
!d Deactivate emission in the GATed burst mode		No response
!t Trigger a burst of pulses in the POD burst mode		No response
!f Set the pulse repetition rate in the burst mode	(float (Hz))	No response
!n Set the number of pulses for each trigger even for the POD burst mode	(integer)	No response

↗ back to **Command list**

5. Overview

Cobolt Tor™ XS laser systems consist of the laser head, key control box, key control box cable and the power supply. Always install the laser system to a properly grounded power outlet. If any part of the supplied equipment is replaced with a part not supplied by Cobolt or if the equipment is not properly grounded system may not conform to CE / CDRH compliance standards listed in section 12. Disabling any of the safety features nullifies the CE marking and violates the laser safety standard.

5.1. Model number

Cobolt lasers are sold in two configurations: CDRH and OEM, described in section 5.2. The model numbers are composed as described below.

WWWW – 06 – 71 –XS- EEEE – XXXX

- WWWW: Wavelength Indicator
- 06 – 71: Laser Head Model
- EEEE: Pulse Energy
- XXXX: Configuration:
  - 1100 = CE / CDRH compliant
  - 1200 = OEM
  - xxxx = OEM customization

5.2. Configuration

5.2.1. CDRH Compliant

The CDRH compliant system is supplied with a key switch box, which must be connected, along with a remote interlock connector. Once power is supplied and 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 key box. 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
- Key control box
- Keys
- 12 V/3 A power supply unit, including 2.1 mm DC to 2-pin Molex converter.
- Remote interlock plug (for short circuiting the remote interlock connector)
- USB communication cable
- 14 pin Molex to 15-pin D-SUB cable from laser head to key control box

5.2.2. OEM

The OEM system is supplied **without** a key switch box. Connecting the power supply to the laser head 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
- 12 V power supply unit, including 2.1 mm DC to 2-pin Molex converter.
- USB communication cable
- Remote interlock plug (for short circuiting the remote interlock connector)

5.3. Laser Head

The Laser Head contains a passively Q-switched diode-pumped solid-state nanosecond pulsed laser cavity and thermoelectric coolers. The laser head also features a manual mechanical shutter, a laser hazard label and a laser classification label. When power is supplied to the laser head, regardless of direct on/off or key-switch state, the temperature control element will be active to reach its set point values. It is possible to trigger the laser externally through the SMB connector on the backside of the laser. When operated in burst mode (with an external trigger) the laser will emit optical pulses as long as the trigger signal is high (Gated), or the demanded number of pulses specified in the software (Pulse-on-Demand) per trigger event. The laser beam is not collimated.

The mini-USB can each be used to communicate with the laser. In addition, the laser head supplies a Molex 14-pin connection, of which the pin 1 and pin 2 are used for the remote interlock function

5.3.1. Key control box

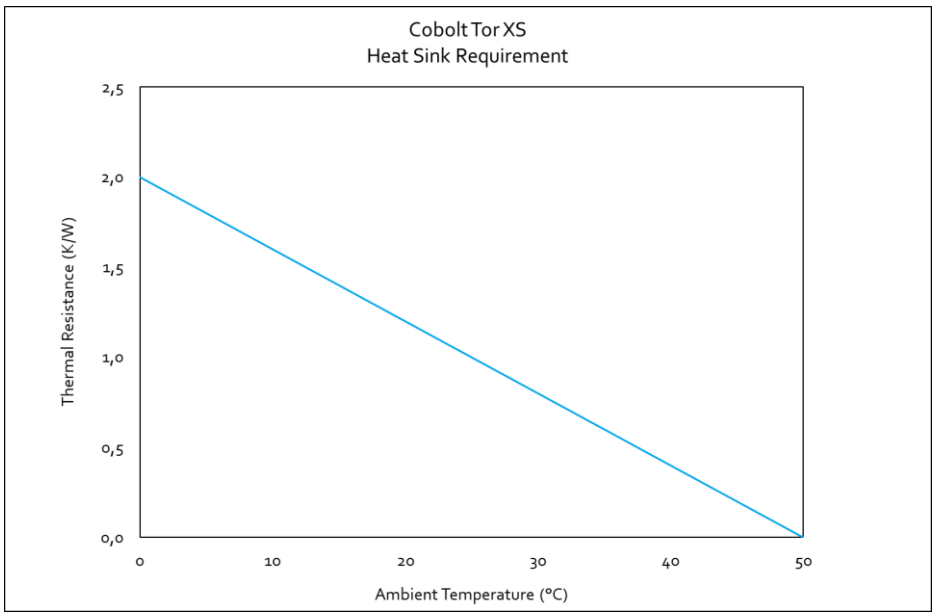
The key control box allows the user to operate the laser with a CE/CDRH compliant key-switch. The key control Box has LEDs to indicate the laser status. When power is supplied to the laser head, regardless of direct on/off or key-switch state, the temperature control elements will be active to reach set point values.

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

PWR	Green	Power is connected to the laser
ON	White	Laser emission is on. This light is on in modulation mode if laser emission is possible.
ERROR	Red	An error has occurred.

5.4. Thermal Management

To ensure operation within given specifications and for the warranty to be valid, the laser head must be mounted on a suitable heat sink. The requirement on thermal resistance of the heat sink can be calculated by taking the difference between the maximum allowed laser head base plate temperature (50 °C) and the ambient temperature at the air-heat sink interface (e.g. 40 °C), divided by the maximum power dissipated from the laser, 25 W for the Cobolt Tor™ XS. The Cobolt Tor™ XS laser head must be attached to a heat sink providing a thermal resistance of < 0.8 K/W. The mounting surface should be flat within 0.05 mm over the mounting surface. Under normal circumstances thermal heat compound is not required, however if the laser is operated in an area with a high ambient temperature it is recommended to use a thermally conductive compound between the laser head and the heat sink to provide good thermal contact. For assistance with thermal management and system integration, please contact the local sales representative, see section 10.



Heat Sink Requirements for Cobolt Tor XS Series.

5.5. Power supply requirements

An appropriate Power Supply Unit (PSU) is supplied by Cobolt with the laser and can be plugged into a standard power outlet. The power supply accepts 90 - 264 VAC and 47-63 Hz. Ripple and noise 1 % peak-peak max. Accepted voltage range for the laser head is (12.0 ± 0.4) VDC. Specification values are given at 12 VDC. The maximum current is 3 A (max 36 W).

The power supply provided with Cobolt Tor™ XS is certified to perform in an ambient temperature of 40°, when integrating this power supply into a larger system care must be taken to ensure that the power supply is not exposed to temperatures above 40°C.

6. System Specifications

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.

6.1. Optical Specifications

Centre wavelength in air (nm)	532.1 ± 0.3	1064.2 ± 0.6
Pulse energy (µJ)	50 ± 5	100 ± 10
Peak power[1] (kW)	> 12	> 25
Repetition rate	Single pulse to 1 kHz	
Pulse width (ns)	2.5 ± 1.0	
Trigger-to-Pulse Jitter (µs)	< 2	
Average power @ 1 kHz (mW)	50 ± 5	100 ± 10
Long-term average power stability (8 hours, (±3 °C))	< 3 %	
Pulse-to-Pulse amplitude stability	< 10 %	
Spatial mode	TEM_{00}, M^2 < 1.3	
Beam divergence (full angle, $1/e^2$) (mrad)	6 ± 1	9 ± 1.5
Beam diameter at aperture ($1/e^2$) (mm)	0.4 ± 0.1	0.6 ± 0.1
Beam symmetry at aperture	> 0.85: 1	
Polarization ratio (linear, vertical)	> 100:1	
Beam angle accuracy (mrad)	< 5	
Beam position accuracy (mm)	< 0.5	
Residual emission	< Class 1	

1. Assuming a top hat profile, Peak Power (kW) = Pulse Energy (µJ) at bottom tolerance ÷ Pulse width (ns) at top tolerance

6.2. Operation and Environmental Specifications – Laser Head

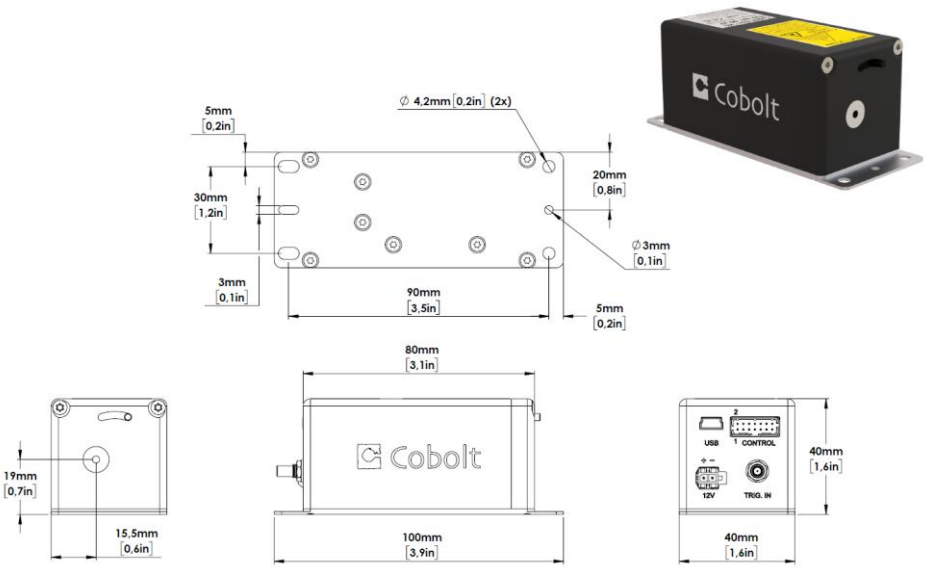
Power supply	12 VDC, 3 A
Intended use environment	Laboratory (indoor)
Pollution Degree	2
Power consumption, total system	< 25 W
Maximum Laser Head baseplate temperature	50°C
Ambient temperature, operation	10 – 40 °C
Ambient temperature, storage	-10 °C to +60 °C
Humidity	0-60 % RH non-condensing
Ambient Air pressure	950-1050 mbar
Heat sink thermal resistance, Laser Head	< 0.8 K/W
Warm-up time, from OFF	< 5 min
Communication protocol	RS-232

6.3. Mechanical Specifications

Laser head dimensions	100 x 40 x 40 mm
Fixation holes, Laser Head	∅ = 4 x 4.2 mm; 90 mm x 30 mm
Laser Head weight	< 0.3 kg

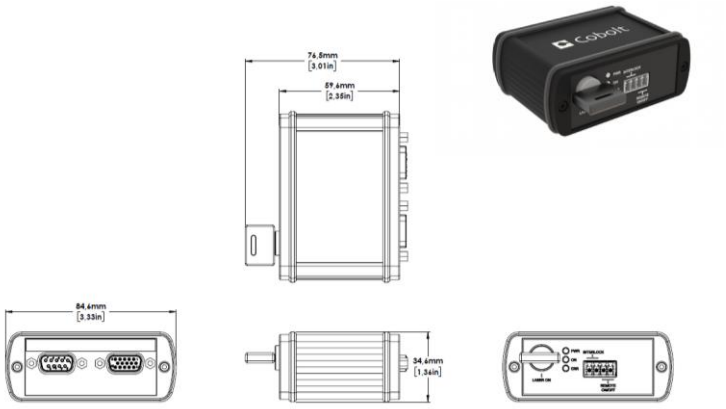
Mechanical Drawings

6.3.1. Laser Head



Laser head mechanical outline. Dimensions in mm [inches].

6.3.1. Key control box



Tor Series Key control box, mechanical outline. Dimensions in mm [inches].

6.4. Electrical Interface Specifications

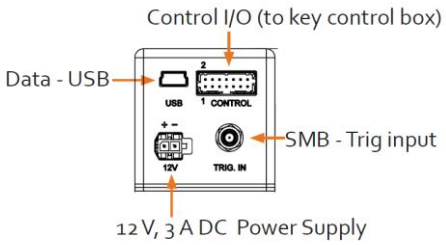
6.4.1. Trigger input signal specifications

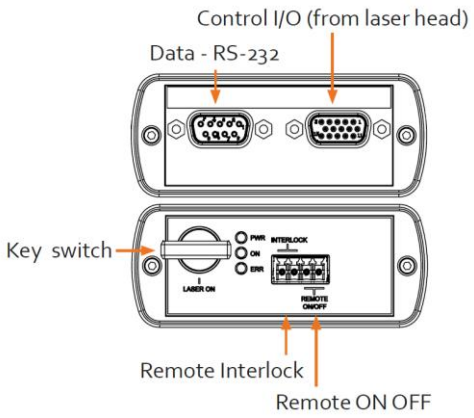
Input trigger ON time	≥ 1 µs
Input trigger frequency	Single pulse up to 1 kHz
Input trigger V_{low}	0 – 0.8 V
Input trigger V_{high}	2.8 – 5 V
Input trigger waveform	Square
Input trigger impedance	2 kΩ
Delay (Input trigger to optical pulse) @ 1 kHz	200 – 250 µs

6.4.2. Interface specifications

All equipment connected to the system should be limited energy as described by IEC 61010:1.

Interface	**Location**	**Connector description**
Input power	Laser Head	2-pin Molex (430450209)
Remote Interlock (OEM)	Laser Head	14-pin Molex; pin 1 & 2 (878331420)
Data port	Laser Head	USB-type mini-B
Key control Box connector	Laser Head	14-pin Molex male (878331420)
Trigger Input	Laser Head	SMB female
Laser Head connector	Key control box	VGA D-SUB 15-pin male
Remote Interlock (CDRH)	Key control box	4 pin Würth header (69132210004); pin 1 & 2
Remote ON OFF	Key control box	4 pin Würth header (69132210004); pin 3 & 4



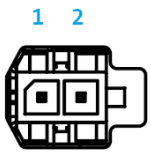


Pin assignment

Power supply connector on laser head

Connector 2 pin Molex (430450209)

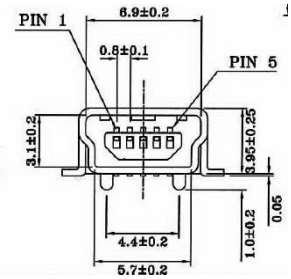
Pin	Function
1	+12 V
2	D-



USB connector on laser head

Connector USB-type, mates with connector mini-B.

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

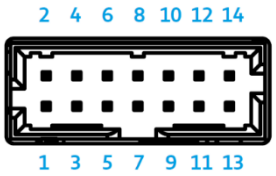


Laser head I/O – alt. to Keybox connector

The pin configuration for the I/O 14-pin Molex on the laser head are described in the table below. For CDRH configured laser heads the key control box cable is connected.

Connector 14 pin Molex (878331420)

Pin	Function
1	Interlock
2	GND
3	GND
4	RS-232 TX
5	RS-232 RX
6	LED 1 – Laser ON
7	LED 1 – Laser ON (secondary)
8	LED 2 – Error
9	Trigger input
10	GND
11	Key switch
12	Remote ON/OFF (+5 V Input)
13	GND
14	*Not used*

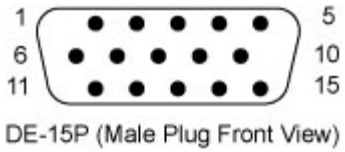


Key box to laser head connector

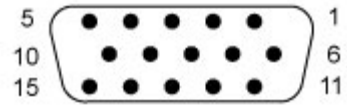
The pin configuration of the Molex connector on the laser head and the 15-pin D-SUB connector on the key control box.

Connector 15 pin D-SUB

Pin	Function
1	LED 1A – Laser ON
2	LED2 (Error)
3	*Not used*
4	0 V GND
5	Key Switch
6	LED 1B – Laser ON (secondary)
7	RS-232 TX
8	RS-232 RX
9	Remote On/Off (+5 V Input)
10	0 V GND
11	Remote interlock
12	*Not used*
13	0 V GND
14	*Not used*
15	0 V GND
Shield	0 V GND



DE-15P (Male Plug Front View)



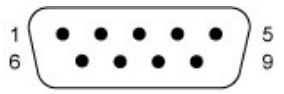
DE-15S (Female Socket Front View)

RS-232 on Key box

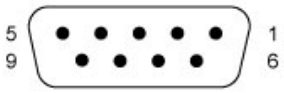
The pin configuration for the RS-232 socket on the key control box.

Connector 9 pin D-SUB

Pin	Function
1	*Not used*
2	RS-232 TX
3	RS-232 RX
4	*Not used*
5	0 V GND
6	*Not used*
7	*Not used*
8	*Not used*
9	*Not used*



DE-09P (Male Plug Front View)

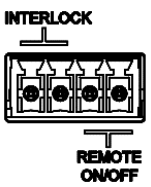


DE-09S (Female Socket Front View)

Interlock and Remote interlock

Connector 4 pin Würth header 69132210004

Pin	Function
1	Remote interlock
2	0 V GND
3	Remote On/Off (+5 V Input)
4	0 V GND



Remote Interlock Connector

The laser is equipped with a remote interlock connector that prevents current flow through the diode when the circuit is open. 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 to start up the laser again or toggling the key switch. 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 < 1 ms, but after filtering by the firmware the reaction time is extended to < 20 ms.

CDRH Configuration

The remote interlock connector is a 2 pin Würth header connected to the 4-pin header on the key control box. The pin 1 and 2 of the header can be connected to short circuit the interlock.

OEM Configuration

In OEM configuration the remote interlock connector is located at pin 1 and 2 of the 14 pin Molex connector on the back of the laser head. To close the remote interlock connector with an external switch, connect to pin 1 and 2 of the Molex plug.

Remote ON/OFF control

The Remote ON/OFF control feature enables turning the laser ON and OFF using a 5 VDC signal. After having configured the laser for Direct Input operation (factory set or by executing REMote:ENAbled 1), the laser can only start-up when 5 VDC (max 12.5 VDC) is applied to pin 12 on the Molex connector with 0 VDC on pin 13 as reference ground. Remote ON/OFF is accessed via pin 3 and 4 on the key control box for CDRH compliant lasers. Shifting the signal to 0 VDC on pin 12 will turn the laser off and put the laser in the 'Waiting for Remote' state. This input only controls the state of the laser and cannot be used to modulate the power output. The remote interlock connection between pin 1 and 2 must also be made.

7. System states and run mode descriptions

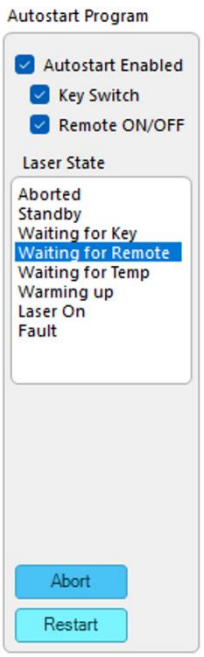
Detailed description of the laser start-up states and run modes can be found in this section. This section is intended to provide a deeper knowledge of how the laser works to allow the user to have full understanding and control of the laser operation.

7.1. Autostart program and startup states

All CE/CDRH compliant lasers are delivered with Autostart enabled. The descriptions below are specific to the use case where Autostart is enabled. If specified by a custom OEM configuration for Autostart to be disabled, some descriptions may no longer be valid.

Aborted

The laser enters the 'Aborted' state when the Autostart sequence has been aborted either by the user sending the Abort command or after a fault. While the laser is in the Aborted state laser emission is disallowed and the TECs will not be running. If the laser operation is aborted due to a fault, the laser will first go into the Fault state. The fault must then be cleared before the laser can proceed to the 'Aborted' state and then be restarted. The laser must be manually restarted with the Cobolt Monitor software, either by sending the restart command or by power cycling the system.



Standby

In the 'Standby' state, laser emission is OFF. Standby is the first state entered during the Autostart sequence after power is supplied to the system. Standby can be reached intentionally by sending the 'STOP' command. While the laser is in the Standby state the enabled TECs are running, maintaining the lasers internal operating temperatures. The laser can be restarted, or turned ON, with the Cobolt Monitor software, by sending the 'STARt' command, the 'AUTOstart:RESTart' command or by power cycling the system.

Waiting for Key

In the 'Waiting for Key' state the system is waiting for the user to manually toggle the key switch. If the key is in the ON position it is necessary to turn it to the OFF position and back to the ON position before the laser will proceed through the Autostart sequence. It may be necessary to toggle the key twice, depending on why the laser was stopped. This is implemented as an intentional safeguard after a manual reset.

Waiting for Remote

The 'Waiting for Remote' state is an optional state available for addition remote emission gating via an external signal. If the Remote ON/OFF is enabled, after the key is switched ON, the laser proceed to the Waiting for Remote state until the ON signal is provided. See section 6.4 for more information on the required input signals.

Waiting for Temp

In the 'Waiting for Temp' state, the temperature controllers are regulating and have not yet reached their set point temperatures. Once the TECs have all reached the set point, the laser will proceed through the Autostart sequence through

Warming up to Laser ON. If Autostart is enabled, then the laser will not start until the set point temperatures are reached. This is important for performance as well as equipment safety. If the Autostart is disabled (OEM only) then this may be bypassed, but it is never recommended to provide current to the laser before the TECs have reached their set point temperature.

Laser On

In the 'Laser On' state the laser is actively emitting or is armed for emission and can be controlled with the modulation input signal. Even if the modulation signal is low and there is no emission the laser is still considered to be ON.

Fault

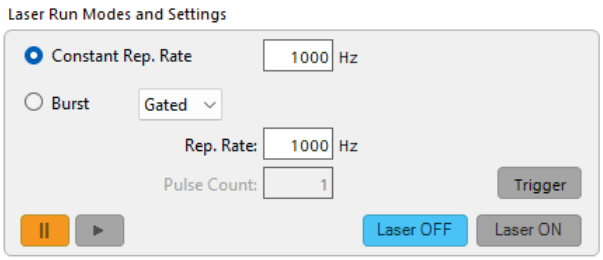
The laser is experiencing a fault. The user must address the fault and clear the fault. After clearing the fault, the laser will proceed to the Aborted state (see above). See section 7.3 : Fault descriptions for information on the most common faults.

7.2. Laser Run Modes and Settings

Cobolt Tor™ XS are delivered in Constant Rep. Rate run mode. Use this section to get a deeper understanding of each run mode to choose the best run mode, and settings within that run mode, for the intended application. The laser run modes are exclusive and cannot be used in combination.

Constant Rep. Rate

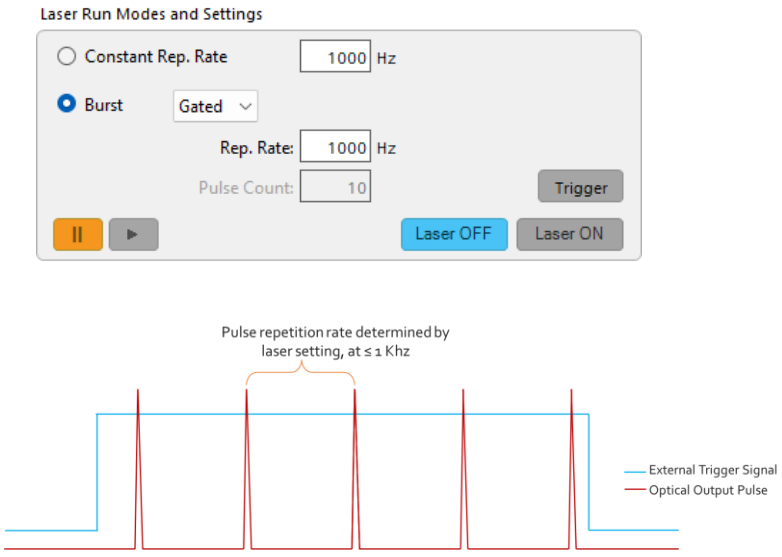
Constant Rep. Rate mode is designed to allow operation of the laser at a fixed repetition rate. The user may input any repetition rate setting up to the nominal repetition rate.



Burst

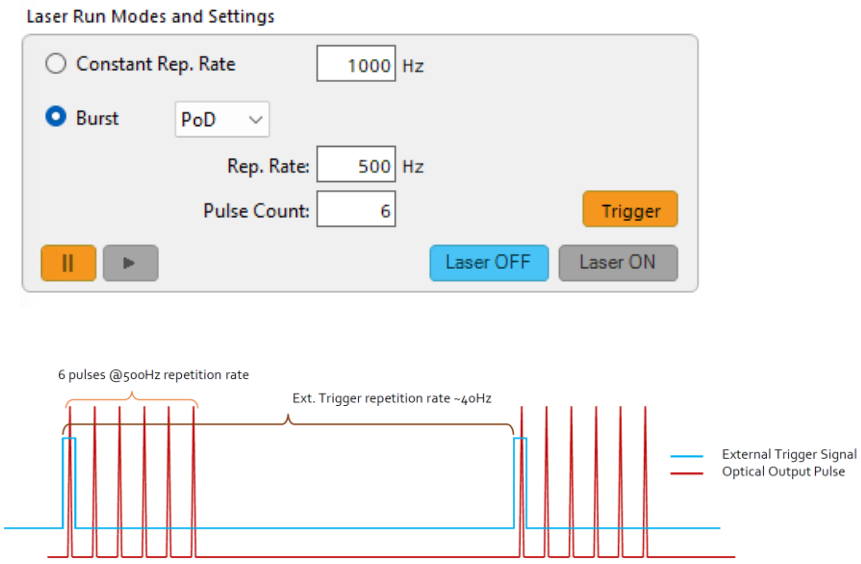
The Burst mode is designed to allow for the user to generate bursts of pulses from the laser, triggered either using software commands or an external trigger signal. The repetition rate of the Burst mode is controlled by the user setting in the laser. The Burst mode can be operated in two trigger modes, Gated and Pulse-On-Demand (PoD).

In the Gated burstmode, the laser will keep emitting pulses while the trigger signal is activated.



Example of gated burst setting with 1kHz repetition rate for a 5ms gate pulse.

In the PoD burst mode, a set number of pulses are generated by the laser at each trigger event. Both the repetition rate of the pulses and the number of pulses generated are set by the laser



Example of PoD setting for a request of 6 pulses with 500Hz repetition rate and 40Hz external trigger signal.

7.3. Fault descriptions

Below is a list of the most common faults the user will encounter.

Fault	Description	Recommended action
InterlockOpen	Laser start failed due to interlock being open	Check the interlock and restart the laser.
NoConvergence	Failed to reach temperature setpoint - not able to stabilize temperature.	The laser's internal temperature regulation is generating a fault. Verify the heatsink requirements are met, and that the ambient temperature is within the specified limits.
NoConvergenceLowerRail	Cannot bring temperature down towards setpoint.	
NoConvergenceUpperRail	Cannot bring temperature up towards setpoint.	
Overtemperature	A temperature reading exceeds the allowed limit. Use 'fault:description?' should provide details	

8. Troubleshooting

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

It is adviced to, if possible, use Cobolt Monitor to monitor the laser status while trouble shouting. Before starting, connect the laser to the computer and open Cobolt Monitor.

No laser emission 3 minutes after start-up

1. Verify that the Input Trigger Signal is connected and according to the specifications in section 6.4.1 , or set the laser in constant rep. rate mode.
2. Verify that the remote interlock connector is connected and restart the laser.
3. Ensure the laser has adequate heat sinking.
4. Verify that Autostart is enabled. Click the restart button in the Monitor software or send the command "@cob1" to force a restart of the laser.
5. Verify the supply voltage is within the range stated in section 5.5 : Power supply requirements.
6. Check the base plate temperature (this is displayed in the Cobolt Monitor™ software). If it is outside of the range 20-50 °C the laser may take longer to stabilize the temperature or be unable to do so.
7. Remove all trigger input and make sure the laser is in constant rep. rate mode (in the software or with the 'LASer:RUNMode ConstantRepRate' command) then restart the laser.
8. Send the command 'FAULt:DESCription?' and use the instructions in section 7.3 to address the fault.
9. Contact the local sales representative.

Interlock fault

1. If using a custom interlock system, connect the Cobolt-supplied remote interlock connector plug to check whether the interlock is correctly wired.
2. This remote interlock connector should be connected as described in section 6.4 : Electrical Interface Specifications.
3. In the software, check that "*Interlock Open*" is not displayed. Send the command 'INTerlock:STATe?' to confirm the remote interlock connector is not open (returns a 1 if closed).
4. If it is verified that the Remote Interlock Connector system is closed yet an interlock fault is returned, contact the local sales representative.

Laser emission stops

1. Ensure the laser has adequate heat sinking.
2. Ensure the Input Trigger Signal is active, connected and fulfills the specifications in section 6.4.1 , or set the laser in constant rep. rate mode.
3. Check the base plate temperature (this is displayed in the Cobolt Monitor™ software). If it is outside of the range 20-50 °C the laser may take longer to stabilize the temperature or be unable to do so.
4. Check that the Remote Interlock Connector is connected.
5. Send the command 'FAUlt:DESCription?'

6. If there is a non-convergence fault returned, check that the heat sink is adequate, and that the ambient temperature is under 40°C.
7. If interlock fault is returned, see the interlock fault checklist.
8. If the issue persists, contact the local sales representative.

9. 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 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.

10. Service

Due to accuracy tolerances in 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 sales 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 sales representative for consultancy and to request a case number (see back cover for contact information). If a case number is issued and the laser needs to be shipped back to Cobolt or your local sales 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.

11. Disclaimer

HÜBNER Photonics 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.

12. Compliance (CDRH models only)

The CDRH model lasers (-1100) 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, key control box, key and Cobolt-supplied power supply. All equipment must be mounted on a common ground plane, such as an optical table. If any part of the delivered equipment is replaced with a part not supplied by Cobolt or if the equipment is not properly grounded, the system may not conform to CE / CDRH compliance standards listed here. Disabling any of the safety features nullifies the CE marking and violates the laser safety standard.

CE

The following harmonized and limits standards have been applied:

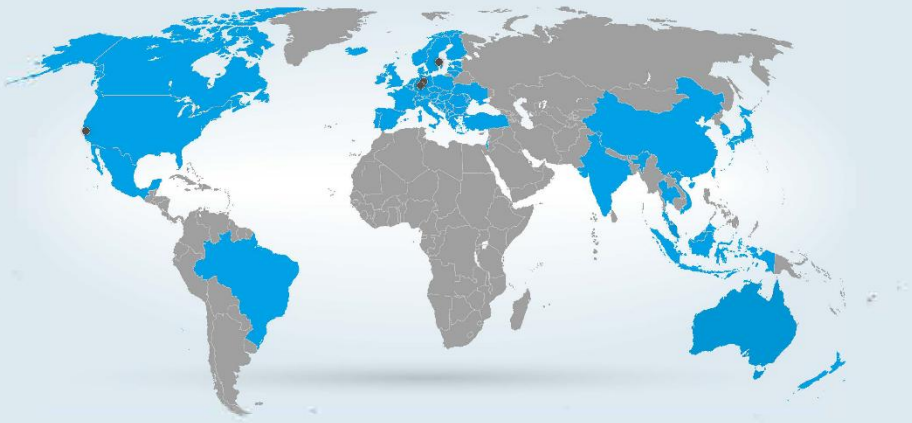
Electrical Safety:	EN 61010-1, IEC-61010-1, UL 61010-1 (Limited Energy System)	
Laser Safety/Class	IEC-60825-1 , CDRH 21 CFR 1040.10 and 1040.11	
EMC	IEC 61326-1	
	EN 55011	Electromagnetic Emission , Class B
		FCC Part 15, subpart B, class B
	Electromagnetic Immunity – Table 2 Requirements	
	EN 61000-4-2	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 10 V/m with 80 % AM @ 1 kHz
		1.4 – 2.7 GHz 10 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
		10 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
RoHS	EU Directive 2011/65/EU	

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

13. Appendix – legacy commands

The laser is delivered with the system set in Autostart mode (see section 7.1 for Autostart sequence description). For system integration the Autostart sequence can be disabled and the following commands can be used to control the laser (NOTE some commands require Autostart to be disabled but others will work when Autostart is active). As long as power is supplied to the system 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?	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).		
l0	Laser OFF Use this command for manual OFF (OEM models).		
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
cf	Clear fault		
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).		



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.se@hubner-photonics.com

HÜBNER GmbH & Co. KG
(Sales in Germany, Switzerland and Austria)
Kassel, Germany
Phone: +49 561 994 060-0
Fax: +49 6561 994 060-13
E-mail: info.de@hubner-photonics.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

HA Photonics Pty Ltd
(Sales in UK and Ireland)
London, United Kingdom
Phone: +44 7359 440 871
E-mail: info.uk@hubner-photonics.com

hubner-photonics.com

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