Cobolt

Owners Manual

Version 04-01, Generation 4 Controller

July 2009 rev 1.24

Cobolt Twist™
CW 457 nm DPSSL

Cobolt Blues™
CW 473 nm DPSSL

Cobolt Calypso™
CW 491nm DPSSL

Cobolt Fandango™
CW 515 nm DPSSL

Cobolt Samba™
CW 532 nm DPSSL

Cobolt Jive™
CW 561 nm DPSSL

Cobolt Mambo™
CW 594 nm DPSSL

Cobolt Dual Calypso™
CW 491 + 532 nm DPSSL

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1. General

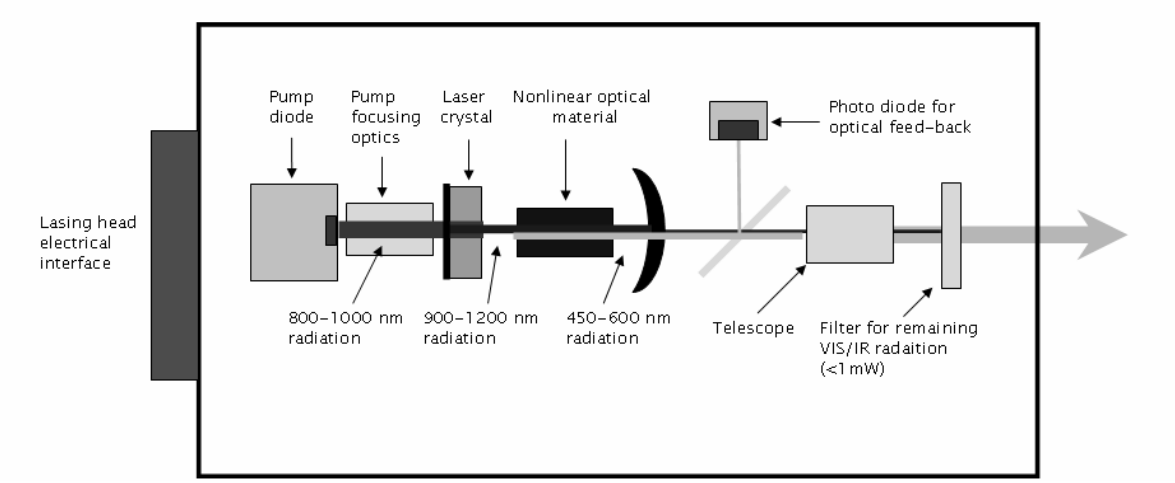
Cobolt lasers are all continuous-wave diode-pumped solid-state laser devices operating at fixed wavelengths as defined in the specifications in Section 4. The lasers have a compact hermetically sealed package and emit a high quality beam with stable characteristics over a wide range of operating conditions. The laser is designed and manufactured to ensure a high level of reliability.

The Cobolt lasers are intended are intended for stand-alone use in laboratory environment or for integration in analytical equipment used in e.g. flow cytometry, DNA sequencing, fluorescence microscopy and Raman spectroscopy.

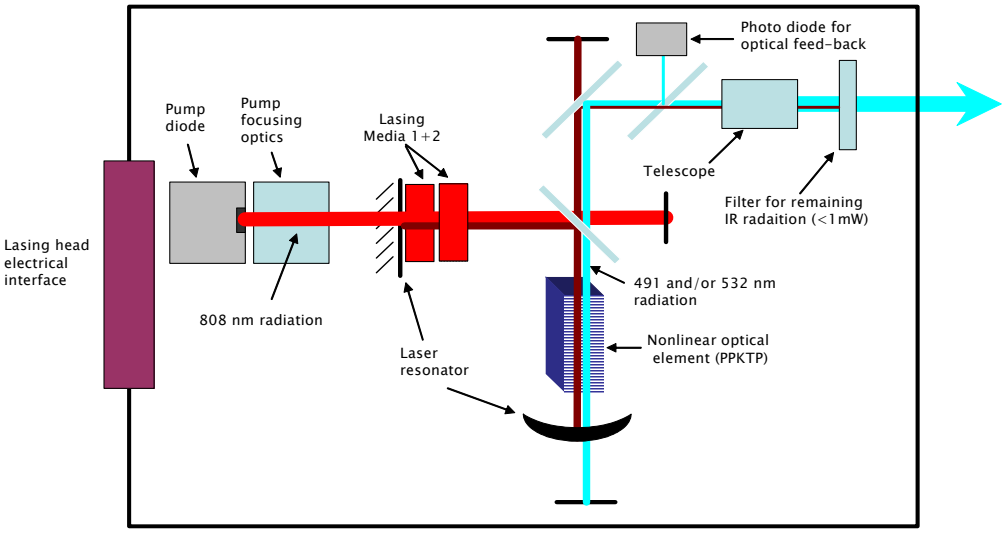
2. Laser design

The radiation from Cobolt lasers is generated by intra-cavity frequency doubling in PPKTP. The resonators are stabilized with a curved mirror, which provides a beam with excellent mode quality. The laser beam is expanded in a telescope and emitted through a manual shutter. The residual IR radiation from the pump and the DPSS laser is contained within the laser housing by filtering optics.

The laser assembly is equipped with elements for temperature control of the cavity and pump diode. The laser is also featured with an optical feed-back loop which ensures long-term power stability of the emitted visual beam. Control signals and drive currents are supplied via an electrical interface.



Cobolt laser design: Blues, Samba, Jive, Fandango and Twist. US Patent 5,986,798
US Patent 6,259,711

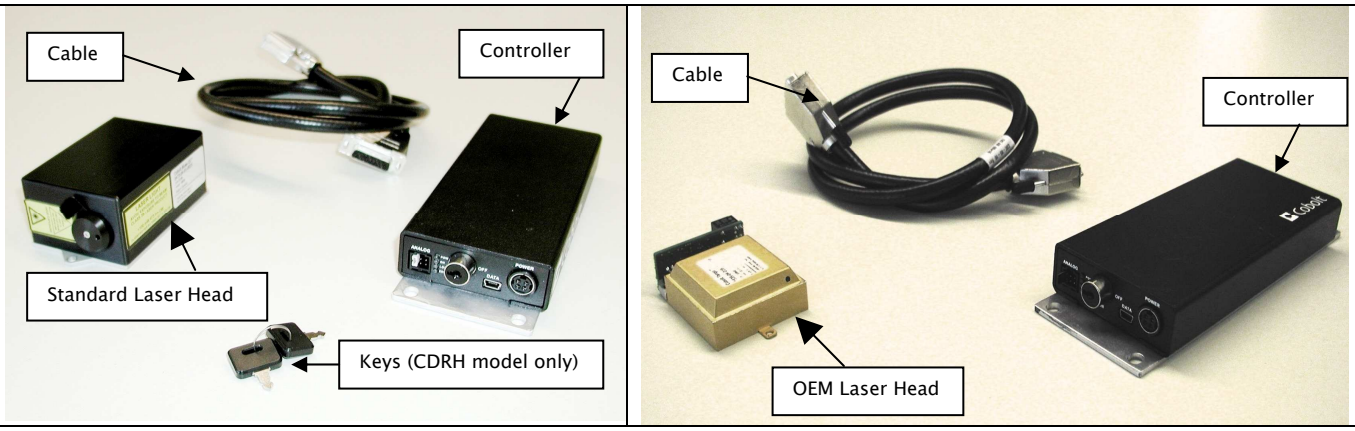


Cobolt laser design: Calypso, Dual Calypso and Mambo.

US Patent 5,986,798
US Patent pending

3. Laser system description

The Cobolt laser systems consist of three main parts: the Laser Head, the Controller and the Cable. The Cable should always be used to connect the Laser Head with the Controller. NOTE: Each Laser Head is unique to its Controller and will not operate to specification with mismatched Laser Heads and Controllers.



Cobolt laser system (left: Standard Laser Head, right: OEM Laser Head).

3.1. Laser Head

The Laser Head contains pump diode, laser cavity, beam formatting optics and Peltier elements. The Laser Head gets electrical power and control signals from the Controller via a 26-pin cable.

The Laser Head can be configured in two ways (decided at laser purchase):

- **Standard Laser Head**: The laser system is CDRH compliant together with the CDRH model of the Controller.

The Laser Head has a manual shutter as well as a laser hazard label and a laser classification label.

- **OEM Laser Head:** Smaller than the Standard Laser Head but not CDRH compliant. There is no shutter and it has only an OEM label.

3.2. Controller

The Controller supplies driving current and control signals to the Laser Head. The operation setpoints of the Controller are specific to each Laser Head and have been fixed during manufacturing.

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

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

The Controller can be configured in two ways (decided at laser purchase):

- **CDRH Controller**: A key is supplied to be used to turn on the laser. Connecting 12 VDC power supply to the Controller supplies power to the laser's Peltier elements which start working to reach the set temperature. At this stage the POW (power) LED flashes to indicate the laser has started the warm-up cycle. After 60 seconds the laser is ready to start by turning the key to its vertical ON-position. This initiates an automatic start-up sequence (temperature stabilisation => warm-up current => constant power; See Section 7 for more information). The laser will be running according to specifications in <2 min. The status of operation is monitored via LED signals. Setting the turn key to its OFF-position puts the laser in stand-by mode.
- **OEM Controller**: The Controller is factory set so that no key is need to turn the laser on. Connecting 12 VDC power supply to the Controller initiates an automatic start-up sequence. The laser will be running according to specifications in <2 min. The operation of the laser can be controlled and monitored via the Data port (supports RS-232 commands and analog signals). See Section 8 for further details.

When power is supplied to the Controller, regardless of on/off state, the temperature control elements are operating to reach setpoint values. The Controller includes a remote interlock connector, 2-pins on the left hand side within the 6-pin analog connector. The connector can be short-circuited with an interlock jumper (included at delivery) for operation of the laser. To make use of the remote interlock as a safety switch, remove the jumper and connect to an external switch. NOTE: when the interlock circuit has been opened during operation, the laser needs to be disconnected from and then reconnected to the power supply in order to start again. Alternatively, it can be re-started using a special sequence of RS-232 commands, see Section 8 for further details.

3.3. Cable

The Cable connects the Laser Head to the Controller. The standard Cable length is 1 m and minimum bending radius 2 cm. When connected care should be taken not to bend or break any of the 26 pins.

3.4. Power supply requirements

An appropriate Power Supply Unit (PSU) is supplied by Cobolt with the laser for low volume orders and is plugged into a properly grounded standard power outlet. The output from the Cobolt supplied PSU is 12 VDC, and the current is 3.75 A (max 45 W). The power supply accepts 90 – 264 VAC and 47–63 Hz. Ripple and noise 1% peak-peak max, 20 MHz bandwidth. For the OEM Controller the accepted voltage range is 11 V – 28 VDC.

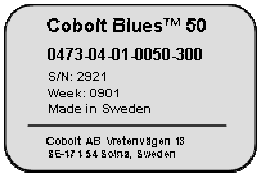
3.5. Warning and identification labels

The Laser Head clearly displays a warning label that shows the location of the laser beam from the aperture and an explanatory label stating the laser safety class compliance of the product. These labels must be visible unless the laser beam is totally enclosed.

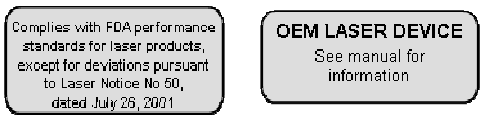
Hazard Symbol and Aperture Label

Explanatory label

The Laser Head and Controller are also provided with a manufacturer's identification label including a serial number which is unique for each laser system and a certification label, either CDRH or OEM.

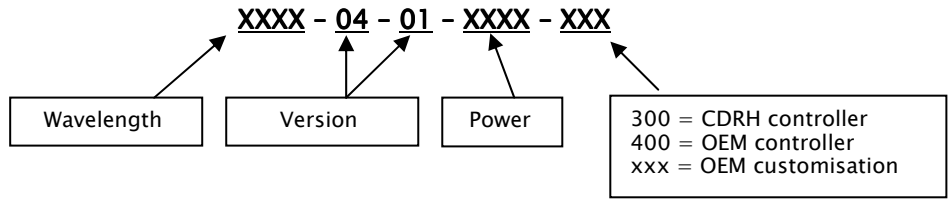


Manufacturers identification label

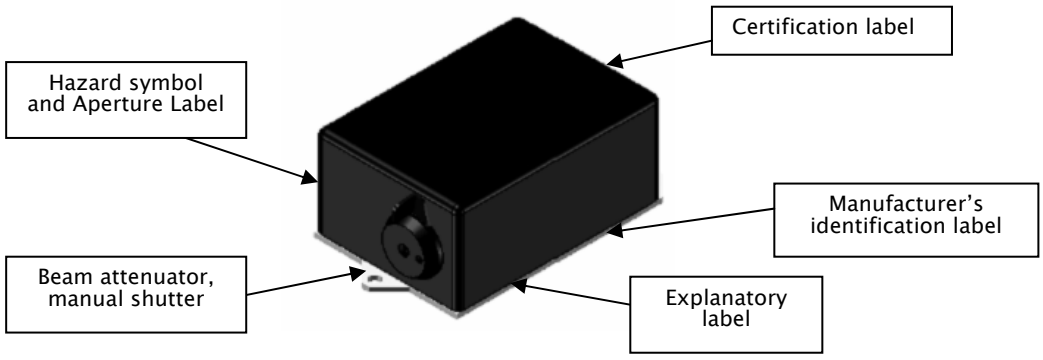


Certification label: CDRH (L) or OEM (R)

Model number description:



Placement of labels:



4. Specifications

4.1. Optical

	Centre wavelength	Output power**
Blues™	473 ± 0.3 nm	25 or 50 mW
Calypso™	491.5 ± 0.3 nm	25, 50, 75 or 100 mW
Dual Calypso™	491.5 & 532 ± 0.3 nm	20+20 mW or 50+50 mW (per colour)
Fandango™	515 ± 0.3 nm	25, 50 or 100 mW
Samba™	532 ± 0.3 nm	25, 50, 100, 150 or 300 mW
Jive™	561 ± 0.3 nm	25, 50, 75, 100 or 150 mW
Mambo™	594 ± 0.3 nm	25 or 50 mW
Twist™	457 ± 0.3 nm	25 or 50 mW

Wavelength stability	± 0.02 nm
Spatial mode	TEM_{00}, M^2 <1.1
Spectral linewidth	<30 MHz (<0.03 pm)
Coherence length	>10 m
Beam divergence (full angle, $1/e^2$)	<1.2 mrad Mambo <1.3mrad
Beam symmetry at aperture	>0.95 : 1
Beam diameter at aperture	700 ± 50 µm
Beam waist location (from exit window)	± 20 cm
Beam angle accuracy*	<5 mrad
Beam position accuracy*	<0.25 mm
Beam pointing stability (after warm-up)	<10 µrad/°C (over 10-40°C)
Noise 10 Hz – 2 MHz (pk-pk)	<3%, typical <2% Dual Calypso <3% (491.5 nm), < 5% (532 nm)
Noise 10 Hz – 2 MHz (rms)	<0.3%, typical <0.2% Dual Calypso <0.3 % (491.5 nm), <0.5% (532 nm)
Long-term power stability (8 hours)	<3%
Polarization ratio	>100:1, vertical
Residual IR emission	<0.1 mW

* relative to beam position reference pins as indicated in Laser Head drawing under Section 5.

**The output power can be adjusted from 10-110% of nominal power using RS-232 commands, see Section 8. Specifications are guaranteed at 100% of nominal power. Recommended power range is 70-100%. Power accuracy 5%.

4.2. Operational and environmental requirements

Power supply	12 VDC, 3.75 A. 11-28 VDC accepted.
Power consumption, total system (Laser Head + Controller)	<25 W (typical ~15 W) Samba 300 mW < 35 W (typical ~25 W)
Maximum heat dissipation of Laser Head	<15 W (typical ~10 W) Samba 300 mW < 20 W (typical ~15 W)
Maximum Laser Head baseplate temperature	50°C
Warm-up time, from OFF	<2 min
Ambient temperature, operation	10-40°C
Ambient temperature, storage	0-60°C
Humidity	0-90% RH
Ambient Air pressure	950-1050 mbar
Shock tolerance, operational (8 ms impact)	60 g
Heat sink thermal resistance, Laser Head	<0.5 K/W

4.3. 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 RS-232 commands
Remote interlock & Analog signals	Molex 90130-3206	Analog input 5 - 12 V => laser on Analog input <2.7 V => laser off
Warm-up time		2 min

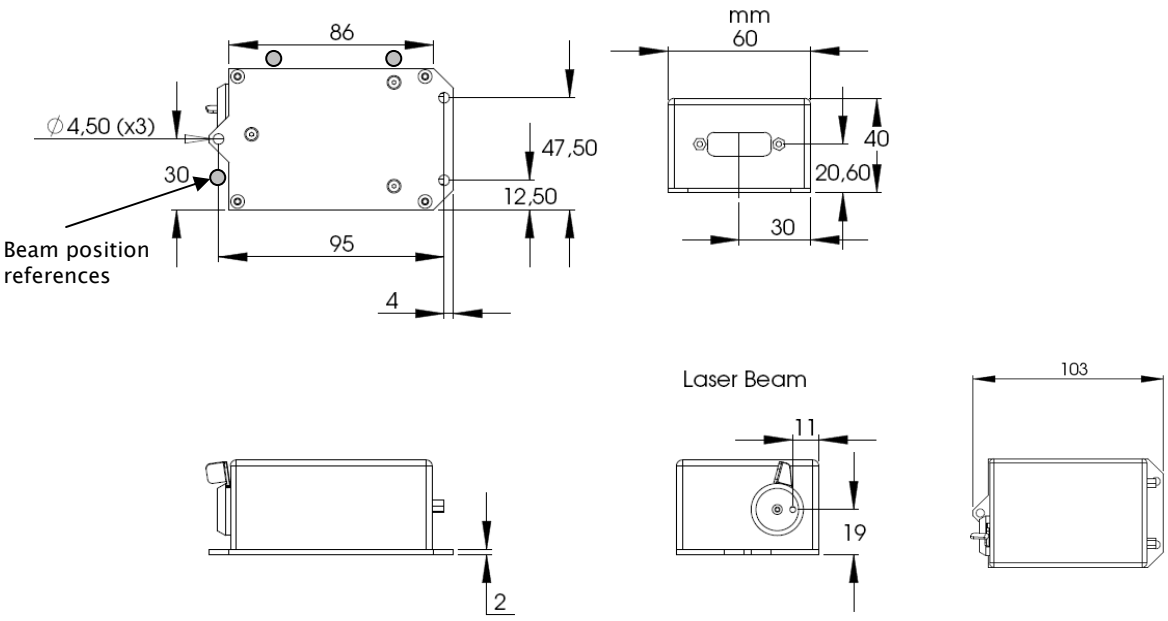
4.4. Mechanical

Dimensions:	
Laser Head	95x60x40 mm
Controller	190x72x28 mm
Fixation holes, Laser Head	size M6 (fitting M4), spacing 64x80 mm
Fixation holes, Controller	spacing 51x178 mm
Cable (Laser Head - Controller)	1 m length, >2 cm bending radius

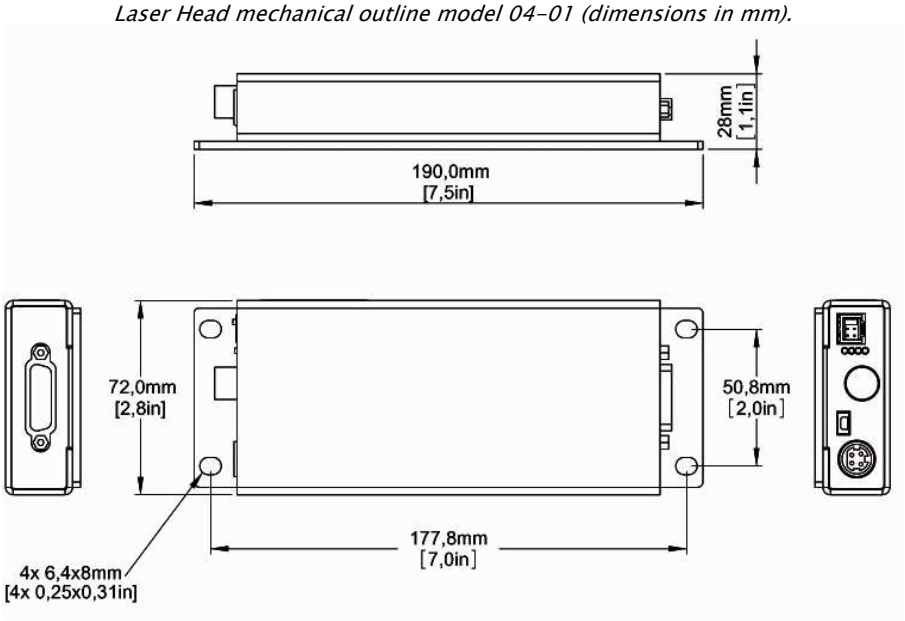
The information presented here is believed to be accurate and is subject to change without notice.

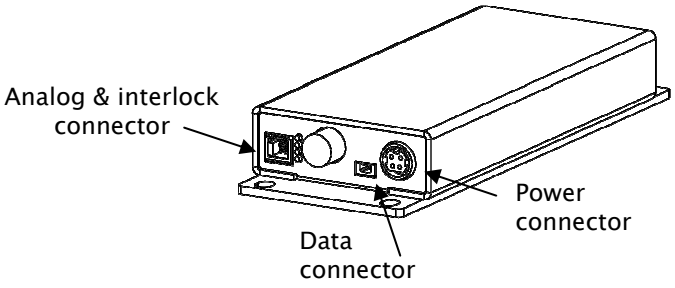
The specifications contained herein cannot be guaranteed outside of normal operational conditions.

5. Mechanical outlines



Laser Head mechanical outline model 04-01 (dimensions in mm).





OEM & CDRH Controller mechanical outline Generation 4 (dimensions in [inches] mm).

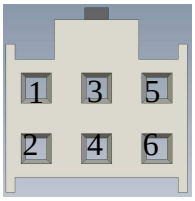
6. Connector drawings & pin assignment

6.1. Analog connector & interlock connector

Manufacturer Molex 90130-3206, mates with 90142-0006.

Pin Function

1. Interlock (connect to pin 2 for enable)
2. GND
3. Analog on/off (Direct input)
4. TST (Internal Cobolt use only)
5. LED “Laser on”
6. LED “Error”

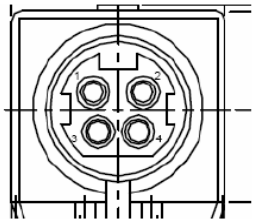


6.2. Power connector

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

Pin Function

1. 0 V
2. +11-28 VDC
3. 0 V
4. +11-28 VDC

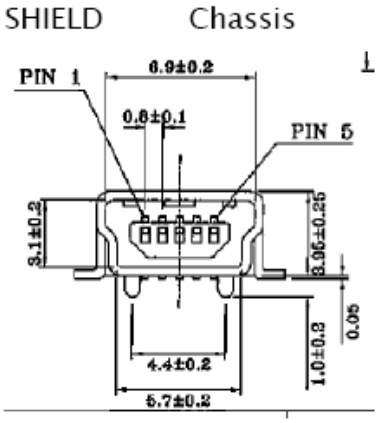


6.3. Data connector

Connector USB-type, manufacturer Hsuan Mao C8320-05BFDSB0, mates with connector mini-B.

Pin Function

1. +5 V (in series with internal 10 Ohm resistor)
2. RS-232_TX
3. RS-232_RX
4. Not connected
5. 0 V (GND)



7. Operation instructions

The laser is 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.

7.1. Installation startup operation

1. Mount the Laser Head on a suitable heat sink (see Section 9).
2. Ensure that the interlock jumper is connected.
3. Connect the Laser Head to the Controller with the Cable and fasten screws at both ends.
4. Apply 12 VDC to power supply connector on Controller.
5. The laser now goes through the following start-up sequence:
   - Temperature stabilisation (1-2 min). Status LEDs: POW flashing, then POW goes on.
   - (For CDRH model: Turn key switch to start the laser. Status LEDs: ON goes on.)
   - The laser starts (light is emitted) in constant current mode (pre-set time of 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.
6. Switching the laser ON/OFF (to/from stand-by mode) via RS-232 commands or Direct Control is described under Section 8.

7.2. Closedown operation

1. Disconnect PSU from mains outlet (Turn the key switch to OFF first for CDRH model).
2. Disconnect Controller from PSU.
3. Disconnect Laser Head from Controller (only required for shipping).

8. Operation via data port

8.1. Baud rates and serial port settings

Each Controller is shipped from the factory with a fixed baud rate (115200), which cannot be changed in the field. 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).

8.2. 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.

8.3. RS-232 commands

The laser is delivered with the Controller set in Auto-start mode (see section 7.1 for Auto-start sequence description). For system integration the Auto-start sequence can be disabled (some commands require Auto-start disabled). 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 system operating hours		Float
ilk?	Get interlock state		0 = OK, 1 = interlock open
@cobas	Enable/disable autostart See sect 7.1 for description	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 of OEM models.		
l0	Laser OFF Use this command for manual OFF of 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 8.4 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		
@cobasky?	Get key switch state		0 = disabled, 1 = enabled
@cobasky	Enable/disable key switch With the key switch disabled the laser is not CDRH compliant.	0 = disable, 1 = enable	

For re-starting the laser with RS-232 commands after having opened the remote interlock switch, execute "cf" for clear fault followed by "@cob1" to restart the laser.

The output power can be adjusted from 10-110% of nominal power using the "p" command. Specifications are guaranteed at 100% of nominal power. Recommended power range is 50-100%.

8.4. Direct control

The Direct 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 5-12 VDC (max 12.5 VDC) is applied to pins 2 & 3 on the analog connector. Shifting the signal to 0 VDC will turn the laser off and put the laser in stand-by mode (status LED:s is POW and not flashing).

9. 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 <0.5 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 (~20 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. For assistance in thermal management and system integration, please contact Cobolt's technical support.

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. Call Cobolt support or your representative to identify corrective action.

LEDs	Status		Explanation	Action
	off	flashing		
POW	x		Mains power off	Check connections
POW		x	Temperatures not stabilised	Check if heatsink is sufficient
LOCK		x	Laser can not 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 system warranty of 18 months after delivery, with unlimited number of operation hours.

The laser systems are designed for modular replacement or repair 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. The warranty will be voided if any of the system units are opened. 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. Clean the aperture with a standard photographers' lens airbrush.

12. Safety and precaution instructions

The Cobolt lasers are a Class IIIB (CDRH), Class 3B (IEC) laser product. The laser is registered to and compliant with IEC 60825-1 and CDRH 21 CFR, subchapter J, via Laser Notice 50.

Cobolt Blues™ emits up to 50 mW of 473 nm laser radiation, Cobolt Samba™ emits up to 300 mW of 532 nm laser radiation, Cobolt Jive™ emits up to 100 mW of 561 nm laser radiation, Cobolt Fandango™ emits up to 100 mW of 515 nm laser radiation, Cobolt Mambo™ emits up to 50 mW of 594 nm laser radiation, Cobolt Calypso™ emits up to 100 mW of 491 nm laser radiation, Cobolt Dual Calypso™ emits up to 50 + 50 mW of 491 + 532 nm laser radiation and Cobolt Twist™ emits up to 50 mW of 457 nm laser radiation. 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. The device must be handled by personnel with experience of 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.

Always install the laser system to a properly grounded power outlet.

Cobolt lasers contain a laser diode which is sensitive to electrostatic discharge (ESD). The device must be handled in an ESD protected workstation.

LASER LIGHT AVOID
EXPOSURE TO BEAM

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

13. Declaration of conformity (CDRH model only)

The Cobolt lasers are designed and manufactured to comply with EC Low Voltage Directive and EC EMC Directive in their standard configuration of Laser Head, Controller, standard 1m cable and supplied with a Cobolt power supply unit.

CE

The following harmonized standards are in use:

- Electrical security: **EN 60950-1, IEC-60950-1**
- Laser Class: **IEC-60825-1, CFR 1040.10-2002 and 1040.11-2002**
- EMC: **EN 61326/A1/A2/A3, incl EN 55011 Class A**

Cobolt lasers are compliant to UL standard:

- Electrical security: **UL 60 950-1**

In addition, Cobolt laser products pass ETC 900 019-2-2 Transport and Vibration Standards including IEC 60068-2-64, IEC 60068-2-29, IEC 60068-2-32, and Shock and Vibration IEC 60068-2-27.
Cobolt lasers are RoHS compliant as defined by the EC Directive 2002/95/EC.

14. Disclaimers

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.

15. Return for repair

If the laser does not function, it must be returned to Cobolt for repair. Do not attempt to open any of the units, or the warranty will be voided. Ensure the unit is free from thermal paste before packing.

1. Call or e-mail Cobolt or your local Cobolt representative for consultancy and to obtain an RMA-number (+46 8 545 91230, e-mail: info@cobolt.se).
2. Pack the unit for shipment using the original package, and ship it back to Cobolt.
3. If the unit is still under warranty, Cobolt will test and repair or replace the units at the option of Cobolt, within 14 days of receipt of the unit.
4. If the unit is not under warranty, Cobolt will contact you with options for repair or replacement.

Cobolt

Contact Information

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