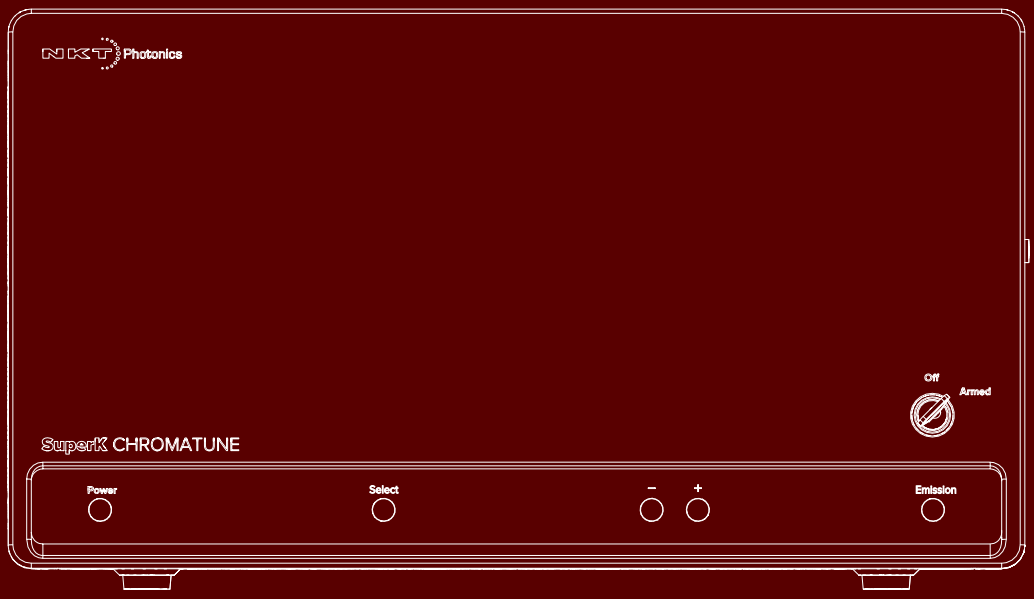
800-642-01

SuperK
CHROMATUNE

Product Guide

Revision 1.1 06-2024



NKT Photonics

A HAMAMATSU COMPANY

PRODUCT GUIDE

This guide includes information for the following NKT Photonics products:

SuperK CHROMATUNE

400 to 1000 nm Wavelength Tunable Laser

CAUTION: Do not open the laser chassis. The laser is equipped with warranty labels (see Figure 75) on the covers of the laser chassis. The warranty is void if the system is opened.

CAUTION: Do not lift the laser alone. The laser is heavy and weighs up to 28 kg; two people are required to lift the laser when placing it into its packaging.

CAUTION: To maintain accurate alignment and output power, the SuperK CHROMATUNE should be handled carefully to avoid mechanical shocks. Make sure to place the laser on a level surface that is free from vibrations.

Manufactured by:

NKT Photonics A/S
Blokken 84, Birkerød-3460 Denmark

Guide Overview

This product guide is intended to provide functional, operational and installation information for the SuperK CHROMATUNE laser systems.

WARNING: Do not operate the laser before first reading and understanding all warnings, cautions and handling information stated within the document:

SuperK CHROMATUNE Laser Safety, Handling and Regulatory Information

The paper copy of this document is included with your laser. However, it can also be downloaded from:

https://www.nktphotonics.com/product-manuals-and-documentation/

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

Target Audience

This guide is for technical personnel involved in the selection, planning and deployment of lasers in laboratory and industrial settings. The guide assumes a reasonable knowledge level of lasers, photonic principles and electrical interface connectivity.

NOTE: CHROMATUNE lasers are designed for anyone to operate. Other than safety measures, laser expertise is not required.

Chapters Inside

This guide includes the following chapters:

- Chapter I "Laser Description" — Describes the SuperK CHROMATUNE laser series including its general operational principles, management and interfaces.
- Chapter 2 "Mechanical Installation" — Includes information and procedures on how to correctly install the laser chassis. Procedures within this chapter focus on providing adequate temperature regulation.
- Chapter 3 "Connecting the Laser" — This chapter provides the information on how to physically connect the safety interlock, power, the optical collimator, synchronization interfaces and how to implement external signals to modulate the output, enhance power stability and gate output pulses.
- Chapter 4 "Front Panel"— Describes the laser's front panel menu and controls that directly operate the laser.
- Chapter 5 "Using CONTROL to Turn On the Laser" — Provides information and procedures on how to connect to the laser's management software and use it to turn the laser emission ON and OFF.
- Chapter 6 "CONTROL Interface" — Includes descriptions and procedures of all other CONTROL menu and panel items.

- Appendices — The guide includes multiple appendices including laser specifications, support contact details, pinout information, and miscellaneous procedures supporting the laser operation and installation.

Added information and Safety Notices

Lasers are highly dangerous devices that can cause serious injury and property damage. This guide use the following symbols to either highlight important safety information or provide further information in relation to a specific topic.

NOTE: Highlights additional information related to the associated topic and/or provides links or the name of the NKT guides describing the additional information.

CAUTION: Alerts you to a potential hazard that could cause loss of data, or damage the system or equipment.

WARNING: The laser safety warning alerts you to potential serious injury when using the laser.

Revision

The section records the document revision details.

Release date	Version and changes
09-2023	First release
06-2024	CONTROL software update

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1 Laser Description

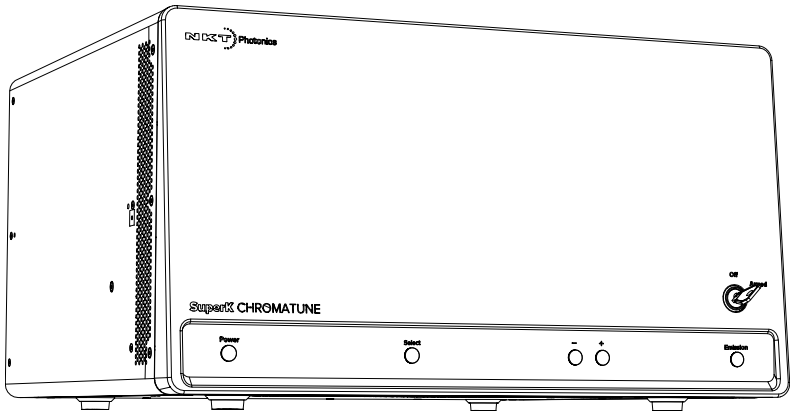
A SuperK CHROMATUNE laser is a wavelength tunable laser source with which you can select from and emit any laser color (line) with a center wavelength in a range from 400 to 1000 nanometers. The line bandwidth is variable from 5 to 50 nm where at the UV end of the spectrum you can narrow the bandwidth down to 5 nm and when selecting longer red wavelengths, the minimum line bandwidth widens to 10 nm. Despite the minimum bandwidth variation, you can widen the bandwidth to 50 nm at any center wavelength selected.

The laser is classified as a Class 3B laser with an optical output power of greater than 1 mW. However, the actual emitted beam power varies and is dependent on the center wavelength and line bandwidth chosen – see “Spectral output” on page 20.

To synchronize external equipment with either the seed or output pulse repetition rate, the laser includes synchronization output ports that can transmit pre or post pulse picker signals using standard industry voltage levels. **A pulse picker is also optional, and it can be added to the laser to select a suitable pulse rate for an application.**

The laser is operated from a PC using NKT Photonics CONTROL management software or a custom platform integrated with an available SDK. And for ease of operation, the laser includes push button controls and a display on the front panel that can among others, set the wavelength, enable emission, and monitor the system.

Figure 1 SuperK CHROMATUNE general view



Terminology

SuperK CHROMATUNE tunable lasers includes the model(s) listed under “Product Guide” on page 2. This guide also uses the term, “laser” to refer to the SuperK CHROMATUNE tunable laser.

Maintenance

SuperK CHROMATUNE tunable lasers are completely maintenance free. No service, alignment or adjustment is required.

Front panel controls

The front panel of the laser is equipped with display and control buttons. The buttons provide basic laser control functions and the display shows the output

selected center wavelength, emission status and system errors and notifications. For a full description, see “Overview” on page 51.

CONTROL The laser and its accessories are managed and configured remotely from a PC using NKT Photonics CONTROL software. The PC connects to the laser over either RS232, USB, or Ethernet links. To configure accessories using the same PC, the laser is equipped with an External Bus port which connects up to eight accessories in a daisy chain. Connecting and managing the laser with CONTROL is described in “Using CONTROL to Turn On the Laser” on page 65.

Temperature regulation The temperature of the laser is regulated by the use of electrical cooling fans. To dissipate heat generated by the laser, the fans draw cool air into the chassis from the vents on the left and right panels. Heated air is then blown out through the rear exhaust vents. The fan speed is automatically adjusted to maintain a stable laser temperature. To maintain proper airflow, install the laser with adequate clearance as described in “Mechanical Installation” on page 37.

Optical output

Optical specifications Table 1 lists the optical specifications of the tunable laser.

Table 1 Optical specifications

Spectral coverage (nm)	400 to 1000 nanometers
Full spectral tuning speed (s)	1 second
Output power per line	>1 milliwatts
Power stability	± 5 percent
Fixed repetition rate5	78 megahertz
Variable repetition rate[i]	0.15 to 78 megahertz
Minimum bandwidth	5 to 10 nanometers
Maximum bandwidth	50 nanometers
Out-of-band suppression	> 40 decibels
Wavelength resolution	1.5 nanometers
Wavelength step size	0.1 nanometers
Beam output	Collimated
Beam quality	$M^2 < 1.1$

i. **Rates only available when optional VRR (pulse picker) is included.**

Spectral output

Tuning range and bandwidth

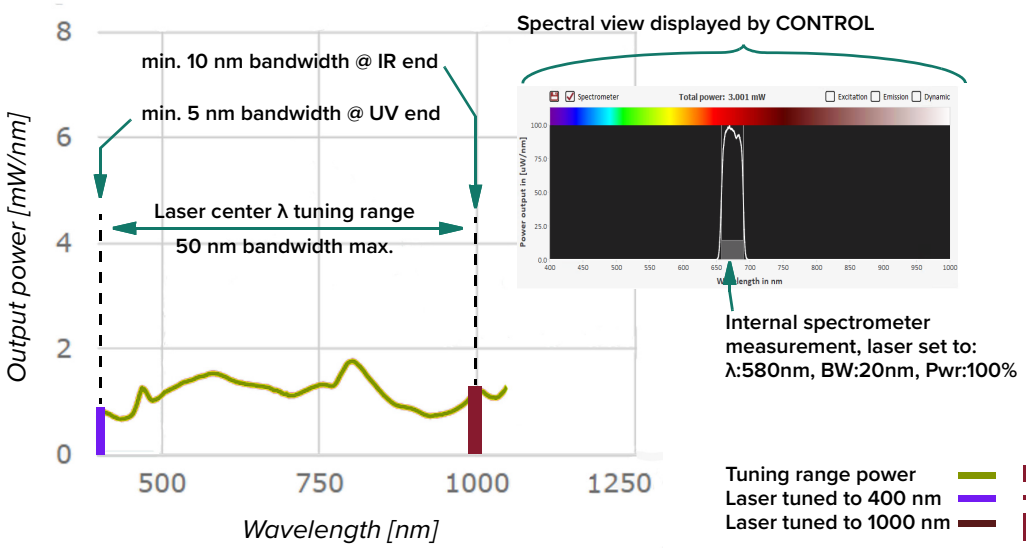
Figure 2 shows the available spectral power density over the tuning range (400 to 1000 nm) of the laser. You can tune the CHROMATUNE laser to any wavelength from this range with a maximum bandwidth of 50 nm. When you tune the laser down to a 400 nm center wavelength, you can narrow the line bandwidth to 5 nm. However, as you increase the wavelength, the minimum

line bandwidth increases over the tuning range to a minimum of 10 nm when set to the maximum 1000 nm center wavelength.

Optical output power

As Figure 2 shows, the tunable laser's optical output power varies across the wavelength tuning range. Because of this, the output power of the laser is dependent on the center wavelength selected. Further, as line bandwidth is increased, so does the total optical power of the emitted beam.

Figure 2 Bandwidth tuning range across spectral power density

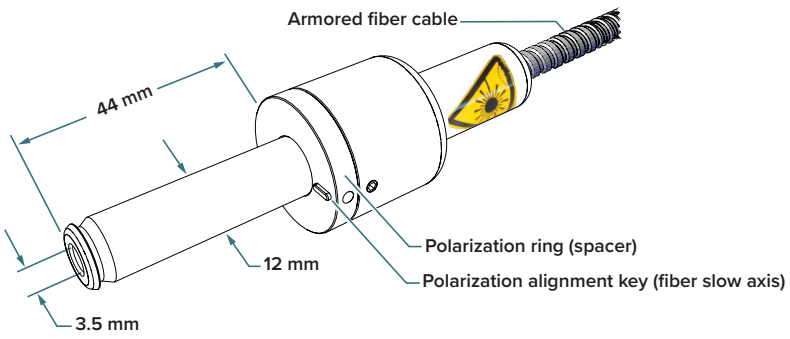


NOTE: The laser emission is limited to the 400 – 1000nm range. If the selected emission band extends outside this range, this will in practice be truncated. For example, tuning to a center wavelength at 400 nm with a bandwidth set to 20 nm you would expect 390 to 410 nm lower and upper bandwidth limits. However, CHROMATUNE emission is limited to a minimum 400 nm wavelength, thus for this setting the bandwidth is from 400 to 410 nm.

Collimator

The optical output of the laser is a collimator at the end of an armored fiber cable as shown in Figure 3. A collimated beam exits the collimator from a steel sleeve connector designed for insertion into a receptacle of a target optical device such as for example, a SuperK accessory, holder, or specifically engineered optical device. Once inserted, the substantial construction of the collimator maintains the output beam alignment.

Figure 3 SuperK CHROMATUNE collimator



CAUTION: Avoid scratching the collimator as this may prevent it from sliding into an input receptacle.

NOTE: It is recommended to fix the collimator using plastic screws instead of metal screws to minimize scratches or other damage to the collimator.

Collimator heat dissipation
A small fraction of the beam power is dumped within the collimator. If the thermal contact between the collimator and the mount or receptacle is inadequate, the collimator can become significantly warm. NKT Photonics recommends that you ensure there is thermal contact between the collimator and its mount/receptacle.

Integrated spectrometer

The collimator includes fiber feedback to an integrated spectrometer constantly measuring the output spectrum. The spectrometer ensures the delivered light corresponds to the laser's set center wavelength and line bandwidth. You can view the measurement using the CONTROL interface, see "Spectrometer" on page 98.

Beam diameter

To maximize the output light coupling with a single mode fiber, the output beam is collimated with an achromatic lens. The lens is designed so the coupling is optimized for maximum average coupling. The beam diameter increases approximately linearly as wavelength increases across the CHROMATUNE tuning range. This is a consequence of the wavelength dependence of the fiber's NA (Numerical Aperture). As an example, Table 2 shows the average measured values of four beams of varying wavelengths from a sample production batch of SuperK CHROMATUNE lasers using a standard M^2 measuring device.

Table 2 Wavelength vs. beam measurement: averages of a sample batch

	CHROMATUNE wavelength			
Beam parameter[i]	**450 nm**	**532 nm**	**650 nm**	**800 nm**
Waist location [mm][ii]	180	200	155	12
Waist diameter [mm][iii]	0.5	0.58	0.72	0.88
Divergence [mrad][iv]	1.18	1.20	1.18	1.18

i. Note that all values are typical measurements from a sample production batch.
ii. Distance from the outside plane of the collimators polarization ring.
iii. Beam width measurement using the second moment method.
iv. Full divergence angle

Factory test report

The system performance of each laser is described in a factory created test and measurement report. Refer to this report for the performance of each individual SuperK CHROMATUNE system.

Polarization ring

A polarization ring is always combined with the collimator as shown in Figure 3. The ring has an alignment key to ensure the optical output is correctly polarized with the intented application. Additionally. when the collimator is inserted into for example, the input receptacle of a SuperK accessory, the ring acts as a spacer to correctly position the collimator.

CAUTION: Always ensure the collimator is fitted with a polarization ring when used with an NKT Photonics accessory.

Pulse picker – VRR (optional)

The optional factory-installed pulse picker or Variable Repetition Rate (VRR) module is capable of suppressing emission output pulses, reducing the repetition rate of the system. For systems without VRR, the output pulse frequency is fixed to 78 MHz.

Repetition rates

When using VRR, the output repetition rate can be lowered by a factor up to 512. Table 3 shows the repetition rates for a sample laser operating with a standard 78 MHz seed laser. Employing VRR or pulse picker operation reduces the output power level but not the pulse spectral shape.

Table 3 Frequency versus VRR factor

Seed frequency MHz	VRR factor	Seed frequency MHz	VRR factor
78	1:1	3.9	1:20
39	1:2	3.5	1:22
26	1:3	3.1	1:25
19.5	1:4	2.9	1:27
15.6	1:5	2.7	1:29
13	1:6	2.4	1:32
11.1	1:7	2.3	1:34
9.8	1:8	2.1	1:37
8.7	1:9	2.00	1:40
7.8	1:10	1.22	1:64
6.5	1:12	0.61 (or 610 kHz)	1:128
5.6	1:14	0.30 (or 300 kHz)	1:256
4.9	1:16	0.15 (or 150 kHz)	1:512
4.3	1:18		

NOTE: Actual repetition rates may differ depending on the laser's specifications. Contact NKT Photonics for further information.

NOTE: The repetition rate can be read and set using either NKT Photonics' CONTROL management software or Software Development Kit (SDK). You can also view the set repetition rate from the front panel display - See "Operation page"

on page 53.

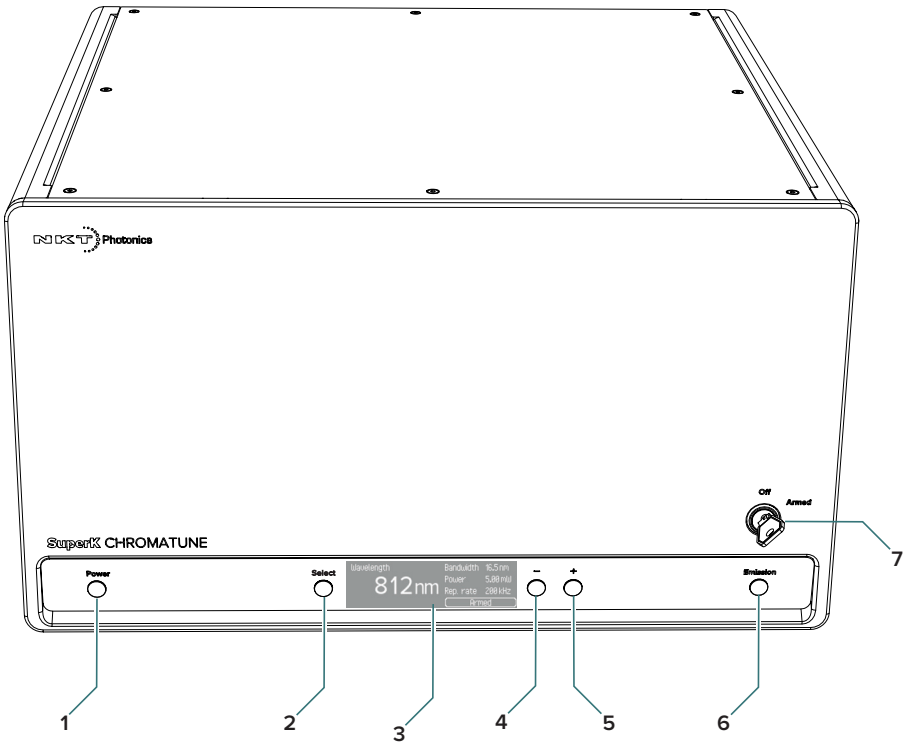
Using VRR If the repetition rate is changed while the system has emission on, the system momentarily disables emission, changes the repetition rate and then re-enables emission. The complete sequence takes only a fraction of a second. To set the rate, see “Repetition rate” on page 82.

Output power Increasing the repetition rate increases the output power level. For example, if the repetition rate is changed from 3.9 MHz to 78 MHz, the output power increases by a factor of 20 (40/2). This is due to the laser being calibrated for constant pulse energy and not for constant average power.

Front panel controls

The front panel controls are highlighted in Figure 4. The panel provides both user controls and a display to directly operate the laser.

Figure 4 Front panel controls



1 Power button
2 Select button
3 Display panel
4 Decrease button
5 Increase button
6 Emission button
7 Key switch

Power button Press this button to turn all system modules ON or OFF. The power button must be pressed for approximately 1 to 2 seconds to turn ON the system.

Select button Press this button to view the next page available in the display.

NOTE: If the screen is dimmed, press *Select* once to brighten it.

Display panel OLED display panel showing system power, emission status, errors, notifications and more.

Decrease button Press this button to decrease the selected parameter.

Increase button Press this button to increase the selected parameter.

Key switch Key control of laser emission:

- When turned to OFF, emission is disabled.
- When turned to ARMED, emission is permitted.

NOTE: When the key switch is turned to OFF, emission is immediately disabled and cannot be re-enabled. When turned to the ARMED position, you can enable emission using emission controls.

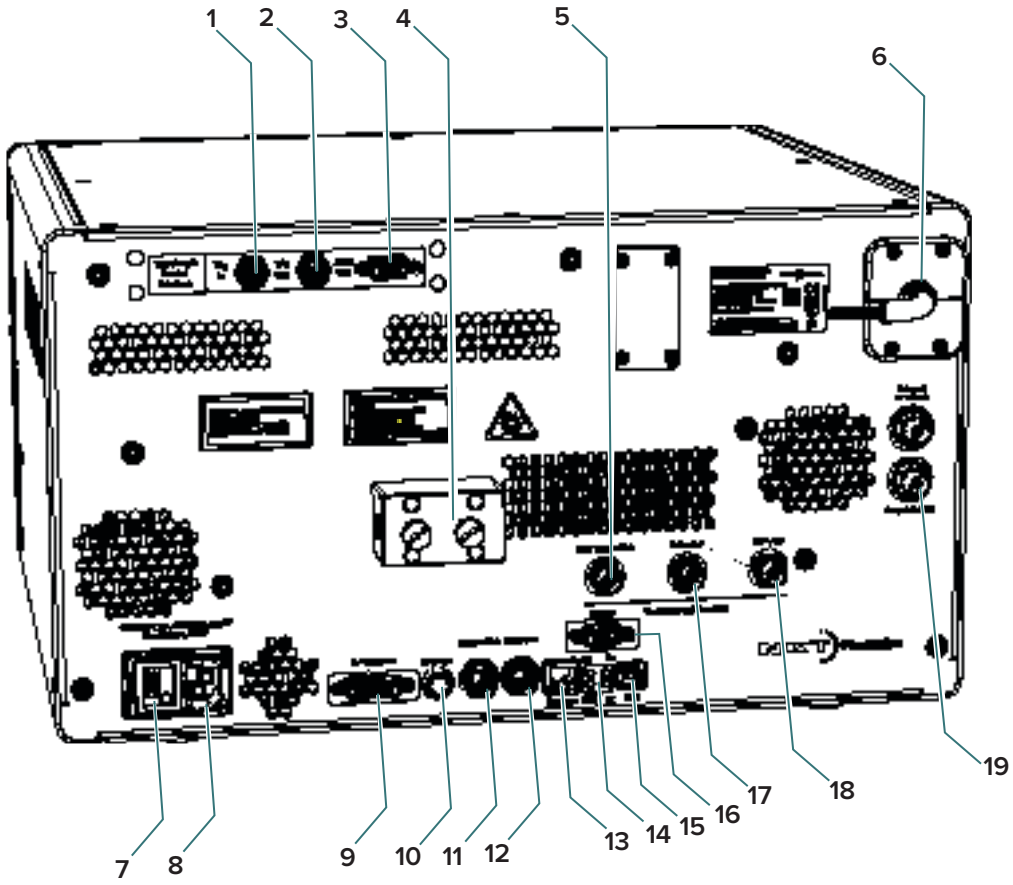
Emission button Press this button to enable or disable emission.

NOTE: For details on using the front panel controls, see “Overview” on page 51.

Rear panel

The rear panel houses the electrical ports, status LEDs, and the optical output cable and collimator. The panel and its components are shown in Figure 5.

Figure 5 Rear panel features and connectors



1 Trig in
2 Trig out
3 ASCII out
4 Collimator Storage Receptacle
5 NIM Pulse out[i] (post-VRR) – BNC
6 Collimator (not shown) and Armored Cable
7 ON/OFF power switch
8 AC power connector – IEC13
9 External Bus – DB-15
10 Interlock – LEMO plug door switch connector
11 NIM pulse out(pre-VRR) – BNC
12 Pulse out (pre-VRR) – BNC
13 Ethernet port – RJ-45
14 Status LEDs
15 USB port – type B
16 RS-232 serial port – DB-9
17 Pulse out[i] (post-VRR) – BNC
18 Gate out[i] (post VRR) – BNC
19 Output control – BNC

i. Only with VRR option

CHROMATUNE ports

Trig in A trigger signal on this BNC port can be used when executing a CHROMASCRIPT to automate the laser. The script can be programmed to wait to proceed until it detects a trigger signal on the port which can be either a: low, high, rising edge, or falling edge. It can be set in either manual operating mode or when executing an automated CHROMASCRIPT or using the “Sequence tab”.

The trigger signal must be a TTL level square wave, with the logic level kept for a minimum of 25 ms.

Trig Out When the CHROMATUNE laser tunes the emission output, this BNC port outputs a trigger signal when the tuning is completed. You can set the trigger signal to either a low or high TTL signal in either manual operating mode or when executing an automated CHROMASCRIPT or using the “Sequence tab”.

ASCII out This serial port outputs an ASCII format dump of the CHROMATUNE configured (setpoint) and measured parameters during a CHROMASCRIPT execution.

Serial port settings are: *115200 baud*, *8 data bits*, *1 stop bit* and *none parity*.

Sample output from the port is shown below.

CWL: Center wavelength in nanometers

BW: Bandwidth in nanometers

POW: Power in milliwatts

Sample output

```
SetPoint: CWL=680.0nm,BW=25.0nm,POW=2.200000mW, Measured:
CWL=680.1nm,BW=25.2nm,POW=2.176205mW, SH=1
SetPoint: CWL=680.0nm,BW=25.0nm,POW=2.200000mW, Mea-
sured: CWL=680.1nm,BW=25.2nm,POW=2.174845mW, SH=1
SetPoint: CWL=680.0nm,BW=25.0nm,POW=2.200000mW, Mea-
sured: CWL=680.1nm,BW=25.2nm,POW=2.174914mW, SH=1
SetPoint: CWL=680.0nm,BW=25.0nm,POW=2.200000mW, Mea-
sured: CWL=680.1nm,BW=25.2nm,POW=2.176205mW, SH=1
SetPoint: CWL=680.0nm,BW=25.0nm,POW=2.200000mW, Mea-
sured: CWL=680.1nm,BW=25.2nm,POW=2.176205mW, SH=1
SetPoint: CWL=680.0nm,BW=25.0nm,POW=2.200000mW, Mea-
sured: CWL=680.1nm,BW=25.2nm,POW=2.174845mW, SH=1
SetPoint: CWL=680.0nm,BW=25.0nm,POW=2.200000mW, Mea-
sured: CWL=680.1nm,BW=25.2nm,POW=2.174914mW, SH=1
SetPoint: CWL=680.0nm,BW=25.0nm,POW=2.200000mW, Mea-
sured: CWL=680.1nm,BW=25.2nm,POW=2.176205mW, SH=1
```

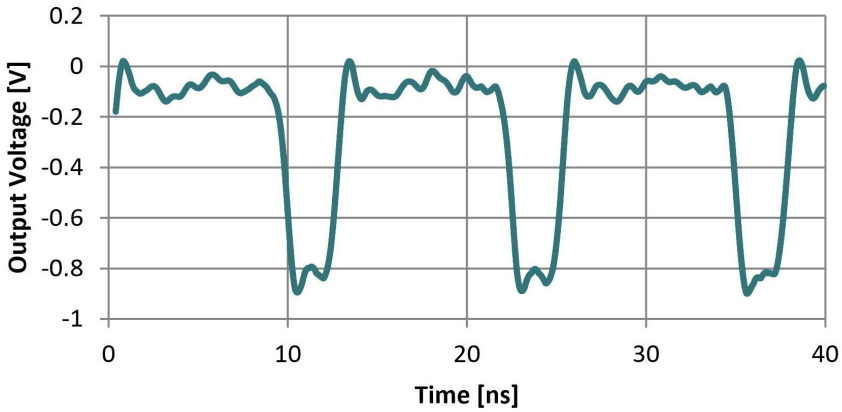
External control and synchronization BNC ports

Pre-VRR ports These interfaces provide synchronization signals that represent the laser pulse output after the optional VRR module.

NIM pulse out

This signal represents the seed pulse of the laser before the optional VRR module (see Figure 5). You can use the signal to synchronize external devices to the seed frequency of the laser. The signal is NIM compliant (see standard DOE/ER-0457) and ranges from 0 to approximately -1 V as shown in Figure 6, For further information, see “Connecting pulse synchronization ports” on page 47.

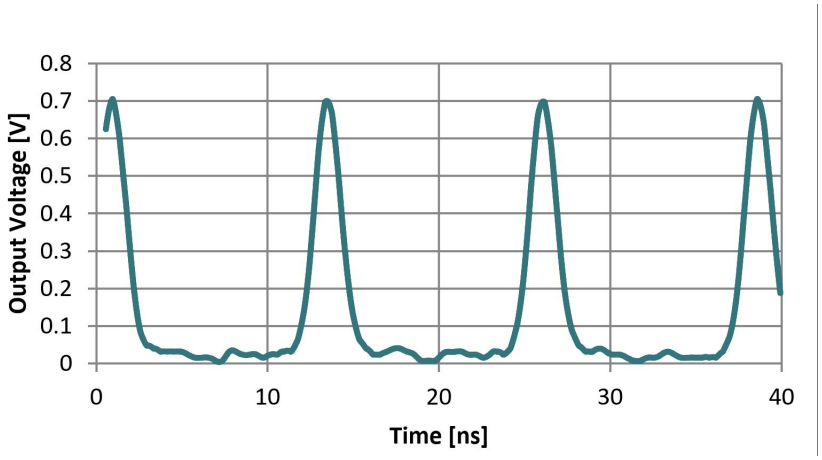
Figure 6 NIM pulse output



Pulse out

This signal represents the seed pulse of the laser before the optional VRR module (see Figure 7). You can use the signal to synchronize external devices to the seed frequency of the laser. The signal is an analog output that ranges from 0 to +0.7 V. For further information, see “Connecting pulse synchronization ports” on page 47.

Figure 7 Pulse output



Post-VRR ports

These interfaces provide synchronization signals that represent the pulse output after the optional VRR module.

NIM Pulse out

The port outputs a NIM level signal similar to the pre-VRR “NIM pulse out” on page 29. However, this signal is synchronized with the laser pulse output after the VRR module. The signal is NIM compliant (see standard DOE/ER-0457) and ranges from 0 to approximately -1 V. A typical NIM Pulse signal is shown in Figure 6. For further information, see “Connecting pulse synchronization ports” on page 47.

Pulse out

The port outputs a signal similar to the pre-VRR “Pulse out” on page 29. However, this signal represents the laser pulse output after the VRR module. The signal is intended for applications that require a positive bias synchronization signal for external devices. Its output level ranges from 0 to +1.2 V (approximately). For further information, see “Connecting pulse synchronization ports” on page 47.

Gate out

This port outputs a digital signal from 0 to +1.2 V (approximately). A high logic signal indicates a pulse passed through the VRR, whereas a low level indicates pulses are suppressed. The output signal frequency is synchronized with the configured repetition rate of the laser after the VRR module. For further information, see “Connecting pulse synchronization ports” on page 47.

NOTE: In any application, the fiber and cable lengths used may add to the delay between pulses measured on any of the pulse monitoring ports.

Connecting a PC

The laser is managed and configured from a PC with NKT Photonics' CONTROL application installed on it. You can connect the PC to the laser using either a serial or Ethernet connection.

Typically a CONTROL PC is connected over a serial connection using the USB2 Type B port. However, a standard serial RS-232 COM cable may also be used to connect a CONTROL PC's serial port or USB (using a converter) port to the laser's standard DB-9 RS232 port.

For remote CONTROL PC operation, a standard 100M RJ-45 Ethernet port is also equipped on the rear panel. The laser supports IPv4 networking and the port must be connected to a local subnetwork that is accessible to the subnetwork that the CONTROL PC is connected to.

USB port

This is a USB2 type B port and operates as a USB serial port. In most cases, you should install the serial USB drivers included with the CONTROL installer for your PC to communicate with the port.

Priority

When more than one communications port is connected, the laser's USB port has priority for external communication over all other ports.

RS-232 serial port

If you connect your PC to the laser using the serial port, set the PC serial port to the settings listed in Table 4.

Table 4 RS-232 serial port settings

Setting	Value
Baud Rate	115.2 kbps
Data Bits	8
Parity	None
Flow Control	None
Transmitted Text	Append LF
Received Text	Mono-spaced

Ethernet port

This port supports an IPv4 connection over 10/100 Mbps Ethernet. Refer to the Ethernet port connection setup: Procedure 13 on page 67.

NOTE: Always use shielded twisted pair (STP) cabling when connecting to the Ethernet port.

Configuration and operation overview

You can configure and operate the laser from a PC or other control device using either:

- NKT Photonics' CONTROL application

  -or-

- a custom software application using NKT Photonics' SDK.

CONTROL application

NKT Photonics' CONTROL application is a graphical interface that can manage the laser from a PC. The application communicates with the laser through the laser's rear panel Ethernet or serial interfaces shown in Figure 5, see "Connecting a PC" on page 31.

Through CONTROL, you can manage the laser's emission and power settings. Within the interface parameters such as wavelength, bandwidth and repetition rate can be configured. Additionally, CONTROL can download the laser's log file.

The chapter "Using CONTROL to Turn On the Laser" on page 65 provides the details and procedures on how to connect CONTROL to the laser and enable emission. For a description of the interface refer to "CONTROL Interface" on page 75.

Advanced laser control

You can also manage the laser by building your own custom platform and software using the NKT Photonics SDK kit. Download the kit and it's documentation from:

https://www.nktphotonics.com/support/

Key switch and interlock safety

To enhance safety, the laser is equipped with an interlock and a keyed switch. The two components work together to safely control laser emission. To permit laser emission, the interlock loop must be closed, the key switch must be in the *Armed* position and a software interlock reset must be activated.

The interlock connects to a door switch operated by an access door to the enclosure surrounding the laser emission. If the door unexpectedly opens, the door switch (interlock) circuit opens and laser emission is immediately shut down. "Connecting the safety interlock" on page 39 describes details on how to connect the interlock.

Interlock safety reset

If the enclosure door opens and closes, the laser is shut down by the interlock. When the door is closed again, laser emission can be enabled after resetting the interlock either on the front panel or by software – see "Interlock operation description" on page 39.

External Bus The External Bus port connects optional SuperK CHROMATUNE accessories. The port provides a bus control interface and 12V DC power to connected accessories. When multiple smart accessories are utilized with the laser, the bus supports daisy chain connectivity. Smart accessories connected to the bus are recognized and managed by the CONTROL PC connected through the laser. Further, the bus extends the interlock safety circuit to the accessories. Because of this, the bus defeater must always be placed on the last open External Bus output, otherwise laser emission cannot be enabled. For information on connecting the bus, see “Connecting the External Bus”.

NOTE: The External Bus only prevents the laser from operating when the Interlock circuit is connected as required by safety regulations.

Status LEDs

The rear panel houses four status LEDs as described in Table 5. The LEDs indicate the status of the laser's USB serial connection with a PC.

Figure 8 SuperK CHROMATUNE rear panel status LEDs

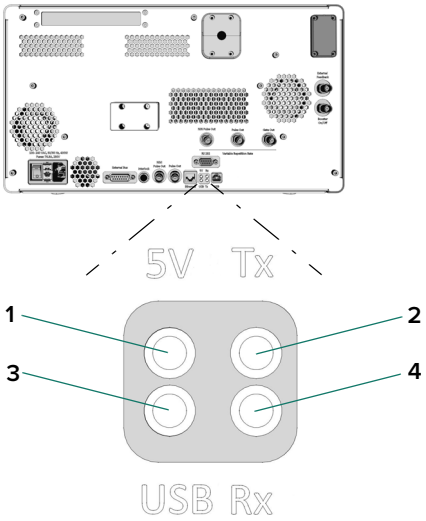


Table 5 Status LEDs

	LED	Condition	Description
1	5V	ON Green	Laser system DC voltage OK
		ON Red	Laser system DC voltage too low
		OFF	Laser system power OFF
2	Tx	Flashing Green	The SuperK CHROMATUNE is transmitting serial data to a connected PC.
		OFF	No received data detected
3	USB	ON Green	USB serial port is connected and the driver is installed and configured correctly.[i]
		ON Amber	USB serial port is in suspend mode; possibly due to the connected PC deactivating its port.[ii]
		OFF	No USB serial data connection detected.[i]
4	Rx	Flashing Amber	The SuperK CHROMATUNE is receiving serial data from a connected PC.
		OFF	No transmitted data detected

i. If system power is OFF, this LED is lit GREEN when the port connects to a USB source.
ii. The laser's RS-232 serial or Ethernet ports are available.

NOTE: DO NOT OPERATE the laser until you are familiar with the controls and have taken all precautions necessary as described in the *SuperK CHROMATUNE Safety, Handling and Regulatory Information* document.

Chassis labels

The SuperK CHROMATUNE chassis includes multiple labels that indicate hazards and regulatory or manufacturing information. The labels are located on the rear panel, the armored fiber cable, and the collimator as described in Table 6. Rear panel label locations are shown in Figure 9.

Table 6 Chassis labels

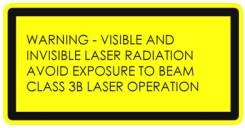
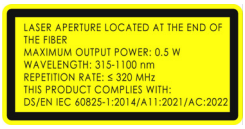
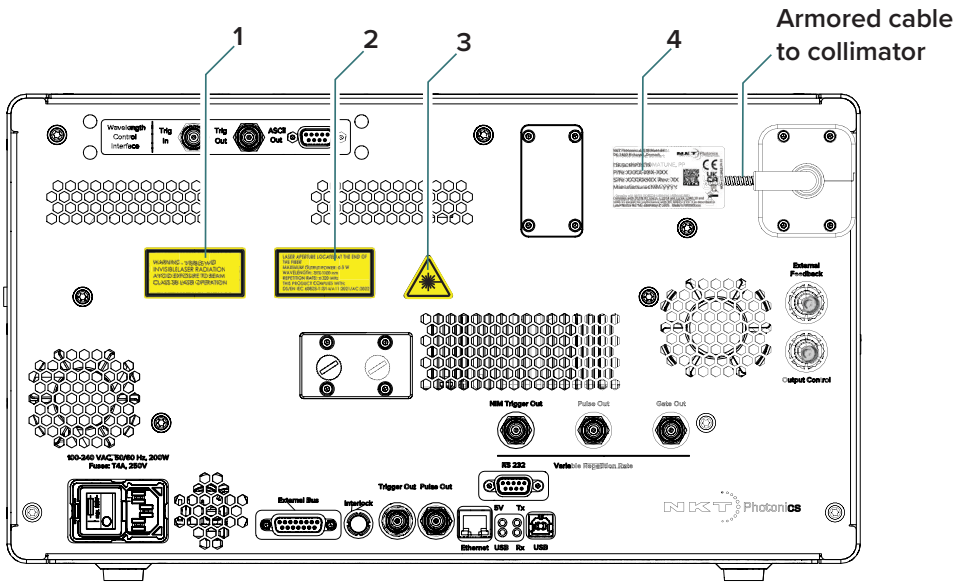
Label	Panel	Description	
Classification	Rear (1)	Safety information stating the laser emission hazards and the laser's class rating.	
Manufacturing	Rear (4)	Manufacturing information including address, part and serial number, date manufactured and regulatory compliances. Note: For European Community Directive 2012/19/EU regulations – see Disposal on page 122.	
Laser Radiation Warning	Rear (3)	Safety information alert indicating this area of the laser is near a source of dangerous laser emission.	
Laser Aperture	Collimator	Safety information alert indicating the location of the aperture where laser radiation is emitted from the laser.	
Product information	Rear (2)	Safety information notice indicating the location of the aperture where laser radiation is emitted from, safety compliance information, and key emission specifications.	

Figure 9 Rear panel labels



2 Mechanical Installation

This chapter provides information on how to mechanically install the laser with focus on ensuring optimal regulation of the laser's temperature.

CAUTION: For reliable operation, the laser should not be exposed to corrosive agents or excessive moisture, heat or dust.

CAUTION: To maintain accurate alignment and output power, the SuperK CHROMATUNE should be handled carefully to avoid mechanical shocks. Make sure to place the laser on a level surface that is free from vibrations.

CAUTION: The SuperK CHROMATUNE laser is heavy. Its weight is approximately 28 kg, observe and follow all regional safety regulations and techniques when lifting and carrying the laser.

General installation

Install the laser on a level surface that is free from vibrations and ensure the ambient temperature surrounding the laser is stable and free from anything that could cause temperature fluctuations. Temperature changes and vibrations may affect the laser's operation and result in abnormal operation.

Location and environment

The laser is intended FOR INDOOR USE ONLY and is rated for operation in POLLUTION DEGREE 2 environments.

Positioning

Ensure the laser is positioned in such as way that its AC power cord can be accessed and removed. Access to the laser's AC inlet and the an AC mains wall outlet that the AC cord is connected to must be free of any obstructions so that the plugs on either end of the cord can be removed freely.

Air cooling

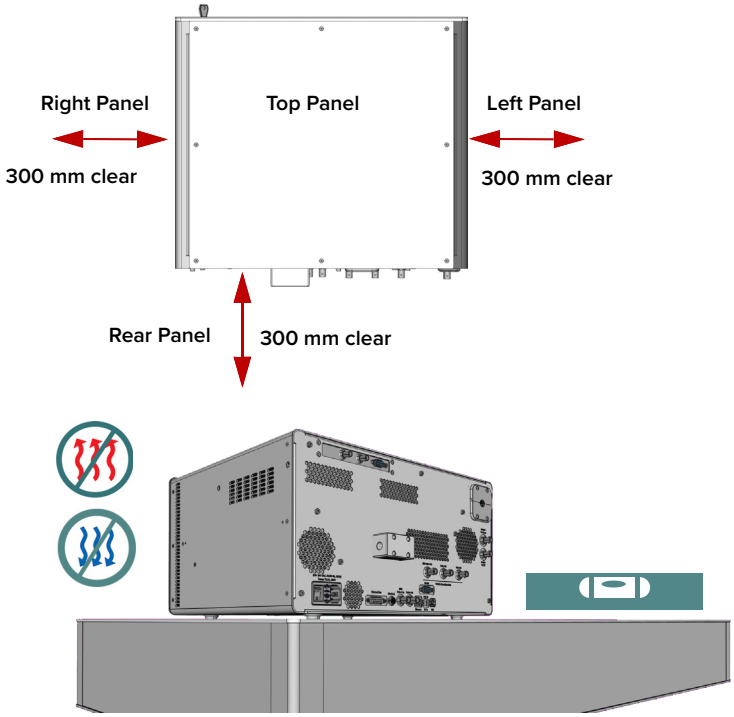
The laser is cooled with forced air. The air is drawn in through the air inlet vents on the side panels and blown out through the exhaust vents on the rear panel. The system features five electrically controlled fans, i.e. air flow is adjusted based on the lasers operating temperature. There should be a clearance gap in front of the inlet and exhaust vents to allow the free flow of air.

Other installation considerations are described under the section "Installation" on page 38.

Installation

The laser should be located so that the fan intake and exhaust vents are not obstructed. The laser is equipped with four mounting feet and can be placed on any suitable level and stable surface capable of supporting the laser's weight.

Figure 10 SuperK CHROMATUNE installation



Air flow considerations

The air cooled chassis must have sufficient clearance at the side and back panels for unobstructed air flow. The clearance and ambient operation temperature required is listed in Table 7. The surface the laser is placed on must be level and free of vibrations.

Table 7 Air flow considerations

Requirement	
Side panel gap	A minimum of 300 mm must be clear of obstructions
Rear panel gap	A minimum of 300 mm must be clear of obstructions
Ambient operating temperature	18°C to 30°C (64°F to 86°F)

3 Connecting the Laser

The laser includes multiple electrical connections. For information on how to connect:

- The safety interlock – see “Connecting the safety interlock” on page 39
- Power – see “Connecting power” on page 41
- The optical output – see “Connecting the optical output” on page 42
- Accessories – see “Connecting accessories with the External Bus” on page 44
- Pulse synchronization ports – see “Connecting pulse synchronization ports” on page 47

Connecting the safety interlock

To comply with safety regulations and help provide a safe operating environment, the safety interlock of the laser must be connected to a switch activated by an access door to the laser’s enclosure. When the connected switch is opened by the door, it opens the interlock circuit which in turn shuts down laser emission. After closing the door, the interlock circuit must be reset either from the front panel (turning the key switch) or from the software control (Reset interlock, see Procedure 15 on page 72), before the emission can be switched on again. The following section describes the general operation of the interlock; to connect a door switch to the interlock, follow the steps in Procedure 1.

Interlock operation description

The interlock circuit in simple terms is a closed loop circuit. When the interlock monitor function of the laser controller detects a break or open in the circuit, the controller immediately shuts down the laser. The loop can be opened by either the keyswitch relay, the door switch circuit or the External Bus loop. In Figure 11, the keyswitch is turned to the *Armed* position which a logic circuit in the laser detects. When a reset command is sent from the front panel controls or CONTROL software to the laser, the controller sends a set signal to the logic circuit energizing the normally open keyswitch relay. Since the door switch is closed, and the External Bus circuit is looped (shorted) using a Bus defeater, the laser controller’s interlock monitor detects that the interlock circuit is closed and so the controller permits laser emission.

Figure 11 Interlock connected to a door switch - laser armed

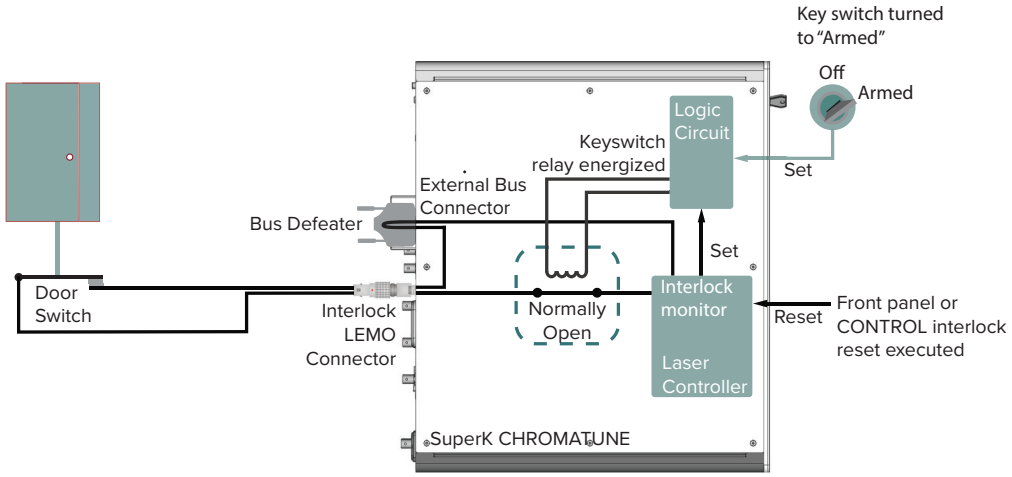
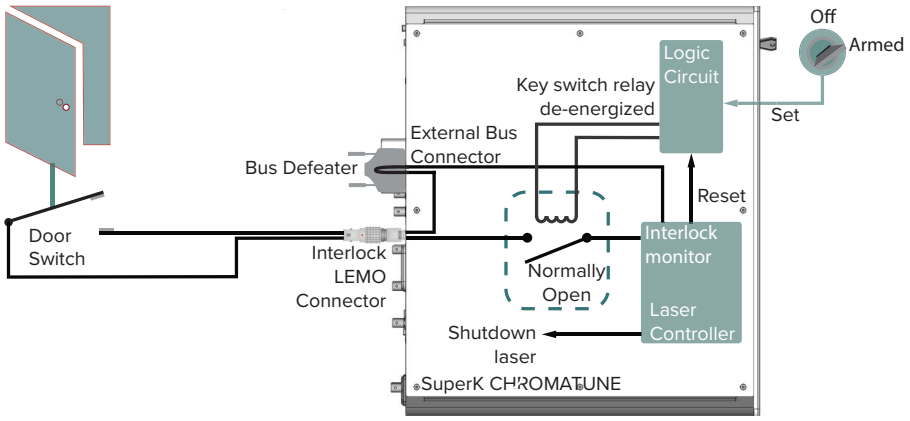


Figure 12 shows the door switch in the open position. This opens the interlock loop which the interlock monitor detects and the controller immediately sends a shutdown signal to the laser (the laser's pump). In addition, the controller sends a reset to the logic circuit. The reset causes the logic circuit to de-energize the keyswitch and the relay opens.

When the door closes again, use either the front panel controls or CONTROL software to reset the interlock. This sets the logic circuit (a D Flip-Flop) to energize the coil again closing the keyswitch relay as shown in Figure 11.

Figure 12 Interlock connected to a door switch - Laser SHUTDOWN



CAUTION: Do not short-circuit the Interlock input. Short-circuiting the interlock circumvents safety regulations and NKT Photonics does not take liability for any injuries or damage caused by doing so.

CAUTION: The switch connected to the interlock must be of an approved type. Further, the switch must be installed in a manner so that its operation cannot be fixed in the open state using a tool to defeat its operation.

WARNING: If the interlock is bypassed, personnel may be exposed to hazardous laser radiation. To reduce the risk to personnel, the person or group responsible for operation of the equipment must undertake a risk assessment and provide personnel with appropriate personal protective equipment and safety training.

Safety door switch

Follow the steps in Procedure 1 to connect a door switch to the interlock safety circuit.

LEMO plug

The laser is shipped with a prewired 2-pin LEMO interlock plug for inter-connecting the laser with a safety door switch circuit. If you need a replacement, contact NKT Photonics support – see “Support contact details” on page 117.

Procedure 1 Connecting the door interlock circuit

	Action
1	Install a switch that opens when the door accessing the laser enclosure is opened. The switch must comply with local regulations.
2	Connect the switch to the prewired interlock plug using insulated wire. Use a cable with a minimum of 26 AWG gauge wire and a maximum length of five meters. For cable lengths longer than five meters, it is recommended to use shielded cable. **NOTE**: For interlock circuit specifications, see Table 8.
3	Perform a continuity test using a multimeter: • First connect the multimeter leads to the interlock plug terminals. • Confirm when the enclosure door is closed, the meter shows the circuit as closed. • Confirm when the enclosure door opens, the meter shows the circuit as open.
4	Insert the LEMO plug into the Interlock connector of the laser, see item 12 - Figure 5.

Table 8 Interlock circuit specifications

Specification	Value
Open loop voltage	12 V maximum
Closed loop voltage	Typically 5 V to ground
Closed loop current	Typically 43 mA

Connecting power

Power is supplied to the laser by connecting it directly to the AC mains. Refer to the specifications in Appendix for the electrical details.

To connect power, follow the instructions in Procedure 2.

Procedure 2 Connecting power

	Action
1	Ensure the laser is positioned in such as way that so you can access and remove the AC power cord. The laser's AC inlet and the AC mains connector that the AC cord is connected to, must be free of any obstructions so that the plugs on either end of the cable can be removed freely.
2	Connect the AC cord supplied with the laser to the rear 3-pin IEC power input connector.
3	Connect the AC cord to a local AC mains supply.
4	Press the power toggle button to the ON position. (The switch is next to the rear IEC power input connector.)

CAUTION: Always connect the laser an earthed (grounded) AC outlet to comply with international and regional safety standards.

CAUTION: DO NOT connect the unit to an AC outlet (power supply) without an earth (ground) connection.

CAUTION: The AC outlet must be near to the laser and easily accessible. You can remove power from the unit by disconnecting the power cord from the outlet.

CAUTION: Ensure you use an approved cord set when supplying AC mains power. The cord set must be suitable for the laser's power ratings and be approved by your regional electrical safety regulations.

CAUTION: The cord's appliance coupler (the connector at the laser; not the wall plug) must be a configuration that mates with an EN 60320/IEC 320 appliance inlet.

WARNING: Care should be taken to mount the collimator so that the beam emitted is contained in an area where no personnel or flammable material is present.

Connecting the optical output

Back reflection

When building and connecting your optical system, you must be careful to avoid creating a path where Back Reflection (BR) can occur. BR occurs when a laser beam is reflected back into the laser cavity. This increases noise and may cause the laser beam to scatter causing damage or injury.

You must always reduce the risk of BR into the laser. For example, in a bulk-optic system, ensure all reflective optics are securely fixed, minimizing the risk of back-reflected light into the laser. Also, before turning on the laser the first time, check the optical path to confirm no BR is possible from the application light path.

WARNING: Back reflection (BR) is a hazard and may cause injury or damage.

Installing the collimator

The collimator is constructed so that its steel sleeve inserts into a holder or a receptacle of a next stage optical device such as a SuperK accessory. To install the collimator, follow the instructions in Procedure 3.

Procedure 3 Installing the collimator

	Action
1	Remove the yellow protective cap from the end of the collimator sleeve.
2	Carefully align the collimator sleeve with the target receptacle as shown in Figure 14.
3	Slide the collimator into the receptacle and then:

– For SuperK accessories:

a. Slide the collimator sleeve into the optical input receptacle of the device.
b. Turn the collimator so that its alignment key aligns with the slot in the receptacle.
c. Push the collimator in until it clicks in place (release button lock).
d. Tighten the accessory lock screw using a 2.5 mm hex key screwdriver (minimum length of 25 mm) to securely retain the collimator.

– For holders, power meters, etc.:

a. Slide the sleeve into the receptacle until it stops.
b. Tighten any locking screws to securely retain the collimator as shown in B of Figure 14.

Figure 13 Collimator installed into a SuperK accessory receptacle

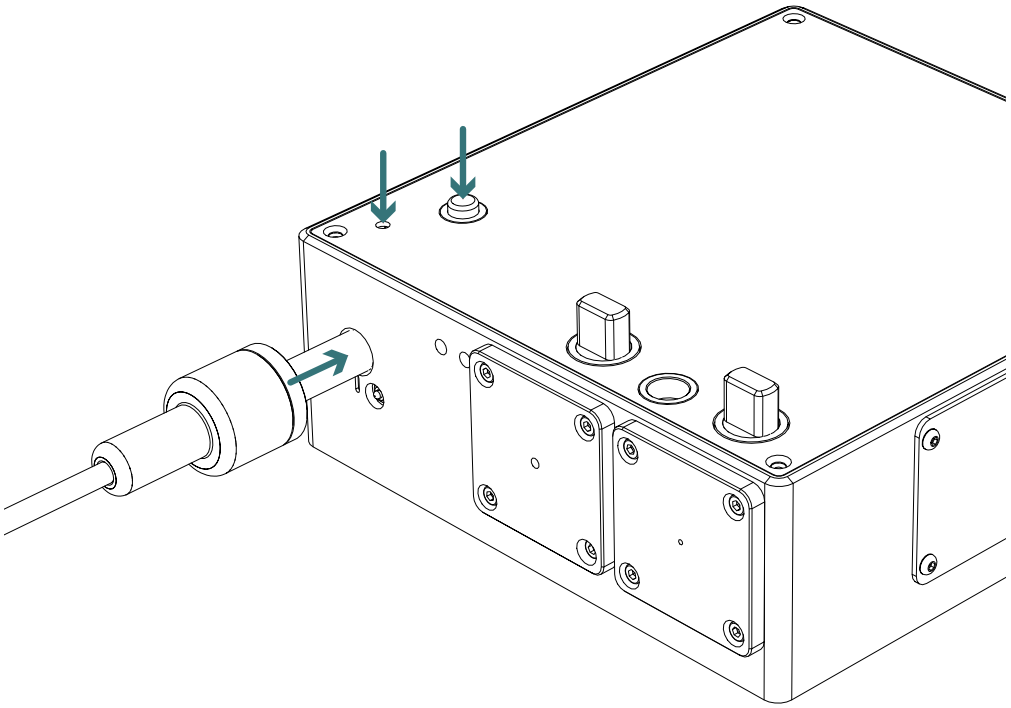
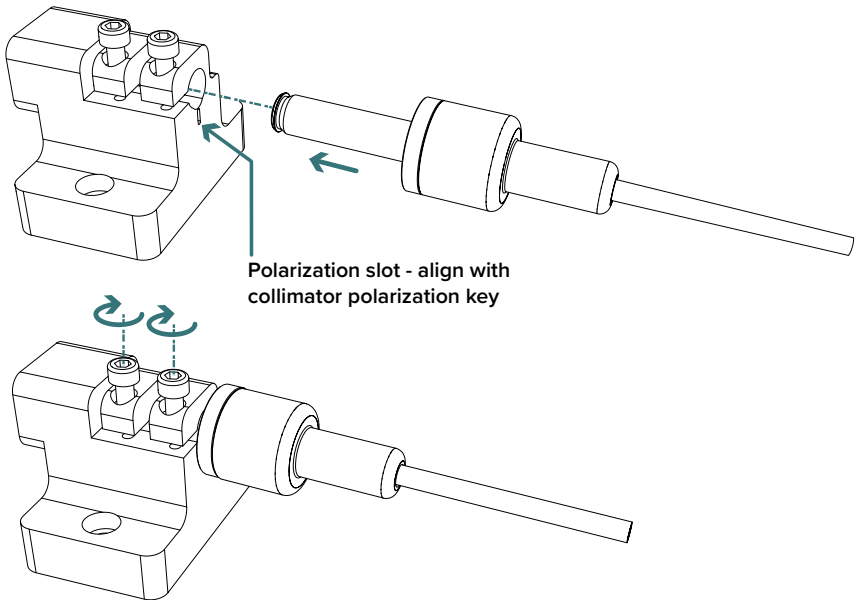


Figure 14 Inserting a collimator into a holder



Connecting accessories with the External Bus

External Bus The External Bus port is a digital bus interface and 12 volt supply for attached smart accessories. The accessories can then be connected to CONTROL

through the bus and the laser. The bus data signals are based on a subset of the RS-485 protocol. The bus is also made up of other signal lines, including a logic output pin representing laser emission and an extension of the laser's interlock circuit.

Connecting the External Bus

When no smart accessories are used with the laser, always connect the supplied bus defeater to the laser's External Bus port. When smart accessories become available, connect them to the External Bus port in a daisy chain configuration using the supplied External Bus cable(s). The last accessory in a daisy chain must have the bus defeater connected to its output bus.

Bus defeater

A bus defeater is a DB-15 connector with it's interlock circuit pins looped back. A bus defeater is included with the laser. If you need a replacement, contact NKT Photonics support – see "Support contact details" on page 117.

Figure 15 Bus defeater

External Bus

Refer to Table 9 for the details on how the External Bus is connected. A bus defeater is connected to the last open External Bus port to loop the circuit back. (Refer to Figure 16 and Figure 17 for connecting the port with and without accessories.)

Table 9 External Bus port – connecting accessories

Accessory #	External Bus port connection
No accessories	Bus Defeater
One accessory	1. External Bus cable to accessory bus input 2. Accessory bus output to bus defeater
Two or more accessories	1. External Bus cable to accessory 1 input. 2. Accessory 1 bus output – External Bus cable to accessory N bus input 3. Accessory N bus output – bus defeater

NOTE: See Appendix C for a pinout description of the External Bus.

Figure 16 External Bus circuit - with no accessories connected[1]

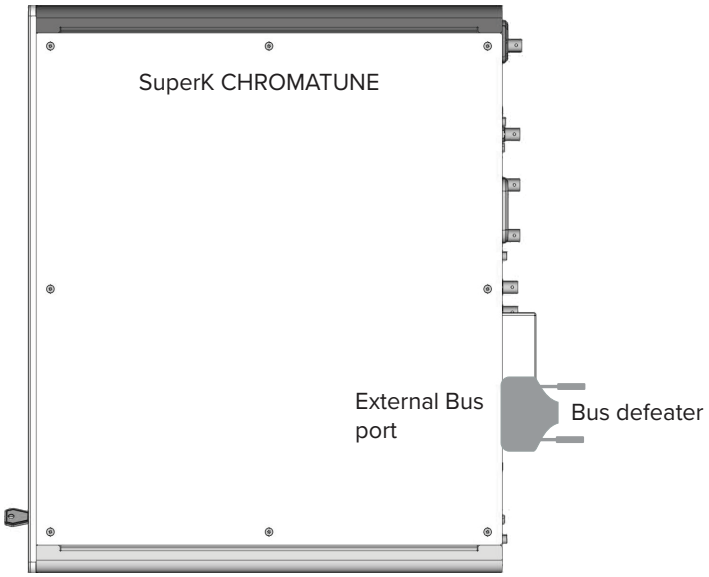
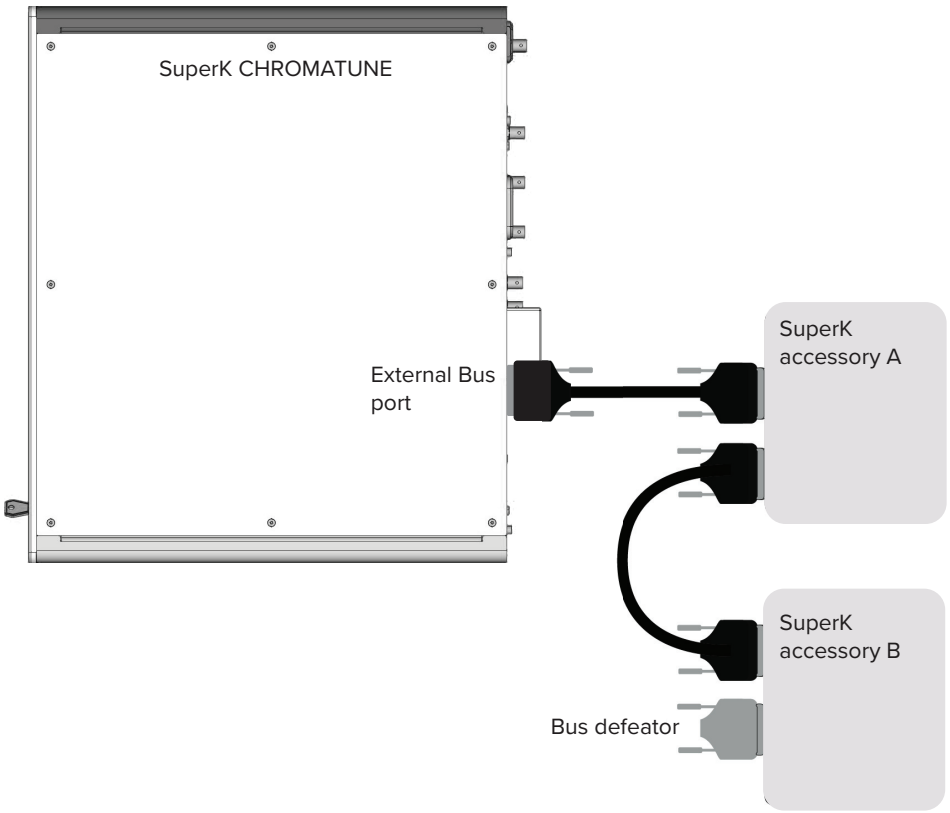


Figure 17 External Bus circuit - with multiple accessories in a daisy chain[2]



1. As of this documents revision date, the Bus Defeater plug must always be placed on the External Bus port.
2. As of this revision date, there are no smart accessories available for the CHROMATUNE laser.

Connecting pulse synchronization ports

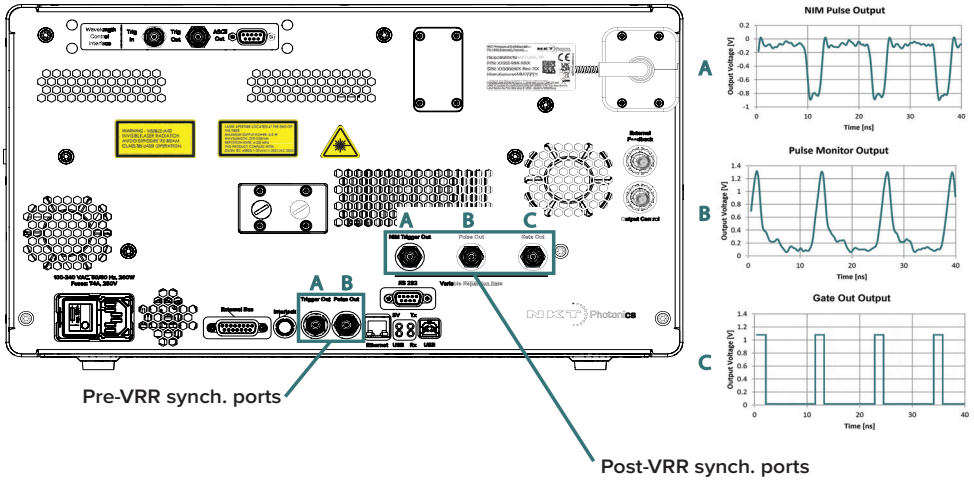
A SuperK CHROMATUNE can supply up to five pulse synchronization signals. The signals can synchronize external devices with the laser pulse at two stages within the laser. If the laser is fitted with a VRR (pulse picker) module, all five signals are available. Otherwise, only the pre-VRR ports are equipped. The rear panel houses the five synchronization ports depicted in Figure 18. The ports are mounted in pre and post-VRR groups on the rear panel.

Table 10 Pulse synchronization signals

Sync. Port	Pulse	Type	Level	See
Gate Out (optional)	Post-VRR[i]	Digital	0 to ~1.2V	Gate out on page 48
Pulse out	Pre-VRR (seed) Post-VRR (optional)	Analog	0 to ~1.2V	Pulse out on page 48
NIM Pulse	Pre-VRR (seed) Post-VRR (optional)	Analog	NIM	Pulse out on page 48

i. VRR - Variable Repetition Rate module or pulse picker

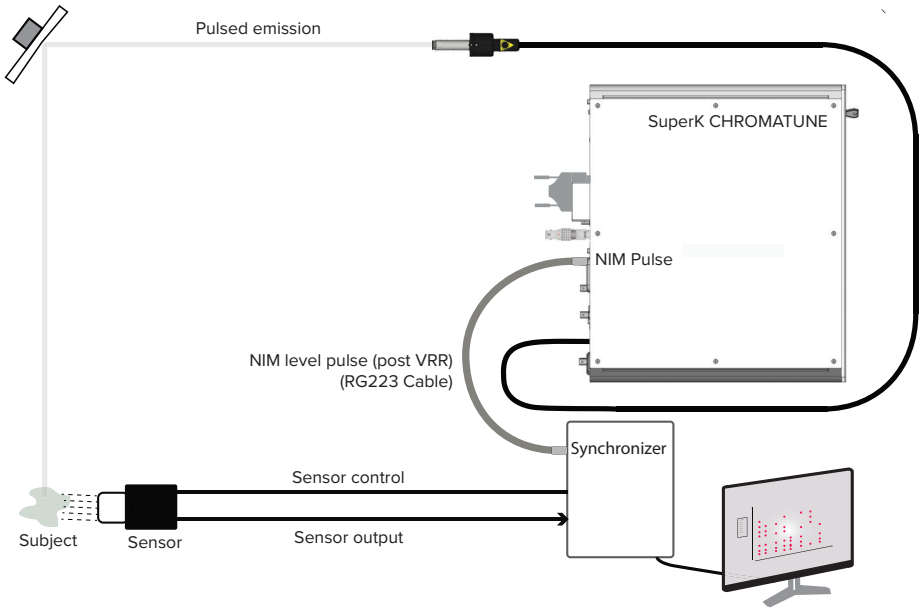
Figure 18 Synchronization ports with output signals



Example synchronization circuit

As an example, the pre or post-NIM pulse signal could be used to synchronize the emission with a subject under study. A general diagram of a synchronization circuit is shown in Figure 19.

Figure 19 Example NIM pulse circuit



Gate out

The Gate out port supplies a digital signal synchronized with the pulse after the VRR module (pulse picker). The port outputs a positive digital signal as shown in graph C of Figure 18.

The signal is a logic high when a pulse is permitted to pass the pulse picker. Otherwise, the signal is a logic low when pulses are suppressed from the pulse picker output. The signal rate matches the configured repetition rate in CONTROL or on the front panel. When connecting the port follow the specifications in Table 11 to obtain the best waveform.

Table 11 Gate out port specification

Item	Description
Cable Type	Use RG223 type or similar double shielded cable ≤ 3M
Connector	BNC
Termination Impedance	50 Ω

Pulse out

The signals of the pre and post-VRR synchronization output ports represent the pulse before and after the VRR module respectively. These are a positive 0 to +1.2 V (approximately) analog signal as depicted in graph B of Figure 18. The signal rate matches the configured repetition rate in CONTROL or on the front panel. When connecting the ports follow the specifications in Table 12 to obtain the best waveform.

Table 12 Pulse out ports specification

Item	Description
Cable Type	Use RG223 type or similar double shielded cable ≤ 3M
Connector	BNC
Termination Impedance	50 Ω

NIM pulse

The pre and post-VRR NIM pulse ports output a NIM level electrical signal representing the laser's pulsed output. The signal of each port conforms to DOE/ER-0457 and they are synchronized with the laser pulse before and after the VRR module has modified the repetition rate respectively. These are an approximately 0 to -0.9 V analog signal when properly terminated. A typical signal from either port is depicted in graph A of Figure 18.

Table 13 NIM pulse ports specification

Item	Description
Cable Type	Use RG223 type or similar double shielded cable ≤ 3M
Connector	BNC
Termination Impedance	50 Ω

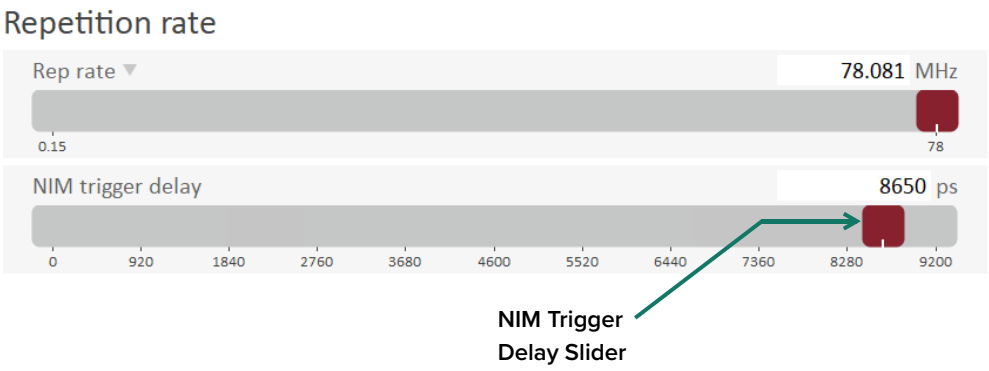
Termination necessary

Both NIM outputs are current outputs and they therefore require to be correctly terminated to avoid signal degradation. As noted above in Table 13, the NIM outputs are specified to be terminated with 50 Ω.

Trigger delay

You can delay the NIM output pulses by up to 9200 picoseconds using the CONTROL interface. Under "Laser settings" in the control panel of the laser's graphical interface, slide the NIM Trigger Delay slider to the desired setting (or use the text input field). The slider is highlighted in Figure 20, set to 8650 picoseconds. In this case, NIM output pulses are delayed by 8650 picoseconds post laser pulse. See also Figure 42 on page 81.

Figure 20 Pulse (NIM) trigger delay control



4 Front Panel

Overview

The front panel features an OLED display, control buttons, and an interlock keyswitch. You can use the display and buttons to:

- Enable and disable emission.
- Select and set emission parameters.
- Switch system power ON or OFF.
- View system errors and notification messages.

Figure 21 Front panel buttons and display

The keyswitch triggers the safety interlock (disabling emission) when turned to *Off* and prevents unauthorized use of the laser when the key is removed from the lock. When set to the *Armed* position, laser emission is permitted.

Figure 22 Keyswitch control – set to *Armed*

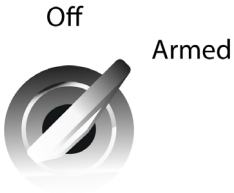


Table 14 summarizes the functions of each button and the keyswitch. Follow the link in the rightmost column to see more details.

Table 14 Panel buttons and keyswitch

Button/switch	Function	See
Power	Turns ON the CHROMATUNE system. The rear AC mains switch must be set to (I).	Powering ON and OFF the laser on page 56
Select	Rotates the emission parameter positions in the operation page and clears the display of error and notification pages.	Rotating the emission parameter positions on page 57
- and +	Press and release to increase or decrease the selected emission parameter. Holding either button down changes the value shown continuously and increasingly; releasing the button sets the value.	Adjusting emission parameters on page 58
Emission	Enables and disables emission.	Enable and disable emission on page 62

Button/switch	Function	See
Keyswitch	• Turn OFF to disable the interlock, disabling and preventing emission. • Turn to ARMED to permit laser emission.	Arming the laser on page 61

Display

The display can show one of four types of pages described in the following and listed in Table 15.

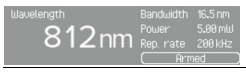
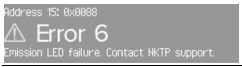
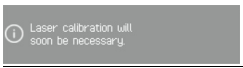
Operation During operation, the display shows the CHROMATUNE's four emission parameters and the laser's state within a badge at the bottom right.

A fault occurs Should the laser experience a fault, an error is raised and the display shows an error page with the error code, module address and relevant information.

Notification This type of page is informational only and provides notifications of system events.

Boot-up When the laser is first powered on, a boot-up page is displayed. This page remains until the front panel collects all relevant system information and finishes its initialization.

Table 15 Display pages

	Page type	Function	See
	Operation	Displays current operational settings and status.	Operation page on page 53
	Error	An Error page appears when a fault is detected by the system.	Error page on page 55
	Notification	System notification pages are informational only.	Notification page on page 56
	Boot-up	The boot-up screen is displayed when the system is first turned on.	Figure 26 of procedure Procedure 4 on page 56

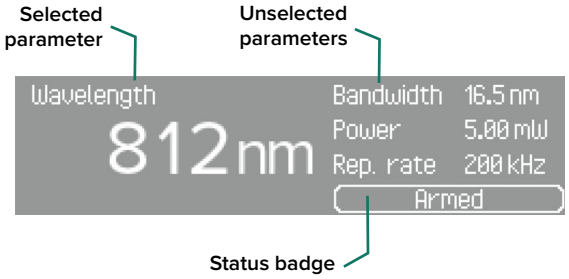
Dimming If no buttons are pressed, The display dims after a few moments. Press the *Select* button to brighten the display again.

Operation page

Figure 23 shows an example of the *Operation* page after the system successfully powers ON. The page displays the fields shown in Figure 23:

- **Selected parameter** – pressing the *Select* button rotates the position of the emission parameters by one position. When a parameter is rotated to the left side of the page, it is shown in large font and considered selected. In the selected position, you can configure the parameter using the "+" and "–" buttons.
- **Unselected parameters** – the three emission parameters not rotated to the selected parameter position, are displayed in a smaller font in a column to the right. The parameters in this column can only be read. To modify, press the *Select* button until the parameter desired is rotated to the selected position on the left.
- Status badge – the badge displays the laser's operational state. All possible states are listed in Table 17.

Figure 23 Operation page



Emission parameters The emission parameters displayed are described in Table 16.

Table 16 Emission parameters

Emission parameter	Description	Range	Resolution
Wavelength	The configured center wavelength of the laser in 1 nm increments.	400 to 1000 nm	1 nm
Bandwidth	The configured bandwidth of the laser in 0.1 nm increments.	5 to 50 nm[i]	0.1 nm
Power	The configured optical power of the laser in µW, 0.01 mW or 0.1 mW increments.	150 µW to 50 mW approximately[ii]	µW, 0.01 mW or 0.1 mW
Rep. Rate[iii]	The configured pulse repetition rate of the laser. The configured pick ratio is also shown when Rep. Rate is moved to the selected position.	150 kHz to 78 MHz Pick ratios from 1 to 520	-

i. Minimum bandwidth may be limited – see "Tuning range and bandwidth" on page 20
ii. Maximum power limited by set wavelength, bandwidth, and repetition rate. "Optical output power" on page 21.
iii. Selecting and configuring the repetition rate is only available on systems equipped with the pulse picker option.

NOTE: For instructions on configuring the emission parameters, see Operating the laser from the front panel on page 56.

Status badge Refer to the table below for status badge descriptions.

Table 17 Status badges – descriptions

Status badge	Description
Emission ON	Emission is ON – Class 3B laser emission is present.
Armed	Laser is armed i.e. laser emission can be enabled.[i]
Reset interlock	Interlock needs a reset due to e.g. after an error or the power was cycled.
Interlock	Interlock OFF due to no specific reason.
Interlock failure	Interlock OFF due to interlock circuit failure.
Interlock power	Interlock OFF due to interlock power failure.
Disabled	Interlock OFF
Internal module	Interlock OFF due to an internal module failure.
External module	Interlock OFF due to an external module failure.
Door open	Interlock OFF due to: an open door switch (access door open). a short to ground or an open in the door switch circuit.
Key off	Interlock OFF due to the keyswitch in the OFF position.
Updating	Firmware update in progress.
Calibrating	System calibration in progress.

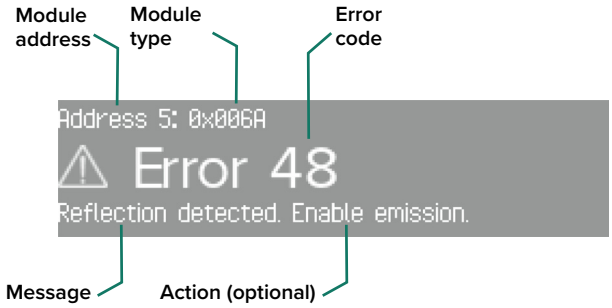
i. Keyswitch - Armed, Interlock and door switch circuits - closed

Error page

If a fault occurs, an error is raised by the system and the display shows a page with an error message. The error message includes the following fields:

- Module address – System module address
- Module type – NKT Photonics use only
- Error code – Code number assigned to the error for a module.
- Error message – A description of the fault the system encountered.
- Action – An action to undertake may be displayed along with the error.

Figure 24 Error page



Error identification

All errors are listed in Table 27 on page 133 of Appendix E. An error is identified by its module address and the error code:

Error = *Module Address*: *Error Code*

Clearing the error message

Pressing the *Select* button returns the display to the Operation page.

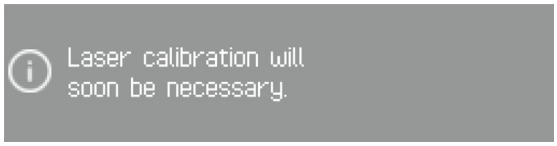
CAUTION: Removing the error message from the screen does not resolve the fault.

NOTE: Before pressing the *Select* button, make a note of the error. The error can subsequently be retrieved over the system communication ports.

Notification page

The system may display a notification. This is for informational purposes only and does not warrant immediate action. Figure 25 shows a Laser calibration notification.

Figure 25 Notifications page – laser calibration



Clearing the notification page

Pressing the *Select* button returns the display to the operation page.

NOTE: Before pressing the *Select* button, make a note of the message if necessary. The notification page cannot be retrieved again.

Operating the laser from the front panel

WARNING: Before turning ON the laser, ensure to implement all Class 3B laser safety recommendations applicable for your region. Ensure all personnel are notified of the laser's operating area and that the beam path is safely contained. For further information refer to the NKT Photonics document:

SuperK CHROMATUNE Safety, Handling and Regulatory Information

Front panel operations

To operate the laser from the front panel controls, follow the links in Table 18.

Table 18 Front panel operations

Procedure
Powering ON and OFF the laser
Rotating the emission parameter positions
Adjusting emission parameters
Set the wavelength
Set the bandwidth
Set the power
Set the repetition rate
Arming the laser
Enable and disable emission

Powering ON and OFF the laser

Procedure 4 Turning ON the laser: front panel

If the laser is OFF, do the following,

1. Ensure AC mains power is connected and the rear AC mains switch is set to the (I) position.

2. To connect power to all internal modules of the laser, press and hold the *Power* button for approximately 1 to 2 seconds before releasing it.

3. A boot-up page (Figure 26) with the NKT Photonics logo is displayed until the system is ready for operation.

Figure 26 Boot-up page

4. If the laser boots correctly, the laser's operation page appears (see Operation page on page 53) and the laser is ready for operation.

5. If the laser encounters a fault on boot up, an Error page appears. Report the error to NKT Photonics – Support contact details on page 117.

NOTE: Certain faults that occur during the system boot may also indefinitely display the boot-up page, contact NKT Photonics support for help.

WARNING: Before turning ON the laser, ensure to implement all Class 3B laser safety recommendations applicable for your region. Ensure all personnel are notified of the laser's operating area and that the beam path is safely contained. For further information refer to the NKT Photonics document:

SuperK CHROMATUNE Safety, Handling and Regulatory Information

Procedure 5 Turning OFF the laser: front panel

To turn off the laser when it is ON (front panel buttons and display are lit), do the following:

1. Press and hold momentarily the *Power* button until the front panel LEDs are extinguished.

2. The laser modules power down and the laser returns to the standby state. In standby state only the laser's internal power supply is ON i.e. the rear AC mains switch is set to (I).

Rotating the emission parameter positions

When the operation page is displayed, press the *Select* button once to counterclockwise rotate the position of each emission parameter. Press the *Select* button repeatedly until the parameters are in their desired positions. A

parameter rotated to the large font position to the left is considered selected and can be modified – see Operation page on page 53.

Figure 27 Parameters rotating position after *Select* button pressed

Rep.rate – pulse picker not equipped

When a pulse picker is not included with the CHROMATUNE laser, the position of the Rep. rate parameter is stationary and cannot be moved. The parameter remains at the lower right side of the page and is not settable.

Figure 28 Parameters rotating when no pulse picker is equipped

Adjusting emission parameters

You can adjust parameters with emission enabled or disabled. To adjust the selected emission parameter, press and release:

– to decrease a parameter setting

+ to increase a parameter setting

NOTE: Emission parameters are modified upon release of the button pressed.

NOTE: When tuning parameters with emission enabled, emission is blocked during for a short period while the CHROMATUNE makes the adjustments.

NOTE: Be aware that when an emission parameter is modified, the system requires a period of time to stabilize the parameters of the emitted light – see Stabilizing emission parameters on page 62.

Press and hold

Pressing and holding down either the – or + button continuously changes the displayed value of the selected parameter. As you hold the button down, the selected parameter also changes at an increasing rate. The system sets the emission parameter with the final value reached upon releasing the button.

NOTE: Emission parameters are not modified until the held button is released.

Parameter flashes
When an end value of a parameter range is reached, the displayed setting flashes momentarily to indicate the limitation. This indicates that another press of the – or + button will not change the value further.

Settable range
The range of each parameter is listed under Operation page on page 53 and in the setting procedures found in Table 18 on page 56.

WARNING: Even when power is set to the minimal setting limit, Class 3B emission may still be present.

NOTE: When turning ON the laser using the power button, the power and shutter modes are at the default setting.

WARNING: Only adjust the power to a higher level when you are certain the beam path is safe and all personnel in the operating area are aware of the danger. The laser is a Class 3B laser and emits emission that can be hazardous to eyes and may over long periods of expose cause damage to skin.

Set the wavelength

You can adjust the center wavelength of the laser from 400 to 1000 nm. To set it, do the following:

Procedure 6 Set the wavelength: front panel

1. If an error or notification page is displayed, press the *Select* button to return to the operation page. Note that you cannot return to the error or notification page.

2. In the operation page, use the *Select* button to rotate the *Wavelength* parameter to the selected position.

Figure 29 Wavelength parameter selected

3. Use the + and – buttons to increase or decrease the set center wavelength value in increments of 1 nm.

Set the bandwidth

You can set the bandwidth from 5 to 50 nm; however, at the maximum infrared wavelength, the minimum bandwidth is limited to 10 nm – see Tuning range and bandwidth on page 20. To set the bandwidth do the following:

Procedure 7 Setting the bandwidth: front panel

1. If an error or notification page is displayed, press the *Select* button to return to the operation page. Note that you cannot return to the error or notification page.

2. In the operation page, use the *Select* button to rotate the *Bandwidth* parameter to the selected position.

Figure 30 Bandwidth parameter selected

3. Use the + and – buttons to increase or decrease the bandwidth in increments of 0.1 nm.

Set the power

The maximum optical output power you can set is dependent on the center wavelength, and varies proportionally to the bandwidth and repetition rate. The maximum output power is emitted when bandwidth and repetition rate are at their maximum settings, and the maximum power mode is selected.

NOTE: When the laser is operating in maximum power mode, it is not possible to change the power level. See "Power mode" on page 102 for controlling the power mode.

To set the power do the following:

Procedure 8 Setting the power: front panel

1. If an error or notification page is displayed, press the *Select* button to return to the operation page. Note that you cannot return to the error or notification page.

2. In the operation page, use the *Select* button to rotate the *Power* parameter to the selected position.

Figure 31 Power parameter selected

3. Use the + and – buttons to increase or decrease the power in the increments shown in Table 19 below.

Table 19 Power setting increment

Power setting	Increment[i]	Example
< 1 mW	1 µW	638 µW
≥ 1 mW	0.01 mW	1.25 mW
≥ 10 mW	0.1 mW	21.2 mW

i. Least significant digit

Set the repetition rate

If the CHROMATUNE laser includes a pulse picker, you can set the output pulse rate in divisions of the base repetition rate of 78 MHz. The division

denominator is known as the pick ratio and is displayed below the repetition rate frequency.

You can set a pick ratio from 1 to 520 where the repetition rate set equals 78 MHz divided by the pick ratio such that:

- Pick ratio 1 means 78 MHz divided by 1 or a pulse repetition rate of 78 MHz.
- Pick ratio 520 means 78 MHz divided by 520 or a pulse repetition rate of 150 kHz.

Increasing the pick ratio divides the rate of pulses emitted with a larger denominator which reduces the optical output power. To set the repetition rate do the following:

Procedure 9 Setting the repetition rate: front panel

1. If an error or notification page is displayed, press the *Select* button to return to the operation page. Note that you cannot access the error or notification page again.
2. In the operation page, use the Select button to rotate the *Rep. rate* parameter to the selected position.

Figure 32 Repetition rate parameter selected

3. Use the + and – buttons to increase or decrease the Repetition rate. Conversely, the + button decreases the pick ratio and the – button increases it.

NOTE: The pulse picker ultimately divides the output pulse frequency by the step ratio, therefore decreasing the step ratio increases the actual output repetition rate. When the pick ratio reaches 79 or greater, the Rep. rate is shown in kHz and at a pick ratio of 78 or less the Rep. rate is shown in MHz.

Arming the laser

The laser is ready to enable emission when *Armed* is displayed in the emission status field (see Operation page on page 53). To arm the laser, do the following:

Procedure 10 Arming the laser: front panel

1. Close the access door to the laser's operating enclosure. The safety door circuit must be in place and the door switch circuit must be closed - see Safety door switch on page 41.
2. Ensure the bus defeater is placed on the External Bus port. See Connecting the External Bus on page 45.
3. Turn the keyswitch from the *Off* to the *Armed* position.

4. If *Armed* is displayed in the emission *status* field (Figure 33), emission can be enabled, END procedure.

5. If another message is displayed, check Table 17 and make any corrections necessary. The laser only achieves the *Armed* emission status if all of the following is true:

   - The keyswitch is set to the Armed position.
   - The door circuit is closed.
   - The interlock circuit is closed.

Figure 33 Laser in the Armed state

Enable and disable emission

Stabilizing emission parameters

Be aware that once emission is enabled, the system requires time to reach a stable operating temperature. NKT Photonics suggests to follow the guidelines below when enabling emission:

Cold start – the laser needs a period of time[1] to thermalize and thus stabilize the parameters of its emission.

Warm start – Once the laser has achieved a stable thermal state and you modify emission parameters, the system can, within a short period, quickly re-stabilize parameters of its emission.

NOTE: It is possible to stabilize the output power using the power mode “continuous” to maintain a constant output power (see “Power mode” on page 102).

Procedure 11 Enabling emission: front panel

1. Press the front panel *Emission* button once. The emission status field changes from *Armed* to *Emission ON*.

WARNING: When enabled, Class 3B emission is emitted from the laser’s aperture.

Calibration

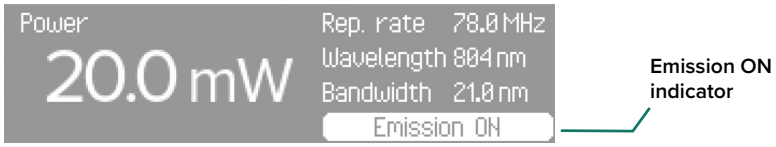
The laser auto-calibrates when emission is enabled from the disabled state. If this is necessary an informational notification is displayed beforehand. See Figure 25 on page 56.

NOTE: If the Laser calibration notification is sent while emission is enabled, an error may be generated if calibration is not executed.

1. Thermalization time varies due to the ambient environment.

NOTE: Laser calibration delays emission approximately 10 seconds. In the unlikely event that it fails, there may be a delay before an error is displayed.

Figure 34 Emission enabled



WARNING: Only enable emission when you are certain the beam path is safe and all personnel in the operating area are aware of the danger. The laser is a Class 3B laser and emits emission that can be hazardous to the eyes and may over long periods of exposure cause damage to skin.

2. Press the *Emission* button again. The laser is disabled and returns to the Armed state.

5 Using CONTROL to Turn On the Laser

You can manage the laser using NKT Photonics CONTROL software installed on a PC. This chapter focuses on:

- How to obtain and install the CONTROL software.
- Connecting a PC to the laser using a USB or Ethernet connection.
- Turning the laser emission ON and OFF including setting the emission parameters.

CONTROL software

You can download the most recent CONTROL software from the following link:

https://www.nktphotonics.com/support/

CONTROL software is capable of managing, configuring and monitoring NKT Photonics products including this laser and associated accessories. Both 32 and 64 bit versions are available and are installed on a PC running Microsoft Windows 7, 8, 10 or 11.

Installing the software

After downloading the CONTROL installer software on to your PC, double click the installer and follow the built-in wizard. Further details on installing the software are available in Appendix D.

Connecting the laser to a CONTROL PC

You can connect a PC with CONTROL software using a convenient USB serial connection. USB connectivity provides a simple connection option within the maximum USB cable length of 3m. Connecting over USB is described in Procedure 13.

After the PC is connected, use CONTROL's search feature (click the *Connect button)* to find the laser or its connected accessories.

Ethernet

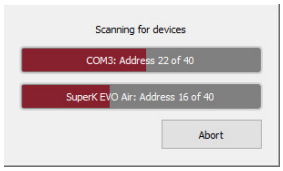
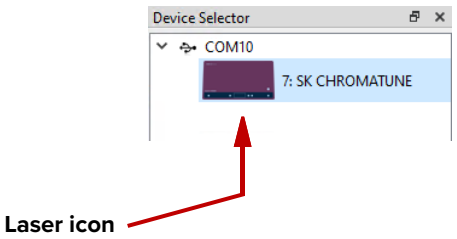
For Ethernet connections, the laser is configured for DHCP IP address assignment from the factory. To assign a static address, first connect over USB to set the IP assignment mode to static and configure the address parameters. Connecting over Ethernet is described in Procedure 13.

NOTE: If necessary, you can also connect the CONTROL PC to the RS-232 serial connection.

NOTE: If both serial ports are connected, the USB2 port has priority.

NOTE: Multiple lasers can be managed from the same PC using CONTROL. The application automatically detects connected NKT Photonics lasers and their accessories.

Procedure 12 Connecting a PC to the laser over USB

	Action
1	Connect power to the laser – see Connecting power on page 41.
2	Connect the PC to one of the available ports[i].
3	Launch the CONTROL software by either: • clicking on Windows – Start – Programs – NKT Photonics –CONTROL – or – • double clicking the CONTROL shortcut on the desktop 
4	The CONTROL window opens. Click on the *Connect* button in the left region of the *Quick Connect* panel. 
5	CONTROL automatically scans for any connect lasers and accessories available on both COM and configured Ethernet ports. 
6	To manage the laser, click on the SuperK CHROMATUNE icon in the *Device Selector* panel. 

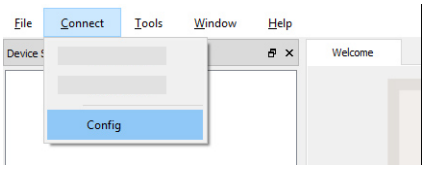
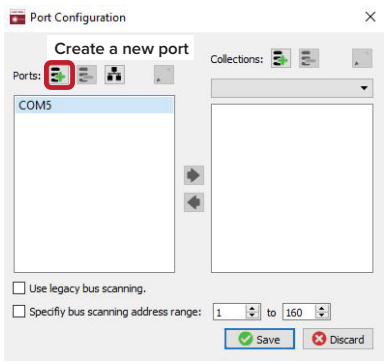
i. To use the laser's Ethernet port, you must first use the SDK to configure a reachable address on the laser over a USB or RS-232 connection.

Ethernet connection

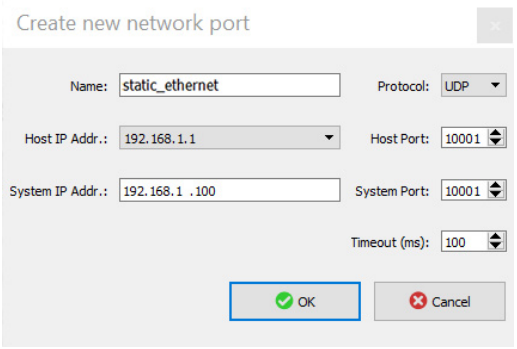
To connect the laser to a PC over Ethernet, connect the PC and the laser Ethernet port to the same or separate IPv4 subnets.

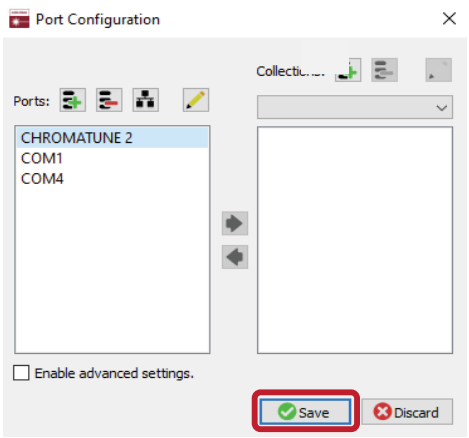
If the PC and laser are on separate subnets, their IP addresses must be reachable to each other. The laser's port is set for DHCP by default from the factory. To configure a static IPv4 address, first connect to the laser using a USB cable directly from a PC using CONTROL and then configure it's IP address statically, see "Ethernet" on page 82.

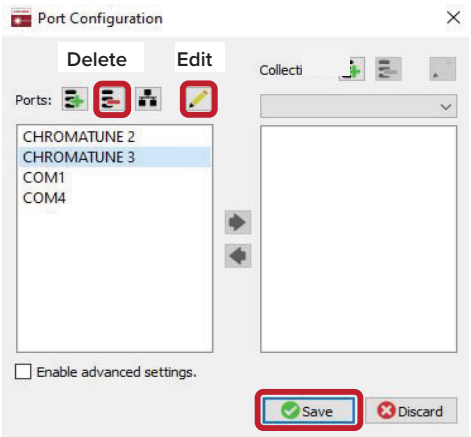
Procedure 13 Connecting a PC to the laser using Ethernet

	Action
1	Connect to the laser from your CONTROL PC using a USB cable as described in Procedure 12.
2	Using a CAT5 or better Ethernet cable, connect the laser's Ethernet port to a local subnet or directly to the CONTROL PC's Ethernet port.
3	Using CONTROL (over USB) - configure the laser's IPv4 address and port - see Ethernet on page 82. **NOTE:** Ensure that the RJ-45 Ethernet port of the laser is connected to your network using a CAT5 or better cable.
4	From the *Connect* menu list select *Config* to open the *Port Configuration* window. 
5	In the *Port Configuration* window, click on the *Create new port* button. 

	Action
6	The *Create new network port* window appears. Configure the port parameters as described below: **Name –** Enter a name for the Ethernet connection (e.g. Lab-Laser-2). **Host IP Addr. –** Select a Host IP address (PC) from the drop down list of the computer's available network adapters. **System IP Addr. –** Enter the laser IPv4 address configured in step 3. **Protocol –** Select either UDP or TCP. UDP is the default and recommended. **Host Port –** Enter a TCP or UDP port the PC will use to communicate with the laser. The default value is 10001. **System Port –** Enter a TCP or UDP port the laser will use to communicate with the CONTROL PC. The default port address is 10001 and set in step 2. **NOTE:** To connect multiple lasers over IP with the same NKT Photonics CONTROL PC, configure each laser with a unique local system port. **Timeout (ms) –** Enter a timeout value in milliseconds. When CONTROL sends a request to the laser, it waits for a reply from the laser until the timeout value expires. Default value is 100 milliseconds. Click *OK* to accept the configuration of the new *Ethernet connection* port. **NOTE:** The parameters set here can be viewed from the Ethernet settings for either DHCP or Static - see Ethernet on page 82. For DHCP ensure the Ethernet port is connected to a DHCP enabled network.
7	Click the *Save* button to save the configuration of the new *Ethernet connection*.



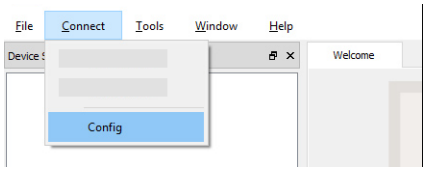
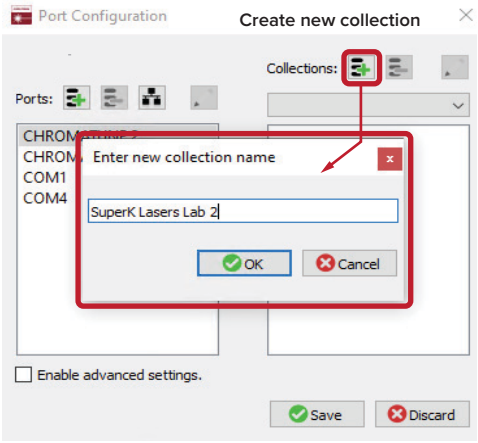


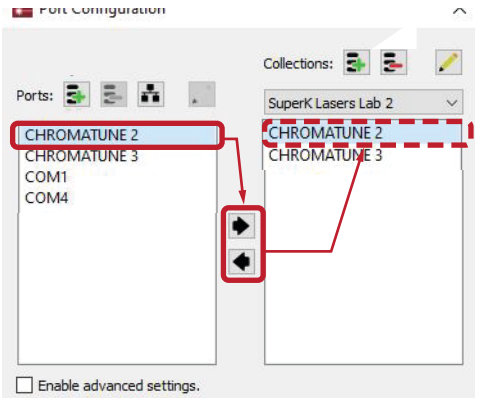
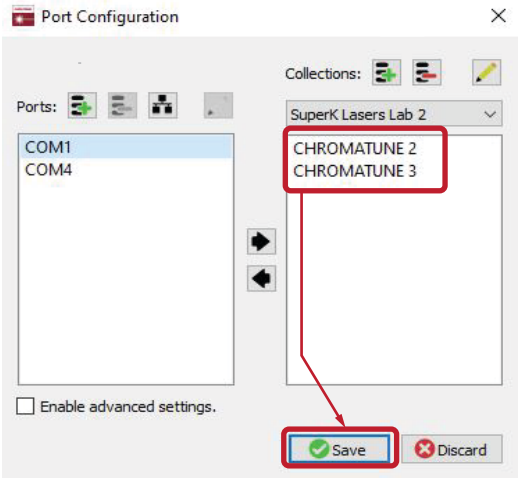
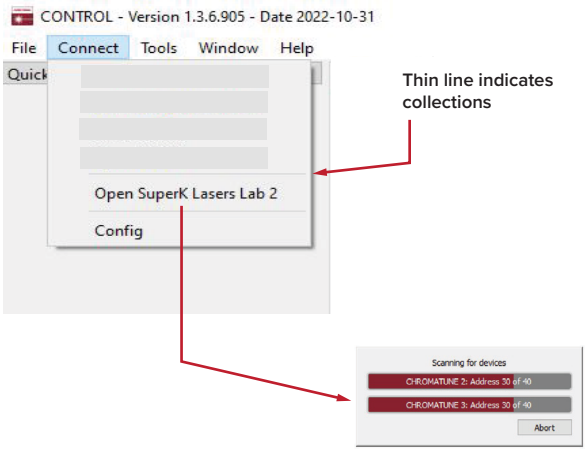
	Action	
8	To delete or modify a configured port: *a.* Highlight the port and: • click the *Delete* button. -or- • click the *Edit* button and make any changes required. *b.* Click *Save* when finished.	
9	Click the CONTROL *Connect* drop down menu item and click on the newly created *Ethernet connection* name.	
10	CONTROL connects to the laser. **NOTE:** If CONTROL cannot reach the laser over Ethernet, verify that the CONTROL PC has connectivity with the laser by executing a PING test.	

Grouping connections

You can group configured lasers into a collection and then connect to all lasers in the group from the *Connect* drop down list. Use the *Port Configuration* dialog box to create the group and then click the *Connect* menu item to select the group from the drop down list. To create a collection group, follow the steps in Procedure 14.

Procedure 14 Grouping connections in a collection

	Action	
1	From the *Connect* drop down menu list, select *Config* to open the Port Configuration window.	
2	Create Ethernet connections for the lasers to be added to the collection – see Procedure 13.	
3	In the *Port Configuration* window, click on the *Create new collection* button. In the *Enter new collection name* dialog box, enter the name of the new collection and click OK.	

	Action	
4	To add a connection to the collection, highlight the connection and click the right arrow button.: **NOTE:** Before adding a new connection, ensure the collection group created is selected in the drop down menu near the top of the right panel. To remove a connection from the collection, highlight the connection and click the left arrow button.	
5	When you have added all connections to the collection, click *Save*.	
6	Open the *Connect* drop down menu and click on the collection name. CONTROL scans only the ports included in the collection. **NOTE:** Collection groups are separated from connections by a thin grey line in the drop down menu.	

Controlling laser emission

Safety Before you turn ON laser emission, ensure that you are completely familiar and follow all safety information and recommendations stated within this document and the document:

SuperK CHROMATUNE Safety, Handling and Regulatory Information

WARNING: You must follow all safety regulations required by the location where the laser is operated.

Preparation Laser emission is ready to be turned ON when the following steps are completed.

1. The laser is securely installed and connected according to the procedures in “Mechanical Installation” on page 37 and “Connecting the Laser” on page 39. This means the laser should be installed in the recommended environment with power applied and at the very minimum, a door switch interlock and CONTROL PC connected.

2. The laser is communicating with the CONTROL application according to Procedure 12.

3. You have configured the emission parameters suitable for the application containing the beam.

NOTE: You can also use the front panel interface to operate the laser, see “Overview” on page 51.

WARNING: Turning ON the laser emits hazardous laser Class 3B radiation. Ensure to observe and implement all safety regulations, warnings and cautions in this guide and the *SuperK CHROMATUNE Safety, Handling and Regulatory Information* document before continuing.

CAUTION: Do not turn ON the laser if it has been exposed to temperature and humidity beyond the operating specifications. The SuperK CHROMATUNE is designed to be operated in a non-condensing environment from +18 to +30°C (or 35°C). Before turning on the laser, allow it at least 30 minutes to reach room temperature. Turning on a laser that is too cold or hot may lead to the system being damaged.

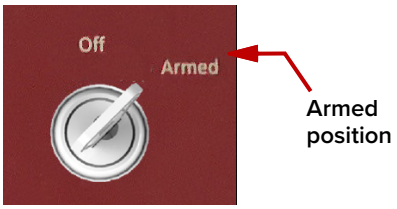
Turning ON the laser

First check you have prepared the laser according to “Preparation” on page 71 and then follow the steps in Procedure 15 to enable laser emission using CONTROL.

Procedure 15 Enabling emission with CONTROL

Action

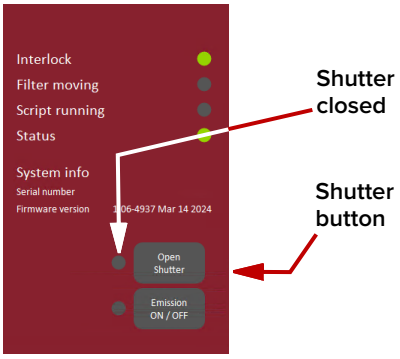
1 On the front panel of the laser, turn the key switch on the laser’s front panel to the *Armed* position.



When the key is in the *Armed* position, the laser emission can be enabled from CONTROL software.

NOTE: The connected interlock circuit must also be closed i.e. door closed for emission to be enabled.

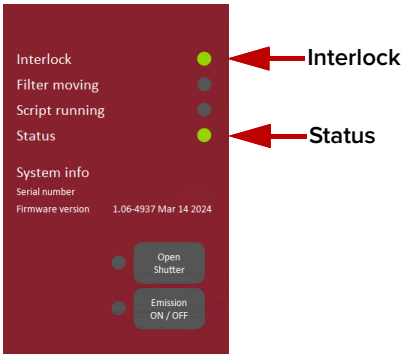
2 In the status panel of the CHROMATUNE, ensure the indicator next to the *Open Shutter* button is grey, meaning the shutter is closed. When the shutter is open, the indicator next to the *Close Shutter* button is lit Red.



- **IF THE SHUTTER IS OPEN** – click the *Close Shutter* button.

NOTE: The shutter button text changes each time it is clicked and the shutter position changes.

3 Before proceeding, check the following two indicators:



- The *Interlock* indicator is lit Green, otherwise:

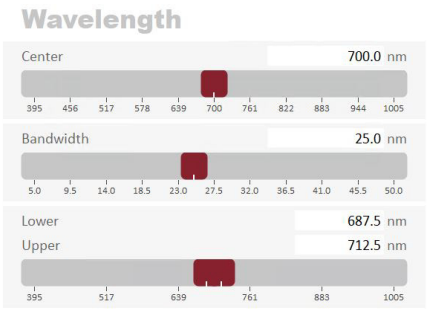
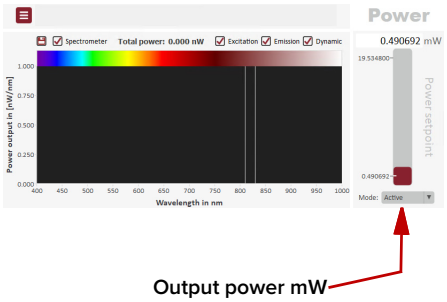
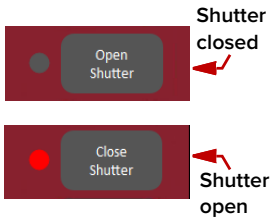
  If it is lit Red, check if the soft Reset button is next to the indicator, click the button to clear the interlock.

  If there is no Reset button and the *Interlock* indicator is still lit Red, the interlock circuit is open or shorted, see Connecting the safety interlock on page 39.

- The *Status* indicator is lit Green, otherwise:

  If it is lit Amber, the laser is thermalizing, momentarily it should change to Green.

  If it is lit Red, an error has occurred, see Error codes - CONTROL on page 132.

	Action	
4	In the *Control Panel* of CONTROL, adjust the *Wavelength* controls to the desired center wavelength and bandwidth.	
5	Set the *Output power* slider to the desired setpoint power. For initial applications, it is suggested to set the setpoint power to a low value before enabling emission. Once the beam path is confirmed then adjust the power to the desired level. **NOTE:** For the power mode setting, see Power mode on page 102.	
6	If the shutter button reads *Open Shutter* and its indicator is off, click the button to open the shutter. The shutter button indicator is lit Red and its text changes to *Close Shutter*.	
7	Enable laser emission by clicking on the *Emission ON/OFF* button. The *Emission* button indicator is lit Red (ON) when laser emission is enabled.	

Errors

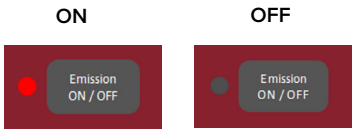
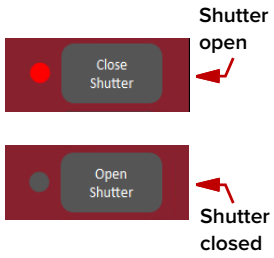
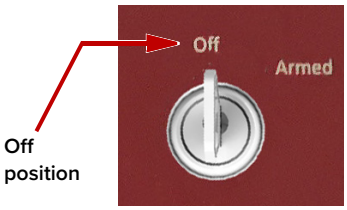
If the laser does not turn ON or is unexpectedly disabled, an error condition may have occurred. Errors occur when the laser controller detects one or more operation conditions not within the normally expected range. When an alarm is raised, the laser is disabled.

For a list of errors and their appropriate responses see Appendix E.

Turning OFF the laser emission

Follow the steps in Procedure 16 to turn OFF the laser emission.

Procedure 16 Disabling emission with CONTROL

	Action	
1	Disable the laser emission by clicking on the *Emission ON/OFF* button. The *Emission ON/OFF* button indicator is extinguished.	
2	If the shutter button reads *Close Shutter* and its indicator is lit Red, click the button to close the shutter. The button text changes to *Open Shutter* and its indicator extinguishes when the shutter is closed.	
3	Turn the key switch to the *Off* position to disable the laser. **NOTE:** To prevent unauthorized operation, it is recommended to remove and store the key in a secure location.	

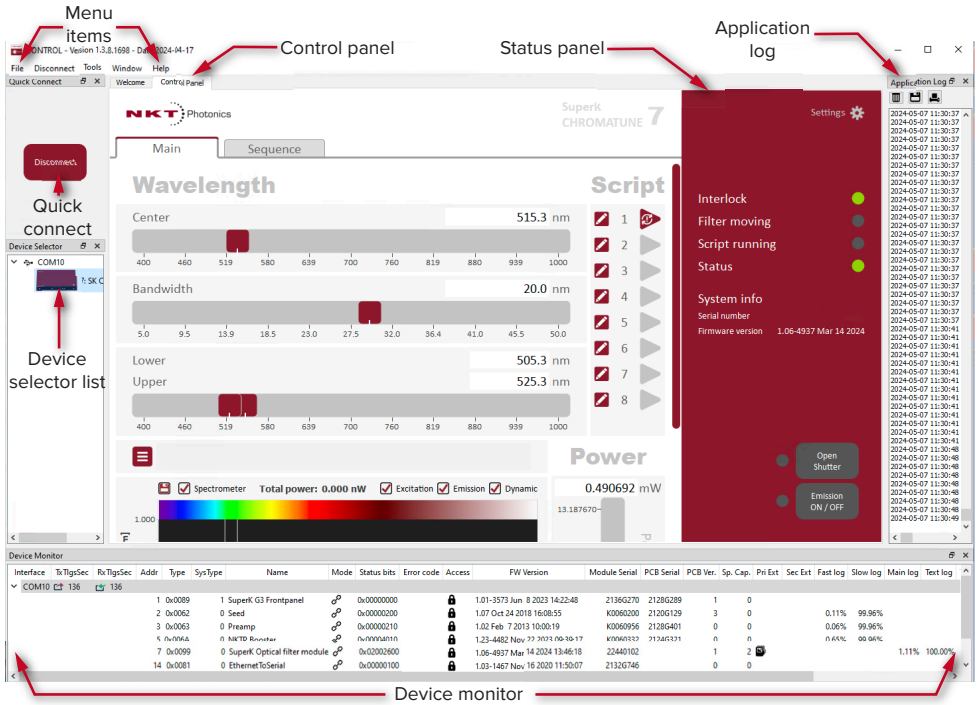
6 CONTROL Interface

Overview

The CONTROL user interface includes multiple panels and a selection of menu drop down items in the upper left corner. Using the drop down menu, you can add or remove panels. You can also reposition the panels within the main window or into separate windows. Figure 35 shows the panels and menu items; their functions are briefly described in the table below.

Panel	Function	See
Device Selector	Selectable list of connected devices assorted by the PC port they are connected to.	Connecting the laser to a CONTROL PC on page 65.
Quick Connect	Button to scan available PC ports for connected NKT Photonics products.	Connecting to the laser on page 77
Status Panel	Includes the selected device status, an emission button and CONTROL settings menu.	Status Panel on page 78
Control Panel	Includes slider controls for output control and trigger delay plus an operating mode drop down menu.	Control panel on page 92
Menu Items	Five drop down menus.	CONTROL menu on page 109
Application Log	A debugging log that can be saved to a file.	Application Log panel on page 112
Device Monitor	Displays multiple port and device module parameters.	Device Monitor on page 113

Figure 35 CONTROL navigation



Relocating panels

You can drag the different panels of CONTROL to any location within the main interface or into a separate floating panel. Procedure 17 describes how to relocate a panel within the main window:

Procedure 17 Relocating panels

	Action
1	Left click and hold the top title bar of the panel.
2	While holding the left mouse button down, drag the panel to another location in the main window.
3	In the new location. when the background turns blue, release the mouse button – see Figure 361
4	Alternatively, drag the panel out from the main window and release the mouse button. A separate window for the panel is created (see Figure 37 ,1

Figure 36 Dragging panels to a new location in the main window

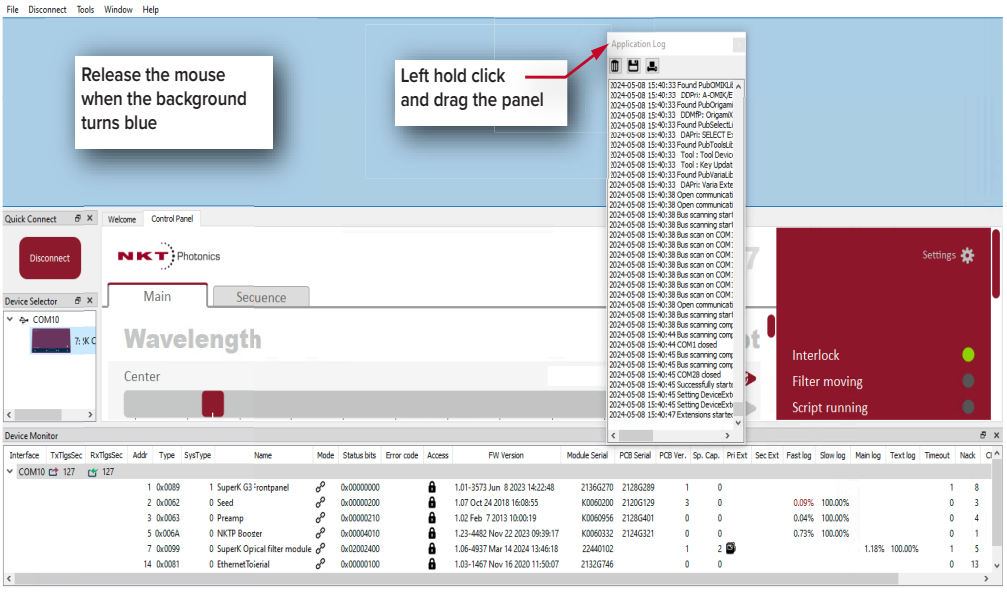
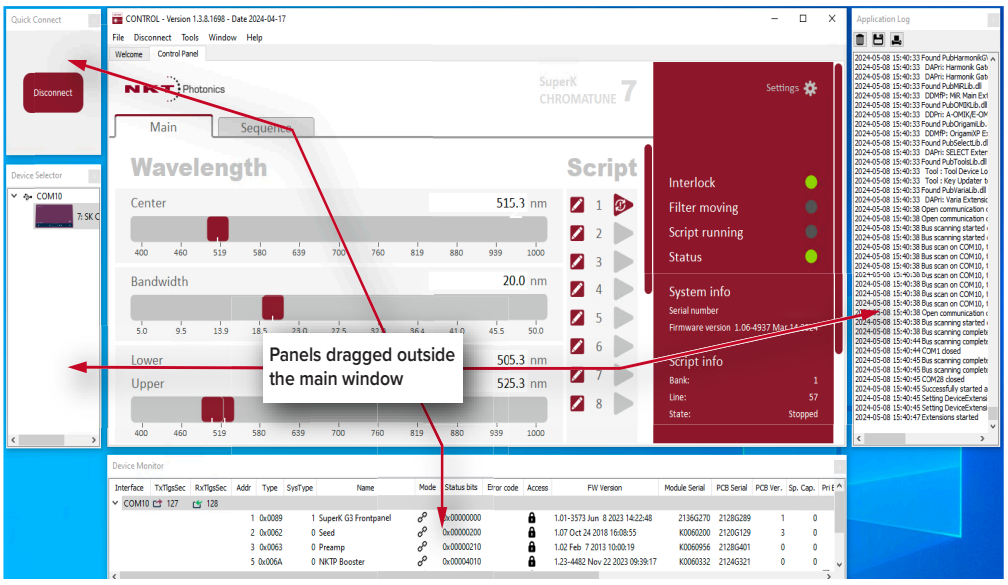


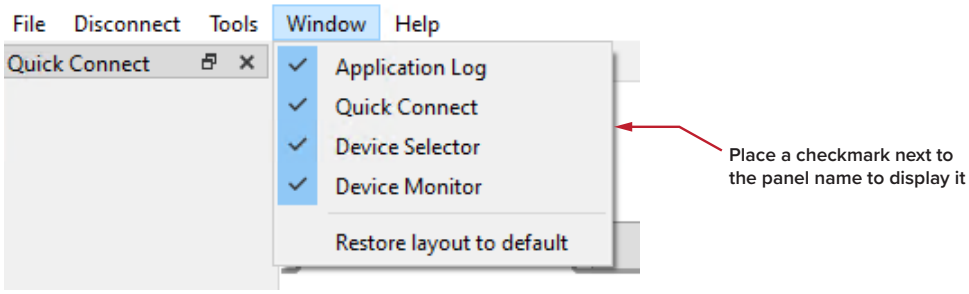
Figure 37 Dragging panels outside the main window



Toggling the panels visible

Click *Menu* > *Window* and check or uncheck the items in the drop down menu. Checking (clicking it) an item shows the panel and unchecking the item (clicking it again) removes it from view.

Figure 38 Toggling panel visibility



NOTE: You can also close the panels by clicking the X in the upper right corner of each panel.

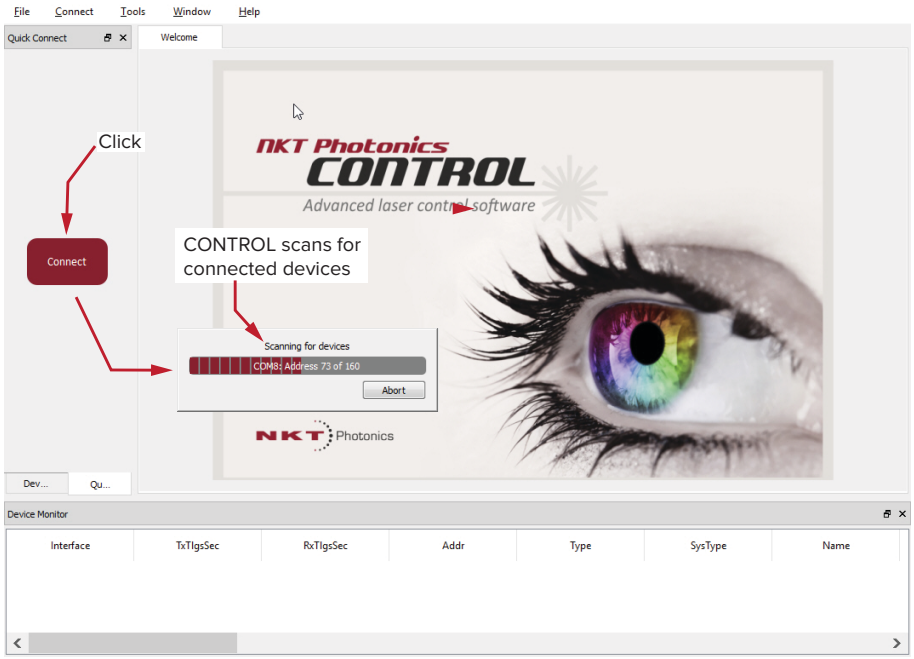
Connecting to the laser

When CONTROL is launched, a “Welcome” panel is displayed as in Figure 39. By default, on the left is the *Quick Connect* panel. Click the *Connect* button and CONTROL scans all available ports for NKT Photonics devices that it can connect to. Once CONTROL finishes the scan, a list of the devices is presented.

See either “Connecting a PC to the laser over USB” on page 66

or “Connecting a PC to the laser using Ethernet” on page 67.

Figure 39 Quick connect

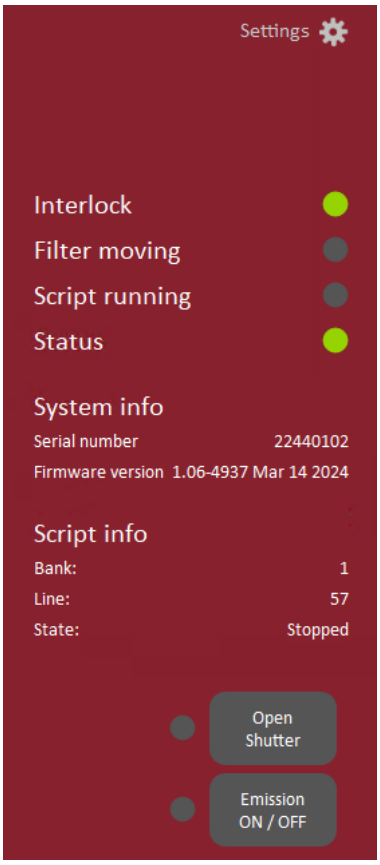


NOTE: Devices must already be connected to the CONTROL PC for quick connect to find them. A connected device means the laser’s USB connector is connected and a Windows COM port is assigned to it. For Ethernet connected lasers, the Ethernet parameters must already be configured or assigned by DHCP.

Status Panel

The Status Panel displays status indicators, system information, error messages, script execution information, emission control functions and CONTROL settings selectable from a drop down menu.

Figure 40 Status Panel



Status Indicators

The panel displays the following indicators:

Interlock
Indicates the status of the Interlock circuit and whether emission can be turned on or not. The indicator is either:

- OFF Red – the interlock circuit is open or shorted to ground – emission not allowed. Note that if a soft reset is required the indicator is also lit Red.
- ON Green – the interlock circuit is closed and reset – emission allowed

NOTE: To clear an OFF Red interlock indicator, the interlock and door switch circuit must be closed and reset. Any shorts to ground must be removed.

Status
Indicates the operational status of the laser. The indicator has the following states:

- ON GREEN – The laser emission can be turned on.
- OFF RED – There is a fault, laser emission is shutdown and cannot be turned ON. A fault message is displayed when this indicator turns OFF RED:

Fault Message	Action
Interlock opened while emission on	Close the external interlock circuit. Click the soft *Reset* button next to the Interlock indicator. Cycle the key switch to *Off* and then *Armed*.
Watchdog timeout	Reconnect NKT Photonics CONTROL and reset the interlock by cycling the key switch.

See "Connecting the safety interlock" on page 39.

Filter moving
During adjustments in the center wavelength or bandwidth of the CHROMATUNE module, the indicator is lit Amber as the system adjusts the output. Otherwise the indicator is Grey.

Script running
When a script loaded in the module is executed, this indicator is lit Green.

System Info

The *System Info* section shows the following:

- Laser Serial Number
- Laser Firmware Revision

Script Info

The following script parameters are updated when a CHROMATUNE script is executed:

- Bank – The CHROMATUNE includes 8 script banks. This lists the bank containing the script that is executing.
- Line – the script line number executing.
- State – the execution state of the script.

For information on creating and executing scripts, refer to the document:

SuperK CHROMATUNE Scripting Guide

Shutter button The button controls the position of the shutter. The button has two states:

- *Open shutter* – in this state the shutter is closed and the button indicator is Grey. Clicking this button, **opens** the shutter, allowing laser emission to put out.
- *Close shutter* – in this state the shutter is open and the button indicator is Red. Clicking this button, **closes** the shutter, and laser output will be blocked.

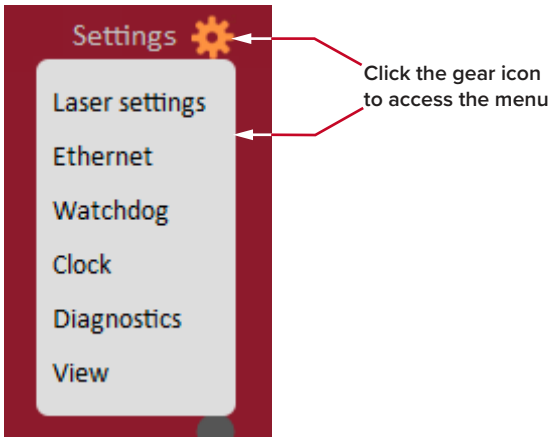
WARNING: The shutter is not a safety function and should not be used to prevent laser emission.

Emission button The *Emission* button turns the laser emission ON or OFF – See Procedure 15 on page 72. The button indicator turns ON Red when laser emission is generated. Otherwise, it is OFF Grey.

Control settings

The CONTROL settings are accessible by clicking the gear icon in the upper right corner of the Status panel. Clicking the gear icon displays a menu of setting items as shown in Figure 41:

Figure 41 CONTROL settings

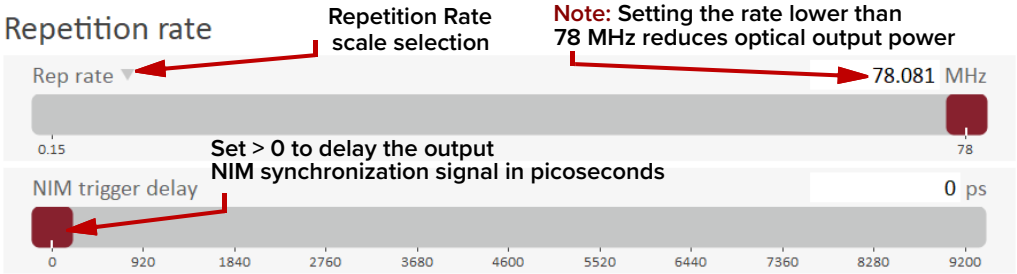


Setting Item	Function	See
Laser settings	Provides access to Variable Repetition Rate settings	Laser settings on page 81
Ethernet	Opens the IP configuration panel	Ethernet on page 82
Watchdog	Enables or disables a watchdog between CONTROL and the connected devices.	Watchdog on page 84
Clock	Sets the time and date that CONTROL uses for time stamping log messages.	Clock on page 84
Diagnostics	Provides access to evaluation of the current system state, as well as power detection self-calibration	Diagnostics on page 85
View	Enables and disables items displayed in the Status panel.	View on page 91

Laser settings

When the Variable Repetition Rate (VRR) feature is included with the laser, the optical output repetition rate and a delay of the post-VRR NIM trigger signal are both adjustable using the control panel sliders shown in Figure 42.

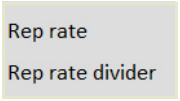
Figure 42 Repetition rate and NIM trigger delay controls



Repetition rate
The slider sets the output pulse frequency using the VRR feature – see “Pulse picker – VRR (optional)” on page 23. Adjust the slider or input the value in the text field to the desired output pulse frequency.

You can set the repetition rate scale to show units in MHz or by the division factor. Click the arrow as shown in Figure 42 to select the desired scale from the drop down menu (Figure 43). Select *Rep rate* for MHz or *Rep rate divider* to show the scale as the division factor.

Figure 43 Repetition rate scale selection



NOTE: When the scale is set to MHz (*Rep rate*), the slider only snaps to the values permitted by the division factors available for the pulse picker.

Available power and range when adjusting the repetition rate
The available output power and power range scales linearly with repetition rate divider. Hence, reducing the repetition rate to 7.8 MHz reduces the actual upper and lower limits of available output power by a factor of ten.

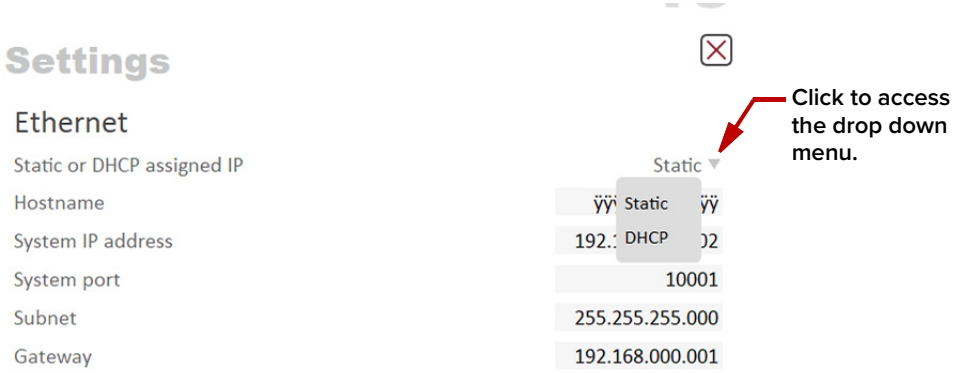
NIM trigger delay
You can delay the trigger pulse, from the post-VRR “NIM Pulse out” port, up to 9200 picoseconds. Use the *NIM trigger delay* slider to adjust the delay of the output trigger as required.

NOTE: To delay the trigger signal more than 9200 picoseconds, a longer cable can be used as an additional offset from the NIM Pulse output to the application.

Ethernet Configures the network settings of the laser when using an Ethernet connection. Over a USB/serial connection, configure the settings in this panel first before setting up an Ethernet connection for the laser in CONTROL – see Procedure 13 on page 67.

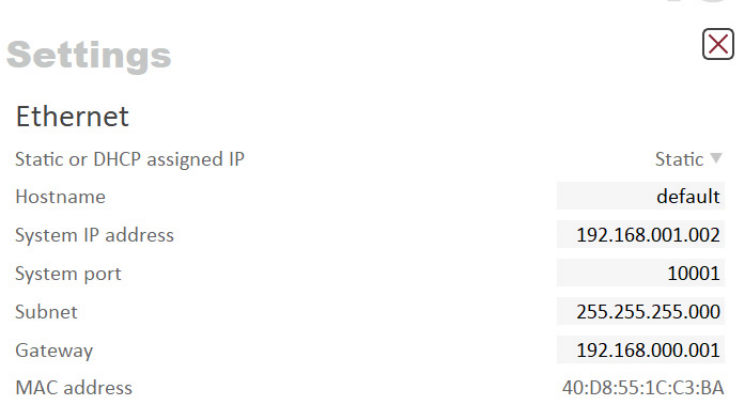
Static or DHCP
You can set the network connection to use either static or DHCP assigned network settings. Click on the down arrow as shown in figure 40 and select either *Static* or *DHCP*. For DHCP ensure the subnetwork that the laser is connected to supports DHCP service. DHCP settings assigned to the laser are displayed (after DHCP lease negotiation completes) and used when setting up the CONTROL PC connection, see Procedure 13 on page 67.

Figure 44 Network address assignment – DHCP/Static



Static network settings

Figure 45 Ethernet (network) static settings



Hostname
If your system supports name resolution, you can use this field to set a hostname for the laser.

System IP address
Enter the IP address assigned to the laser. The IP address set must be reachable from the subnet that the CONTROL PC is connected to.

System port
The *System port* sets the port address the laser uses for reception of TCP or UDP packets. The *System Port* address set in the network connection of CONTROL must match this address – default: 10001.

Host IP address
To help prevent unauthorized access, the laser can be configured to only accept packets from a single IP address assigned to the CONTROL PC.

Configure the *Host IP address* with the IP address of your CONTROL PC. When set, the laser only accepts packets with a source address that matches the *Host IP address* and ignores all others. When set to 000.000.000.000 (default setting), the laser accepts packets from any source IP address.

Host port
The *Host port* sets the port address the laser uses for transmission of TCP or UDP packets. The *Host Port* address set in the network connection of CONTROL must match this address – default: 0.

NOTE: If the *Host port* is set to 0, the laser uses the same port address for transmission as for reception i.e. the *System port* setting. The ports addresses set in the laser and in CONTROL must match.

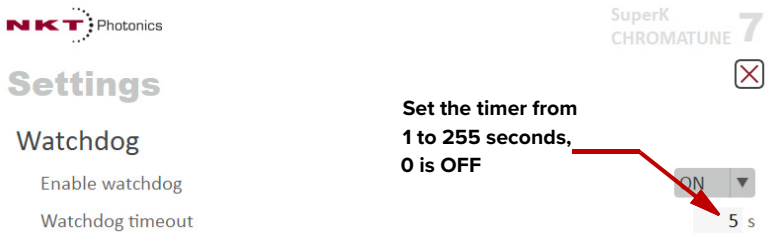
MAC Address
The unique *MAC address (Ethernet hardware address)* of the CHROMATUNE is displayed only and cannot be set.

Watchdog

As an added safety feature, the watchdog automatically disables laser emission if communication with CONTROL is lost. The feature can be enabled or disabled and has an adjustable timeout. When communication is lost with the laser, the laser watchdog timer counts down from the timeout setting value (1 to 255 seconds). Upon expiry, the watchdog disables emission by internally opening the interlock circuit.

NOTE: Setting the timeout to 0 seconds disables the watchdog.

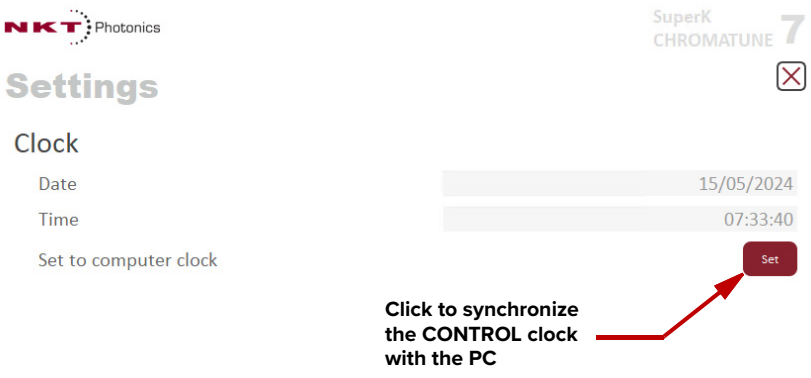
Figure 46 Watchdog



Clock

You can view and set the laser's time and date using this settings. Click the *Set* button to synchronize the laser clock with the PC time and date. Logs collected by the laser are time stamped with the date and time shown here.

Figure 47 Clock settings



Diagnostics

The CHROMATUNE laser system and NKT Photonics CONTROL software have some built-in functions for evaluation of the current state of the system and, in case this is required, for calibration of the actual output power level of the laser. Calibration will determine the current output power and adjust the available power setting to match this as well as possible.

Diagnostic self-test

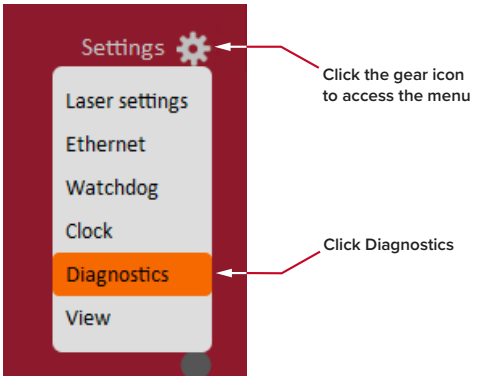
The self-test enables a diagnostic analysis of the filtering part of the CHROMATUNE laser. This allows detection of potentially malfunctioning components in case the laser is not providing the expected output. The self-test is only required if non-typical behavior has been observed and it can be performed in a few minutes.

NOTE: The output collimator of the CHROMATUNE laser must be mounted in the black holder at the back panel of the chassis for the complete duration of the calibration procedure.

NOTE: Emission must be turned off and on by the user as part of the self-test (please follow the instructions during the test sequence).

NOTE: A 50 Ohm cable with BNC connectors is required to connect the Trig In and Trig Out connectors. Please mount the cable when instructed to. The test is optional and may be skipped if not required.

Procedure 18 Performing a diagnostic self-test

	Action
1	Connect the CHROMATUNE to the USB interface of a PC, launch NKTP Control and connect as described in Connecting the laser to a CONTROL PC on page 65.
2	Click the gear icon and select *Diagnostics* to enter the diagnostics page. 
3	Turn emission OFF by clicking on the *Emission ON/OFF* button. The *Emission ON/OFF* button indicator is extinguished. 

Action

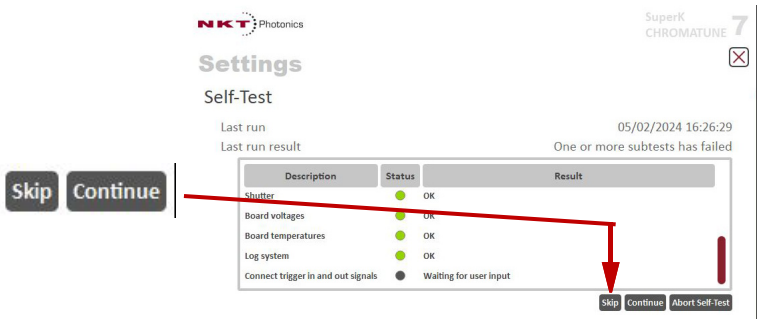
4 Place the output collimator in the black holder on the rear side of the chassis of the CHROMATUNE.

See Installing the collimator on page 43 for instructions on installing the collimator.

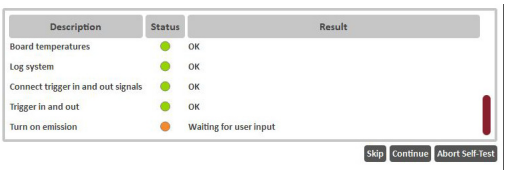
5 Click *Run Self-Test* to start the test.

6 For the external connector (Trigger IN and Trig Out) test a 50Ohm BNC cable must be connected to the two connectors. Click *Continue* when the cable is mounted.

The test is optional and can be skipped by clicking *Skip*.



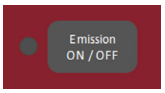
7 The final part of the test requires that the emission is ON.

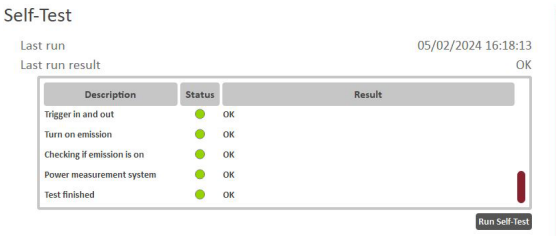


Please turn Emission ON when prompted to do so.

	Action
8	When the test is complete, please turn emission OFF by clicking on the *Emission ON/ OFF* button. It is now safe to remove the collimator from the holder. In the last line the test result is shown. The test results can be: OK -or- One or more subtests have failed

OFF





9 Failing self-test:

a. Power measurement system failing:

- Make sure that the collimator is well mounted in the holder at the rear of the chassis during the test.
- Perform a self-calibration of the system as described in Procedure 19.

b. Other failures:

- Please repeat the test and contact NKTP service if the failure persists.

Self-calibration

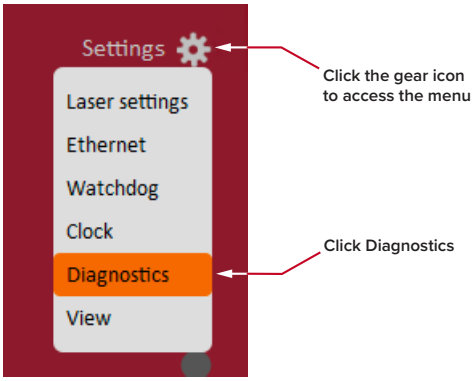
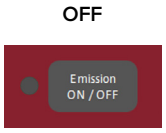
The output power of the CHROMATUNE laser has been calibrated during manufacture. However, for various reasons the output power and spectrum may change over the lifetime of the CHROMATUNE laser. The self-calibration algorithm allows the CHROMATUNE to perform a calibration of the current state based on the internal power detection.

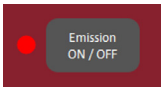
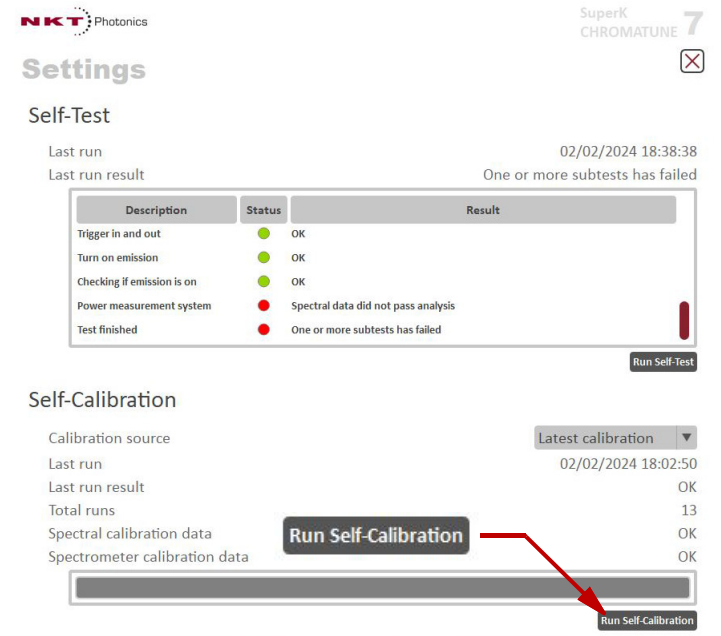
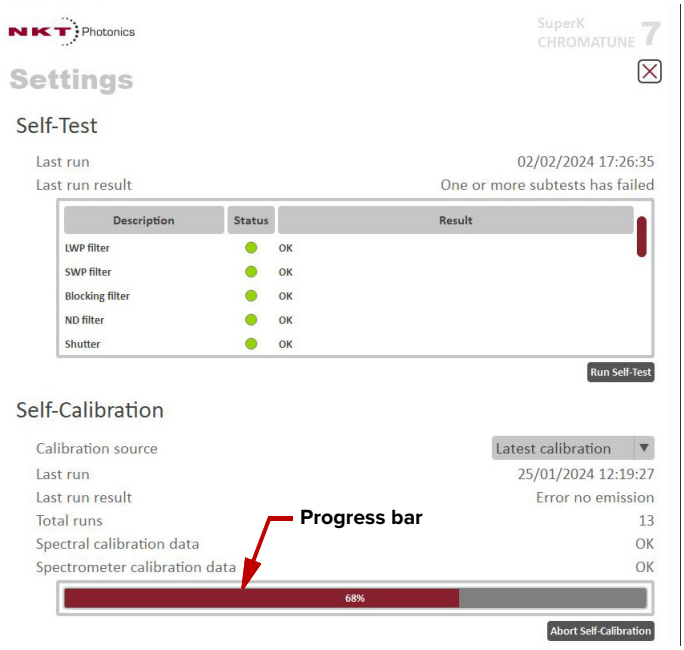
NOTE: The output collimator of the CHROMATUNE laser must be mounted in the black holder at the back panel of the chassis for the complete duration of the calibration procedure.

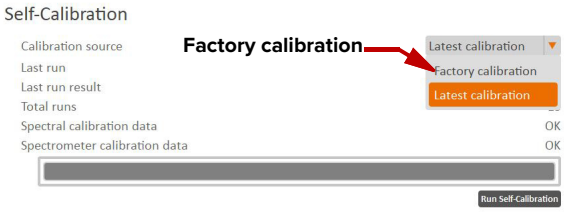
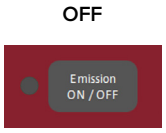
NOTE: It is important that the CHROMATUNE laser is allowed to warm up with emission ON for 30 minutes prior to the calibration. Shorter warm-up time can cause less accurate results.

NOTE: A failed self-test is not a prerequisite for self-calibration.

Procedure 19 Performing a self-calibration

	Action
1	Connect the CHROMATUNE to the USB interface of a PC, launch NKTP Control and connect as described in Connecting the laser to a CONTROL PC on page 65.
2	Click the gear icon and select *Diagnostics* to enter the diagnostics page. 
3	Turn emission OFF by clicking on the *Emission ON/OFF* button. The *Emission ON/OFF* button indicator is extinguished. 
4	Place the output collimator in the black holder on the rear side of the chassis of the CHROMATUNE. See Installing the collimator on page 43 for instructions on installing the collimator. 

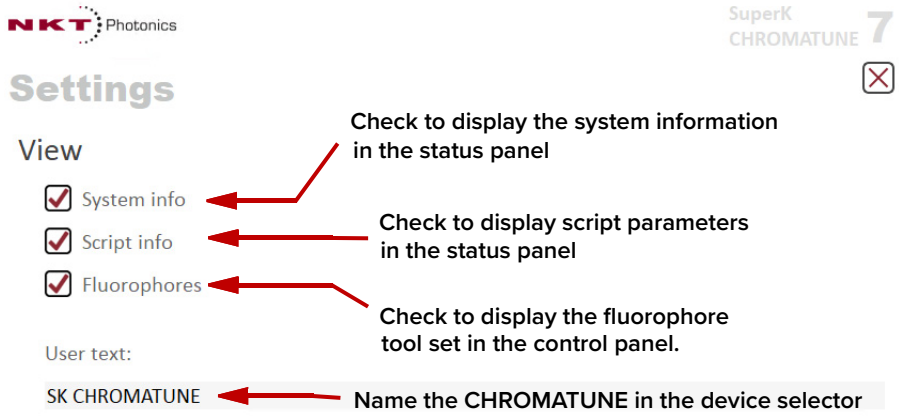
	Action	
5	Turn emission ON by clicking on the *Emission ON/OFF* button. The *Emission ON/OFF* button indicator is red.	ON 
6	Allow the laser to warm up for 30 minutes. Shorter warm-up time can result in less accurate results.	
7	Click *Run Self-Calibration* to start the calibration procedure.	
8	Allow the calibration procedure to run. This will take a few minutes. The progress bar shows the status.	

	Action	
9	The calibration result is shown after completion of the procedure. If successful, the new calibration values are used.	
10	If needed, it is possible to revert to the original calibration by selecting “Factory calibration” from the drop-down menu.	
11	When the calibration process is complete, please turn emission OFF by clicking on the *Emission ON/OFF* button. It is now safe to remove the collimator from the holder.	

View The View settings toggle on (check) or off the display of the following:

- *System info* – when checked CONTROL displays the system information within the status panel.
- *Script info* – when checked script information on bank, line and state are displayed in the status panel.
- *Fluorophores* – check this box to display the Fluorophore tool set in the control panel.

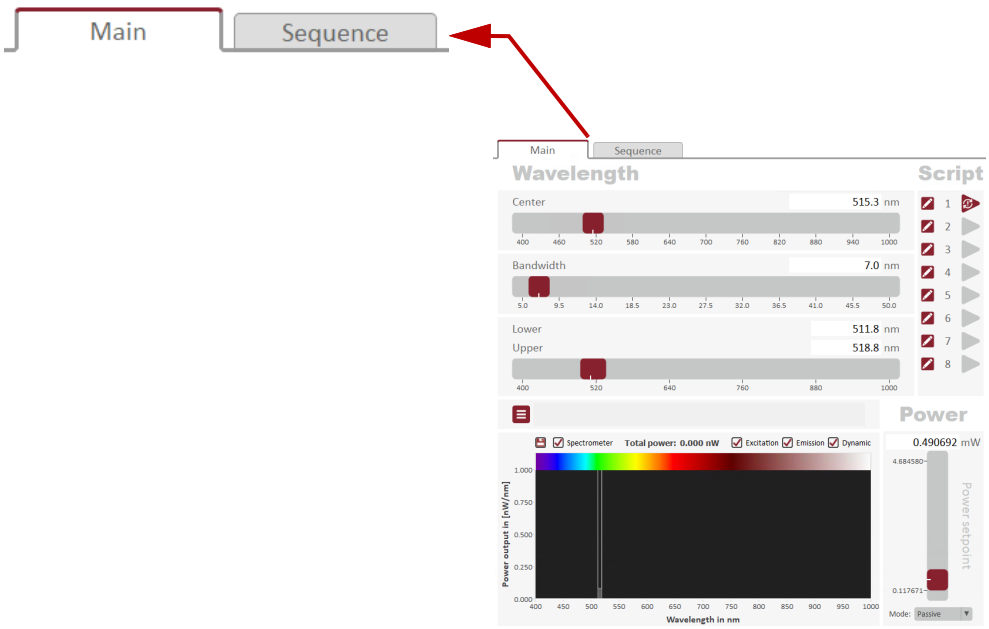
Figure 48 View settings



Control panel

After Connecting to the laser, the Control Panel tab is automatically selected. Here you will find two tabs:

Figure 49 Control Panel tabs



Main tab

- The *Main* tab provides:
  - manual controls for both emission wavelength and power.
  - a spectrometer with optional graphical fluorophore views.
  - 8 editable and executable script banks to automate emission sequences using simple CHROMASCRIPTs.

This tab's functions are fully described under section "Main tab" on page 93.

To write and execute CHROMASCRIPTs refer to the document:

SuperK CHROMATUNE Scripting Guide

Sequence tab

The *Sequence* tab provides a user-friendly method of entering a series of illuminations which for each you can set the emission color, output power, and exposure time. The tab works similar to writing and executing CHROMASCRIPTs except that no coding is required. The tab is fully described in section "Sequence tab" on page 104.

Main tab

Control groups You will find 5 groups of controls/displays in the main tab:

1. In the Emission wavelength manual controls group there are 3 manual controls to set the emission wavelength – see “Emission wavelength manual controls” on page 94.

2. The Fluorophore control group allows you to add graphs of fluorophore datasets to the spectrum view in group 3 – see “Fluorophore control group” on page 95.

3. The spectrum view displays the band window and optionally a spectrometer measurement of the optical output. Also optional fluorophore datasets loaded using group 2 controls can be plotted in the view – see “Spectrum view” on page 97.

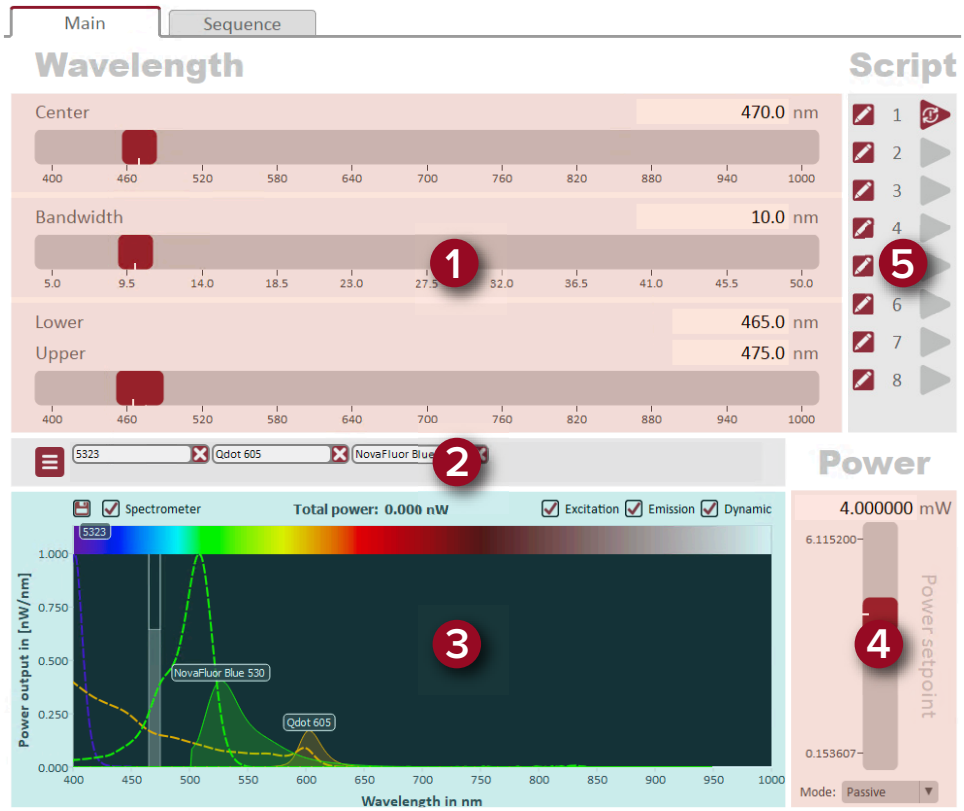
4. The output power control group provides a manual slider to adjust the power setpoint along with a menu to select the power mode that the laser operates under – see “Power” on page 101.

5. The *Script* group gives access to 8 memory banks on the laser control module in which you can add and execute CHROMASCRIPTS that can automate the output spectrum in multiple ways. Refer to the document:

   SuperK CHROMATUNE Scripting Guide

   for information on how to use the *Script* controls.

Figure 50 Main tab control groups

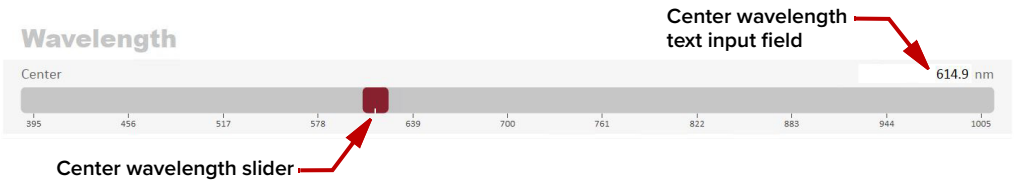


Emission wavelength manual controls

Center wavelength

You can set the center wavelength of the light emitted from the CHROMATUNE laser using this control. Grab the slider with your mouse and move it to any wavelength from 400 to 1000 nm. You can also use the text input field at the right of the slider scale to enter the values directly from your keyboard.

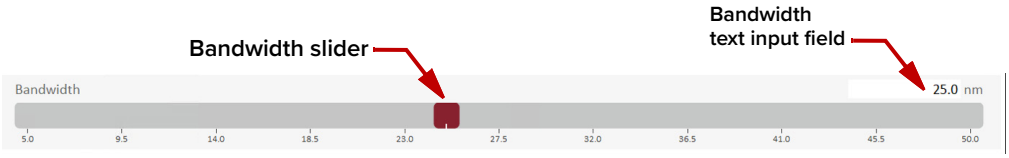
Figure 51 Laser wavelength control



Bandwidth

Grab the slider with your mouse and move it to configure the emission bandwidth of the laser from 5 to 50 nanometers. Alternatively, enter the bandwidth directly in the text field at the upper right side of the slider scale.

Figure 52 Bandwidth controls



UV bandwidth

When the center wavelength is set to 400 nm at the UV end of the spectrum, you can configure a bandwidth from 5 to 50 nm.

Near-IR bandwidth

As the center wavelength of the emission approaches 1000 nm or near-IR, the bandwidth is still configurable from 5 nm to 50 nm; however, the actual emission at this end of the spectrum is approximately 10 nm in bandwidth. As the you decrease the center wavelength the minimum bandwidth also decreases.

NOTE: For other center wavelengths, the minimum bandwidth increases (approximately) linearly between the center wavelength end points.

NOTE: The laser emission is limited to the 400 – 1000nm range. If the selected emission band extends outside this range, this will in practice be truncated. For example, tuning to a center wavelength at 400 nm with a bandwidth set to 20 nm you would expect 390 to 410 nm lower and upper bandwidth limits. However, CHROMATUNE emission is limited to a minimum 400 nm wavelength, thus for this setting the bandwidth is from 400 to 410 nm.

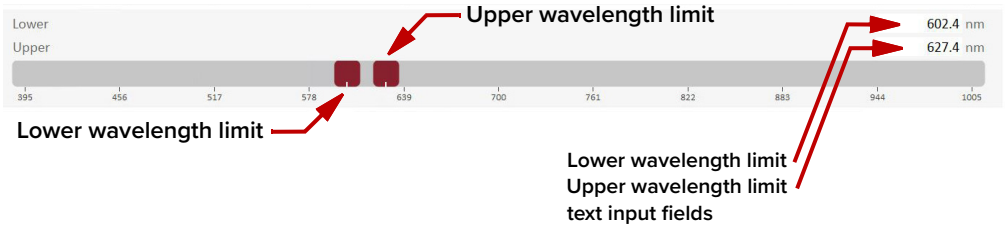
Lower Upper

Using this control, you can also set both the Center wavelength and bandwidth within one control. With your mouse, grab the left slider in the control and position it to configure a lower wavelength limit. Then grab the right slider and move it to an upper wavelength limit. Both the *Center* wavelength and

Bandwidth controls adjust synchronously as you change the lower and upper wavelengths.

NOTE: The lower and upper limit sliders move synchronously when their spacing reaches either 5 or 50 nanometers.

Figure 53 Wavelength limit control



NOTE: You can also enter the lower and upper wavelength limits using the text input fields at the upper right side of the slider scale.

Fluorophore control group

The fluorophore management group enables a graphical representation and visualization of absorption and emission processes of various predefined and user-defined fluorophores shown in the spectrometer view.

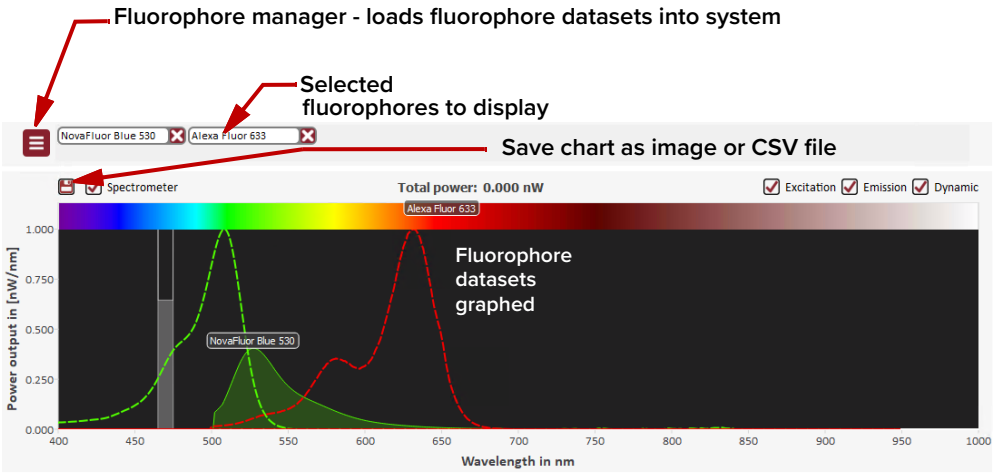
Adding fluorophore datasets

You can add graphs of fluorophore datasets to the spectrum view to visually view the output emission in comparison to the fluorescence excitation and emission graphs of a particular fluorophore. The steps to add the graphs are as described in the following procedure:

Procedure 20 Adding fluorophore datasets to the spectrum view

1. In the status panel access the view settings menu – see “View” on page 91.
2. Check the box next to *Fluorophores* to turn on the fluorophore dataset controls in the tab view.
3. Referring to Figure 54 below, click the fluorophore manager button at the top left of the spectrum view (the red button with 3 horizontal bars) to load and add fluorescent dataset(s) so they are available for display – see Figure 55 on page 97.
4. Click the add icon (+) next to the desired fluorophore to add it to the spectrum view. You can click and add up to 8 fluorophore datasets which can be graphed simultaneously.

Figure 54 Spectrum view with fluorophore graphs



NOTE: Ensure the *Excitation* and *Emission* boxes at the top right of the spectrum view are checked – see "Spectrum view" on page 97.

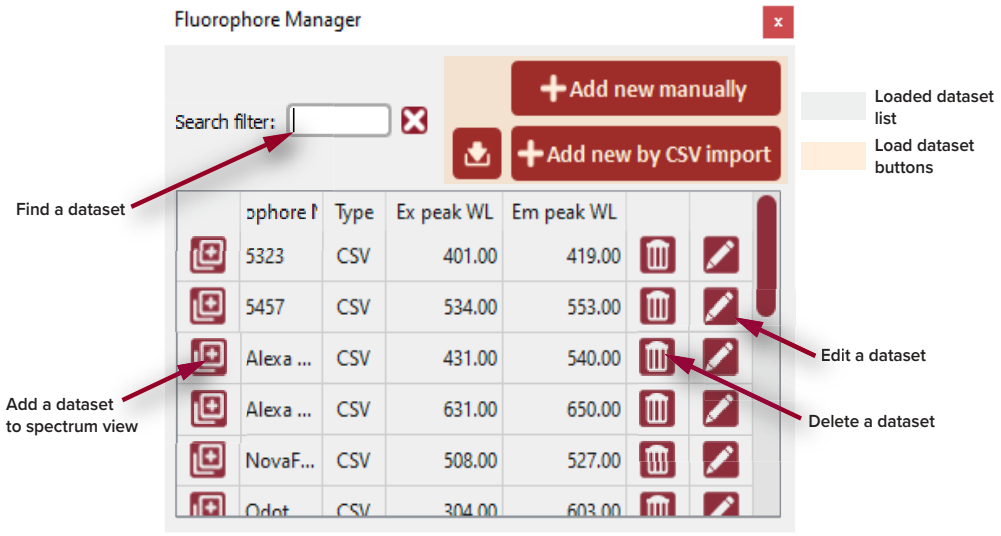
To display fluorophore datasets in a graph within the spectrum view, launch the fluorophore manager as previously mentioned in step 3 of Procedure 20.

The manager includes three methods of loading a dataset:

- **Add new by CSV import** – CSV files containing fluorophore datasets are commonly accessible. With the file loaded on the PC, you can import it into CONTROL using this button.
- **Add new manually** – You can enter a dataset manually by entering a fluorophore's:
  - excitation peak and bandwidth
  - emission peak and bandwidth

  Then enter a name and text description. To create the graphs, the system generates a Gaussian distribution based on the entered data.
- **Add new fluorophore from a URL** – the datasets available on some websites may not be available in CSV format. In some of these sites, you can use this down-arrow button to load directly from the URL containing the fluorophore dataset.

Figure 55 Fluorophore manager



Spectrum view

The spectrum view provides a visual reference of the emission graphed as power versus wavelength. It includes a basic option of displaying only the emission configuration and then more advanced options that include a spectrometer measurement of the output and optional fluorophore dataset graphs with dynamic simulation of the florescence emission. The view options are described in the following sections and also include a mouse-over function to display the measurement at any point in the graph.

Basic

Without selecting any options, the basic spectrum view shows a band and power setpoint *settings window* superimposed on the spectrum range of the CHROMATUNE. The window shows the emission wavelength settings and the power setpoint of the laser superimposed on the graph.

Wavelength settings

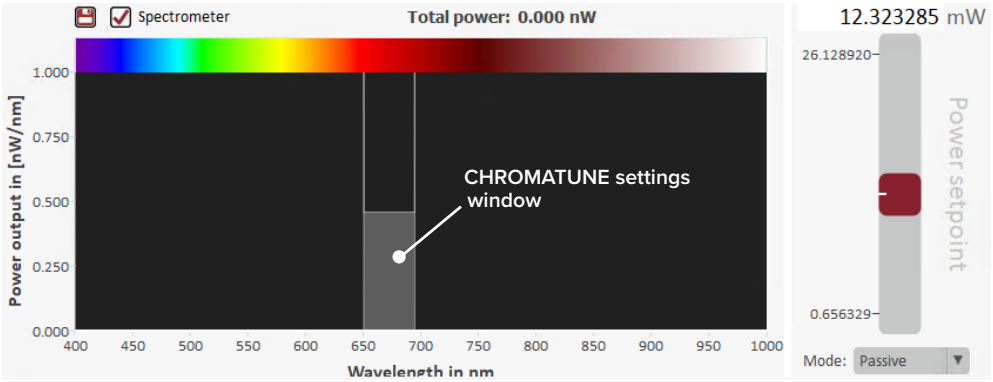
The width of the window is centered over the set wavelength with the left and right lines representing the lower and upper wavelengths, respectively. The window moves dynamically across the range as you adjust the center wavelength and it expands or contracts as the bandwidth settings are modified.

Power setpoint

Within the window, a visual indication of the current power setpoint is shown as a light gray bar which moves up and down dynamically with the power setpoint level.

NOTE: The power level is set using the slider and displayed directly above. The left-hand axis of the spectrum graph does not display the power setpoint level directly.

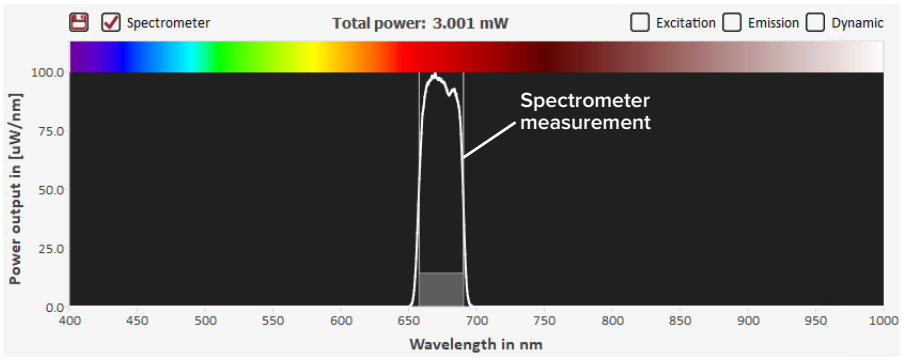
Figure 56 Spectrum view - basic



Spectrometer Checking the spectrometer box option turns on a spectrometer measurement function. The emission measurement is then displayed as a white line in the spectrum view as can be seen in the Figure 57.

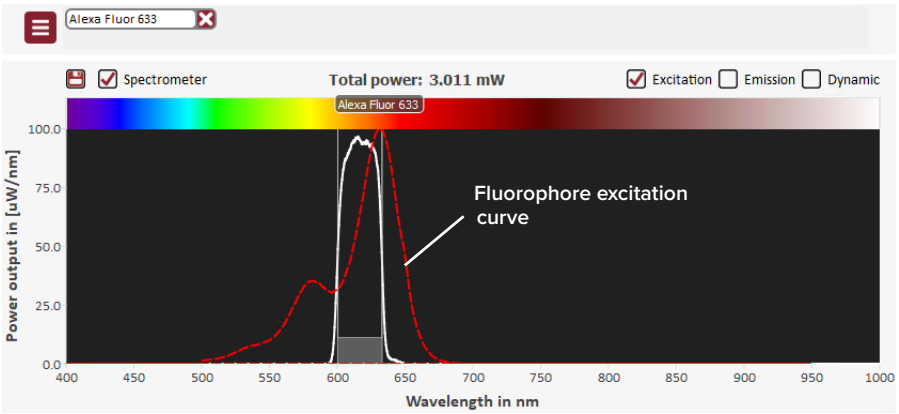
NOTE: The amplitude of the spectrometer graph corresponds to the left-hand axis on the graph - not the power setpoint slider.

Figure 57 Spectrum view - spectrometer option



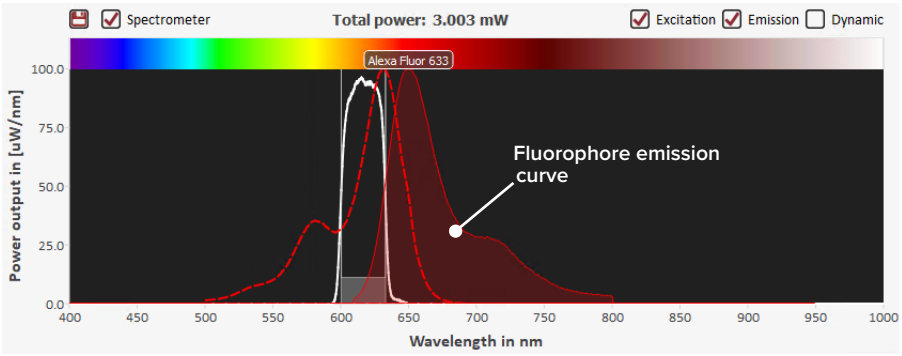
Excitation When using the fluorophore options of the CHROMATUNE, you can plot the excitation curve of any loaded fluorophores added to the view – see “Fluorophore control group” on page 95. To plot the fluorophore curves, check the *Excitation* box in the upper right of the view as shown in Figure 58.

Figure 58 Spectrum view - adding fluorophore excitation curves



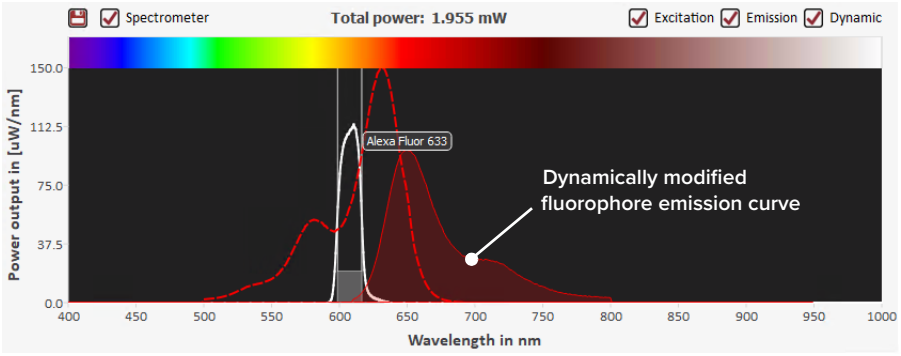
Emission Along with the fluorophore excitation curve, you can plot the emission data curves from any added fluorophores by checking the Emission box in the upper right. Figure 59. shows the Excitation and Emission boxes checked and note the emission data is distinguished from the excitation data in that it is tinted underneath its curve.

Figure 59 Spectrum view - adding fluorophore emission curves



Dynamic When this function's *Dynamic* box is checked, you can simulate the fluorescence emission for various CHROMATUNE emission settings. The function works by dynamically modifying the fluorophore emission plots for the set wavelength, bandwidth and power as they are changed.

Figure 60 Spectrum view - fluorophore dynamic simulation option

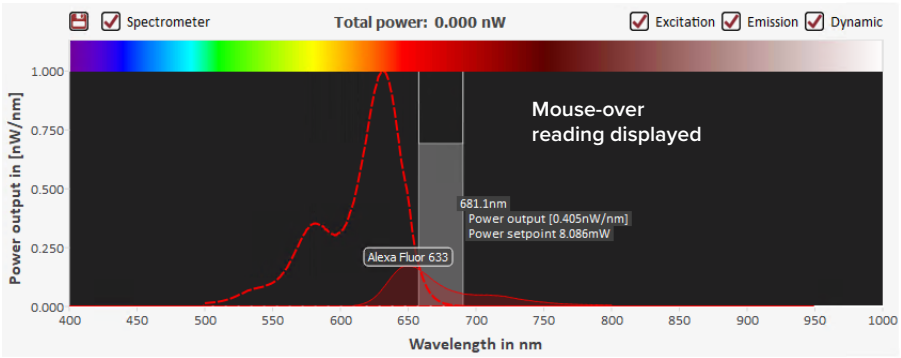


Mouse over function

To display the spectral values anywhere in the view, hover your mouse pointer over a point as shown in Figure 61. Next to the mouse pointer you can read:

- the wavelength in nm
- the power output in nW/nm
- the power setpoint in mW

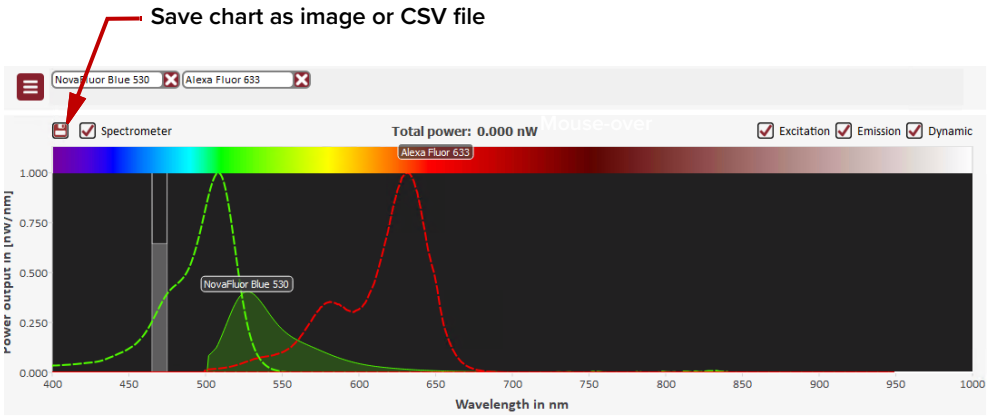
Figure 61 Spectrum view – mouse-over function



Save chart as image or CSV data

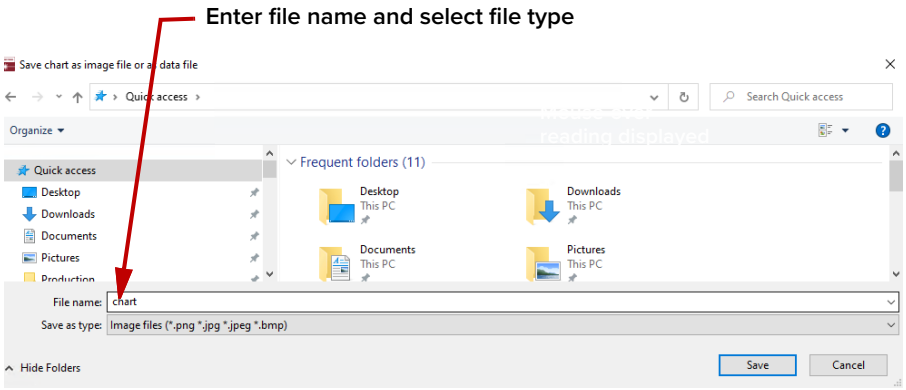
To save the spectrum view as an image or CSV file, click on the save icon as shown in Figure 62.

Figure 62 Spectrum view – Save chart



Enter a file name and select the file type from the drop-down list.

Figure 63 Save chart file



Click *Save*.

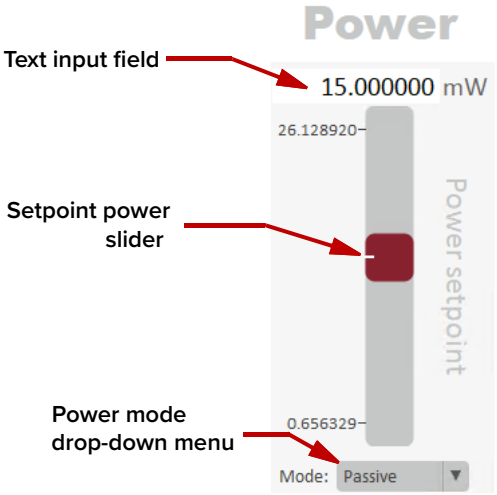
Power

Power setpoint

You can adjust the setpoint power in mW using this slider. Alternatively you can enter the setpoint power directly using the text input field above the slider. Note that the actual range of the setpoint power control is dependent on the Total output power available as determined by the CHROMATUNE settings. This power depends on the selected combination of center wavelength, bandwidth, and repetition rate[i], and will change dynamically when the parameter values are modified.

[i]for systems with VRR (pulse picker) option

Figure 64 Setpoint power control

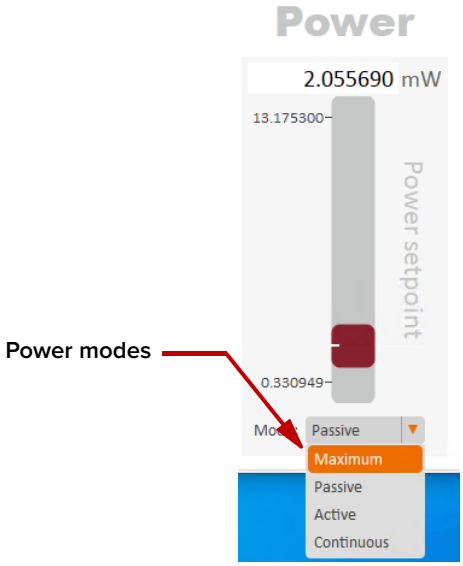


Power mode

The method the CHROMATUNE uses to determine and control the output power can be changed by selecting one of 5 modes from the power mode drop-down menu shown in Figure 65. The selectable modes are as follows:

- *Maximum* – this mode causes the laser to operate with maximum power for the selected combination of center wavelength, bandwidth, and repetition rate.
- *Passive* – in this mode the laser uses internal mapping tables to set the output power based on the power setpoint and other filter settings.
- *Active* – in active mode the laser first uses the mapping tables to set a power level and then makes adjustments based on internal feedback until the setpoint power value is reached.
- *Continuous* – this mode causes the laser to first use the mapping tables to set a power level and then make adjustments based on internal feedback on a continuous basis to maintain the setpoint power value.

Figure 65 Power mode menu



Total output power available

Total output power available for a CHROMATUNE tunable laser depends on the following settings:

- “Center wavelength” on page 94 – output power, as shown in Figure 2 on page 21, varies depending on the center wavelength.
- “Bandwidth” on page 94 – as the set bandwidth increases more light is emitted, hence increasing the total output power. As the bandwidth decreases less light is emitted, decreasing total output power.

Script

The *Script* group of controls provides access to 8 banks on the CHROMATUNE module which can be used to load, edit and execute CHROMASCRIPTS. The script contains commands to set the output emission characteristics along with the exposure timing. Creating and executing scripts gives you the means to automate a sequence of illuminations.

For a full description of the CHROMASCRIPT interface and using the script controls, refer to the document:

SuperK CHROMATUNE Scripting Guide

Sequence tab

Instead of writing scripts, the *Sequence* tab simplifies the method of creating an automated sequence of illuminations through its user-friendly interface. Within the tab, a series of visual steps are added, and each step contains illumination characteristics. Add steps containing the illuminations needed and when ready click the *Run sequence* button and the laser enables emission with the configuration of each step in a sequence. The steps are by default executed in ascending order; however, steps can be delayed, disabled or re-ordered in the sequence.

NOTE: The sequence is stored as an auto-generated script in the selected script bank. If a script is already stored in the script bank, it will be overwritten.

Sequence configuration

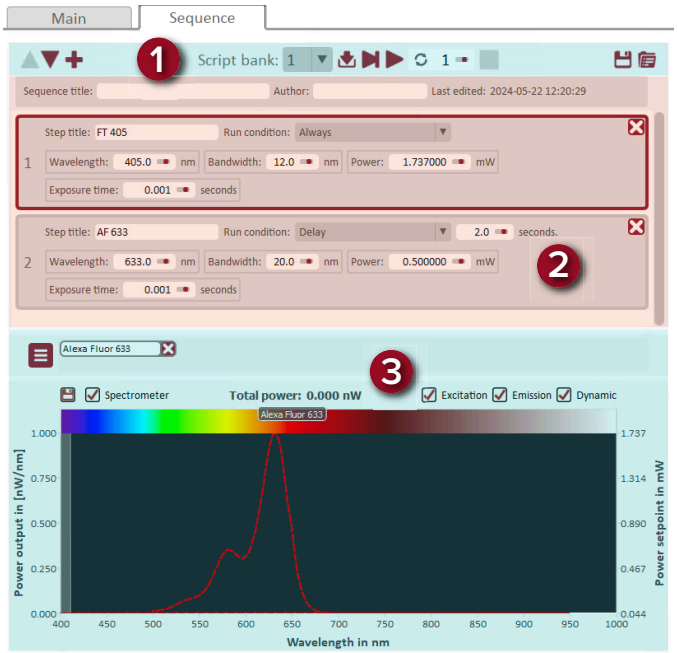
In the sequence tab there are three control groups:

1. Group 1 of Figure 66 are controls to add one step of a sequence. A step is a configured illumination settings of light for a predefined exposure amongst other settings. The system allows up to 16 sequence steps to be added. The controls in this group allow you to add, navigate, save, open, and execute sequences of these steps. These controls are described in “Sequence controls” on page 105.

2. Group 2 of Figure 66 are the actual sequence steps added and controlled by the controls of group 1. Each step includes the illumination settings and its execution timing in the sequence. The attributes configured in the step sequence are entered as a CHROMASCRIPT into a script bank either automatically when the sequence is executed or by manual command. To configure these steps refer to “Sequence steps” on page 107.

3. The items in group 3 of Figure 66 are the identical spectrum view and fluorophore controls described in the Control panel tab. Refer to section “Spectrum view” on page 97 and “Fluorophore control group” on page 95.

Figure 66 Sequence tab control groups



Sequence controls

The sequence controls allow you to manage the steps in the sequence so that you can add steps, run the sequence and other functions as described in the following sections.

Figure 67 Sequence controls

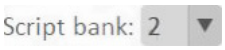
Move step

Click on a step in the sequence to highlight it, and then click either the up or down arrow to move the step's position in the sequence order.

Add step

Click on the plus button to a step to the sequence. You can add a maximum of 16 steps in one sequence.

Script select



Select a script bank from this drop-down menu. The sequence is coded and written into the selected bank when executed. You can also force a sequence into a bank using the write sequence button described in the following.

NOTE: The sequence is stored as an auto-generated script in the selected script bank. If a script is already stored in the script bank, it will be overwritten.

Write sequence to a script bank

Click this button to force the sequence to be coded and written into the bank selected using the script select menu described in the previous section. Using this button the sequence does not need to be executed in order to be coded and written to a bank.

NOTE: The sequence is stored as an auto-generated script in the selected script bank. If a script is already stored in the script bank, it will be overwritten.

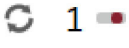
Run step

Click on a step in the sequence to select it and then click this button to only execute the step.

Run sequence

Click this button to execute the sequence.

Repeat sequence



Select the number of times to repeat the current sequence. The text entry field can also be configured using an optional pop-up slider. To access the slider, click the small slider icon in the text entry field to the right of the field value.

Stop

Click this button to stop execution of the script.

Save

Save the sequence in the tab to a file on the CONTROL PC.

Load Load a saved sequence into the tab from the CONTROL PC.

NOTE: To delete a step – see “Deleting a step from the sequence” on page 108.

Sequence steps

Each step allows you to enter illumination characteristics in its attribute fields and menus for one of up to 16 steps in the sequence. In this way, you can order and sequence a series of 16 different illuminations. The step attributes are configured manually and described in the following sections.

Figure 68 Sequence title and author

Sequence title Enter a title and/or an author name for the sequence.

Figure 69 Sequence steps

Step title Enter a name for the step, the title is listed in the comments of the script code for the step.

Run condition Click on the menu and select:

- Always – The step is included in the sequence when executed.
- Disabled – The step is excluded from the sequence when executed.
- Delay – Before the step is executed a settable delay occurs, see “Step delay time” on page 108.
- Dialog - The step is confirmed or canceled in a pop-up box.
- External Trigger Low - The step waits until a logical low input level is detected on the external trigger input port
- External Trigger High - The step waits until a logical high input level is detected on the external trigger input port
- External Trigger High->Low - The step waits until a transition from logical Low to logical High is detected on the external trigger input port
- External Trigger Low->High - The step waits until a transition from logical High to logical Low is detected on the external trigger input port

Wavelength Sets the center wavelength of the emission when the step is executed.

Bandwidth Sets the bandwidth of the emission when the step is executed.

Power Enter the setpoint power of the emission when the step is executed. Note that the power mode is set manually – see “Power” on page 101.

NOTE: Changing the Repetition rate may change the power setting when the target power is no longer within the allowable range for the new repetition rate set.

Exposure time Enter the length of time the emission is enabled when the step is executed. The time is set in seconds and milliseconds.

Step delay time Enter the delay time in seconds and milliseconds before the step is executed. This field only appears when *Run condition* is set to *Delay*.

Deleting a step from the sequence To remove a step in the sequence, click the X in the upper right corner of the step.

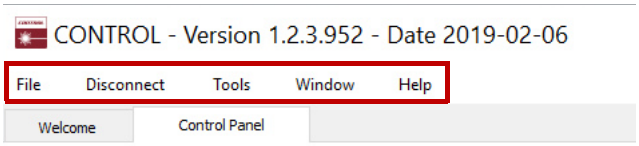
Slider control The text entry fields of a step can also be configured using an optional pop-up slider. To access the slider, click the small slider icon in the text entry field to the right of the field value.

Figure 70 Slider control for a step attribute field

CONTROL menu

There are five menu items at the top left of the main CONTROL window. highlighted in Figure 71. Clicking on each item, reveals a drop down menu.

Figure 71 Menu items



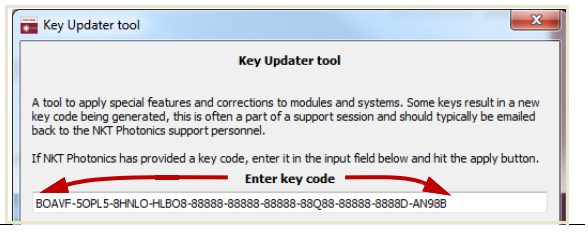
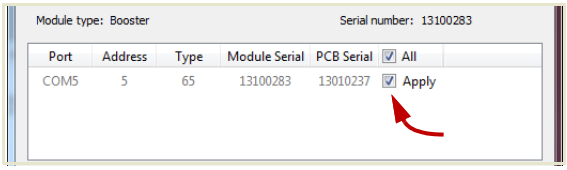
Menu Item	Function	See
File	Click *File>Exit* to exit the CONTROL program	N/A
Disconnect	Click *Disconnect>Close All to* disconnect the currently connected device from CONTROL.	N/A
Tools	Select from one of three special tools to use with your laser. Tools available are: • Key Updater Tool • Log Downloader • Extensions Overview	 Key Updater tool on page 109 Log Downloader on page 110 Extensions overview on page 111
Window	Sets whether certain panels are visible or not.	Toggling the panels visible on page 77
Help	Displays the current version of CONTROL and provides access to the included CONTROL user help.	N/A

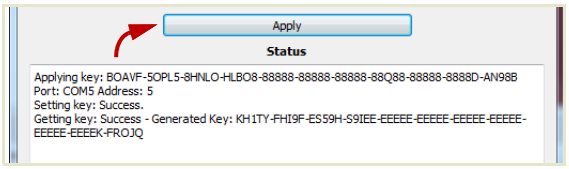
Key Updater tool

You can use the *Key Updater* tool to apply special features and corrections to modules and systems of the laser.

To use the *Key Updater* tool follow Procedure 21.

Procedure 21 Using the Key Updater tool

	Action	
1	Enter a key code in the field “Enter key code”. **NOTE:** Key codes are generated by NKT Photonics.	
2	In the list of modules, check the box on the right of each applicable module.	

	Action	
3	Click “Apply”	

NOTE: Certain keys generate a new locally generated key code. Locally generated keys are usually required during a support session and are emailed back to the NKT Photonics support personnel.

Log Downloader

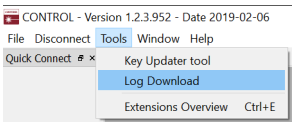
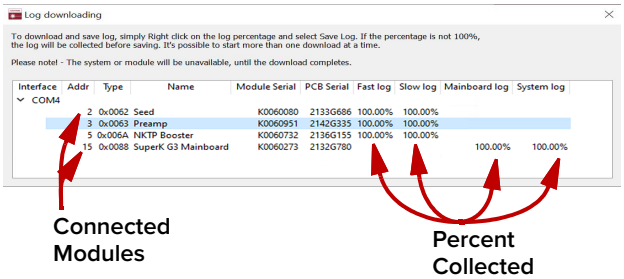
If your laser requires support from NKT Photonics, our support engineers may request you send them log files collected by the laser. You can use the *Log Downloader* tool to save log files from the laser to your CONTROL PC.

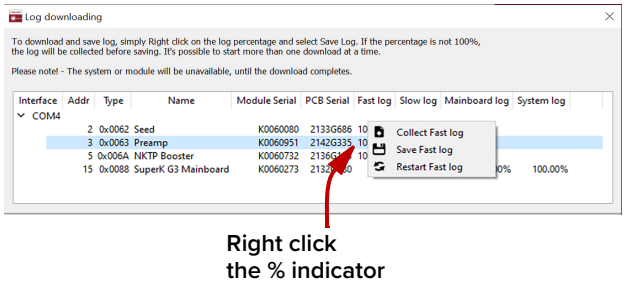
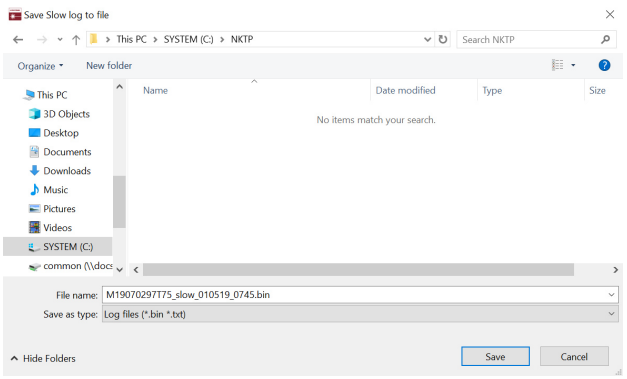
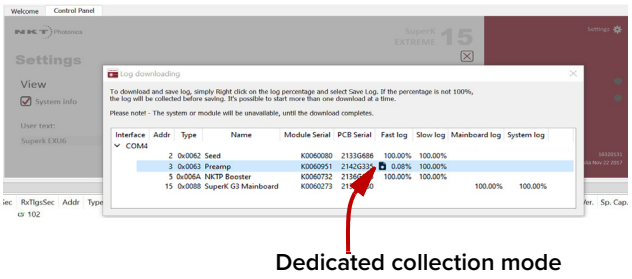
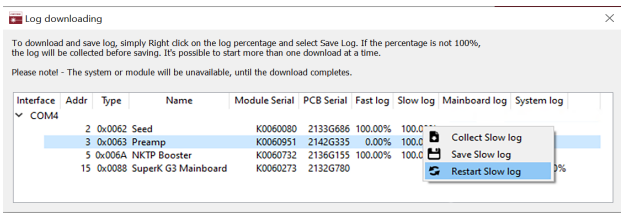
NKT Photonics CONTROL automatically downloads log files from modules of any connected devices. The log files are stored in a local database of the CONTROL PC. However, certain NKT Photonics modules, including the SuperK CHROMATUNE mainboard, do not support automatic download of log files. For these modules, you can use the *Log Downloader* tool to put the device into dedicated log download mode by enabling a collect log function.

NOTE: When the collect log function is enabled, it temporarily disables automatic log collection from all other devices. The CONTROL interface turns gray, and communication with the laser and log collection with all other modules is disabled.

To download log files use the *Log Downloader* as described in Procedure 22.

Procedure 22 Using the Log Downloader

	Action	
1	Click the *Tools* menu and click on *Log Download* to start the Log Downloader tool.	
2	The tool displays all connected modules with log capability. To decrease the download time of the module log files, CONTROL continuously collects module log data and stores this log data in a local database on the PC. Logs are collected from each module and each has a percentage indicator that shows the percentage (%) collected of the module’s total log data.	

Action	
3 To download and save a log file to the CONTROL PC, right click the percentage indicator and select either: • **Save log** – Immediately saves the file onto the CONTROL PC. If the percentage shows less than 100%, the log is first collected. See Collect log below. • **Collect log** – Starts a dedicated log collection mode that disables all other CONTROL activity.	
4 If you select *Save* log, a dialog box prompts for a filename and folder to store the log in.	
5 If you select *Collect* log, the log is retrieved and saved in dedicated mode. The CONTROL panel turns grey and all other functions are disabled. When the log collection is finished, all other CONTROL functions are accessible again.	
6 Select *Restart* to clear out all collected log data and restart log data collection.	

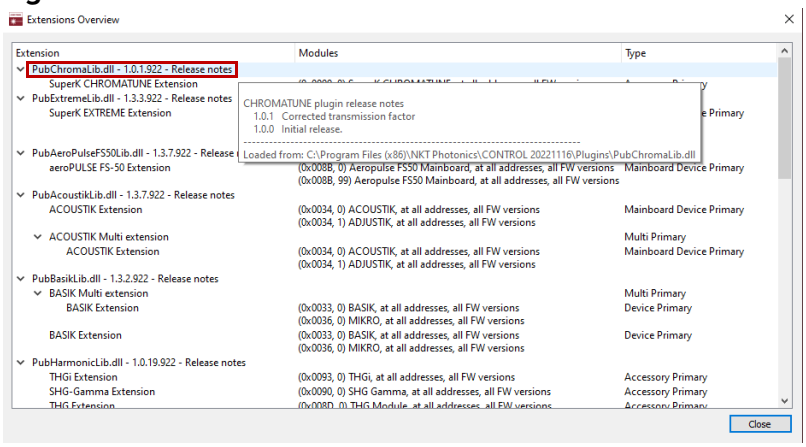
Extensions overview

This tool is used to view the installed extensions (plugins) that are included with CONTROL. The extensions are found in the following folder:

C:\Program Files (x86)\NKT Photonics\NKT Photonics CONTROL\Plugins

To view the extensions, click the *Tools* menu and then click on *Extensions Overview*. The *Extensions Overview* window is launched as shown in Figure 72.

Figure 72 Extensions Overview



NOTE: To show a short description of the release notes as seen in Figure 72, hover the mouse pointer over the “Release notes” text.

The PubChromaLib.dll details highlighted in Figure 72 shows the version of the .dll file (1.1.2.303), the included extensions (SuperK CHROMATUNE Extension) and which module types they support.

NOTE: Multiple extensions for a wide range of NKT Photonics lasers types are typically installed when using the default installation of CONTROL.

Application Log panel

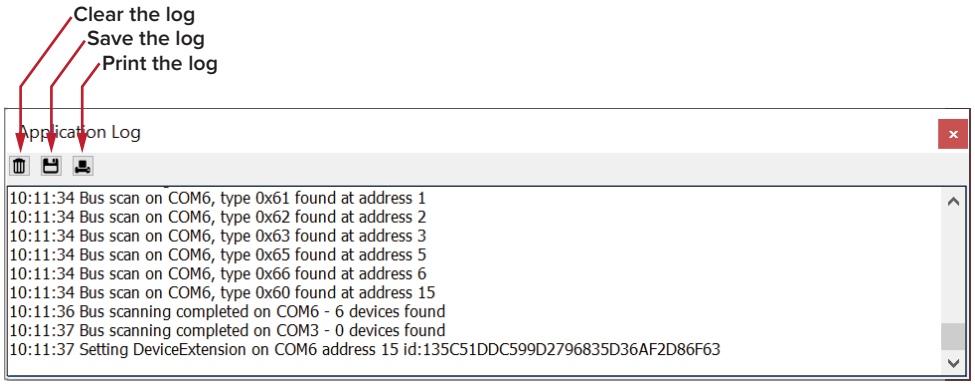
The *Application Log* panel displays and logs the communication of status messages. You can use the log to debug connection issues between CONTROL and NKT Photonics devices.

The panel displays and timestamps the following types of log messages:

- Port Scans
- Discovered Devices
- Closed Communication Ports

The panel includes three buttons in the upper left corner. You can use the buttons to clear, save or print the log. Click on the cross in the upper right corner of the Application Log window to close the Application Log.

Figure 73 Application Log window



Device Monitor

The device monitor provides a live display of transmit and receive parameters of the laser's communication ports and any connected device modules.

The display parameter values are continuously updated and can be used to help debug issues with connected devices. The parameters are described in Table 20.

Table 20 Device Monitor parameters

Parameter	Description
Interface	The PC port interface the device(s) is connected to. Click the "greater than" symbol to the left of the port to display the connected device(s) parameters.
TxTlgsSec	The number of telegrams per second being transmitted to the connected device.
RxTlgsSec	The number of telegrams received per second from the connected device.
Addr	The address of the connected module.
Type	The type of the connected module; read from the module.
SysType	The system type, default 0 – can be used to describe system variants and is read from the module.
Name	The name of the connected device module.
Mode	The mode or status of the connected module: *connected*, *disconnected*, or *disabled*.
Status bits	The actual status bits read from the connected module.
Error code	The actual error code read from the connected module.
Access	Protected/Locked status of the module.
FW Version	The device module's firmware release date.
Module Serial	The serial number of the device module.
PCB Serial	The device module's printed circuit board serial number.
PCB Ver,	The version of the device module's printed circuit board.

Parameter	Description
Sp. Cap.	The module speed capability in bits per second as read from the module – values: 0=(default) 115200, 1=230400, 2=460800, 3=921600
Pri Ext	Primary extension/GUI loaded for this module. Hover over the icon to list more details – Note that there can only be 1 primary.
Sec Ext	Secondary extension/GUI loaded for this module.
Fast log	0%-100% collected. Note only if the module has a fast log and only internal modules have fast and slow logs.
Slow log	0%-100% collected. Note only if the module has a slow log.
Main log	0%-100% collected. Note only if the module has a main log. Only main boards have main and system logs.
Text log	0%-100% collected. Note only if the module has a system log. Only main boards have main and system logs.
Timeout	Time in milliseconds since the last telegram was received from the device module.
Nack	Total number of negative acknowledgments received from the device module.
CRC	Total number of received telegrams with CRC failures.
COM	Total number of communication errors with framing or protocol errors. Hover over the icon to list more details.
Busy	Total number of busy responses from the module. Busy responses occur when a module receives a message but cannot process it due to its current work load.

A Specifications

Table 21 Interfaces

PC and micro processor interfaces	RS-232 serial COM - 9 Pin D-Sub Female Connector USB 2.0 - Type B Female Connector
External Pulse Control	External Feedback: BNC 0 to 4.1 V analog input – power stabilization Booster ON/OFF: BNC 0 to 5V TTL/CMOS input – on/off control
Pulse Synchronization	NIM Pulse: BNC – NIM synchronization pulse (Seed and post-VRR) Pulse Monitor – 0 to 0.9 V synchronization pulse (Seed and post-VRR) Gate Output: BNC +5 V saw or square wave input – pulse picking (post-VRR only)
External Bus	RS-485 Bus - 15pin D-Sub Female Connector
Door Interlock	2 pin Connector - LEMO Part Number FGG.0B.302

Table 22 Mechanical dimensions

Size (H x W x D)	443 x 252.3 x 376.8 mm (17.44 x 9.93 x 14.83 in)
Weight	27 kg / 28 kg with VRR option (59.5 lb / 61.7 lb)
Operating Temperature	18°C to 30°C (64°F to 86°F)
Operating Humidity (non-condensing)	20 to 80%
Storage Temperature	-10°C to 55°C (14°F to 140°F)
Maximum Operating Altitude	2000 m
Output Cable Length	1.5 m (59 in)

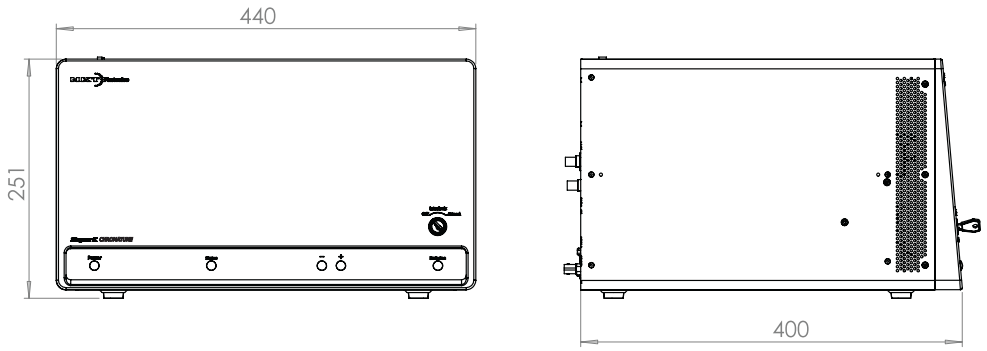
Table 23 Electrical

AC Power	Input 100-240 VAC 50-60 Hz
Maximum Power Consumption	< 175 W
Fuse	T4A, 250V 5 × 20 mm cartridge fuse

CE Mark – Declaration of Conformance for EMI, Safety and ROHS (EEC)

UKCA Mark – Declaration of Conformance for EMI and Safety (UK)

Figure 74 Mechanical dimensions



B Service and Support

Servicing the laser

The SuperK CHROMATUNE series lasers have no user serviceable components. In case of malfunction, contact NKT Photonics using the support channels in section “Support contact details”.

Return shipping

Damage may occur to the laser during shipping. To minimize the chance of shipping damage, package the laser in its original NKT Photonics shipping material - see “Shipping the laser” on page 118.

Factory safety tests

End of line safety tests according to EN61010-1 Annex F are performed on all Laser chassis.

WARRANTY VOID IF REMOVED label

The unit is sealed with a label “WARRANTY VOID IF REMOVED”. NKT Photonics strongly advise against removing the chassis cover, as doing so invalidates the warranty.

Figure 75 WARRANTY VOID LABEL

Support contact details

If you need help or have questions regarding your SuperK CHROMATUNE laser or its accessories, contact NKT Photonics through our support website below:

Support website

1. Go to:

   https://www.https://www.nktphotonics.com/support/

2. Scroll down and click or press:

3. Select the type of help required, fill in the form, and click or press *Submit*.

NOTE: To ship the laser see “Shipping the laser” on page 118.

Shipping the laser

To ship the laser, prepare and pack the laser according Procedure 23 and ship it to the address below.

Shipping address

NKT Photonics A/S
Blokken 84
DK-3460 Birkerød
Denmark

Shipping information

Please include the following contact details:

- Name
- Address
- Contact information (e-mail address, phone number etc.)
- RMA number

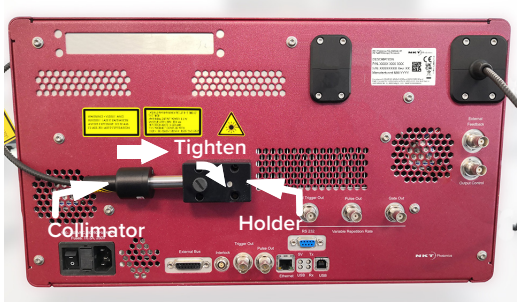
Packing the laser for return

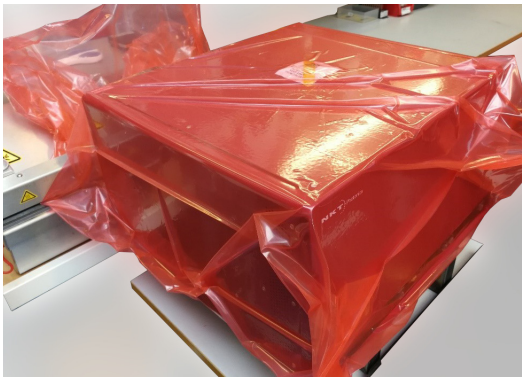
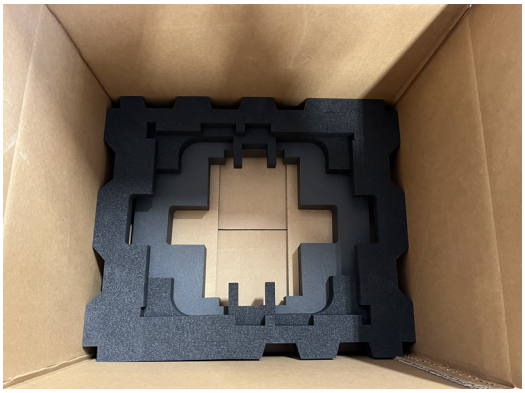
When shipping the laser, always use the original packaging that you received the laser in. If you no longer have the original packaging with foam inserts, you can request new packaging from us at a cost.

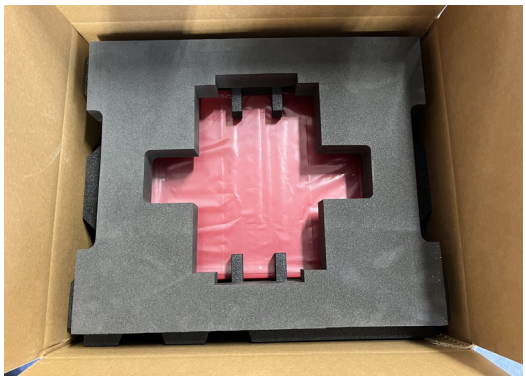
CAUTION: The SuperK CHROMATUNE laser is heavy. Its weight is approximately 28 kg, observe and follow all regional safety regulations and techniques when lifting and carrying the laser.

Procedure 23 Packing the laser

	Action
1	Cool the laser by turning it off and disconnecting it at least one hour before you pack it.
2	Place the output collimator in its holder on the rear panel of the laser. Ensure to secure it in place by tightening the lock screw.



	Action
3	Tape the loose output fiber to the top panel of the laser.
4	Place the laser in an ESD bag. Slip the bag carefully over the laser from one side as shown. 
5	Seal the bag to prevent moisture from entering. **OPTIONAL**: if you have a vacuum sealing machine, seal it as shown. **OPTIONAL**: You can include a bag of silica pellets inside the bag for further moisture removal. 
6	Place the carton on a half pallet with the top flaps open. **WOODEN CRATE**: Should your original packing consist of a carton within a wooden crate, skip the following steps and continue packing using Procedure 24. 
7	Place the bottom layer of foam into the carton orientated as shown. 

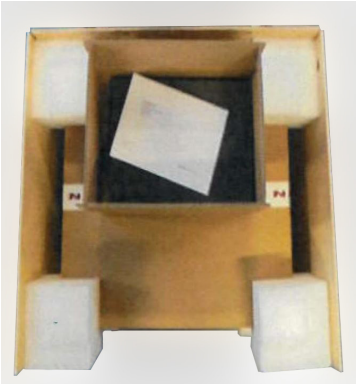
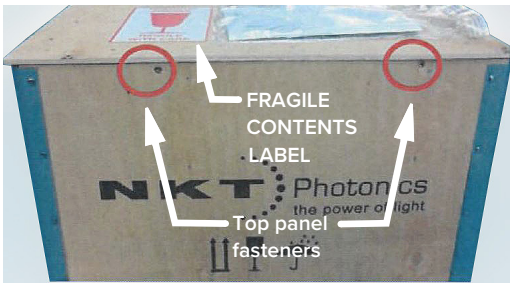
	Action	
8	Place the laser wrapped in the ESD bag onto the bottom foam layer in the carton. **NOTE:** Align the rear panel of the laser with the foam cutout shown in step 7.	
9	Place the top layer of foam onto the laser as shown.	
10	You may be specifically requested to return certain accessories with the laser. Insert the requested accessories into the accessory box; then place the box in the foam cutout as shown. Never return accessories to NKT Photonics unless they are requested. **NOTE:** If you are shipping the laser to operate elsewhere be sure to pack all accessories with the laser.	
11	Using packing tape, seal the top flaps of the carton.	

	Action
12	Strap the carton securely to the pallet.

		Action
13	*a.*	Before shipping, ensure there are FRAGILE CONTENTS labels placed on the carton.

Procedure 24 Legacy wooden crate packaging

	Action
1	Place the original white protective “techno” foam onto the side panels of the laser **CAUTION**: Ensure the output fiber is not pinched between the laser and the foam.
2	Carefully place the laser in the original shipping carton as shown. **NOTE**: Check again to make sure the output fiber is clear of the foam and carton sides.

	Action	
3	Place the laser's shipping carton and accessory boxes into the crate with support foam inserts at each corner as shown. Accessory boxes - optional Only pack and return accessories requested by NKT Photonics personnel. Never return accessories to NKT Photonics unless they are requested. **NOTE**: If you are shipping the laser to operate elsewhere, be sure to pack all accessories with the laser.	
4	Ensure to seal any accessory boxes with tape. **NOTE**: Check to make sure the laser's carton and accessory boxes are held firmly in place to prevent them from shifting during transport.	
5	*a.* Fasten the lid on the crate by tightening the screws along the outside edge of the crate. *b.* Before shipping, ensure there is a FRAGILE CONTENTS label placed on top of the crate.	

Disposal

Within EU territory

NKT Photonics follows the European directive on Waste of Electrical and Electronic Equipment or WEEE. The WEEE symbol affixed to the front of the laser and as shown within this document means that upon retirement of the equipment it must not be mixed with general waste.

For proper treatment, recovery, and recycling, please contact our support team to arrange returning the laser to us. The laser will be accepted and disposed of according to WEEE regulation.

Outside EU territories

The WEEE symbol is only valid within the European Union. To discard this product please contact your local authorities or dealer and ask for the correct method of disposal.

C External Bus Pinout

Table 24 External bus pinout

Pin	Name	Description
1	NC	Not connected
2	RS485-	Negative (inverted) RS485 data signal
3	Interlock loop+	Positive connection of the safety interlock loop. Connect pin 3 to pin 4 *Interlock loop-* to enable laser emission.
4	Interlock loop-	Negative connection of the safety interlock loop. Connect pin 4 to pin 3 *Interlock loop+* to enable laser emission.
5	GND	0 volt / ground
6	GND	0 volt / ground
7	+12 V	+ 12 volt supply voltage for external accessories
8	+12 V	+ 12 volt supply voltage for external accessories
9	Emission	Logic output – set **high** (5V) when laser **emission** is **enabled**. To indicate laser emission using an external LED, connect the anode of an LED to this pin. Connect the LED's cathode to GND (pin no. 5,6, 13 or 14). **Note:** The pin features a 240 Ω internal series resistor to support connecting an LED.
10	RS485+	Positive (non-inverted) RS485 data signal
11	Not in use	For future use. Do not connect this pin.
12	Interlock	This pin outputs a logic **high** (5V) when the interlock circuit is closed and has been reset. This signal indicates the interlock is enabled and can be optionally used to control safety related precautions on the External bus.
13	GND	0 volt / ground
14	GND	0 volt / ground
15	+12 V	+ 12 volt supply voltage for external accessories.

D Control Software Installation

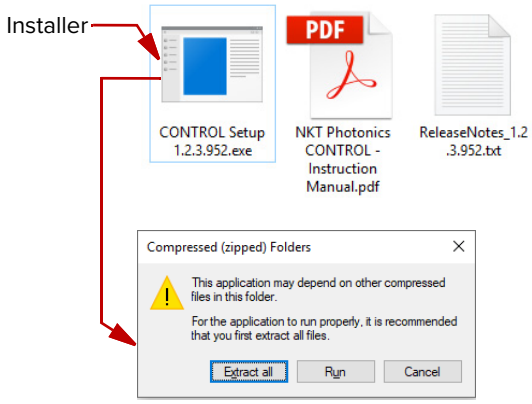
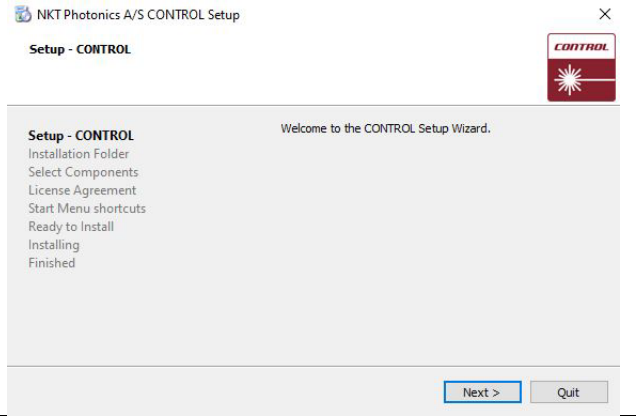
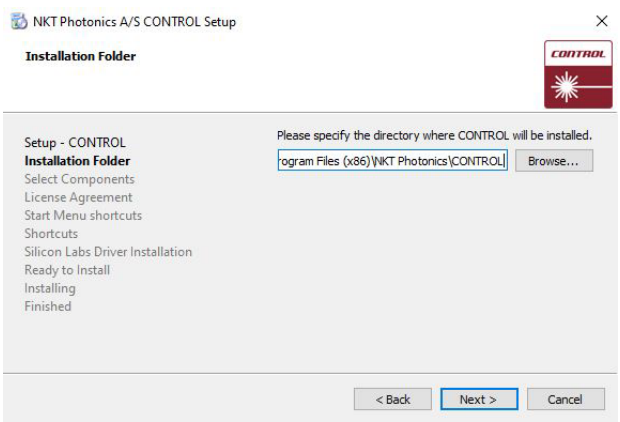
Installing CONTROL

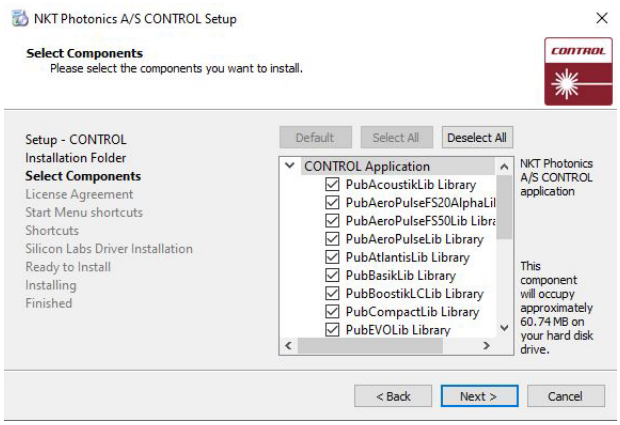
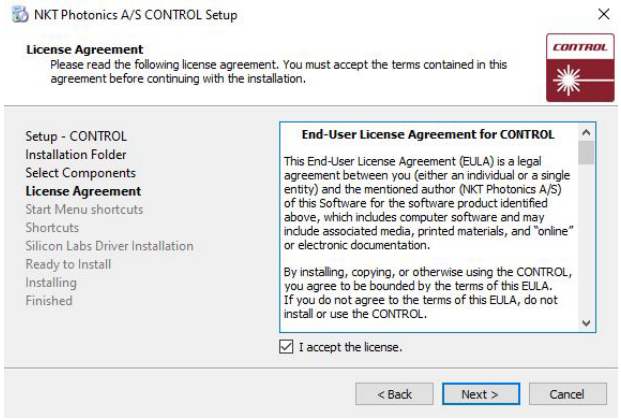
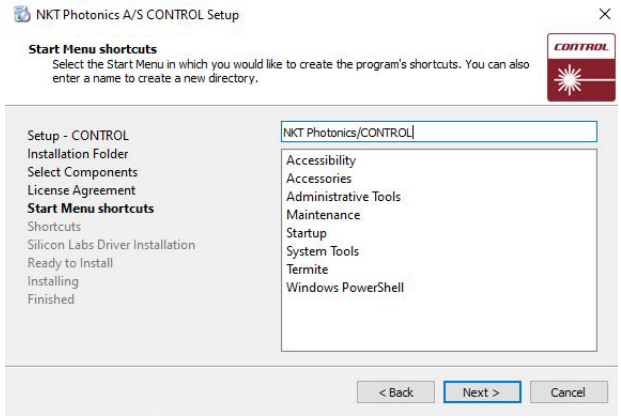
Download the software from:

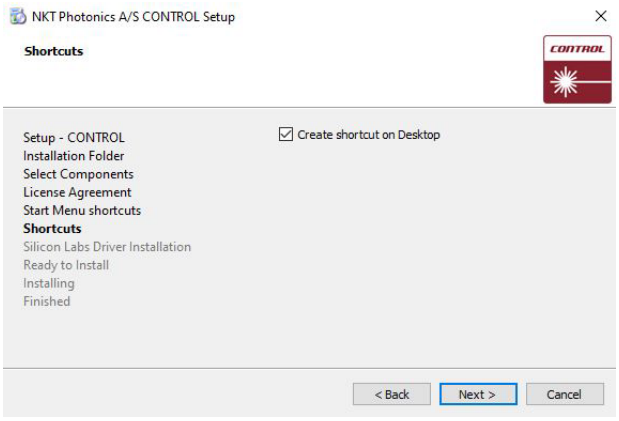
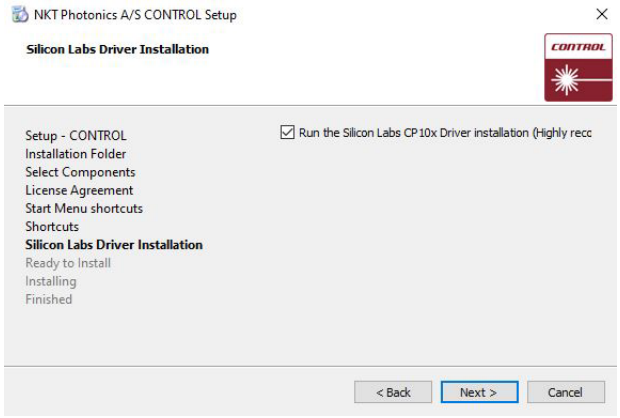
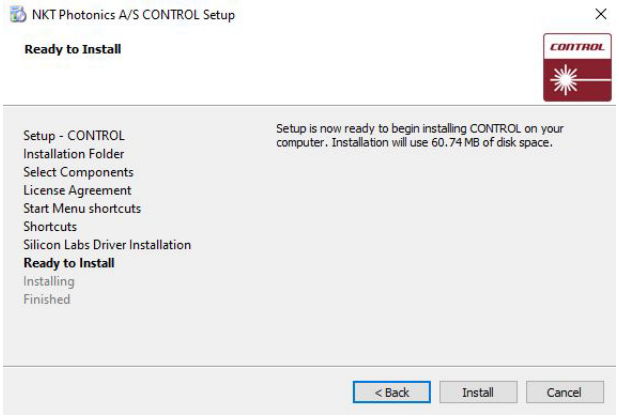
https://www.nktphotonics.com/lasers-fibers/support/software-drivers/

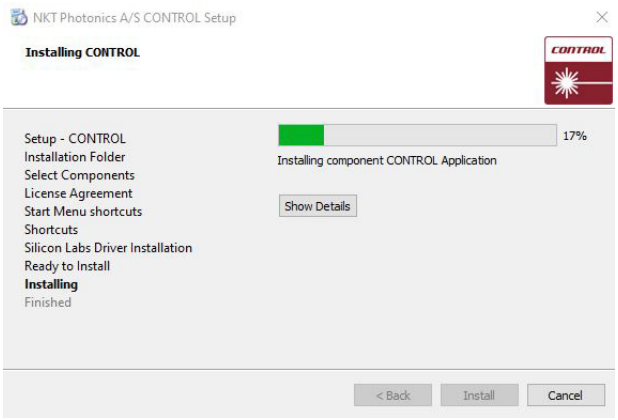
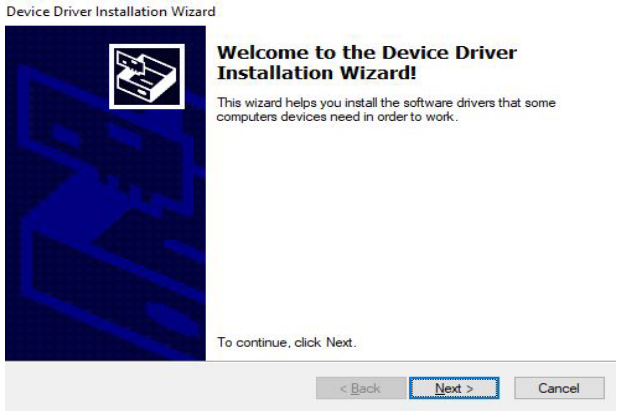
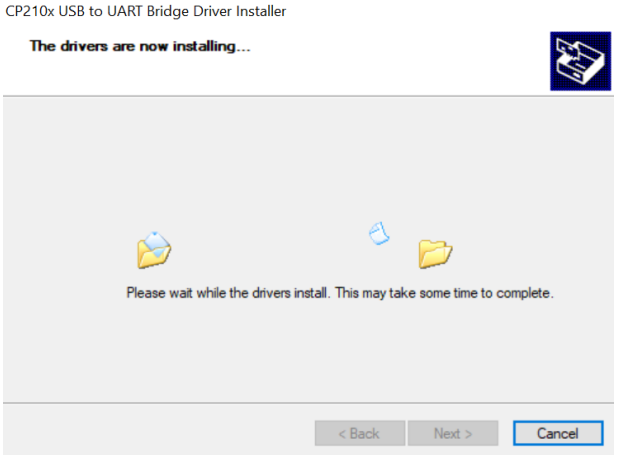
Follow the steps in Procedure 25.

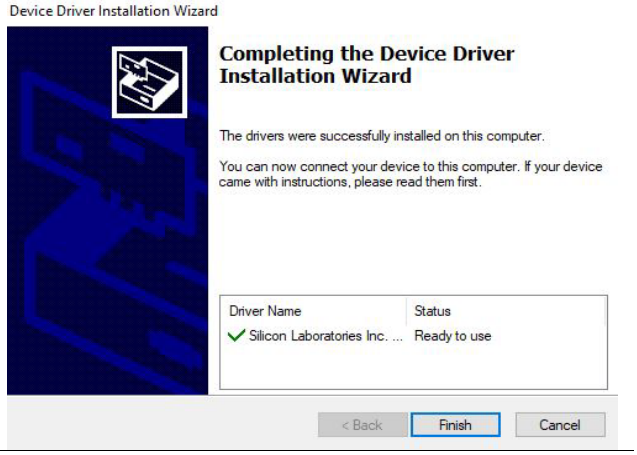
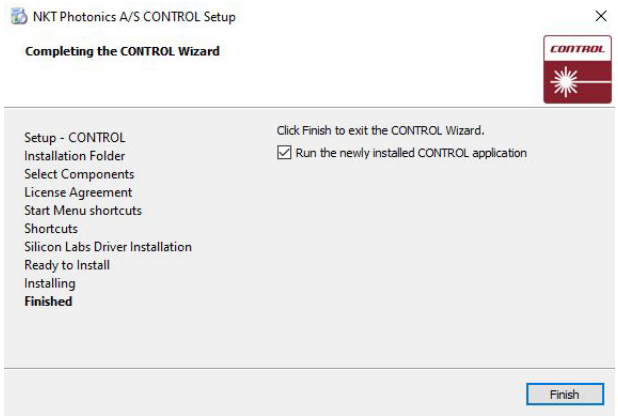
Procedure 25 Installing CONTROL

	Action	
	On the PC, launch the installer package and then double click the installer icon.	
3	The installation wizard appears. Click Next to continue.	
4	Accept to use the default installation directory or select another directory by clicking the *Browse* button. Click *Next* to continue.	

	Action	
5	Uncheck the components you do not require. By default, all components are installed. Click *Next* to continue.	
6	Read the End-User License Agreement, and check “I accept the license.” box. Not checking the box ends the installation wizard. Click *Next* to continue.	
7	The wizard creates a start menu folder with program short-cuts. Use the default name or enter a new name for the folder. Click *Next* to continue.	

	Action	
8	Check the box to create a desktop shortcut to access Control. Click *Next* to continue	
9	Check the 'Run the Silicon Labs CP10x driver installation' box and click *Next*. **NOTE:** If you do not have the driver installed USB connectivity will fail.	
10	Click *Install* to install NKT Photonics CONTROL software on your PC. Click *Cancel* if you want to abort the installation.	

	Action	
11	**The wizard displays a progress meter for the installation.** **Note: a normal install should only take a few seconds.**	
12	**Click *Next* to install the UART drivers for the PC USB port.**	
13	**The drivers are installed.** **NOTE:** Depending on your computer this occurs so fast you may not see this.	

	Action	
14	The Silicon Labs drivers is installed successfully. Click *Finish* to end the driver installation.	
15	CONTROL is now installed. Check the Run box to launch CONTROL when the *Finish* button is clicked. Click *Finish* to end the installation wizard.	

E Troubleshooting and Errors

Troubleshooting

Table 25 Laser troubleshooting

Symptom	Possible cause(s)	Action
Laser Disabled	Interlock signals shorted to ground.	1. Disconnect the power to the laser. Locate and remove the interlock circuit short to ground. 2. Turn ON the SuperK CHROMATUNE system and reset the interlock with the key switch.
No Communication with CONTROL	1. No Power 2. COM port setting incorrect 3. Defective USB Cable	1. Check the AC Mains and the AC power cable. 2. Check that the PC has assigned a COM port to the laser. 3. Check the USB cable condition or swap it with a known working cable.
No emission	1. Key Switch is *Off* 2. Interlock Circuit is open 3. The laser experiences a failure due to an alarm condition. 4. External Feedback mode is configured with no input signal.	1. Turn the Key to the *Armed* position 2. Correct the circuit open and reset the key switch. The circuit open could be one of the following: • External Bus Defeater loose or not connected • External Bus Accessory cable loose or defective • Door switch defective or an open in its connecting cable to the LEMO plug. • LEMO plug loose or defective 3. Check the laser alarms and refer to Table 26 on page 132.

Error codes - CONTROL

Table 26 lists the alarms and their appropriate responses.

Table 26 Errors codes - CONTROL

Error code	Recovery action
2	Check if the interlock has been activated, otherwise turn the key switch to the on position to enable the laser.
5	Check the communication links between the PC and CONTROL software. Enable the laser by clicking the *Emission* button OFF/ON. **If the problem persists** – disable watchdog mode.
7, 12	Ensure the ambient temperature in the environment surrounding the laser is within the specified range. See Appendix Specifications. Also ensure the cooling requirements such as air or water flow are met depending on the chassis. See “Mechanical Installation” on page 37..
17-23	Laser calibrating - informational only; to clear the error, enable emission.
48	*1.* Move the beam delivery collimator head against a power meter. *2.* Set to 0% power. (Slider set all the way to the left.) *3.* Enable the laser by clicking the *Emission* button on. *4.* Slowly increase power to 100%. **If the alarm clears:** Before returning the laser to normal operation, check the installation for back reflections to the laser (e.g. from a lens mounted in front of the collimator) – see “Back reflection” on page 42.**.** **If the alarm persists:** – or – **If the laser emission is disabled**: Contact NKT Photonics. See Appendix B.
3, 49, 50, 55	*1.* Set to 0% power. (Slider set all the way to the left.) *2.* Enable the laser by clicking the *Emission* button ON. *3.* Slowly increase power to 100%. **If the problem is not resolved** contact NKT Photonics. See Appendix B.
Other codes:	Contact NKT Photonics. See Appendix B.

Errors - front display panel

Table 27 Error codes - front panel

Module address	Error number	Error message
2	2	Interlock open
2	3	Contact NKT Photonics support
2	4	Contact NKT Photonics support
2	7	Temperature out of range
2	8	Contact NKT Photonics support
2	12	Contact NKT Photonics support
2	17	Laser needs to calibrate. Enable emission.
2	18	Laser needs to calibrate. Enable emission.
2	19	Laser needs to calibrate. Enable emission.
2	20	Laser needs to calibrate. Enable emission.
2	21	Laser needs to calibrate. Enable emission.
2	22	Laser needs to calibrate. Enable emission.
2	23	Laser needs to calibrate. Enable emission.
2	25	Laser needs to calibrate. Enable emission.
2	26	Enable emission. If error persists, contact NKT Photonics.
2	27	Enable emission. If error persists, contact NKT Photonics.
2	28	Contact NKT Photonics support
3	2	Interlock open
3	3	Contact NKT Photonics support
3	4	Contact NKT Photonics support
3	5	Temperature out of range
3	7	Temperature out of range
3	8	Contact NKT Photonics support
3	12	Enable emission. If error persists, contact NKT Photonics.
3	32	Enable emission. If error persists, contact NKT Photonics.
4	40	Enable emission. If error persists, contact NKT Photonics.
5	2	Interlock open
5	3	Contact NKT Photonics support
5	7	Temperature out of range
5	8	Contact NKT Photonics support
5	11	Enable emission. If error persists, contact NKT Photonics.
5	12	Enable emission. If error persists, contact NKT Photonics.
5	48	Reflection detected. Enable emission.
5	49	Enable emission. If error persists, contact NKT Photonics.
5	50	Enable emission. If error persists, contact NKT Photonics.

Module address	Error number	Error message
5	51	Enable emission. If error persists, contact NKT Photonics.
5	52	Enable emission. If error persists, contact NKT Photonics.
5	53	Enable emission. If error persists, contact NKT Photonics.
5	55	Enable emission. If error persists, contact NKT Photonics.
5	56	Enable emission. If error persists, contact NKT Photonics.
5	57	Enable emission. If error persists, contact NKT Photonics.
5	60	Enable emission. If error persists, contact NKT Photonics.
5	61	Enable emission. If error persists, contact NKT Photonics.
5	62	Enable emission. If error persists, contact NKT Photonics.
5	63	Enable emission. If error persists, contact NKT Photonics.
5	64	Enable emission. If error persists, contact NKT Photonics.
5	65	Enable emission. If error persists, contact NKT Photonics.
5	66	Enable emission. If error persists, contact NKT Photonics.
5	67	Enable emission. If error persists, contact NKT Photonics.
5	68	Contact NKT Photonics support
5	69	Contact NKT Photonics support
7	80	Contact NKT Photonics support
7	81	Contact NKT Photonics support
7	82	Contact NKT Photonics support
7	83	Contact NKT Photonics support
7	84	Contact NKT Photonics support
7	85	Contact NKT Photonics support
15	2	Interlock open
15	3	Contact NKT Photonics support
15	4	Contact NKT Photonics support
15	5	Watchdog timeout
15	6	Emission LED failure. Contact NKT Photonics support.
15	7	Temperature out of range
15	128	Contact NKT Photonics Support

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