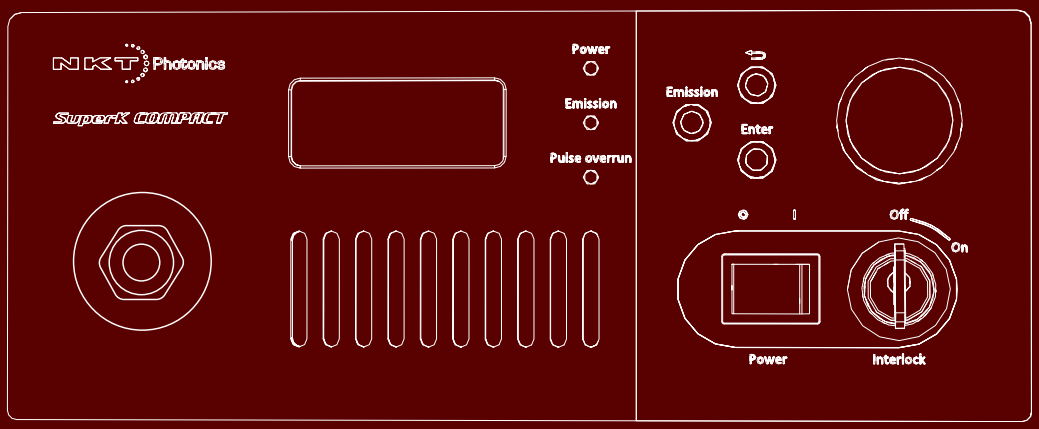
800-629-01

SuperK
COMPACT

Product Guide

Revision 1.5 02-2025



NKT Photonics

A HAMAMATSU COMPANY

PRODUCT GUIDE

This guide includes information for the following NKT Photonics products:

SuperK COMPACT

White Light Laser

CAUTION: Do not open the laser module. The laser is equipped with warranty labels (see Figure 60) on the covers of the module. The warranty is void if the system is opened.

Manufactured by:

NKT Photonics A/S
Bregnerødvej 144, Birkerød-3460 Denmark

Author: W-10456

Guide overview

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

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

SuperK COMPACT Safety, Handling and Regulatory Information

NOTE: 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/

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.

Chapters Inside

This guide includes the following chapters:

- Chapter I "Laser Description" — Describes the SuperK COMPACT laser series including its general operational principles, management and interfaces.
- Chapter 2 "Front Panel Controls" — Describes the laser's front panel menu and controls that directly operate the laser.
- Chapter 3 "Connecting and Turning ON the Laser" — Provides information and procedures on how to connect to the laser's management software and use it to turn laser emission ON and OFF.
- Chapter 4 "CONTROL Interface" — Includes descriptions and procedures of all other CONTROL menu and panel items.
- Chapter 5 "Mechanical Installation" — This chapter provides information on how to install the laser including installation surface, environment and cooling requirements.
- Chapter 6 "Connecting the Laser" — This chapter provides the information on how to physically connect the safety interlock, power, the optical collimator, and the synchronization interfaces.
- Appendices — The guide includes multiple appendices including laser specifications, support contact details, pinout information, fiber maintenance, laser accessory descriptions and how to install the CONTROL management platform.

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 that may be caused when using the laser.

Revision

This section records the document revision details.

Release date	Release version and changes
2021-June	1.0 first release - Using an older manual version as a source, completely updated the format, layout and added new information obtained.
2022-March	Revision 1.1 – updated the following • Updated language throughout to improve clarity. • Changed the figure arrows and other figure highlights throughout. • Procedure "Installing CONTROL" on page 101 changed to show Windows 10 screenshots.
2022-April	Revision 1.2 – updated the following • Updated text and figures in section "Connecting the safety interlock" on page 71
2022-August	Revision 1.3 – updated the following: • Microsecond units shown in Figure 3 on page 21 were incorrect and are now updated to nanoseconds.
2023-October	Revision 1.4 – Update the document style.
2025-February	Revision 1.5 – Included note on burst mode in three locations.

Contents

Tables

Figures

Procedures

1 Laser Description

A SuperK COMPACT laser is a white light lasers (WLL) system that can generate a pulsed supercontinuum as a class 3B laser source.

Using a seed laser, light frequencies from 450 to 2400 nanometers (typical) are emitted in a single spatially coherent beam with a pulse rate that is customizable according to application requirements. To synchronize external equipment with the laser pulse repetition rate, the laser is equipped with both analog and logic ports that output synchronization signals at the laser pulse rate. Further, the output laser pulse can be triggered using either internal software settings or an external signal connected to one of its trigger input ports.

Figure 1 SuperK COMPACT general view

Terminology

The SuperK COMPACT series includes the models listed in the “Guide overview” on page 3. This guide uses the term, “laser” to refer to all SuperK COMPACT laser variants. When information related to any specific variant is noted, the model name is specified. The guide may also refer to NKT Photonics as simply NKTP, the two are one and the same.

Accessories A series of accessories are optionally used with the laser to modify the output beam. For specific application requirements, accessories can deliver or filter the laser's beam to obtain a desired narrow band, wide band, or extended spectrum. An overview of the accessories is described in Appendix E.

CONTROL The laser and its accessories are managed and configured using the NKTP CONTROL application from an external PC. The PC can connect to the laser over either RS-232 or USB serial links. To configure accessories using the same PC, the laser is equipped with an external bus interface which can connect up to eight accessories in a daisy chain configuration. Connecting and managing the laser with CONTROL is described in "Connecting and Turning ON the Laser" on page 43.

Temperature regulation The temperature of the laser is regulated by the use of cooling fans. To dissipate the laser's heat, the fans draw cool air into the laser through the front panel vent grills. The heated air is then blown out through the rear exhaust vent. The fan speed is automatically adjusted to maintain a stable laser temperature. To maintain adequate air flow, ensure to install the laser with proper clearance as described in "Mechanical Installation" on page 69.

Safety

WARNING: SuperK COMPACTs are rated as Class 3B lasers and are therefore hazardous. Before turning on the laser, ensure to read and understand all safety statements of the NKT Photonics document:

SuperK COMPACT Safety, Handling and Regulatory Information

A paper copy of this document is included with your laser. If you do not have access it, you can download a copy from:

https://www.nktphotonics.com/lasers-fibers/support/product-manuals/

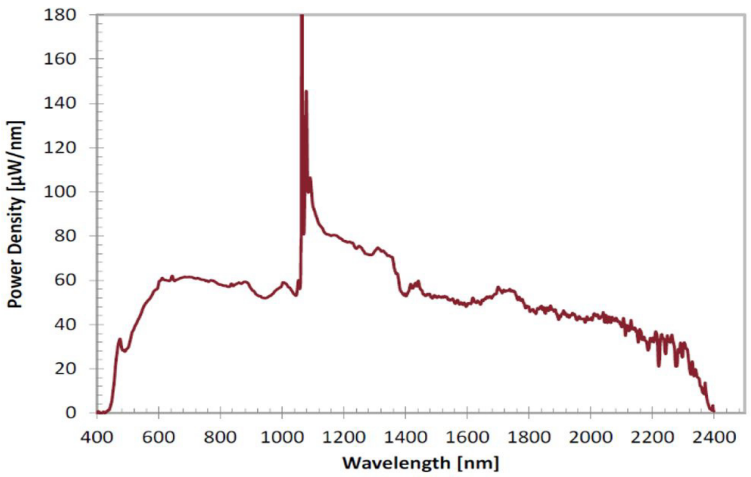
Optical output

Supercontinuum The term supercontinuum does not cover a specific phenomenon, but rather numerous non-linear effects leading to a considerable spectral broadening of the seed pulses. As spectral broadening is caused by non-linear effects, it increases with the input pulse power. Accordingly, the width of the spectral output increases with the output power.

Spectral output The Figure 2 shows the output spectrum (limited to 2400nm by the measurement equipment) of a SuperK COMPACT. The spectral power density is distributed such that it is approximately >20% in the visible spectrum and <80% in the IR spectrum.

NOTE: Performance may vary between individual lasers, always refer to the factory test report for your SuperK COMPACT for specific information on its output performance.

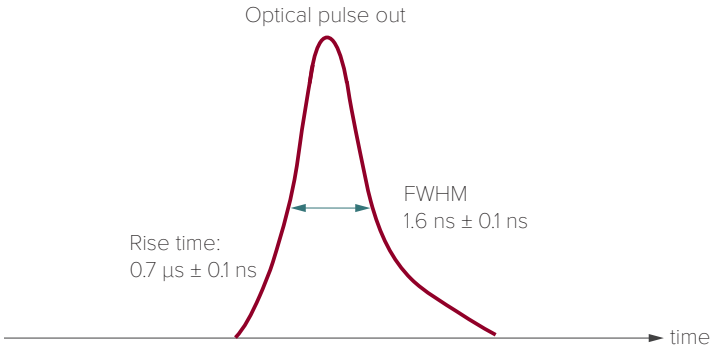
Figure 2 Supercontinuum output of the laser



Output pulse

The output pulse of a SuperK COMPACT is a dispersed pulse made up of the supercontinuum with a pulse length of less than 2 ns. The pulse shape is independent of the laser repetition rate and the spectral distribution of the output spectrum does not change upon a change in repetition rate but remains constant at any set rate. An approximation of the pulse is depicted in Figure 3 below.

Figure 3 Approximation of the SuperK COMPACT output pulse



Output fiber

The output fiber is a non-linear crystal fiber with a 0.20 numerical aperture[1] The fiber is terminated with either an FC/PC connector, an FC/APC connector, or a collimator unit. Note that the fiber is sheathed in an armored jacket.

FC Connector

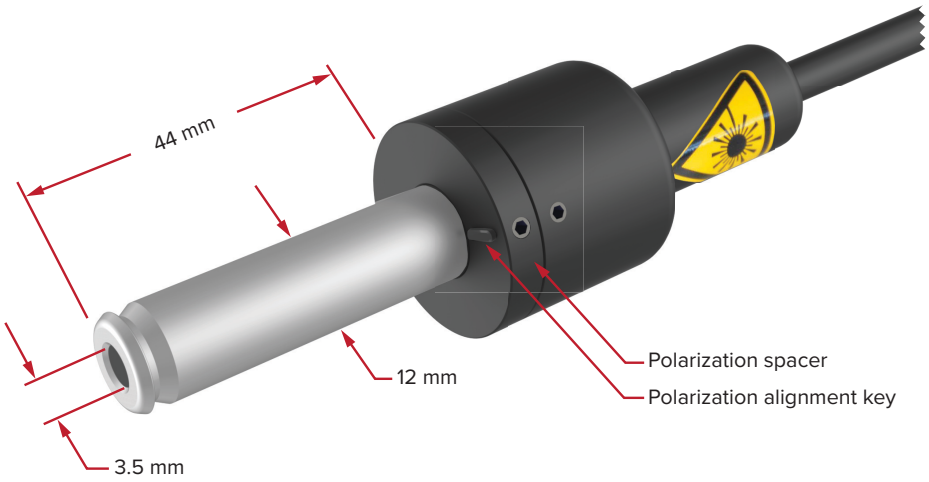
The optical output of both the S024-010-000 and S024-010-010 lasers are equipped with either an FC/PC or FC/APC connector at the end of a standard plastic-sheathed optical fiber cord. Either connector provide a convenient means of terminating the fiber and allow the use of standard receptacles or holders to launch the light through free space into other optical components or equipment.

NOTE: A black fiber boot indicates an FC/PC connector and a green fiber boot indicates an FC/APC connector.

Collimator

The optical output of the S024-010-020 laser is equipped with a collimator at the end of an armored cable (see Figure 4). A collimated beam exits the collimator from a tube within a steel barrel that can be inserted into a receptacle of a target optical device such as for example, a SuperK accessory or an optical power meter – see “Collimator installation” on page 75.

Figure 4 SuperK COMPACT collimator



CAUTION: Avoid scratching the collimator as it may prevent it fitting properly into an optical input receptacle.

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

Collimator beam properties

Within the collimator, an achromatic lens collimates the output beam to maximize and subsequent coupling. However, using a single lens prevents the simultaneous maximum coupling efficiency across all wavelengths of the beam. The laser and collimator are designed so that the coupling is optimized for maximum average coupling across the visible spectrum. This results in the beam being slightly wider for infrared wavelengths when compared to the

1. @ 1060 nm

visible wavelengths. Note that in Appendix G, beam measurement examples are included for reference.

Factory test report

The laser's actual spectral performance is described in a factory created test and measurement report included with your laser.

Polarization spacer

A polarization spacer (see Figure 4) must be fitted with the collimator when it is inserted into the optical input of a SuperK accessory. The spacer has an alignment key to correctly orient beam polarization with the accessory. The spacer also ensures that the optical input interlock switch of the accessory is correctly engaged when the collimator is in the locked position. When the switch is engaged the interlock circuit is closed; an open interlock circuit disables emission.

CAUTION: Inserting a collimator without a spacer into an accessory optical input, results in a gap between collar face of the collimator and the interlock switch of the accessory. When the switch is not engaged, emission is disabled.

Output power

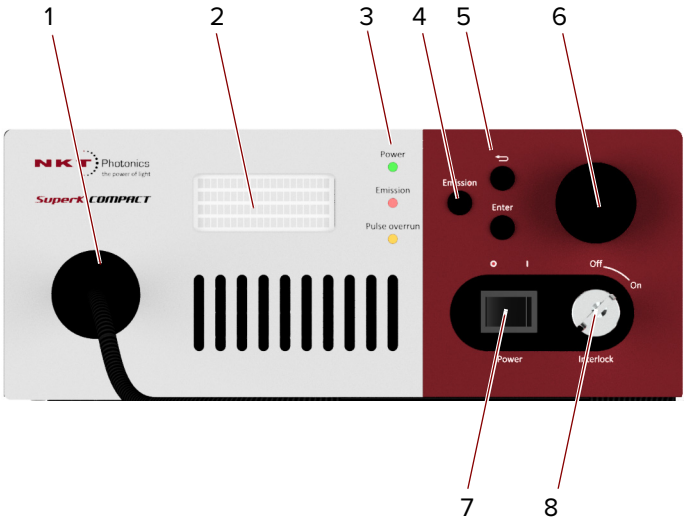
Output power from the laser is controlled by changing the pulse repetition rate. Increasing the repetition rate increases the output power level. For example, if the repetition rate is changed from 1 kHz to 20 kHz, the output power increases by a factor of 20, as twenty times the number of pulses are emitted within the same time span.

NOTE: The actual output power or spectral form of the output pulse remains constant but by changing the repetition rate, the average power of the beam is modified.

Front panel controls

The front panel features are highlighted in Figure 5. The panel includes user controls and a display to operate the laser.

Figure 5 Front panel features



1	Optical output fiber (laser aperture)	5	Navigation buttons
2	LCD display menu	6	Selection dial
3	Status LEDs	7	ON/OFF switch
4	Emission button	8	Key Switch

Optical output fiber

Laser output – This is a standard (FC connector) or armored fiber cord (collimator)– see “Optical output” on page 20 for further details.

LCD display menu

The LCD display menu provides an interactive menu to operate the laser in conjunction with the operation dial and return/enter buttons. The menu items shown on the display included laser status, configuration and operation.

Status LEDs

Power LED
When lit ON Green, this LED indicates AC mains power is connected and the laser is switched on.

Emission LED
When lit ON Red, this LED indicates laser emission is enabled.

Emission button

Button used to enable or disable laser emission.

Navigation buttons

Return button
This button confirms and enters settings made with the operation dial.

Enter button
When pressed, this button either enters a selected menu sub-level or confirms a setting or function within the menu system.

Selection dial The dial is used with both the display and return button to configure, operate and view the laser status.

ON/OFF switch Turns power ON or OFF.

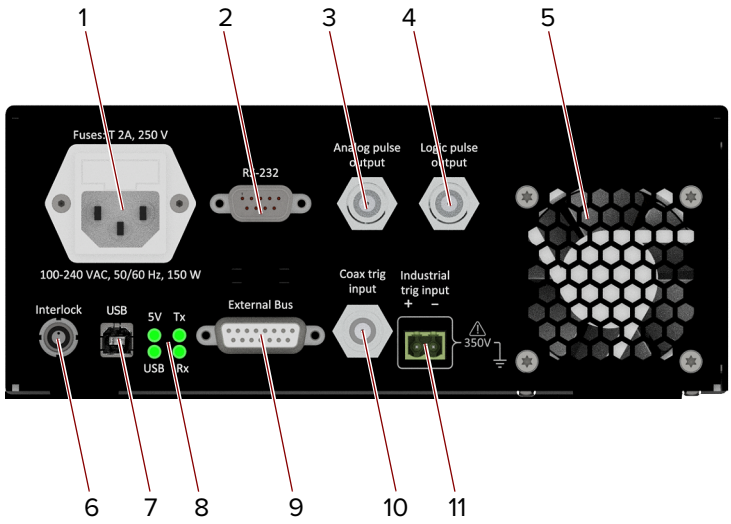
Key switch Key access control of laser emission, when set to OFF, emission is not permitted. The switch also resets the interlock alarm when cycled from ON to OFF and back to ON, see “Connecting the safety interlock” on page 71.

NOTE: Remove and secure the key to help prevent unauthorized access.

Rear panel interfaces

The rear panel includes electrical ports, status LEDs, and the laser’s exhaust vent. The panel and its components are depicted in Figure 6.

Figure 6 Rear panel features and connectors



1 AC input – *IEC C14*
2 RS-232 serial port – *9 pin female D-sub*
3 Analog pulse output – *BNC*
4 Logic pulse output – *BNC*
5 Exhaust vent – *cooling fan*
6 Interlock connector – *LEMO 2-pin*[ii]
7 USB serial port – *type B USB*
8 USB port Status LEDs
9 External bus – *15 pin female D-sub*
10 Coax trig input – *BNC*
11 Industrial trig input – *2 pin 5.08 mm*[i]

i. 5.8 mm pitch pluggable terminal block
ii. See Connecting the safety interlock on page 71

AC input Connects to AC mains (100 to 240 VAC @ 50-60 Hz) with the included power cord or a suitable and approved power cord for your region. Power consumption for the laser is as follows:

- Typical power consumption (emission ON) – 20 to 30 W
- Maximum power consumption (emission ON) – 50 W
- Maximum power consumption (with an accessory) – 100 W

RS-232 serial port The RS-232 management port follows the TIA/EIA-232-F standard. To connect a management PC or other control device, set its Serial COM port to the parameters in Table 1.

Table 1 RS-232 serial COM port settings

Setting	Value
Baud rate	115.2 kbps
Data bits	8
Parity	None
Stop bit	1
Flow control	None
TX & RX text	Append LF
RX text	Mono-spaced

Analog pulse output You can synchronize an external device to the laser's optical pulse from this BNC port. The signal from the port represents the optical pulses from the laser. An external device connected to the port, can detect when a pulse is emitted with minimum timing jitter.

Logic pulse output You can trigger an external device or count optical pulses from this port. The logic signal from the port is a digital version of the *Analog output* pulse signal. The signal is created from the analog signal and transmits a positive logic signal when an optical pulse is emitted.

USB connector Connect a PC to this port in order to manage the laser using NKT Photonics CONTROL software.

NOTE: To connect to the port, the PC must have NKTP USB port drivers installed. You can find the driver installation software at:

https://www.nktphotonics.com/support

Status LEDs Status LEDs are described in "Status LEDs" on page 28.

External bus This 15 pin port connects power, communications and the interlock circuit to any external accessories used with the laser. When no accessories are used with the laser, connect the *interlock defeater* plug onto this port – see “External bus” on page 76.

COAX trig input You can trigger emission of output pulses from the laser using this BNC coaxial input. The input accepts logic level trigger signals terminated with a 50 Ω impedance. See “Trigger input ports” on page 78 for further information.

Industrial trig input Similar to the COAX trig input port, you can trigger emission of output pulses from the laser using this two pin connector input. This port has a higher impedance and wider voltage range and is electrically isolated from the laser. However, the actual trigger thresholds set pulse emission ON and OFF are fixed within the input voltage range. See “Trigger input ports” on page 78 for further information.

Configuration and operation overview

The laser is operated by using either NKTP’s CONTROL application on an external PC or your own custom application, using NKTP’s Software Development Kit (SDK), connected to the laser over one of the laser’s rear panel serial interfaces shown in Figure 6. To help prevent accidental exposure to emission, a key switch and door interlock circuit provides overriding control of the laser.

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

NOTE: You can manage multiple laser from the same PC using CONTROL. The application automatically detects connected NKTP lasers and their accessories.

NOTE: Once connected, you can use CONTROL to manage the laser’s emission and power settings. Additionally, CONTROL can be used to upload firmware or download the laser’s log file.

NOTE: The Chapter “Connecting and Turning ON the Laser” on page 43 provides the details and procedures on how to connect CONTROL to the laser.

Advanced laser control As mentioned previously, you can control the laser from a custom platform connected to either the USB or serial port. To build your own custom control application, NKTP provides an SDK Kit which can be downloaded from:

https://www.nktphotonics.com/support

Key switch and interlock safety To enhance safety, the laser is equipped with an interlock interface and a keyed switch. The two components work together to safely control laser emission. Both an interlock safety switch (door closed position - switch not supplied) and the laser key switch must be in the ON position to permit laser emission using management commands.

The interlock interface is connected to a switch which is activated by an access door in the enclosure surrounding the laser emission area. If the door unexpectedly opens, the door switch circuit also opens and laser emission is immediately shut down. “Connecting the safety interlock” on page 71 describes the details on how to connect the interlock.

Interlock Safety Reset
When a door switch is properly connected and the enclosure door opens and closes, the laser is shut down by the interlock. Despite the door being closed again, the laser cannot be started until the key lock is first cycled to the OFF position and back to the ON position. Only after the key is cycled, the interlock is reset and emission is permitted.

Laser accessory management

The “External bus” port connects optional SuperK accessories. The port provides a communications interface, 12V DC power and interlock signal to optional smart accessories. When multiple smart accessories are utilized with the laser, the bus supports daisy chain connectivity. Smart accessories connected to the External bus are recognized and managed by the CONTROL PC connected to the laser. Since this bus connection includes the interlock signal, the bus defeater must always be on the last open External Bus output port to loop back the interlock signal. For information on connecting the bus, see " Connecting accessories with the external bus".

Status LEDs

Rear panel LEDs

The rear panel houses four status LEDs shown in Figure 7 and described in Table 2.

Figure 7 SuperK COMPACT rear panel status LEDs

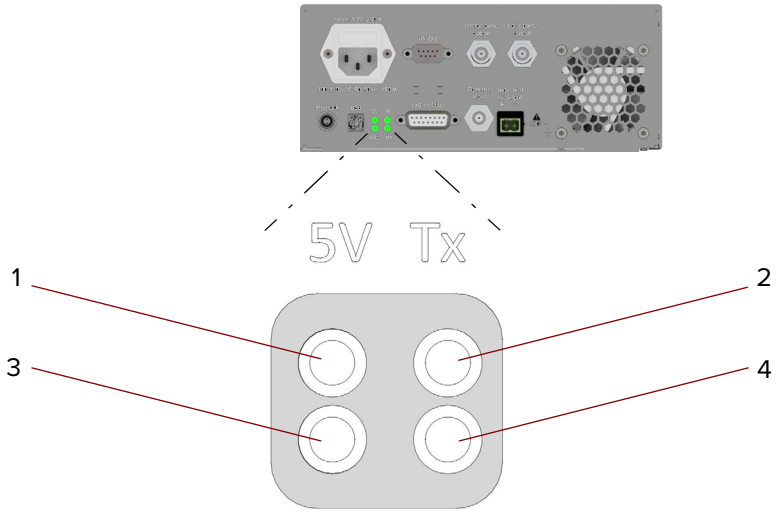


Table 2 Status LEDs

	LED	Condition	Description
1	5V	ON Green	Correct +5 VDC is supplied to the main controller board.
		ON Red	The DC supply voltage to the main controller is too low/ high.
		OFF	No power is connected.
2	Tx	Flashing Green	The SuperK COMPACT is transmitting serial data to a connected PC.
		OFF	No transmitted data detected
3	USB	ON Green	USB serial port is connected and the driver is installed and configured correctly.
		ON Amber	USB serial port is connected but the driver is incorrectly configured or not installed.
		OFF	No USB serial connection detected
4	Rx	Flashing Amber	The SuperK COMPACT is receiving serial data from a connected PC.
		OFF	No received data detected

Front panel LEDs

The three LEDs on the front panel are described in Table 3.

Table 3 Front panel LEDs

	LED	Condition	Description
1	Power	ON Green	AC power is connected and the laser is switched ON.
		OFF	The laser is OFF or AC power is disconnected.
2	Emission	ON Red	Laser emission is enabled.
		OFF	Laser emission is disabled.
3	Pulse overrun	Amber ON	Unable to support the current pulse width for the configured frequency.
		OFF	Pulse width and frequency operating within nominal conditions.

Chassis labels

The SuperK COMPACT 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 4 with their rear panel locations shown in Figure 8.

Table 4 Chassis labels

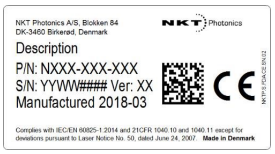
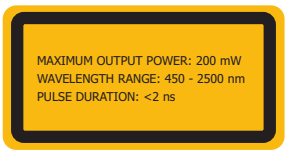
Label	Panel	Description	
Classification	Side	Safety information stating the laser emission hazards and the laser's class rating.	
Manufacturing	Side	Manufacturing information including address, part and serial number, date manufactured and regulatory compliance.	
Laser Radiation Warning	Side & Collimator	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.B	
Product Information	Side	Safety information alert indicating the location of the aperture where laser radiation is emitted from, safety compliance information, and key emission specifications.	

Figure 8 SuperK COMPACT side panel labels

2 Front Panel Controls

Overview

The front panel features an LCD operations menu and controls to configure, monitor and operate the laser. The menu items available are listed in Table 5.

Table 5 Front panel LCD menu items

	Menu Item	Function	See
	Top menu level	Displays the trigger mode, laser pulse frequency and any faults.	Top menu level on page 32
Sub-menu levels	Operating mode	Sets the trigger mode of the laser. This determines when pulses are emitted.	Operating mode on page 34
	Frequency	Configures the output optical pulse frequency, also known as the lasers repetition rate or rep.rate.	Frequency on page 36
	Power %	Adjusts the laser's output power by percentage.	Power % on page 36
	Burst pulses	Sets the number of pulses the laser emits upon a trigger event.	Burst pulses on page 37
	Coax trig level	Sets the voltage level that when detected on the Coax trig input port, triggers pulse emission.	Coax trig level on page 38
	Watchdog timer	Timer that when set, disables emission when CONTROL communications is lost.	Watchdog timer on page 38
	Display Backlight	Sets the LCD menu display brightness.	Display backlight on page 39
	Serial Number	Sub-menu to display the serial numbers of the laser modules and accessories.	Serial Number on page 39
	Firmware versions	Sub-menu to display the firmware revisions of the laser modules and accessories.	Firmware version sub-menu on page 40

General operation

Accessing

If the panel is off – press the Enter button.

Menu selection and parameter adjustment

Turn the Selection dial any direction to scroll through the available sub-menus or adjust a selected parameter. Press the Enter button to select and access the sub-menu system and the parameter setting for each sub-menu level.

Exiting menus

Press the Return button to exit a sub-menu level and return to the menu above it.

Menu items

Top menu level

The top menu level (Figure 9) displays the following:

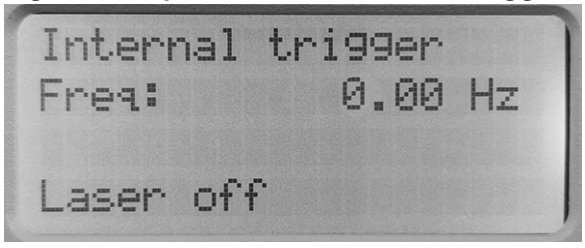
- Trigger mode (Operating mode)
- Pulse Frequency
- Number of burst pulses (count)

At the bottom of the top menu level screen, the laser's status is displayed. Status messages include the:

- Emission state
- Alarms
- Notifications

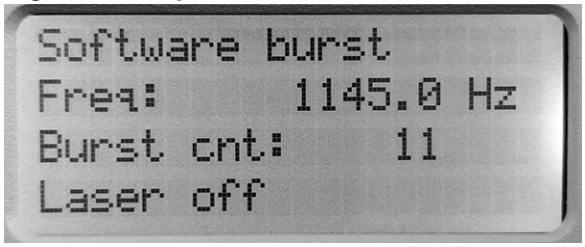
Access the top menu
To access the top menu, press the return button once or twice until the display exits the sub-menus.

Figure 9 Top level menu – Internal trigger mode



Top level menu - *Operating mode setting*
In the top level menu, the currently set *operating mode* is shown at the top. The mode can be any of the operation modes configurable using the Operating mode sub-menu. Figure 10 shows an example of the top level menu with the laser set to the *Software burst* operating mode.

Figure 10 Top level menu - Software burst mode

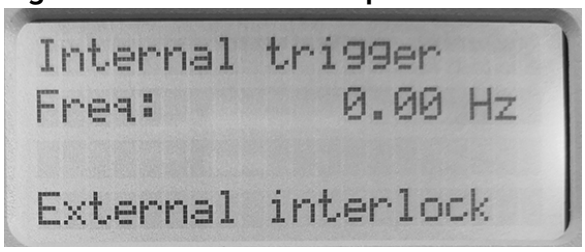


NOTE: You can also use CONTROL to set the operating mode. In CONTROL the modes are configured as *Trigger modes* - see "Trigger mode" on page 59

Top level menu - *Interlock notification*
If the interlock circuit (See “Key switch and interlock safety” on page 27) is open or shorted to ground, the LCD menu displays one of the following alarms:

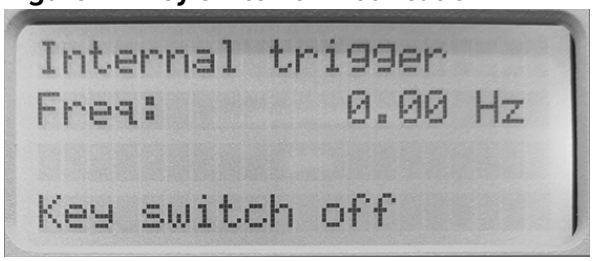
- *External interlock* (Figure 11) – the external bus interlock circuit is open or shorted.
- *Door interlock* – the door interlock circuit is open or shorted.

Figure 11 Interlock circuit open notification



Top level menu - *Key switch notification*
If the laser key switch is set in the OFF position, a notification that the key switch is OFF is displayed as shown in Figure 12.

Figure 12 Key switch off notification



NOTE: When the key switch is in the OFF position, laser emission cannot be started. Emission is disabled if the switch is turned from ON to OFF.

Top level menu
This menu notification (Figure 13) appears when the laser is restarted or the interlock circuit has been closed again after a previous open or shorted state has been repaired. The display shows:

Reset interlock:

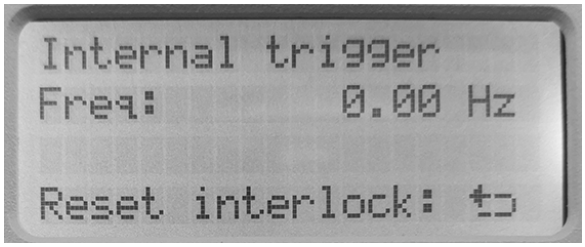
To reset the interlock to permit laser emission, press either the

- front panel *Return* button

– or –

- the *Interlock – RESET* button in the status panel of CONTROL – see Figure 28 on page 52.

Figure 13 Reset interlock request



Operating mode

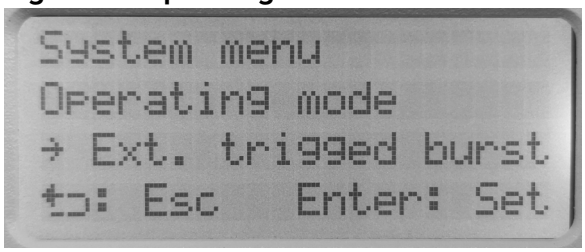
The operating mode determines when and how often the light source emits an optical pulse and is also referred to as the trigger mode.

To set the operating mode:

1. Press the enter button to enter the laser's sub-menus.
2. Turn the selection dial until the menu displays, System menu - *Operating Mode*
3. Press the enter button to enter the *Operating Mode* selection menu.
4. Use the selection dial to choose an operating mode
5. Press the return button twice to return to the top level menu.

The operating modes available are described in the following.

Figure 14 Operating mode sub-menu



Internal trigger
The laser emits continuous pulses at the set repetition rate. The rear panel trigger inputs are not used. The repetition rate is set using the Frequency sub-menu.

External trigger
One pulse is emitted each time the leading edge (low to high transition) of a trigger signal is detected at one of the external trigger input ports. The rising edge of the trigger signal must reach the detection threshold level for the port.

Software burst
A burst of pulses at the set repetition rate is emitted each time the laser receives a telegram to initiate the burst. To send telegrams to the laser over it's RS-232 serial or USB interface, you must implement the NKT Photonics Software Development Kit (SDK). The SDK can be downloaded from:

https://www.nktphotonics.com/support

NOTE: The telegram to initiate the burst is sent to register 0x34 (Burst pulses). Burst number (Burst pulses) and repetition rate (Frequency) can be set with either the front panel sub-menus or with registers 0x34 and 0x33 respectively.

NOTE: Software burst mode is not supported using CONTROL

Ext. trigged burst:
A burst of pulses at the set repetition rate is emitted each time the leading edge (low to high transition) of a trigger signal is detected on one of the external trigger input ports. The rising edge of the trigger signal must reach the detection threshold level for the port. The number of pulses in the burst is set using Burst pulses sub-menu and the repetition rate is set using the Frequency sub-menu.

When the light source senses a positive edge at one of the trig inputs, the light source emits a specified number of pulses (Burst count) at the specified repetition rate.

External gate on
When a logic high level signal is detected at one of the trigger input ports, pulses are continuously emitted at the set repetition rate. When the signal at both trigger inputs is at a logic low level, no pulses are emitted. An output pulse truth table of trigger inputs for External gate on and External gate off modes is shown in Table 6.

NOTE: Typically, an additional pulse is emitted after the external signal drops to a logic low level. The repetition rate is set using the Frequency sub-menu.

NOTE: When using the CONTROL interface, the *External gate on* mode is set using the “Gated trigger mode” described on page 61. Refer also to Figure 37 showing the input trigger signal levels and their effect on the optical output set in this mode.

External gate off:
When a logic low level signal is detected at both of the trigger input ports, pulses are continuously emitted at the set repetition rate. When the signal at one of the trigger inputs changes to a high logic level, no pulses are emitted. An output pulse truth table of trigger inputs for External gate on and External gate off modes is shown in Table 6.

NOTE: Typically, an additional pulse is emitted after the external signal rises to a logic high level. The repetition rate is set using the Frequency sub-menu.

NOTE: When using the CONTROL interface, the *External gate off* mode is set using the “Gated trigger inverted mode” described on page 63. Refer also to Figure 38 showing the input trigger signal levels and their effect on the optical output in this mode.

WARNING: Although some operating modes can stop pulses from being generated, the laser must still be regarded as having emission on. Stopping pulses by using the input trigger signals in a certain combination, is considered an unsafe method to disable emission.

Table 6 External gate modes – pulse emission truth table

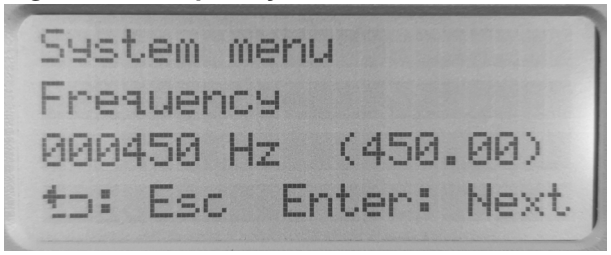
Operating mode	COAX trig input	Industrial trig input	Output pulses
	Low	Low	Disabled
	High	Low	Continuous pulses
	Low	High	Continuous pulses
External gate ON	High	High	Continuous pulses
	Low	Low	Continuous pulses
	High	Low	Disabled
	Low	High	Disabled
External gate OFF	High	High	Disabled

Frequency

To set the laser pulse frequency (repetition rate):

1. Press the enter button to enter the laser's sub-menus.
2. Turn the selection dial until the menu displays *System menu - F.requency*
3. Press the enter button to enter the *Frequency* setting menu.
4. One position of the *frequency* digits flashes. This indicates the selection dial can modify the frequency digit.
5. Turn the selection dial to set the digit(s).
6. Press enter to select another digit position and repeat steps 4 and 5 to modify any remaining digits of the frequency
7. Press the return button twice to return to the top level menu.

Figure 15 Frequency sub-menu



WARNING: When increasing the frequency, the output power increases proportionately.

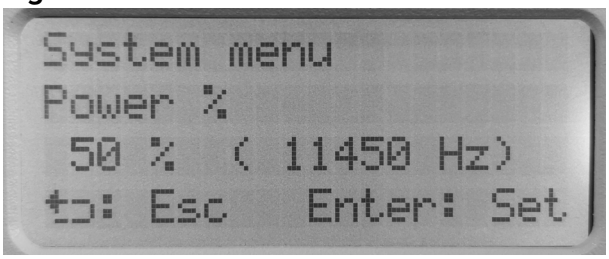
Power %

To set the output emission power level in percent:

1. Press the enter button to enter the laser's sub-menus.
2. Turn the selection dial until the menu displays *System menu - Power %*
3. Press the enter button to enter the *Power %* setting menu.
4. Turn the selection dial to set the power level.
5. Press the return button twice to return to the top level menu.

NOTE: The laser's frequency is directly proportional to its output power and hence automatically adjusts as the power level setting is changed.

Figure 16 Power sub-menu



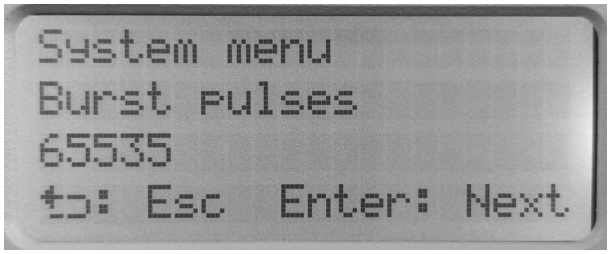
Burst pulses To set the number of burst pulses emitted when a trigger signal detects a leading edge:

1. Press the enter button to enter the laser's sub-menus.
2. Turn the selection dial until the menu displays *System menu - Burst pulses*
3. Press the enter button to enter the *Burst pulses* setting menu.
4. One position of the *number of pulses in a burst* digits flashes. This indicates the selection dial can modify them.
5. Turn the selection dial to set the digit(s).
6. Press enter to select another digit position and repeat step 4 and 5 to modify any remaining digits of the number of pulses in the burst.
7. Press the return button twice to return to the top level menu.

NOTE: The exact number of pulses emitted in the burst mode might deviate from the nominal value. Burst to burst variation could also be expected. The deviation will vary in size depending on repetition rate, trigger frequency and number of pulses per burst. To optimize the performance, it is recommended to avoid pulse overrun by lowering the number of pulses, trigger frequency and repetition rate. If a more stable/accurate burst mode performance is desired within a limited set of operating parameters, please contact our sales for a customized laser optimized for your specific needs. Please note that this may impact standard specifi-

cations such as maximum repetition rate, visible power and total power.

Figure 17 Burst pulses sub-menul

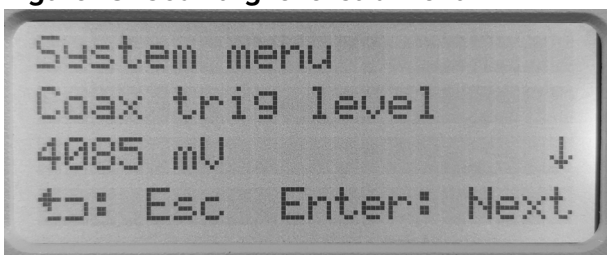


Coax trig level

To set the voltage level at the Coax trig input that triggers emission of a pulse or burst:

1. Press the enter button to enter the laser's sub-menus.
2. Turn the selection dial until the menu displays *System menu - Coax trig level*
3. Press the enter button to enter the *Coax trig level* setting menu.
4. One position of the *trigger detection voltage level* digits flashes. This indicates the selection dial can modify them.
5. Turn the selection dial to set the digit(s).
6. Press enter to select another digit position and repeat step 4 and 5 to modify any remaining digits of the voltage level.
7. Press the return button twice to return to the top level menu.

Figure 18 Coax trig level sub-menu



Watchdog timer

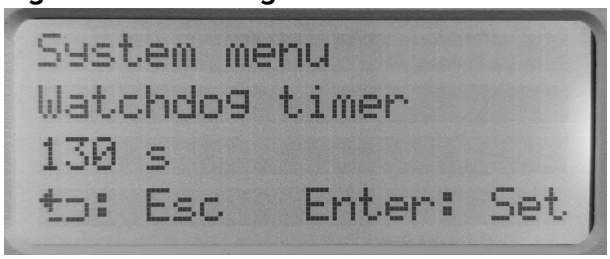
The watchdog timer disables emission when it expires. The counter starts to count down when the laser is disconnected from CONTROL. To set the watchdog timer:

1. Press the enter button to enter the laser's sub-menus.
2. Turn the selection dial until the menu displays *System menu - Watchdog timer.*
3. Press the enter button to enter the *Watchdog timer* setting menu.

4. Turn the selection dial to set the digits from OFF, 1-255 seconds.

5. Press the return button twice to return to the top level menu.

Figure 19 Watchdog timer sub-menu



Display backlight

The brightness of the display backlight can be adjusted in percent, to set it:

1. Press the enter button to enter the laser's sub-menus.

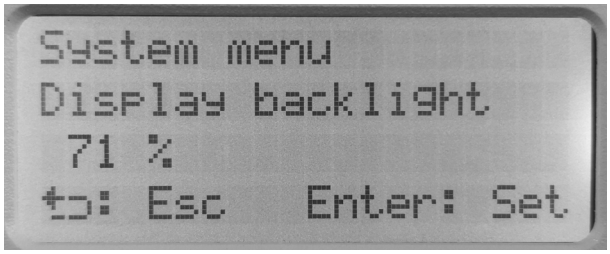
2. Turn the selection dial until the menu displays *System menu - Display backlight*.

3. Press the enter button to enter the *Display backlight* setting menu.

4. Turn the selection dial to set brightness percentage.

5. Press the return button twice to return to the top level menu.

Figure 20 Display backlight sub-menu



Serial Number

Select this sub-menu to view the laser serial numbers. The serial numbers of the laser and its connected accessories are displayed.

To display the serial numbers:

1. Press the enter button to enter the laser's sub-menus.

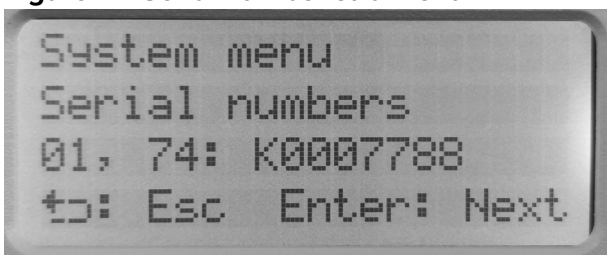
2. Turn the selection dial until the menu displays *System menu - Display backlight*.

3. Press the enter button to enter the *Display backlight* setting menu.

4. Press the enter button to scroll through the serial numbers of the laser and its connected accessories.

5. Press the return button twice to return to the top level menu.

Figure 21 Serial number sub-menu



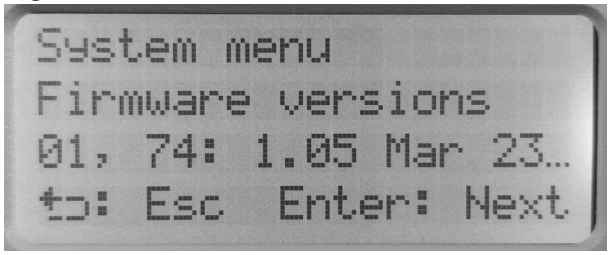
Firmware versions

Select this sub-menu to view the laser firmware revisions. The firmware revisions of the laser and its connected accessories are displayed.

To display the firmware revisions:

1. Press the enter button to enter the laser's sub-menus.
2. Turn the selection dial until the menu displays *System menu - Firmware versions.*
3. Press the enter button to enter the *Firmware versions* setting menu.
4. Press the enter button to scroll through the firmware versions of the laser and its connected accessories.
5. Press the return button twice to return to the top level menu.

Figure 22 Firmware version sub-menu



Emission button

Press the Emission button to turn laser emission ON and OFF. The Emission LED on the front panel is lit Red when emission is enabled.

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

WARNING: Turning on the laser emits laser Class 3B emission. Ensure to observe and implement all safety regulations, warnings and cautions in this guide and the *SuperK COMPACT 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 COMPACT is designed to 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.

Further, ensure the laser is securely installed and connected according to the procedures in “Mechanical Installation” on page 69 and “Connecting the Laser” on page 71. This means the laser should be installed in the recommended environment with power applied and at the very minimum, the door switch interlock connected.

3 Connecting and Turning ON the Laser

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

- How to obtain and install the CONTROL software
- Connect a PC using USB connectivity
- Turning the laser emission ON and OFF

CONTROL software

The laser is shipped with the CONTROL software installer on a USB key. You can also download the most recent CONTROL software from the following link:

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

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 must be installed on a PC running Microsoft Windows 7, 8, or 10.

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 is available in Appendix F .

Connecting the laser to a CONTROL PC

You can connect a PC with CONTROL software using either a convenient USB serial connection. USB connectivity provides a simple connection option within the maximum USB cable length of less than 3m.

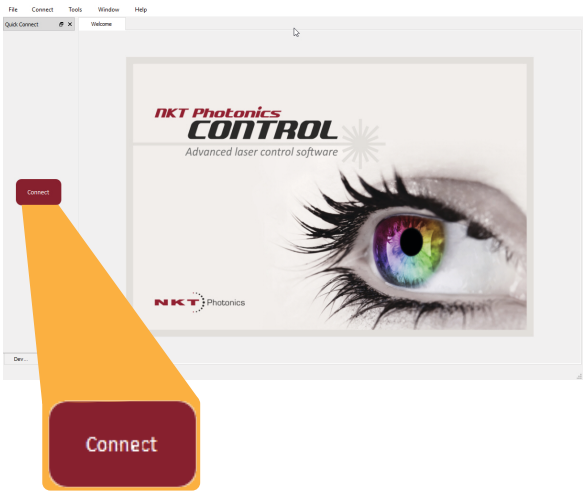
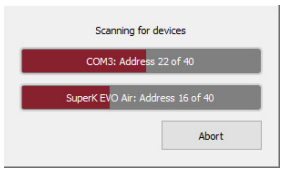
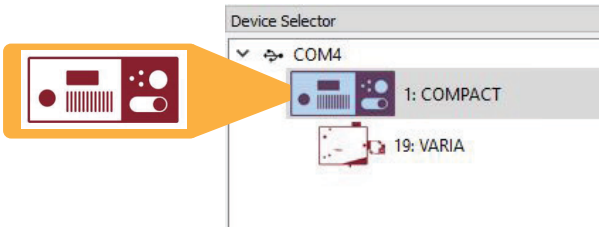
After the PC is connected, use CONTROL's *Connect* button feature to find the laser or its connected accessories.

NOTE: It is also possible to connect a CONTROL PC to the RS-232 serial connection of the laser.

USB connection

Connect a PC directly to the laser using either the supplied USB cable or any USB Type A-B cable 3 meters or less in length and follow the instructions in Procedure 11

Procedure 1 Connecting a PC to the laser using a USB cable

	Action
1	Using a USB Type A-B cable, connect an available USB Type A port of the CONTROL PC to the laser's USB Type B port. [i]
2	Connect power to the Laser – see Connecting power on page 73.
3	If necessary, wait for the Windows device manager to install the USB drivers for the connection.
4	Launch the CONTROL software by either: • clicking on Windows – Start – Programs – NKT Photonics –CONTROL – or – • double clicking the CONTROL shortcut on the desktop 
5	The CONTROL window opens. Click on the *Connect* button in the upper left region of the window. 
6	CONTROL automatically scans for any connect lasers and accessories available on both COM and configured Ethernet ports. **NOTE**: SuperK COMPACT lasers only support serial connections. 
7	To manage the laser, click on the SuperK COMPACT laser icon from the *Device Selector* list. 

i. You can also connect a PC serial port to the RS232 port on the laser using a standard RS232 serial cable.

Controlling laser emission

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

SuperK COMPACT Safety, Handling and Regulatory Information

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

Preparation The laser 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 69 and “Connecting the Laser” on page 71. 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 the procedures in “Connecting and Turning ON the Laser” on page 43.

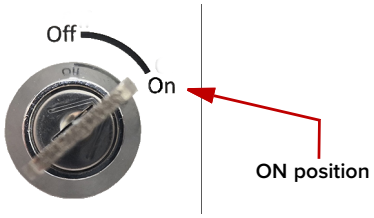
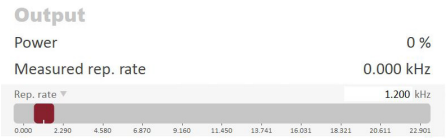
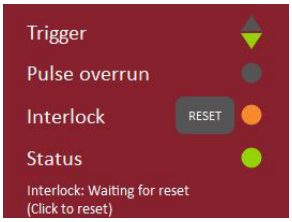
WARNING: Turning on the laser emits hazardous laser Class 3B radiation. Ensure to observe and implement all safety regulations, warnings and cautions in this guide and the *SuperK COMPACT Safety, Handling and Regulatory Information* document before continuing.

CAUTION: Do not turn on the laser if it has been exposed to temperature and humidity beyond the operating specifications. The SuperK COMPACT is designed to 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

Follow the steps in Procedure 2 to enable laser emission using CONTROL.

Procedure 2 Turning ON the laser

	Action	
1	On the front panel of the laser, turn the key switch on the laser's front panel to the ON position. When the key is in the ON position, laser emission can be enabled from CONTROL software. Note: The connected interlock circuit must also be closed i.e. the door (switch) closed to permit emission.	
2	In the CONTROL application, set the *Trigger mode* drop down setting to *Internal trigger*. Note: Internal trigger mode sets the laser to emit a continuous pulse train. **NOTE:** Other trigger modes require an external trigger signal to control emission of laser pulses.	
3	In the Control application, adjust the laser's repetition rate by using the slider marked *Rep. rate*. (The *Rep. rate.* slider control may also be set as a *Set Power* slider, both controls adjust the repetition rate of the output pulses.) Note: External trigger mode does not support *Rep. rate* or *Set Power* sliders.	
4	If the *RESET* (interlock) button is visible in the status panel, click it to clear the interlock alarm "*Interlock waiting for reset*". **NOTE:** Clicking the button acknowledges to the laser that you have correctly connected all interlock and door switch circuits.	
5	Turn ON laser emission by clicking on the software Emission button. The Emission button light turns from green (OFF) to Red (ON).	

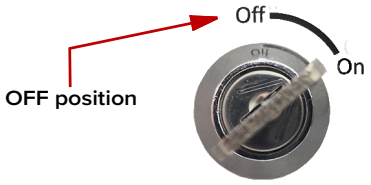
Errors

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.

Turning OFF the laser

Follow the steps in Procedure 3 to turn off or disable laser emission.

Procedure 3 Turning OFF the laser

	Action	
1	Turn OFF laser emission by clicking on the software Emission button. The Emission button light turns from Red (ON) to green (OFF).	
2	Turn the key switch to the 0 position to disable the laser. **Note**: If you plan to leave the laser unattended, it is recommended to remove and store the key in a secure location.	

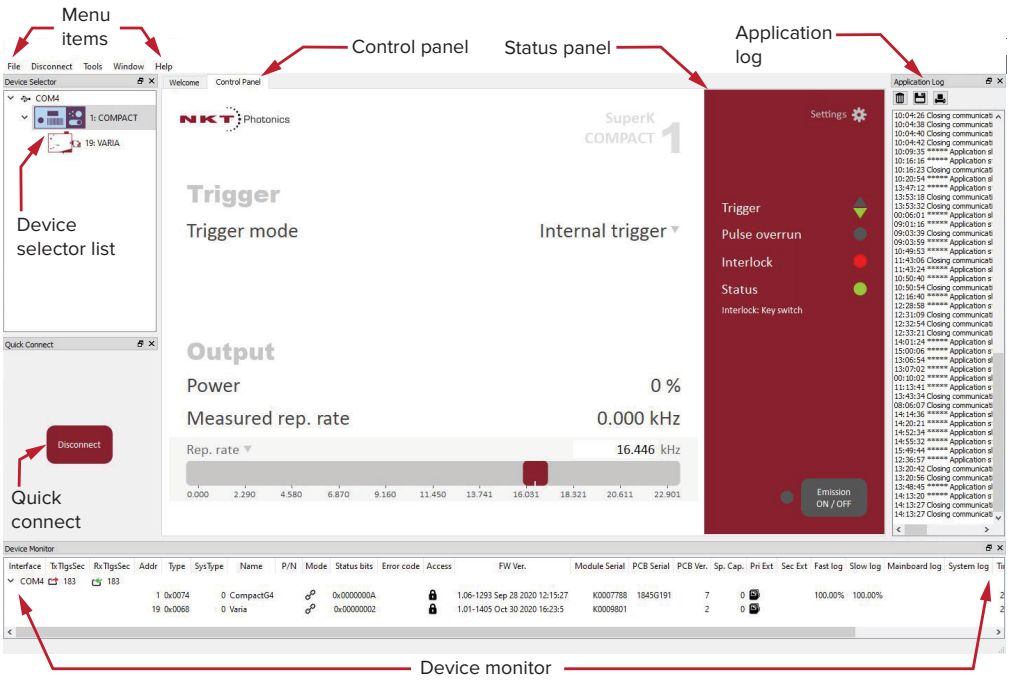
4 CONTROL Interface

CONTROL 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 repositioned the panels within the main window or into separate windows. Figure 23 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 (lasers and accessories) sorted by the PC port they are connected to.	Connecting the laser to a CONTROL PC on page 43.
Quick Connect	Provides a button when clicked, scans all available PC ports for connected NKTP products.	Connecting to the laser on page 51
Status Panel	This panel displays the selected device status, emission control and a CONTROL settings drop down menu.	Status panel on page 52
Menu Items	Five drop down menus with multiple functions.	CONTROL menu on page 56
Control Panel	Includes trigger mode settings and slider controls for output control.	Trigger mode on page 59 Controls on page 65
Application Log	This panel displays a debugging log that can be saved to a file.	Application log panel on page 67
Device Monitor	To also help debugging issues, this panel displays multiple port and device module parameters.	Device monitor on page 67

Figure 23 CONTROL panel 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 4 describes how to relocate a panel within the main window:

Procedure 4 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 241
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 25 ,

Figure 24 Dragging panels to a new location in the main window

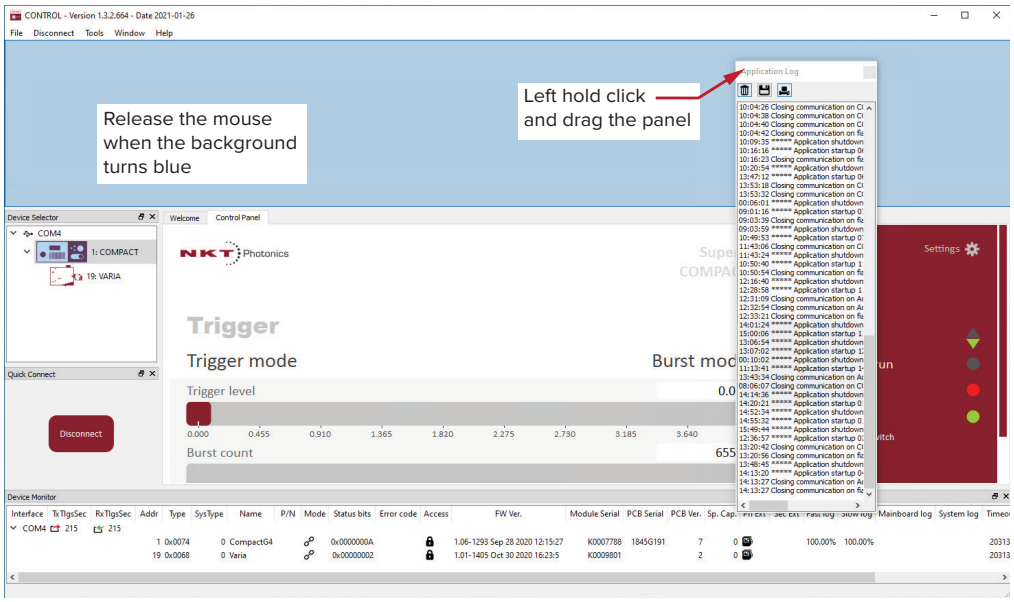
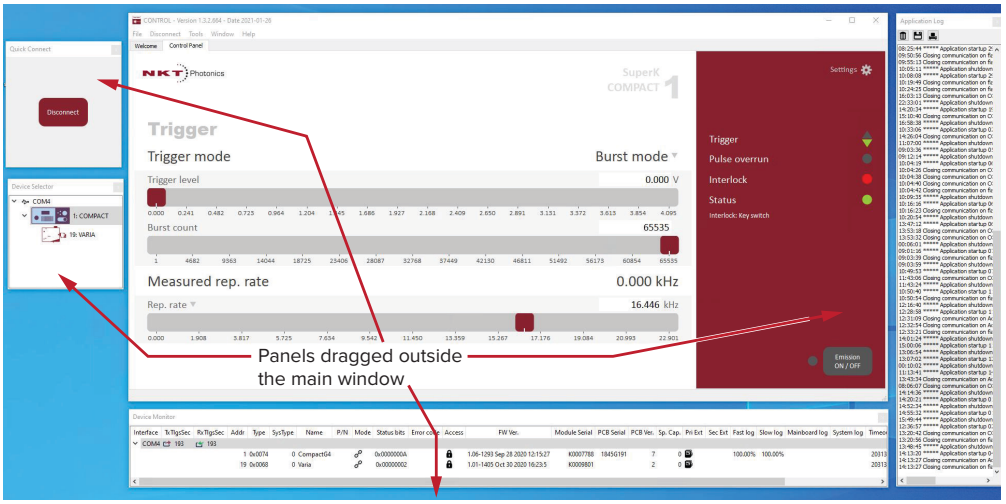


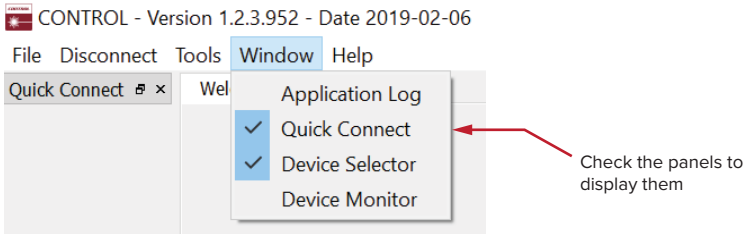
Figure 25 Dragging panels outside the main window



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 26 Toggling panel visibility



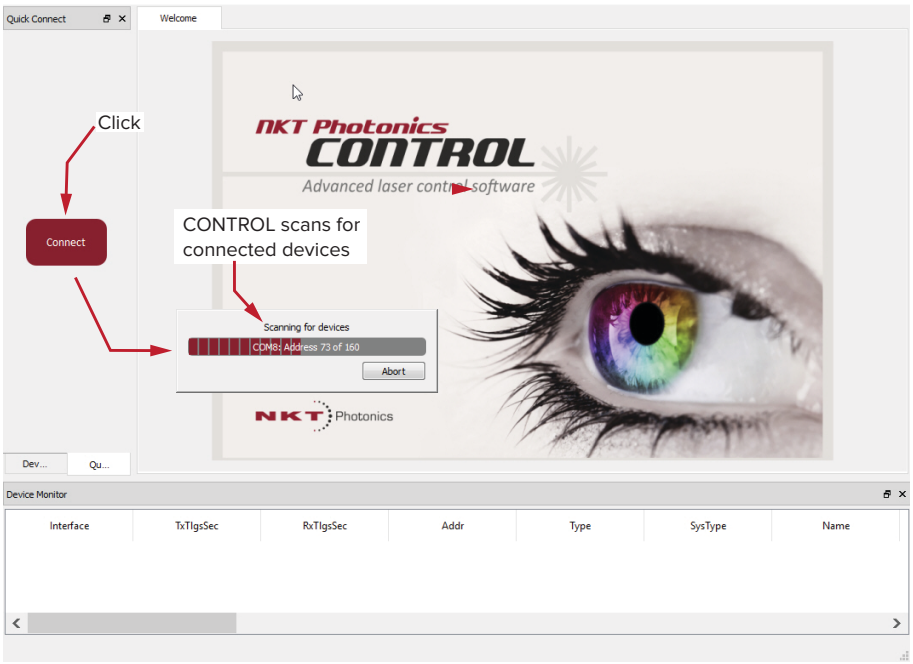
NOTE: Clicking the X in the upper right corner of any panel also closes it.

Connecting to the laser

When CONTROL is launched, the *Welcome* panel is displayed as in Figure 27. On the left is the *Quick Connect* panel. Click the *CONNECT* button and CONTROL scans all available ports for NKTP 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 using a USB cable” on page 44

Figure 27 Quick connect

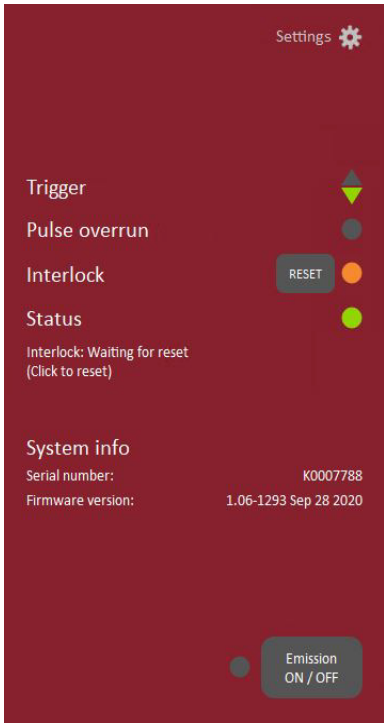


NOTE: Devices must already be connected to the CONTROL PC for quick connect to find them. A connected device means the laser USB connector is connected and a Windows COM port is assigned to it.

Status panel

The Status Panel provides status indicators, error messages, emission control function and a CONTROL settings menu.

Figure 28 Status Panel



Status indicators

The panel displays the following indicators:

Trigger

The ▲ (up) and a ▼ (down) arrow indicators display the status of the trigger signal measured at a trigger input. You can use the indicators when setting the trigger level control (see “Trigger level” on page 66) or the actual trigger input signal level.

- ▲ ON – Trigger input signal level too high versus the set trigger threshold.
- ▼ ON – Trigger input signal level too low versus the set trigger threshold.
- ▲ / ▼ ON – Trigger input signal level and trigger threshold are correctly set (matched) to trigger a pulse or burst. When a trigger event is detected, both indicators stay ON for approximately 100 ms indicating a recent trigger event.

Using the arrows: The arrows indicate if the trigger signal voltage is either too high, too low, or set correctly when compared to the set trigger threshold. For example, a trigger signal at 1 kHz is connected and the ▼ down arrow is ON and the ▲ up arrow is steady OFF. In this case, the trigger signal voltage is too low for the set threshold. Either set the trigger threshold lower or increase the signal level until both arrows (▲ / ▼) are lit. Likewise, if the ▲ up arrow is ON,

and the ▼ down arrow is OFF, then the trigger signal level is too high; either the threshold needs to be increased or the signal level decreased.

NOTE: If the frequency of the input trigger signal is very low i.e. 10 Hz, then the arrow states change at roughly the rate of the trigger signal pulses. At higher trigger signal frequencies, the arrows appear steady ON.

NOTE: Visible flashing of the arrows may also indicate that the trigger signal level is slightly low, such that only a few of the trigger signal pulses are detected. If the signal level cannot be increased, decrease the trigger threshold level slightly (Coax trig input only).

Pulse overrun
When operating at low repetition rate and the repetition rate is increased, a *Pulse overrun* state may occur. For example, changing from 1 kHz to 20 kHz could momentarily trigger a *Pulse overrun* state due to the sudden change in pulse acquisition. When this occurs, increase the repetition rate in smaller steps of for example, 5 kHz. Whenever a *Pulse overrun* state is encountered, turn down the repetition rate until the *Pulse overrun* warning disappears.

A *Pulse overrun* state can also occur when set to burst mode. To avoid this, either lower the number of pulses or lower the repetition rate.

When operating in *Internal Trigger* mode and a continuous *Pulse overrun* warning is observed, contact support – see “Support contact details” on page 88.

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

- ON Red – the interlock circuit is open or shorted to ground – No emission permitted
- OFF Grey – the interlock circuit is closed and reset – emission permitted

To clear the ON Red indicator, the interlock 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 enabled.
- ON Red – There is a fault and a fault message is displayed; laser emission is shutdown and cannot be enabled.

Fault Message	Action
Interlock opened while emission on	a) Cycle the key switch to OFF and then ON b) Close the external interlock circuit

Fault Message	Action
Watchdog timeout	Reconnect NKTP CONTROL and reset the interlock by cycling the key switch.

See “Connecting the safety interlock” on page 71.

System info The *System Info* section displays the following:

- Laser Serial Number
- Laser Firmware Revision

NOTE: *System info* is only displayed when the option is checked in “View” on page 55.

Emission button The emission button turns the laser emission ON or OFF – See “Controlling the laser emissions” on page 53. 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 29.

Figure 29 CONTROL settings

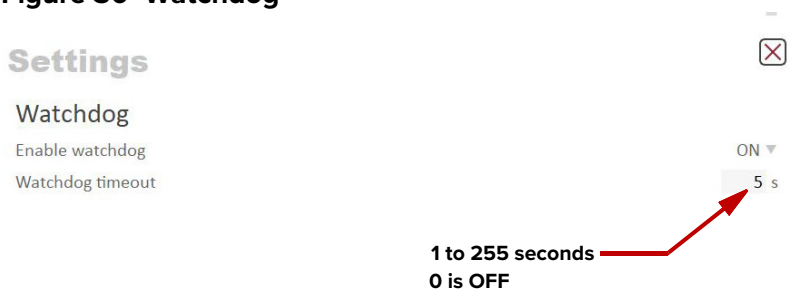
Setting Item	Function	See
Watchdog	Enables or disables a watchdog between CONTROL and the connected devices.	Watchdog on page 55
View	Enables and disables items displayed in the Status panel.	View on page 55

Watchdog

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

NOTE: Setting the timeout to 0 seconds turns OFF the watchdog function.

Figure 30 Watchdog



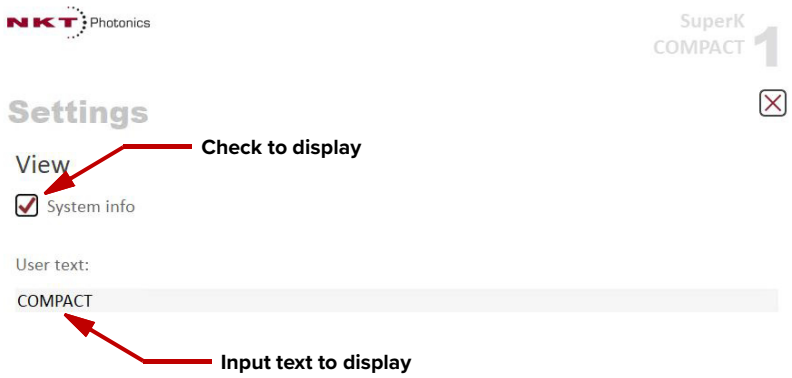
View

The View settings control the display items in the status panel and the front LCD panel:

System info – check the box to toggle on displaying the system's serial number and firmware version within the status panel.

User text – enter a text string of up to 240 characters. The string is displayed next to the device icon in the Device selection window.

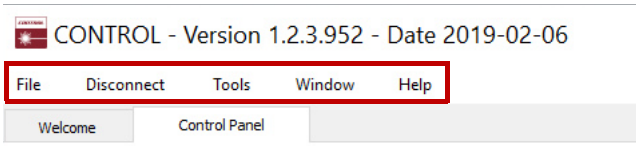
Figure 31 View



CONTROL menu

There are five drop down menus in the main control window as highlighted in Figure 32. Click on the items in the menu to reveal the drop down menus.

Figure 32 Menu items



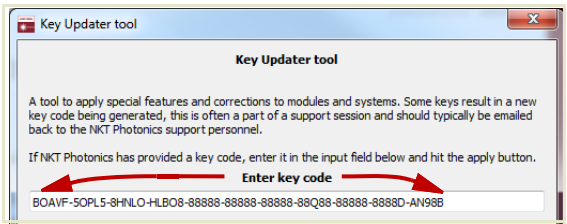
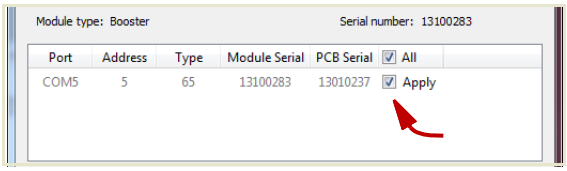
Menu Item	Function	See
File	Exits the CONTROL program	N/A
Disconnect	Disconnects the currently connected device from CONTROL.	N/A
Tools	Select from one of three special tools to use with your laser. Tools available are: • Key Updater Tool • Log Downloader • Extensions Overview	 Key Updater tool on page 56 Log downloader on page 57 Extensions overview on page 58
Window	Controls (toggles) which panels are displayed.	Toggling the panels visible on page 51
Help	Displays the current version of CONTROL and provides access to the included CONTROL user help.	N/A

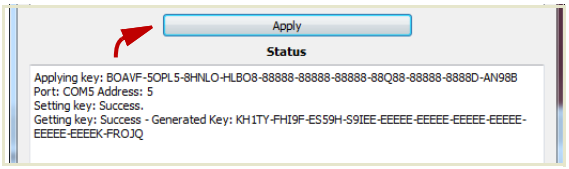
Key Updater tool

The Key Updater tool is used to apply special features and corrections to modules and systems of the laser.

To use the Key Updater tool follow Procedure 5.

Procedure 5 Using the Key Updater tool

	Action	
1		Enter the key code in the field *Enter key code*.
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

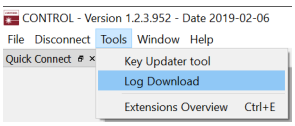
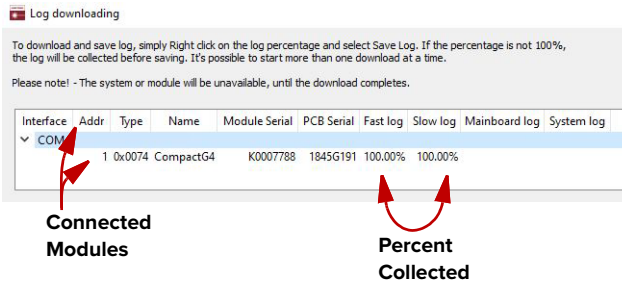
If your laser requires support from NKT Photonics, our support engineers may request that you send the log files collected by the laser. You can use the log downloader tool to save the laser log files to your CONTROL PC.

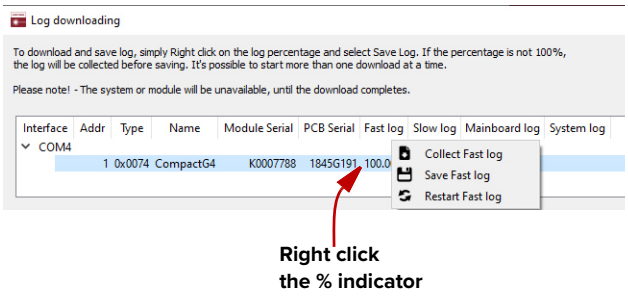
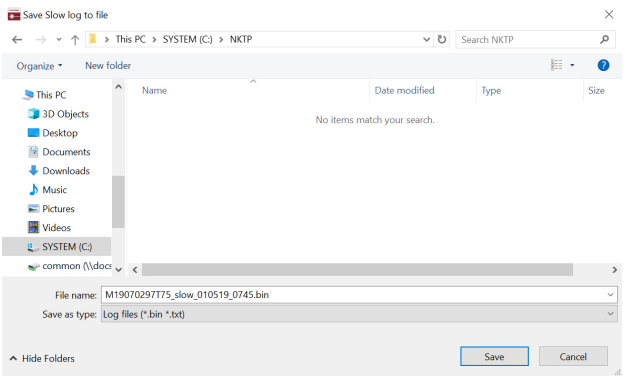
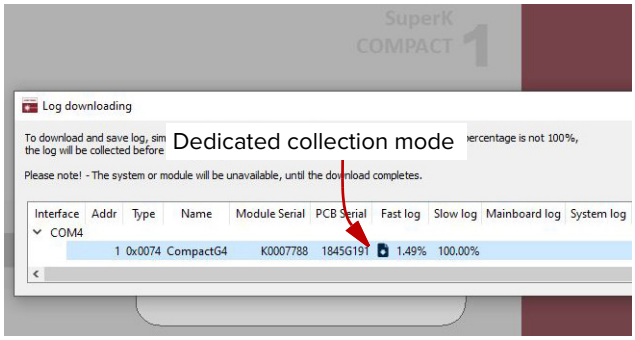
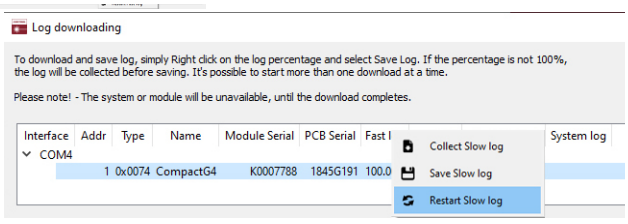
NKTP CONTROL automatically downloads log files from the modules of any connected devices. The log files are stored in a local file on the CONTROL PC. However, certain NKTP modules, including the SuperK COMPACT main board do not support automatic download of log files. For these modules. you can use the 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 grey (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 6.

Procedure 6 Using the Log Downloader

	Action	
1	Open 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. The percentage indicator shows the amount of log data collected for each module. Logs are collected from each module. The total collected percentage is displayed for the module's logs.	

	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 fast or slow log file onto the CONTROL PC. If the percentage shows less than 100%, the log is collected first. See Collect log below. • **Collect log** – Starts a dedicated log collection mode that disabled all other CONTROL activity.	
4	If you select *Save Fast* or *Slow log*, a dialog box prompts for a filename and folder to store the log in.	
5	If you select *Collect Fast or Slow log*, the log is collected and saved in dedicated mode. The CONTROL panel turns grey and all other functions are disabled. When the log is finished being collected, all other CONTROL functions are enabled.	
6	Select *Restart Fast* or *Slow log* to clear all the collected log data and restart the log data collection.	

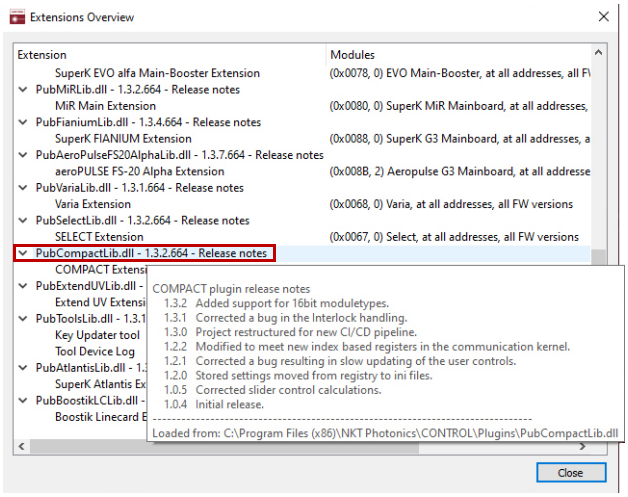
Extensions overview

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\NKTP CONTROL\Plugins

To view the extensions, open the Tools menu and click on Extensions Overview. The Extensions Overview window is launched as shown in Figure 33.

Figure 33 Extensions Overview



NOTE: To show a short description of the release notes as seen in Figure 33, hover the mouse pointer over the “Release notes” text

The PubCompactLib.dll details highlighted in Figure 33 shows the version of the .dll file (1.1.2.303), the included extensions and which module types they support.

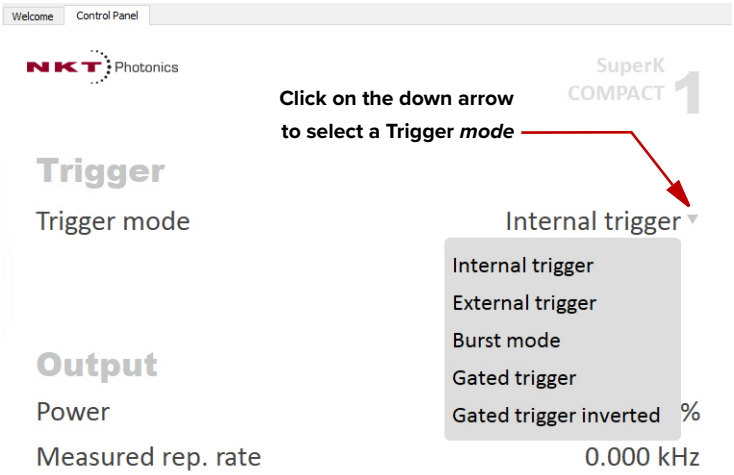
NOTE: Multiple extensions for a wide range of NKTP lasers types are typically installed when using the default installation of CONTROL.

Trigger mode

Using NKTP CONTROL, you can select to operate the laser using one of five trigger modes. The modes determine when and how pulses are emitted. When a trigger mode is selected, the *Control Panel* shows the settings relevant for the mode. To select one of the modes, click on the *Trigger mode* drop down menu located on the right side of the panel (See Figure 34).

NOTE: Trigger signals must be supplied from an external source. NKTP CONTROL software does not include any functionality to generate trigger signals.

Figure 34 Trigger mode



Internal trigger

The laser emits continuous pulses at the set repetition rate. The rear panel trigger inputs are not used. The repetition rate is set using the Frequency sub-menu.

Controls

“Repetition rate” on page 65

Trigger ports

None

External trigger

One pulse (Figure 35) is emitted each time the leading edge (low to high transition) of a trigger signal is detected on one of the external trigger input ports. The rising edge of the trigger signal must reach the threshold for the detection voltage level set for the port.

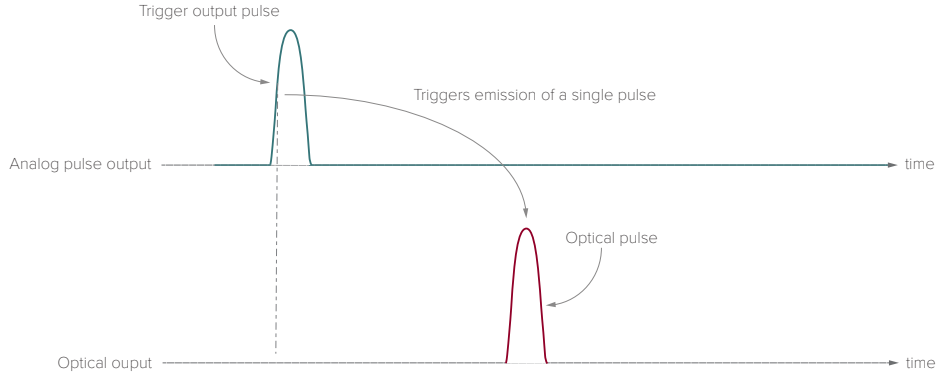
Controls

“Trigger level” on page 66

Trigger ports

“COAX trig input” on page 27
“Industrial trig input” on page 27

Figure 35 External trigger mode



Burst mode

A burst of pulses (Figure 36) at the set repetition rate is emitted each time the leading edge (low to high transition) of a trigger signal is detected on one of the external trigger input ports. The rising edge of the trigger signal must reach the detection threshold level for the port. The number of pulses in the burst is set using Burst pulses sub-menu and the repetition rate is set using the Frequency sub-menu.

When the light source senses a positive edge on one of the trig inputs, the light source emits a specified number of pulses (Burst count) at the specified repetition rate.

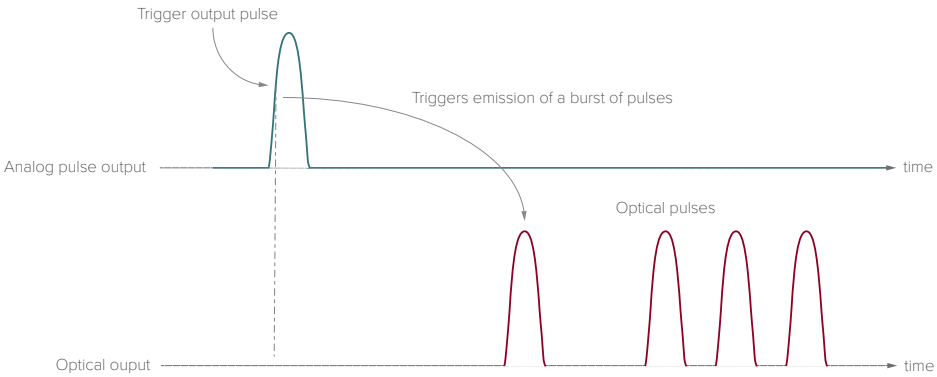
Controls

“Trigger level” on page 66
“Burst count” on page 66
“Repetition rate” on page 65

Trigger ports

“COAX trig input” on page 27
“Industrial trig input” on page 27

Figure 36 Burst mode



NOTE: The exact number of pulses emitted in the burst mode might deviate from the nominal value. Burst to burst variation could also be expected. The deviation will vary in size depending on repetition rate, trigger frequency and number of pulses per burst. To optimize the performance, it is recommended to avoid pulse overrun by lowering the number of pulses, trigger frequency and repetition rate. If a more stable/accurate burst mode performance is desired within a limited set of operating parameters, please contact our sales for a customized laser optimized for your specific needs. Please note that this may impact standard specifications such as maximum repetition rate, visible power and total power.

Gated trigger

When a logic high level signal is detected at one of the trigger input ports, pulses (Figure 37) are continuously emitted at the set repetition rate. When the signal at both trigger inputs is at a logic low level, no pulses are emitted. An output pulse truth table of trigger inputs for gated and gated inverted modes is shown in Table 7.

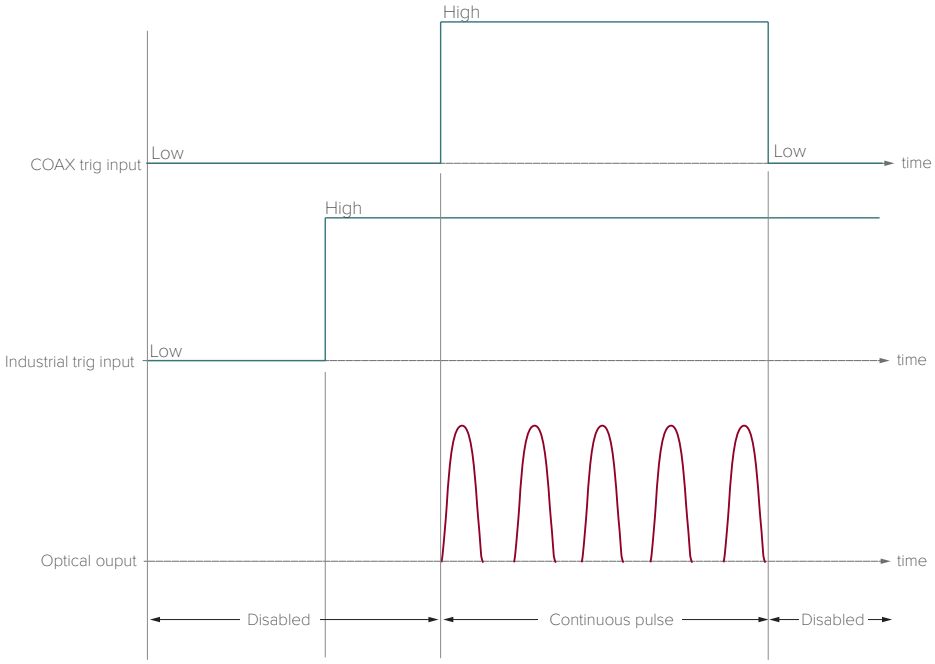
Controls

“Trigger level” on page 66
“Repetition rate” on page 65

Trigger ports

“COAX trig input” on page 27
“Industrial trig input” on page 27

Figure 37 Gated trigger mode



NOTE: When using the Front panel controls, the *Gated trigger* mode is set using the “External gate on mode” described on page 35.

Gated trigger inverted

When a logic low level signal is detected at both of the trigger input ports, pulses (Figure 38) are continuously emitted at the set repetition rate. When the signal at one of the trigger inputs changes to a high logic level, no pulses are emitted. An output pulse truth table of trigger inputs for gated and gated inverted modes is shown in Table 7.

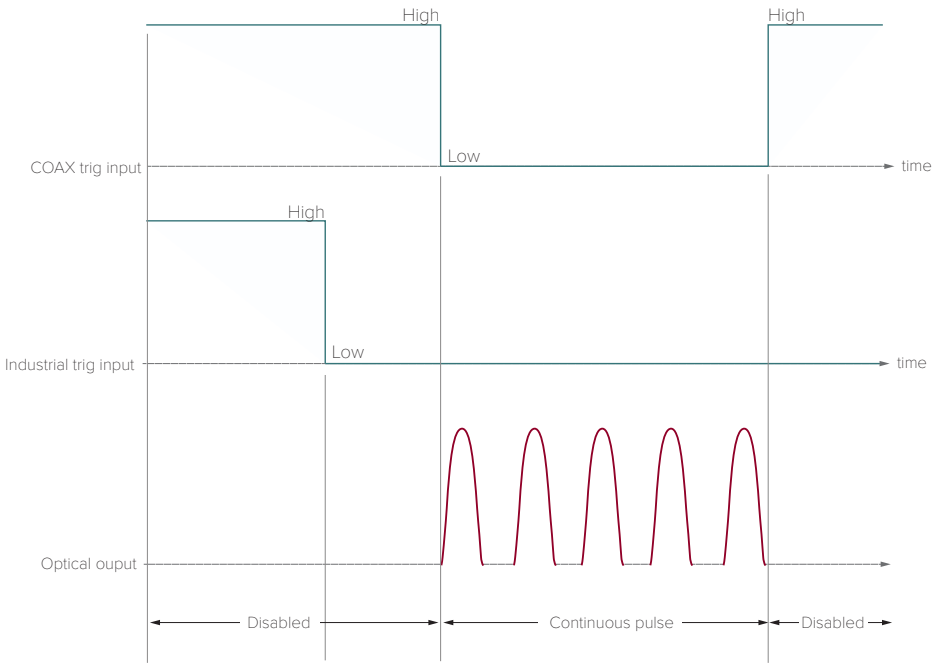
Controls

“Trigger level” on page 66
“Repetition rate” on page 65

Trigger ports

“COAX trig input” on page 27
“Industrial trig input” on page 27

Figure 38 Gated trigger inverted mode



NOTE: Typically, an additional pulse is emitted after the external signal rises to a logic high level. The repetition rate is set using the Frequency sub-menu.

NOTE: The front panel supports Software burst trigger setting. This mode cannot be set using CONTROL.

NOTE: When using the Front panel controls, the *Gated trigger inverted* mode is set using the "External gate off: mode" described on page 35.

WARNING: Although some operating modes can stop pulses from being generated, the laser must still be regarded as having emission on. Stopping pulses by using the input trigger signals in a certain combination, is considered an unsafe method to disable emission.

Table 7 Gated modes – pulse emission truth table

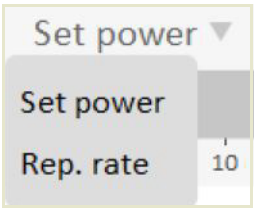
Trigger mode	COAX trig input	Industrial trig input	Output pulses
	Low	Low	Disabled
	High	Low	Continuous pulses
	Low	High	Continuous pulses
Gated trigger	High	High	Continuous pulses
	Low	Low	Continuous pulses
	High	Low	Disabled
	Low	High	Disabled
Gated inverted trigger	High	High	Disabled

Controls

Power or repetition rate selection

You can adjust the repetition rate of the output pulse using either a Power or Rep. rate slider. The average output power of the laser is directly proportional to the pulse repetition rate. To set CONTROL to show either the Power or Rep, rate slider click on the downward pointing.

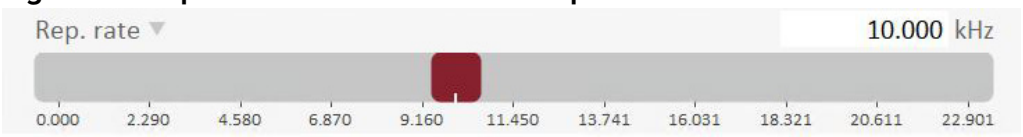
Figure 39 Set power or repetition rate slider selection



Repetition rate

You can set the output pulse repetition rate using the slider shown in Figure 40. You can also enter the repetition rate in kilohertz using the text input field at the upper right corner.

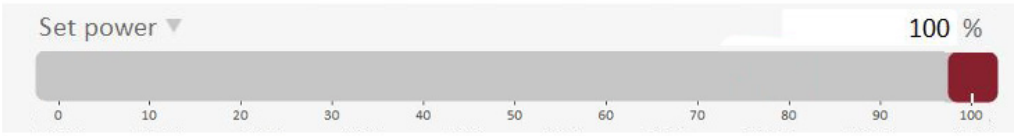
Figure 40 Repetition rate slider and text input field



Power

You can set the output power in percent using the slider shown in Figure 41. You can also enter the power in percent using the text input field at the upper right corner.

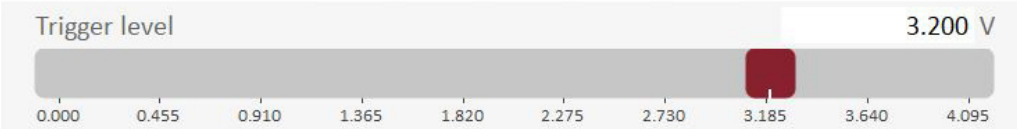
Figure 41 Repetition rate slider and text input field



NOTE: Output power is modified my setting a pulse repetition rate proportional to the power level desired.

Trigger level Use the slider shown in Figure 42. to set the voltage level threshold at the Coax trig input that triggers emission of a pulse or burst. You can also enter the level in voltage using the text input field at the upper right corner.

Figure 42 Trigger level slider and text input field

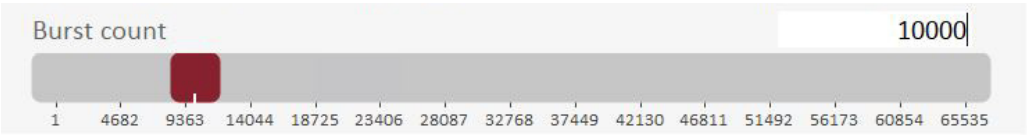


NOTE: You can use the trigger indicators in the status panel (see "Trigger" on page 52) to set the trigger level threshold correctly.

NOTE: If the Coax trig input is left disconnected, set the Trigger level to a high setting to avoid inadvertent noise causing a trigger event.

Burst count Use the slider shown in Figure 43. to set the number of burst pulses emitted when a trigger signal detects a leading edge. You can also enter the number of pulses in a burst using the text input field at the upper right corner.

Figure 43 Burst count slider and text input field



NOTE: The exact number of pulses emitted in the burst mode might deviate from the nominal value. Burst to burst variation could also be expected. The deviation will vary in size depending on repetition rate, trigger frequency and number of pulses per burst. To optimize the performance, it is recommended to avoid pulse overrun by lowering the number of pulses, trigger frequency and repetition rate. If a more stable/accurate burst mode performance is desired within a limited set of operating parameters, please contact our sales for a customized laser optimized for your specific needs. Please note that this may impact standard specifications such as maximum repetition rate, visible power and total power.

Application log panel

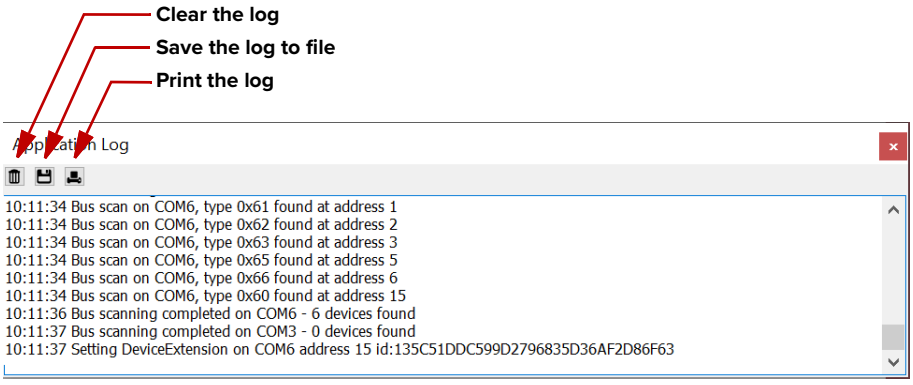
The *Application Log* panel displays and logs the communication of status messages. You can use the log to debug connection issues between CONTROL and NKT Photonics devices.

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. Use the buttons to clear, save or print the log. Click on the cross in the upper right corner of the *Application Log* to close it.

Figure 44 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 8.

Table 8 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 per received from the connected device.
Addr	The address of the connected module.
Type	The type of the connected module read from the module.

Parameter	Description
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.
P/N	The device module part number.
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 Ver.	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.
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.
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.
Mainboard Log	0%-100% collected. Note only if the module has a main log. Only main boards have a main and system logs.
System Log	0%-100% collected. Note only if the module has a system log. Only main boards have a 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 the module receives a message but cannot process it due to its current work load.

5 Mechanical Installation

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

General installation

Installation surface The laser must be installed on a level surface that is free from vibrations.

Environment The ambient temperature surrounding the laser should be stable and free from temperature fluctuations such as heat or cold sources. Temperature changes and vibrations may affect the laser's operation and result in abnormal operation.

Ambient environment
15-30°C non-condensing

Air cooling The laser is cooled with forced air. The air is drawn in through the air inlet vent on the front panel and blown out through the exhaust vent on the rear panel. There should be a clearance gap of 7.5 cm (3 inches) in front of the inlet and exhaust vents to allow the free flow of air.

CAUTION: Do not place or stack items on top of the laser. Doing so may affect its operation and cause damage.

Output fiber Do not bend the output fiber such that it exceeds its maximum bending radius. The output fiber can be coiled down to a maximum 10 cm diameter.

6 Connecting the Laser

Before operating the laser, follow the procedures in this chapter to ensure its correct and safe operation.

For information on how to connect:

- the Safety Interlock – see “Connecting the safety interlock” on page 71
- Power – see “Connecting power” on page 73
- The Optical Output – see “Connecting the optical output” on page 74
- Accessories – see “Connecting accessories with the external bus” on page 76
- Trigger input ports – see “Trigger input ports” on page 78
- Synchronization output ports – see “Synchronization output ports” on page 79

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 emissions. To prevent the laser from immediately turning on when the door subsequently closes, the interlock must be reset either from the front panel or software control.

Interlock operation description

Note: this section describes the functional operation of the interlock. To connect a door switch to the interlock, follow the steps in Procedure 7.

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 45, the keyswitch is turned to the *On* 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 45 Interlock connected to a door switch - Laser ON[1]

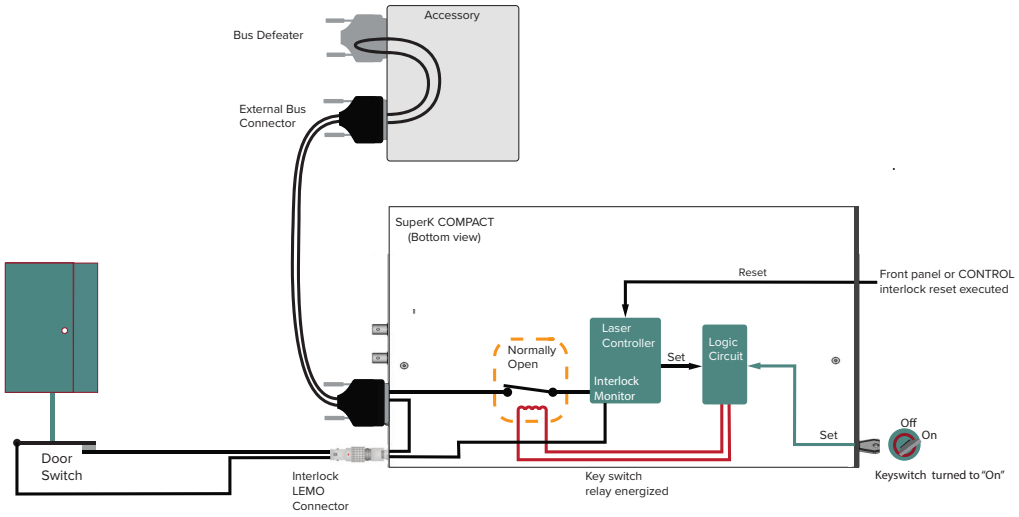
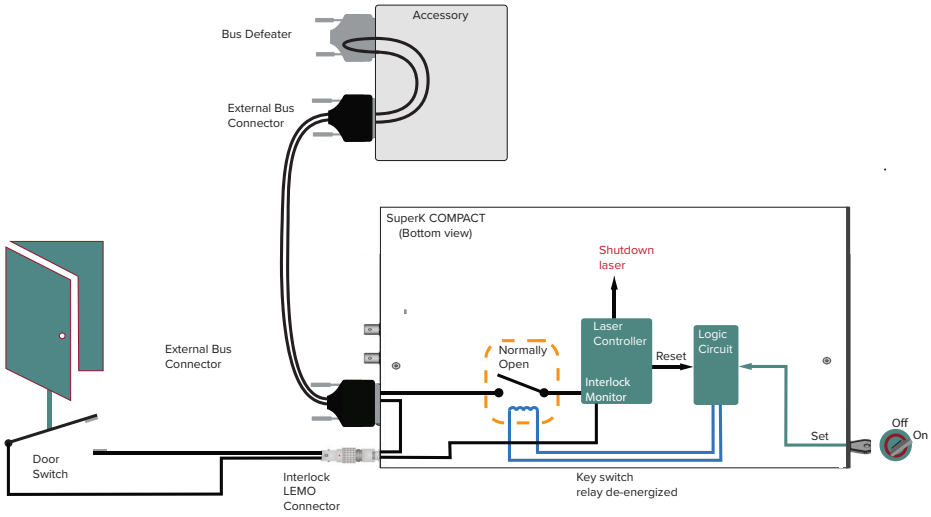


Figure 46 shows the door switch in the open position. This opens the interlock loop which the interlock monitor detects and the controller immediately sends a shutdown signal to the laser (the laser's pump). In addition, the controller sends a reset to the logic circuit. The reset causes the logic circuit 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 45.

Figure 46 Interlock connected to a door switch – laser SHUTDOWN[1]



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.

Follow the steps in Procedure 7 to install the interlock safety circuit.

LEMO plug
The laser is shipped with a prewired 2-pin LEMO interlock plug for interconnecting the laser with a safety door switch circuit. Specifications for the door safety switch circuit are as follows:

- Voltage, operational (nominal):5 VDC
- Current, operational (nominal):43 mA
- Voltage range: 0 to 12 VDC_{max}
- Short circuit current: 80 mA_{max}
- Maximum allowable circuit resistance: 40 Ω

Procedure 7 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. The wire gauge should be at a minimum 26 AWG with a maximum length of five meters. For cable lengths longer than five meters, it is recommended to use shielded cable.
3	Perform a continuity test using a multimeter: *a.* First connect the multimeter leads to the interlock plug terminals. *b.* Confirm when the enclosure door is closed, the meter shows the circuit as closed. *c.* 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 Figure 6 on page 25.
5	Connect the external bus to an accessory or the supplied bus defeater, see Connecting accessories with the external bus on page 76).

Connecting power

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

To connect power, follow the instructions in Procedure 8.

Procedure 8 Connecting power

	Action
1	Connect the AC cable supplied with the laser to the rear 3-pin IEC power input connector.
2	Connect the AC cable to a local AC mains supply.
3	Press the power toggle button to the ON position. (The switch is next to the keyswitch on the front panel.)

Connecting the optical output

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.

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.

FC connector installation

When a SuperK FC connecterized fiber[1] is mated to another connecterized component, there is a risk of damage to the connector. Any loss, dirt or stress at the connector mating junction, can result in damage due to the significant peak power capability of the laser.

When connectors are mated, it is not guaranteed that this damage can be avoided. You can reduce the risk by ensuring the fiber facet is clean as described in the following.

Cleaning the fiber facet

Before connecting the output, ensure that the fiber facet is clean and free of dust particles. A fiber facet fouled by foreign particles, oil, or other contaminants may cause severe damage to the fiber facet resulting in a significantly distorted beam profile. Dust from the fiber facet may be removed using a number of approved fiber cleaning methods. Lens cleaning tissue (lint free wipes) or similar appropriate material may be employed. See “Fiber Maintenance” on page 91 for further information on preparing the fiber surface for mating.

1. Model#s S024-010-000 and S024-010-010 only

NOTE: The exit delivery fiber and connector are NOT covered by the laser's warranty.

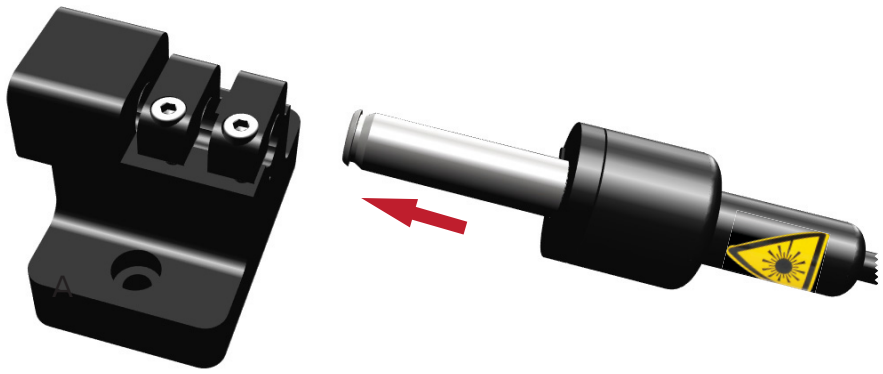
Collimator installation

The collimator[1] is constructed so that its sleeve is inserted into a holder[2] or a receptacle of a next stage optical device such as a SuperK accessory. To install the collimator, follow the instructions in Procedure 9.

Procedure 9 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 47.
3	Slide the collimator into the receptacle and then: • **for SuperK accessories:** push down on the release button and insert the collimator into the receptacle until it stops as shown in Figure 48. Then release the button to lock the collimator in place. • **for holders, power meters etc.**: slide the sleeve into the receptacle until it stops. Then tighten the mounting screws to securely retain the collimator as shown in Figure 49.

Figure 47 Inserting the Collimator into a Holder[1]



NOTE: Use of non-NKTP holders: we recommend to gently fix the collimator output barrel using plastic screws instead of metal screws thereby minimizing the risk of scratching the collimator.

CAUTION: Scratching the collimator may prevent it from fitting into the collimator

1. Model# S024-010-020 only
2. SuperK collimator holder A000-000-002

input receptacle of SuperK accessories.

Figure 48 Collimator Installed into a SuperK Accessory Receptacle

Figure 49 Collimator Installed in a Holder Receptacle

CAUTION: NKT Photonics recommends to ensure there is firm thermal contact between the collimator and its surroundings. If the thermal contact between the collimator and its surroundings is poor, the collimator can become significantly warmer than its surroundings. This is due to a small fraction of beam power (stray light) being absorbed within the collimator.

Connecting accessories with the external bus

External bus The *External Bus* port is a digital bus interface and 12 volt supply for attached accessories. The accessories used with the laser are connected to CONTROL through the external 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

If no accessories are used with the laser, place the supplied bus defeater onto the laser's *External Bus* port. If accessories are used, connect the accessories to the *External Bus* port in a daisy chain configuration using the supplied external bus cable(s). The last accessory connected to the daisy chain must have the bus defeater placed onto 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 88.

Figure 50 Bus defeater

Connecting the external bus

Refer to Table 9 for the details on how the external bus is connected. A bus defeater is placed on the last open external bus port to loop the circuit back. (Refer to Figure 51 and Figure 52 for connecting the port with and without accessories.)

Table 9 External Bus port – connecting accessories

Accessory #	External Bus port connection
No accessories	Bus Defeater
1 accessory	1. External Bus cable to accessory bus input 2. Accessory bus output – Bus Defeater
2 tor 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 51 External Bus circuit - with no accessories used

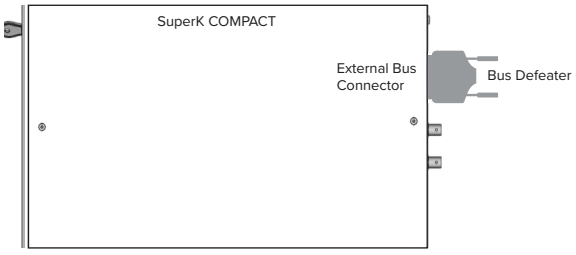
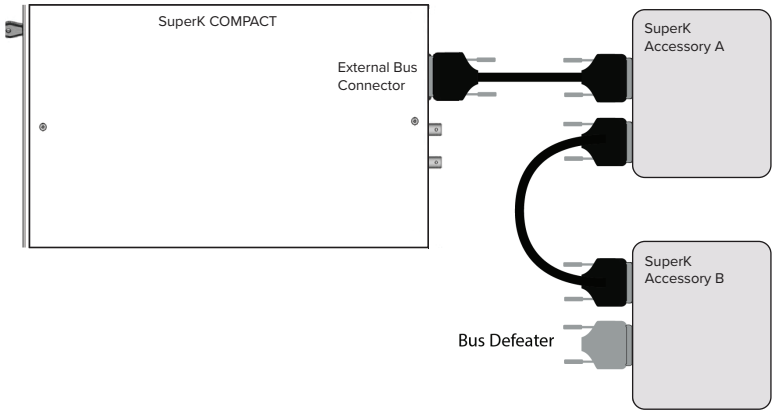


Figure 52 External Bus circuit - with multiple accessories in a daisy chain

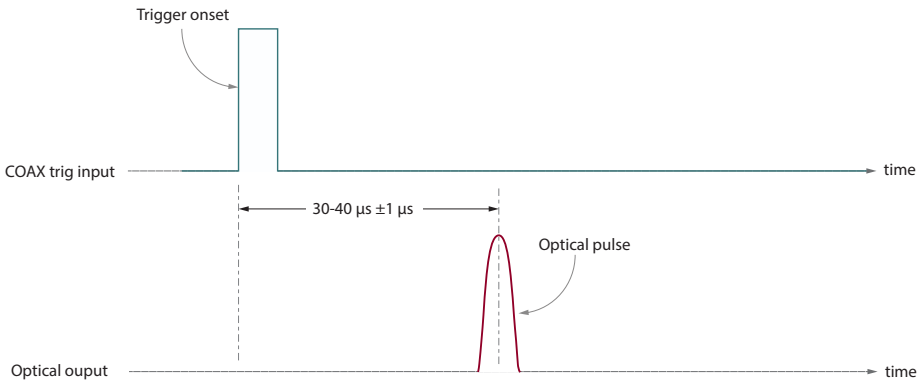


Trigger input ports

Coax trigger input

This BNC port is considered a logic input. Figure 53 shows that when a signal voltage connected to the port reaches the set trigger level, a pulse or burst is emitted a short time after. The trigger timing advance and jitter specifications are also shown in the figure. The trigger level is the voltage level at which, the laser is *triggered* to emit a pulse or pulse burst. The voltage level is adjustable using either the front panel controls (“Coax trig level” on page 38) or NKT Photonics CONTROL management software (“Trigger level” on page 66). To reduce noise sensitivity, the port has a hysteresis of approximately 1%.

Figure 53 Optical output delay and jitter vs. the *COAX trig input* port



NOTE: The pulse-to-pulse timing jitter, is in general a function of repetition rate, increasing as the rate increases. For applications requiring minimal jitter, it is recommended to lower the laser’s repetition rate to below 5 kHz and possibly as low as 1 to 2 kHz.

NOTE: When triggering the output pulse using either “Burst mode” or “Gated trigger” mode, a lowered repetition rate can also help avoid a **pulse overrun** warning situation. A pulse overrun[1] warning indicates that the laser could not output an optical pulse before receiving the next trigger pulse, effectively reducing the number of output pulses expected.

1. See Status LEDs on page 28

Table 10 Coax trigger input specifications

Parameter	Value
Nominal impedance	50 Ω
Peak voltage	minimum −7 V to maximum 7 V
Maximum power	0.8 W or 29 dBm RMS
Minimum pulse width	200 ns
Trigger level adjustable range	minimum 0 V to maximum 4 V
Hysteresis	~ 1%
Connector type	BNC
Maximum trigger frequency	200 kHz

NOTE: If the port is not in use, ensure to set the trigger level threshold (see "Trigger level" on page 66) to a level well above zero volts to avoid noise inadvertently triggering the laser.

Industrial trigger input

This input is isolated electrically from the laser. This gives the laser the ability to trigger the laser from a wider variety of equipment. The maximum input voltage range is high, and the input impedance is considerably higher than the *Coax trig input* impedance. However, this input is not as fast as the *COAX trig* input. Note that the *Industrial trigger* voltage level is fixed and cannot be set.

Table 11 Industrial trigger input specifications

Parameter	Value
Input impedance @ 5 V	1.45 kΩ
Input impedance @ 24 V	1.7 kΩ
Maximum input voltage	30 V RMS
Minimum pulse width	5 µs
ON signal threshold	3.9 V
OFF signal threshold - typical	2 V
OFF signal threshold - minimum	1.2 V
Connector type	5.08 mm terminal connector
Isolation voltage	350 V

Synchronization output ports

Analog pulse output

The signal from the *Analog pulse* output is an amplified representation of the optical signal. This may be used for detection of optical pulses, with minimum timing jitter, i.e. for timing critical purposes.

The signal is a positive analog signal from 0 to 2 V and corresponds to the electrical specifications shown in Table 12. The signal rate matches the configured pulse repetition rate set in CONTROL or using the front panel. The trigger output pulse is transmitted prior to the optical pulse emission. The timing advance between arrival of an analog trigger pulse and the optical pulse is illustrated in Figure 54.

The advance is brief, but useful for obtaining notification of the next emitted optical pulse. The actual total advance can vary and is dependent on the final application setup, where the length of the trigger cables versus the actual total optical path length can shorten or lengthen the advance time.

Figure 54 Analog trigger output timing advance

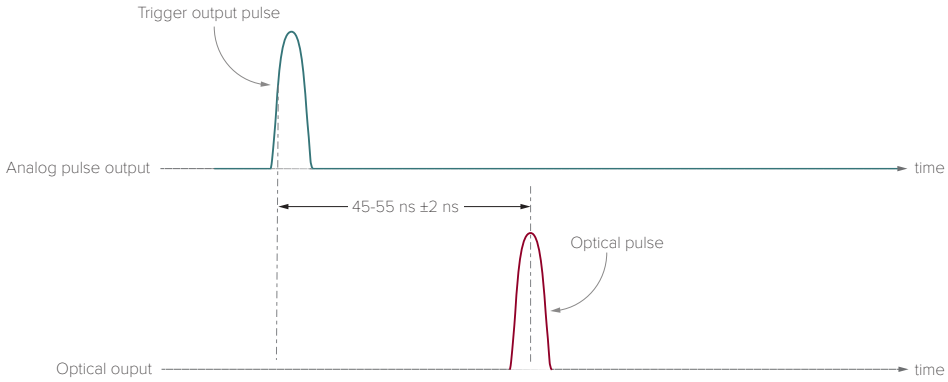


Table 12 Analog pulse output

Parameter	Value
Output impedance	50 Ω[
Pulse voltage[i]	2 V maximum
Pulse width	10 ns
Connector type	BNC
Cable type[ii]	Use RG223 type or similar double shielded cable ≤ 3M

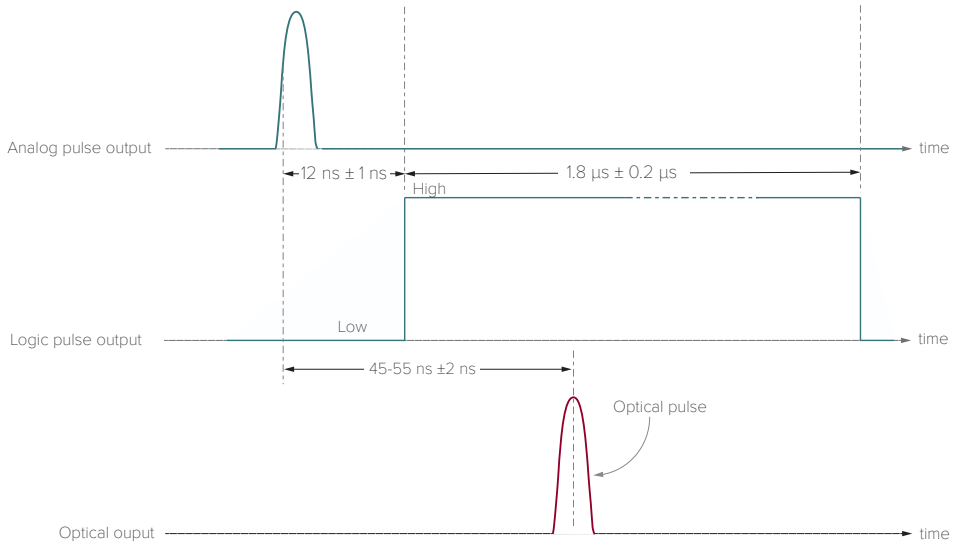
i. System dependent
ii. Recommended

Logic pulse output

The signal from the *Logic pulse* output is a digital representation of the analog trigger signal and corresponds to the electrical specifications shown in Table 13. The signal on the *Logic pulse* output rises to a positive logic signal in advance of the optical pulse emission. As Figure 55 shows, the rising edge of the logic trigger occurs shortly after the analog output trigger and remains high for an order of magnitude longer than its timing advance before the optical pulse. The signal is typically used for triggering an external application and/or

pulse counting. The signal rate matches the configured repetition rate using CONTROL or on the front panel.

Figure 55 Logic pulse output vs. Analog pulse output



NOTE: As mentioned for the *Analog pulse* output, the actual total advance can vary and is dependent on the final application setup, where the length of the trigger cables versus the actual total optical path length can shorten or lengthen the advance time.

Table 13 Logic pulse output

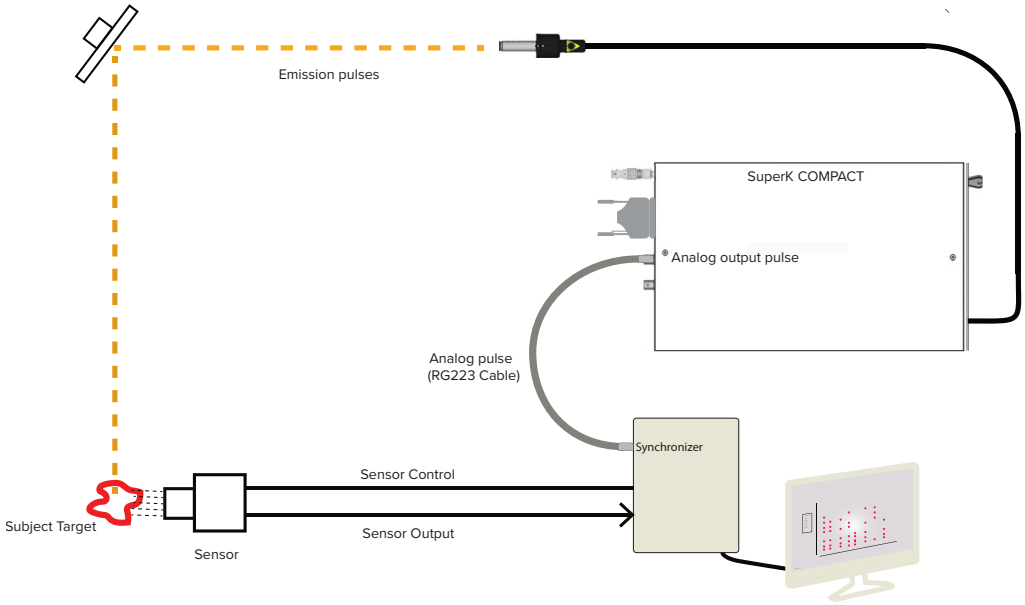
Parameter	Value
Input impedance	50 Ω[
Nominal pulse voltage[i]	2.5 V
Minimum pulse width	1 µs
Nominal Low-level output voltage	0 V
Connector type	BNC
Cable type[ii]	Use RG223 type or similar double shielded cable ≤ 3M

i. 50 Ω load
ii. Recommended

Example synchronization circuit

As an example, the *Analog output* pulse signal could be used to synchronize emission with a subject under study using a sampling sensor. A general diagram of a synchronization circuit is shown in Figure 56.

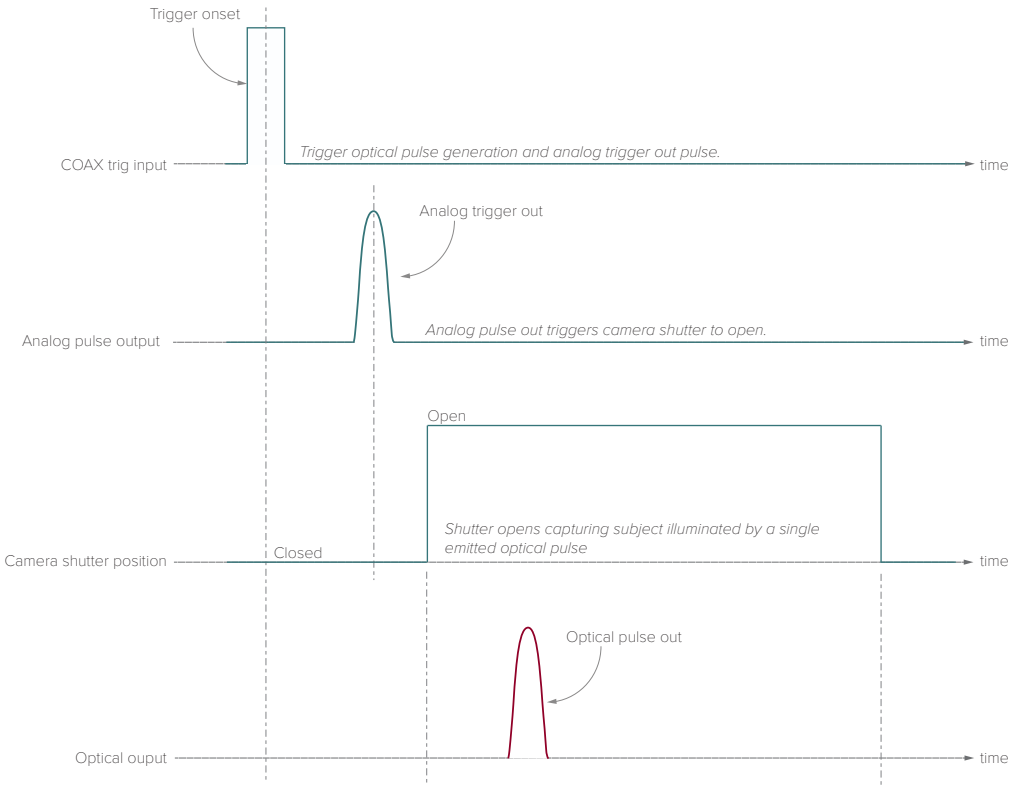
Figure 56 Example Pulse Circuit



Synchronization signaling - single pulse vs. burst mode

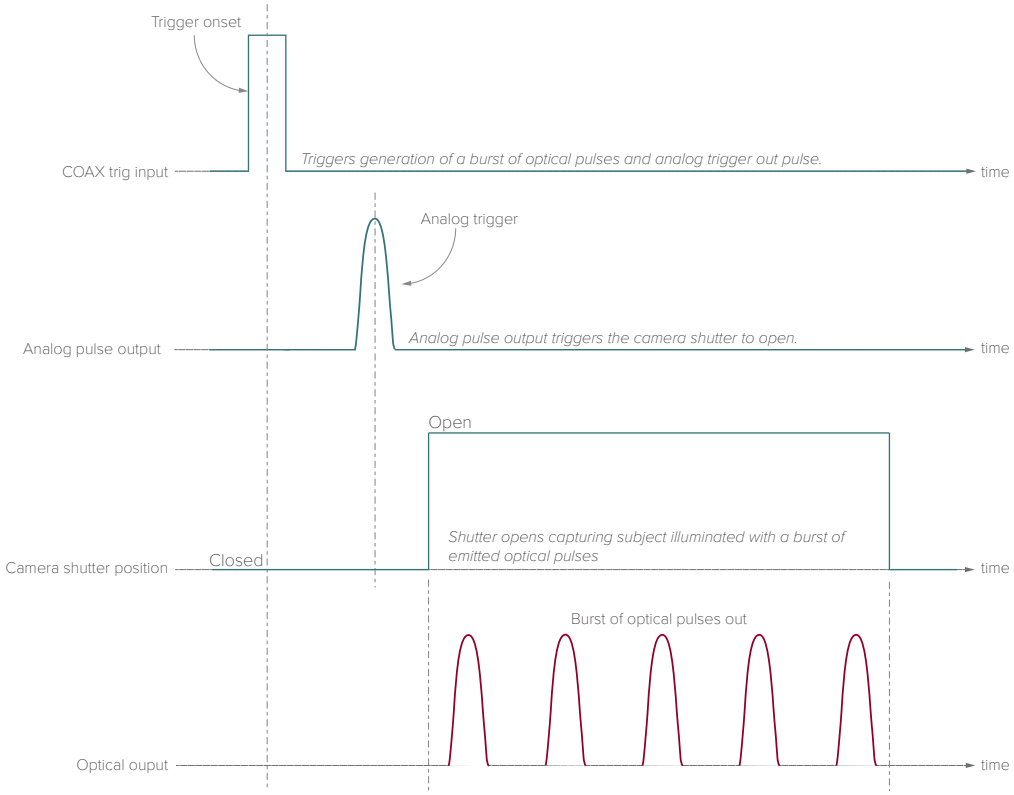
Figures 57 and 58 demonstrate how a subject can be imaged when illuminated with either a single pulse or a burst of pulses. In each case, a camera shutter is synchronized to triggers from the *Analog pulse* output that is driven by the *COAX trig input* signal initiating emission. Subsequent to the *Analog pulse* output trigger, the shutter opens, and the camera captures the subject image.

Figure 57 Synchronization with single pulse illumination



By using burst mode as shown in Figure 58, a subject can be illuminated by multiple pulses, increasing the dosage of light energy delivered to the subject.

Figure 58 Synchronization with pulse burst illumination



A Specifications

Table 14 Optical

Parameter	
Repetition rate	1 Hz to min. 20 kHz
Spectral coverage	450 – 2400 nm
Total power[i]	> 110 mW
Total VIS power (450-850 nm)[i]	> 20 mW
Total power stability[ii]	< ± 1.0 %
Output pulse width	< 2 ns
Pulse-pulse jitter (standard deviation)[i]	< 2 us
Polarization	Unpolarized
Beam output	Gaussian, Single Mode
Beam quality TEM	$M^2 < 1.1$
Output beam divergence @500 nm	1.1 mrad ± 0.1 mrad
Waist width @500 nm	600 µm ± 60 µm
Waist location @500 nm	300 mm ± 150 mm
Optical Output	Collimated

i. Repetition rate dependant
ii. For ± 0.5 % contact NKT Photonics

Table 15 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	Coax trigger inpt: BNC -7 to 7 V analog input – pulse trigger Output Control: 5.08 mm 2-pin terminal 0 to 30 V analog input – pulse trigger
Pulse Synchronization	Analog pulse output: BNC 0 to 2 V – analog synchronization pulse Logic pulse output: BNC Monitor 0 V & 2.5 V – digital synchronization pulse
External Bus	RS-485 Bus - 15pin D-Sub Female Connector
Door Interlock	2 pin Connector - LEMO Part Number FGG.0B.302

Table 16 Mechanical dimensions and environment

Size (H x W x D)	93 x 220.5 x 367 mm (3.66 x 8.68 x 14.45 in)
Weight	3.5 kg (7.7 lb)
Operating temperature	18°C to 30°C (59°F to 86°F)
Operating humidity (non-condensing)	20 to 80%

Table 17 Electrical

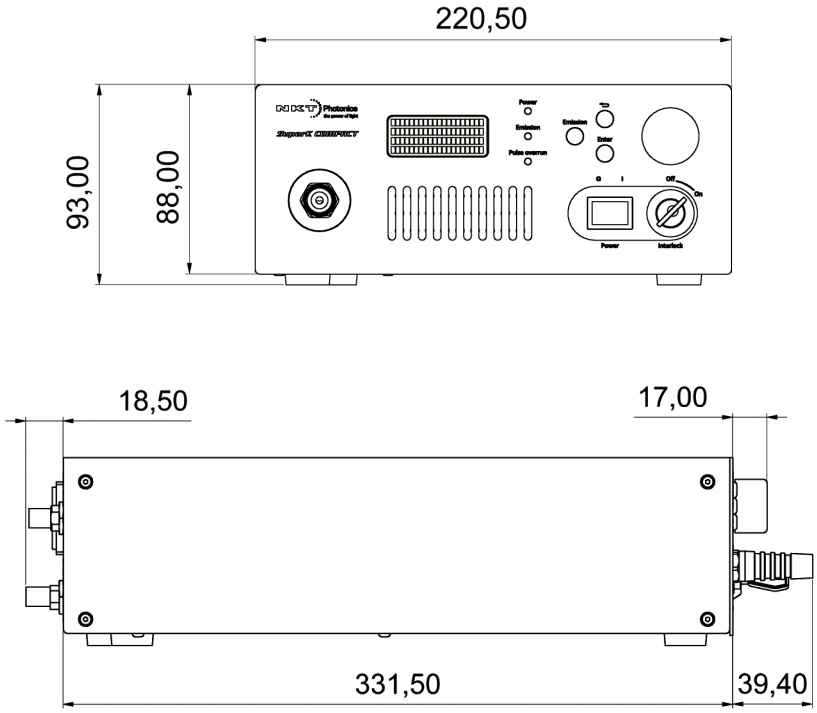
AC Power	Input 100-240 VAC 50-60 Hz
Fuse types	T 2A, 250 V
Typical power consumption – emission ON[i]	20-30 W
Maximum power consumption – emission ON	50 W
Maximum power consumption with accessory[ii]	100 W

i. Repetition rate set to 20 kHz.
ii. Accessory connected to COMPACT external bus connector.

CE

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

Figure 59 Mechanical dimensions



B Service and Support Information

Servicing the laser

The SuperK Extreme series lasers have no user serviceable components. In case of malfunction, contact NKT Photonics using the support website listed below under “Support contact details”.

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

Opening the laser chassis

There are no user serviceable components inside the SuperK Extreme chassis. Should your laser malfunction, and it cannot be serviced on site, it must be shipped to the NKT Photonics Headquarters in Denmark.

WARRANTY VOID IF REMOVED label

Chassis

The chassis is sealed with a label “WARRANTY VOID IF REMOVED”. It is strictly prohibited to remove the chassis cover.

Figure 60 WARRANTY VOID LABEL

Collimator

The collimator housing is sealed with a label “WARRANTY VOID IF REMOVED”. It is strictly prohibited to disassemble the collimator housing.

Figure 61 WARRANTY VOID IF REMOVED - Collimator

Support contact details

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

Support website

1. Go to:

   https://www.nktphotonics.com/support

2. Scroll down and click or press:

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

Shipping address

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

C External Bus Pinout

Table 18 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 Fiber Maintenance

Fiber tip cleaning

Only use cleaning tools specifically designed for use with optical fibers. Always use extreme caution when cleaning fibers.

Examples of appropriate cleaning tools are:

Lens cleaning tissue (lint free wipes) see Figure 62

Optical fiber cleaning tool see Figure 63

Figure 62 Lens cleaning tissue - lint free

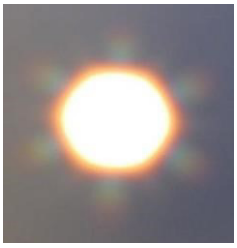
Figure 63 Optical fiber cleaning tool

Signs of damage

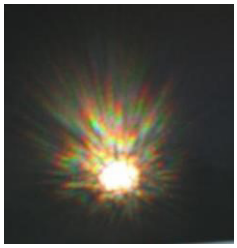
Indications of a damaged fiber facet may be due to one of the following:

- Power suddenly decreases (from e.g. 100 mW to 60-70 mW)
- The spectrum (recorded from an optical spectrum analyzer) is significantly degraded compared to the original spectrum found in the measurement report.
- Light emitted from the fiber facet results in with a large color variation. A correct hexagonal pattern vs a random is shown in Figure 64.

Figure 64 Correct vs incorrect beam profile



Correct beam profile



Incorrect beam profile

When the fiber facet is clean and undamaged, the emitted beam has a noticeable hexagonal shape which is the correct beam profile. An Incorrect beam profile occurs as a result of a damaged or dirty fiber facet. In this case, the emitted beam is random in direction and displays considerable variation in color.

Damaged facet

If the fiber facet is damaged, the connector must be re-polished before operating the laser. Failing to do so, could result in incorrect measurements/ usage or even damage to the laser unit itself.

CAUTION: A SuperK COMPACT is equipped with a Photonic Crystal Fiber (PCF). The connector attached to it should NOT be removed, special equipment and procedures are required to fit a new connector with the fiber.

Polishing

The end of the fiber is collapsed to a length of 150-200 microns. This allows enough length to polish the fiber end; however, you must be careful not to over polish and generally NKTP recommends to return the unit for factory polishing.

The general procedure is to:

1. Clean the connector and quickly and very lightly, polish the connector end.

CAUTION: Do not over-polish the connector end (fiber facet). Over-polishing the connector end damages it due to its limited length.

2. Clean the connector and then switch the source on. Observe the exit beam on a screen. If it is not a well-formed single mode emission, repeat step 1.

3. Continue this "quick polish, check beam" process until a well-formed beam is obtained.

If you do not obtain a good beam profile after polishing, the connector may be damaged. Return the laser to NKT Photonics for repair. Note that this type of repair is not covered by warranty.

E Accessories

This appendix provides a brief overview of the accessories available for your laser. Table 19 lists the accessories and their functions and provides a link to descriptions of the SuperK COMPACT advanced accessories.

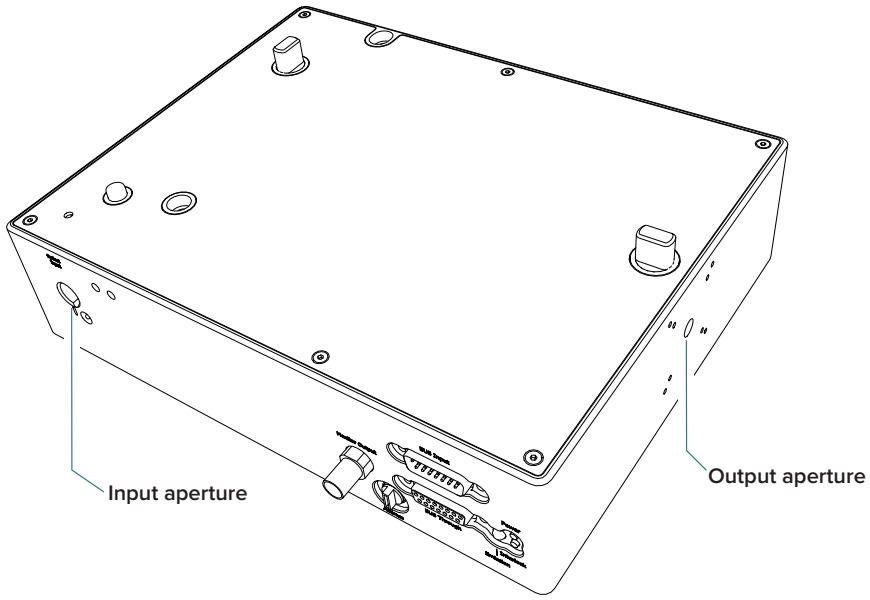
Table 19 SuperK COMPACT accessories

Advanced accessories	Function	Part number	
VARIA	Variable bandpass filter	A301-100-000	“SuperK VARIA” on page 94.
SELECT	Multi-wavelength AOTF	A203-XXX-000 or A203-XXX-010	“SuperK SELECT” on page 95.
LLTF	Narrow laser line filter	A371-500-000 or A371-200-000	“SuperK LLTF” on page 97.
SPLIT	Broadband filter	A102-200-000 or A102-500-000	“SuperK SPLIT” on page 98.
CONNECT	Delivery fiber	A401-000-000 or A401-200-000 or A401-500-000	“SuperK CONNECT and Fiber Deliver System” on page 100.
Other accessories			
Connect Holder	Optical table mount for Connect accessory.	000-000-003	
Collimator Holder	Receptacle for laser or accessory collimator.	M0002-4041-00	
External Filter Holder	Beam path 1” filter mount for any filter accessory.	A000-000-004	
TL30 mm Adapter	Accessory adapter for Thorlabs 30 mm cage system.	A000-000-005	
USB Adapter Kit	USB to RS485 adapter, used to connect accessories to a PC.	A911-100-103	
Key	Spare key for the laser’s key switch.	A911-100-009	
External Bus Defeater	Spare bus defeater for the External Bus ports.	A911-100-007	
Door Interlock Connector	Spare Lemo connector assembly for the door interlock circuit.	A911-100-005	
Bus Cable	Used to connect the laser to any accessories.	A911-100-006	
USB Cable	Spare Type A to B USB cable.	A911-100-004	
BNC Cable	Used to connect External Control Input or Pulse Output.	A911-100-008	

SuperK VARIA

VARIA accessories act as bandpass filters when connected to the collimator of a SuperK COMPACT laser. A portion of the beam from the SuperK COMPACT is diverted to the VARIA's bandpass filter which removes the light wavelengths that fall outside a variable wavelength range. The filtered beam is then emitted from the main optical output of the VARIA. A CONTROL PC connected to the SuperK COMPACT controls the VARIA through the laser's front panel External Bus connector connected to the VARIA's bus input connector. CONTROL is used to configure the variable range of the VARIA's bandpass filter. The beam portion not diverted to the bandpass filter is output from the auxiliary optical output of the VARIA. A diagram of the accessory connected to the laser is shown in Figure 65.

Figure 65 VARIA



VARIA specifications

The bandpass filter specifications of the VARIA are shown in Table 20.

Table 20 VARIA specifications

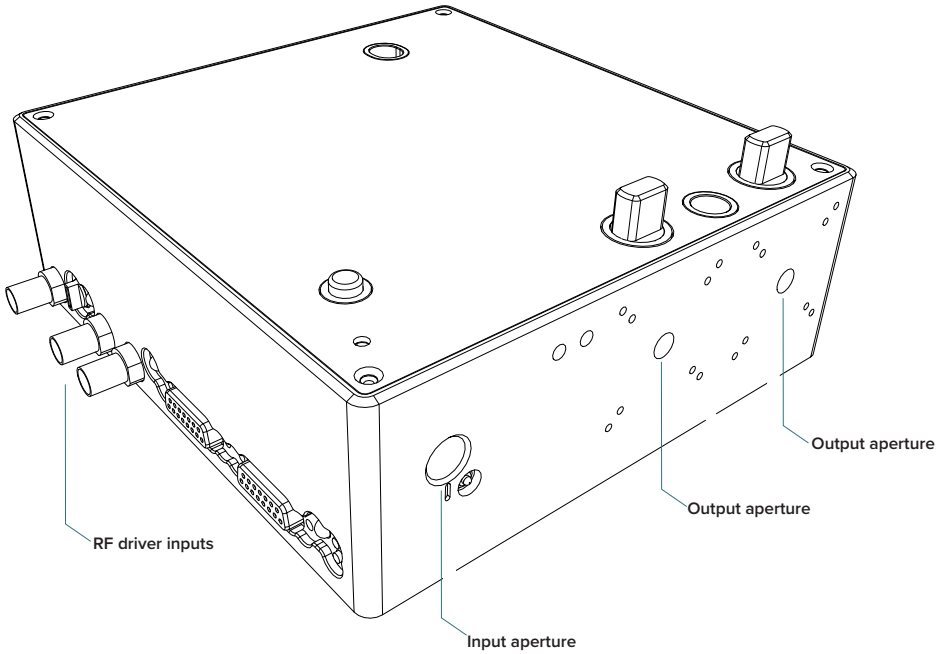
Specification	Function
Bandpass filter range (wavelength)	400 to 800 nm
Minimum linewidth	10 nm
Transmission efficiency	Approximately 80%
Filter suppression	Approximately 50 dB

NOTE: For further details, refer to the *SuperK VARIA Product Guide*.

SuperK SELECT

SuperK SELECT accessories can be fitted to extract multiple specific light wavelengths from the broadband spectrum output of the SuperK COMPACT laser. The SELECT accessory uses Acousto-optic Tunable Filter (AOTF) technology using tellurium dioxide crystal(s) that diffracts the desired beam wavelength. The specific wavelength diffracted by each crystal is tuned by applying an RF signal to it. A single SELECT crystal filter can output up to eight tunable wavelengths configurable through CONTROL. A SELECT accessory is fitted with either one or two AOTF crystal filters to deliver a maximum of 16 specific wavelengths tuned and extracted from the laser's broadband output. A SELECT connected to a SuperK COMPACT is shown in Figure 66.

Figure 66 SELECT



Output delivery

The beam delivery from the SELECT output is either a free space collimated beam or fiber coupled using SuperK Fiber Delivery (FD) with a SuperK CONNECT (fiber coupling connector). The AOTF crystal output naturally includes power from numerous sidebands, see Figure 67 on page 96. Free space delivery implements a small aperture to suppress the bulk of the side lobe power beyond the first order. However, when using a fiber delivery system with the SuperK CONNECT, a small aperture is not required; the delivery system aperture provides the suppression.

Output beam specifications

The AOTF type(s) is specified when ordering a SuperK SELECT. The type of AOTF determines the possible wavelength range and bandwidth that can be diffracted from the crystal. Table 21 lists the available AOTFs that can be fitted to a SuperK SELECT.

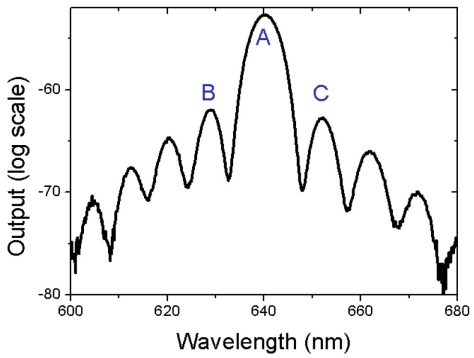
Table 21 SELECT AOTF types[1]

AOTF Type	Wavelength Range (nm)[i]
UV-VIS	400-650
VIS (1x)	430-700
VIS (4x)	450-700
VIS-nIR	500-900
nIR1	640-1100
nIR2	800-1400
IR	1100-2000

i. Subject to change, refer to the current product datasheet for the latest specifications.

As noted earlier, the tuned beam which is defracted from a SELECT crystal filter also includes a number of n'th order side lobes. A typical example is shown in the output spectrum graph of Figure 67. In this case, the tuned wavelength is set to 640 nm and the energy of the 1st order side lobe is approximately 10 dB less than the central wavelength.

Figure 67 SELECT AOTF example output - 640 nm central wavelength



NOTE: For further details, refer to the *SuperK SELECT Product Guide*.

1. Ranges subject to change, refer to the latest NKT Photonics datasheet.

SuperK LLTF

A Laser Line Tunable Filter (LLTF) Contrast accessory provides a tunable and extremely narrow bandpass filter with out-of-band (OOB) suppression in the order of 60 dB. The filter is continuously tuned over the entire spectrum of the supercontinuum laser, converting the wide band beam to a finely tuned ps laser. The LLTF Contrast uses a non-dispersive filter that maintains the intrinsic single-mode beam quality of the laser.

There are four LLTF Contrast models, each with a specific tuning range as shown in table Table 22. Depending on the tuning range required, the LLTF accessory supports filters that cover both visible and NIR tuning ranges. Note that a separate PC-based GUI application is required to provide filter tuning control using USB 2.0 connectivity. The LLTF Contrast connected to a SuperK COMPACT is illustrated in Figure 68.

Output Delivery

The beam delivery from the LLTF Contrast is fiber coupled using a Fiber Deliver (FD) such as a SuperK Connect (fiber coupling connector).

Figure 68 SuperK LLTF Contrast

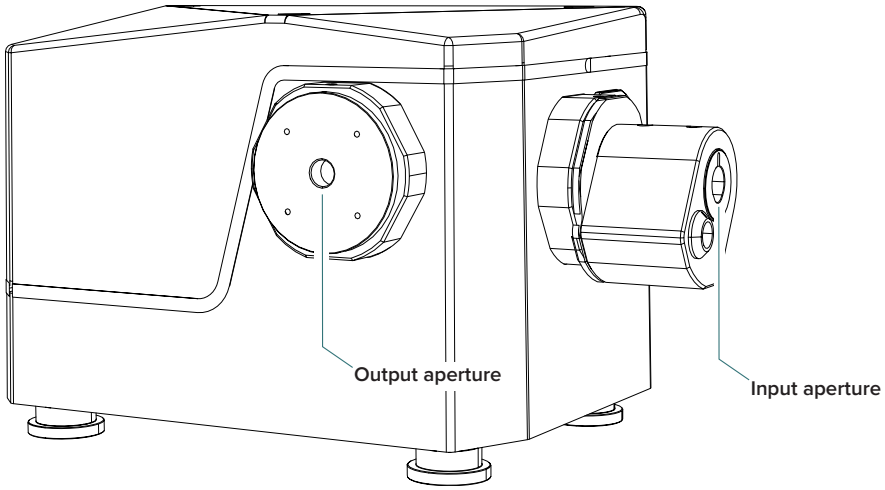


Table 22 LLTF Contrast model specifications

LLTF model	Wavelength range	Spectral bandwidth	Maximum power
LLTF Contrast VIS	400-1000 nm	1.0-2.0 nm	8 W
LLTF Contrast SWIR	1000-2300 nm	2.0-5.0 nm	8 W

SuperK SPLIT

Use a SuperK SPLIT to divide the SuperK COMPACT emission into two separate spectral outputs. A SPLIT is a passive filter and it is available in two standard models where the spectral outputs are configured as either:

- VIS/IR – Visible and Infrared

  – or –

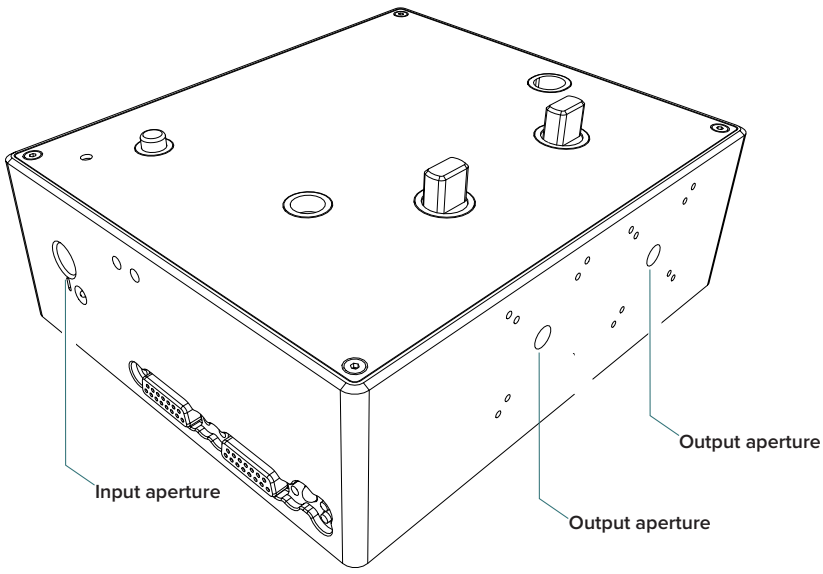
- nIR/IR – Near Infrared and Infrared

NOTE: A SPLIT can be ordered with custom wavelength splits, see Table 23 for the details regarding the wavelengths.

The separate outputs are both collimated and free-space and can be fitted with additional filters, polarizers, attenuators and for beam deliver, the CONNECT accessory.

A diagram of the SPLIT connected to the laser is shown in Figure 69.

Figure 69 SuperK SPLIT



SuperK SPLIT specifications

The specifications of the SPLIT are shown in Table 23.

Table 23 SPLIT wavelength ranges

Model	Wavelength Ranges
VIR/IR	400-800 and 915-2400 nanometers
nIR/IR	600-1120 and 1180-2400 nanometers

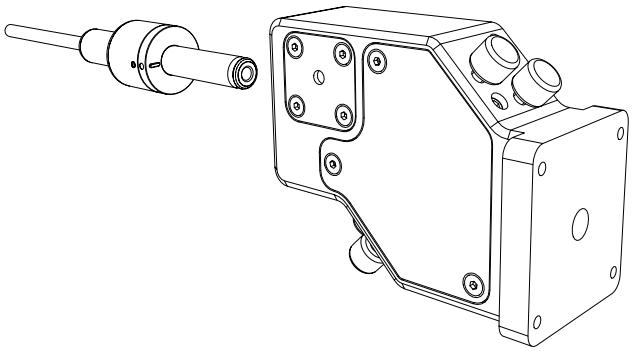
NOTE: For further details, refer to the *SuperK SPLIT Product Guide*.

SuperK CONNECT and Fiber Deliver System

A CONNECT is a single mode fiber coupling device which can terminate to a collimator and an FC /PC or FC/APC connector. As a fiber delivery system, CONNECT can be used with the laser or its accessories. It combines high coupling efficiency with power handling up to 500 mW over a spectrum from 400 to 2000 nm. You can disconnect and reconnect it to a photonic system without needing to realign the coupling. There are multiple CONNECT models built to match the emission characteristics of the application, contact NKT Photonics for more information on the available models.

A general view of the Connect accessory showing the location of the collimator input is shown in Figure 70.

Figure 70 SuperK Fiber Delivery System using a CONNECT



F Control Software

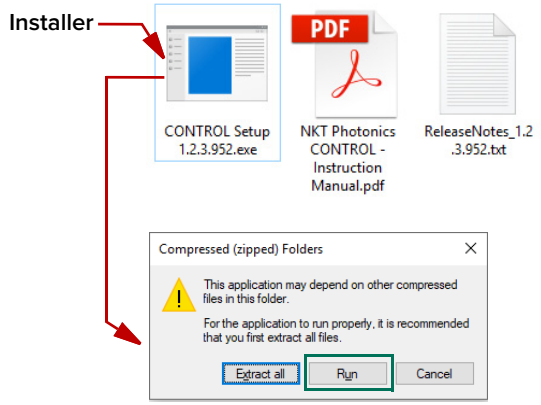
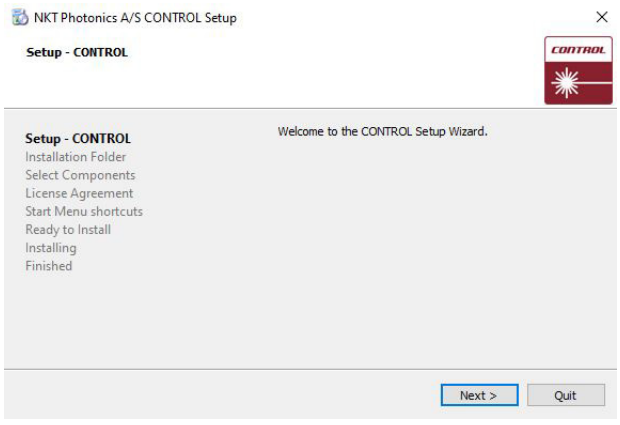
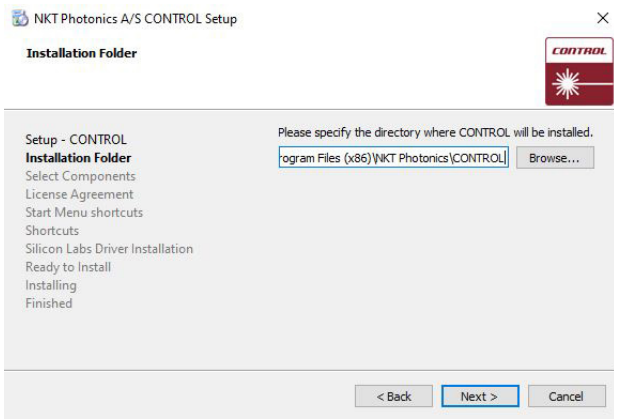
Installing CONTROL

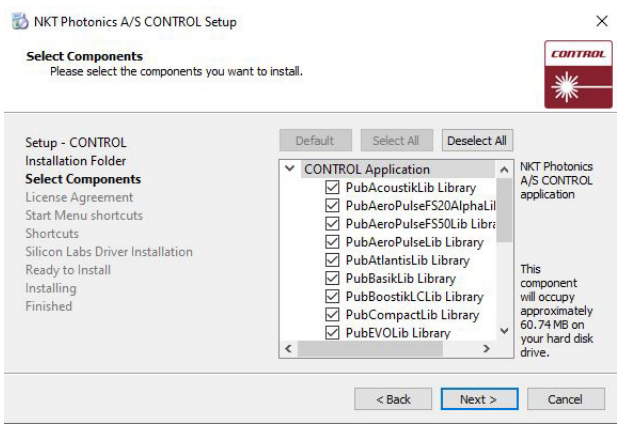
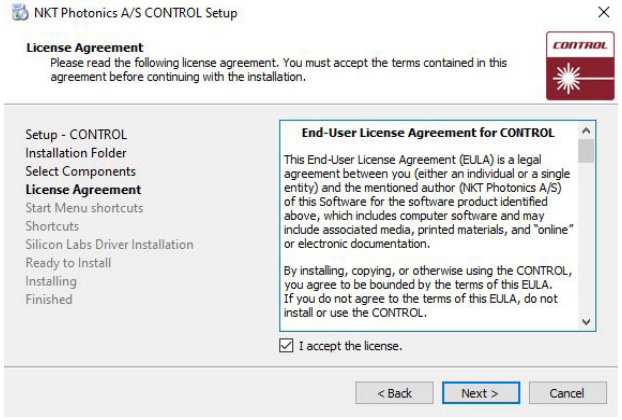
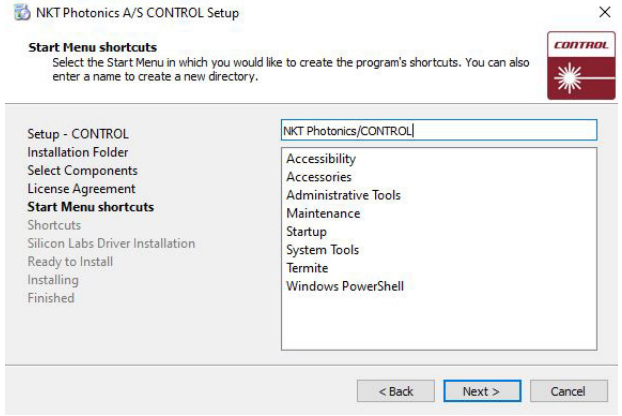
Download the software from:

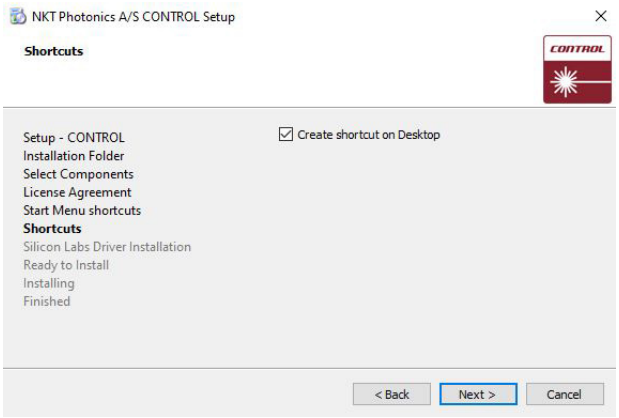
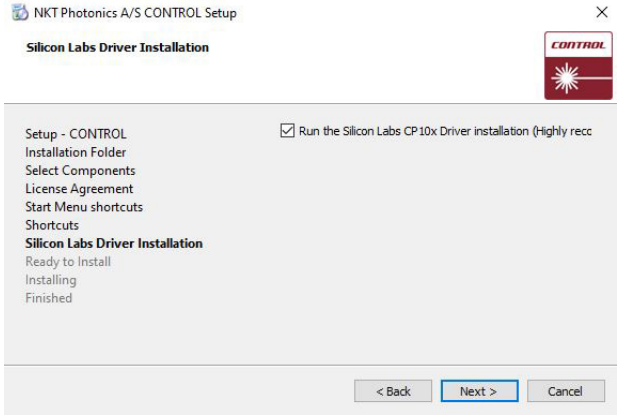
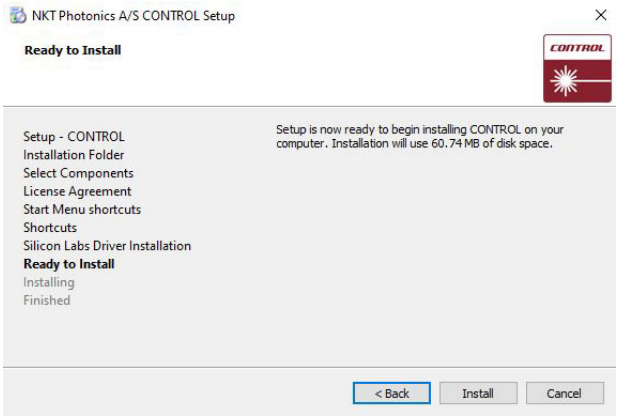
https://www.nktphotonics.com/lasers-fibers/support/software-drivers/

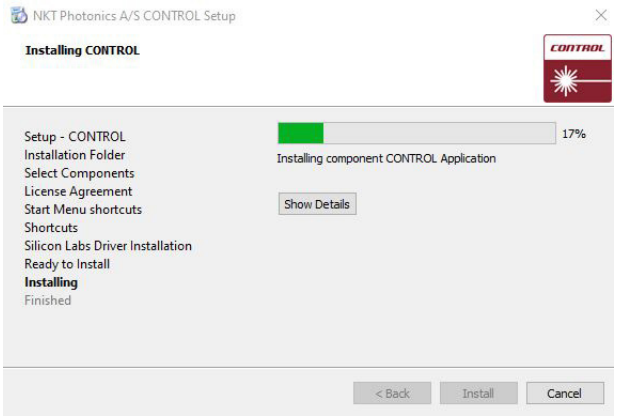
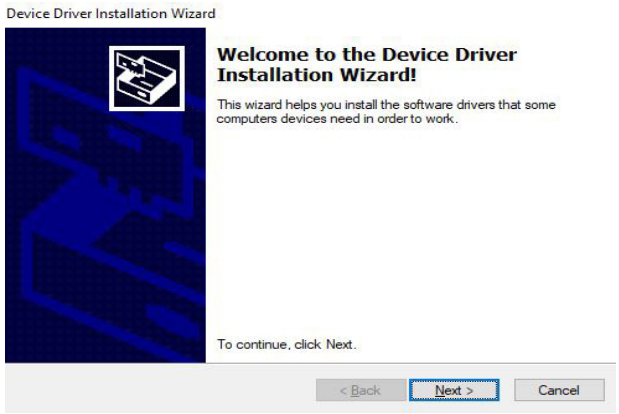
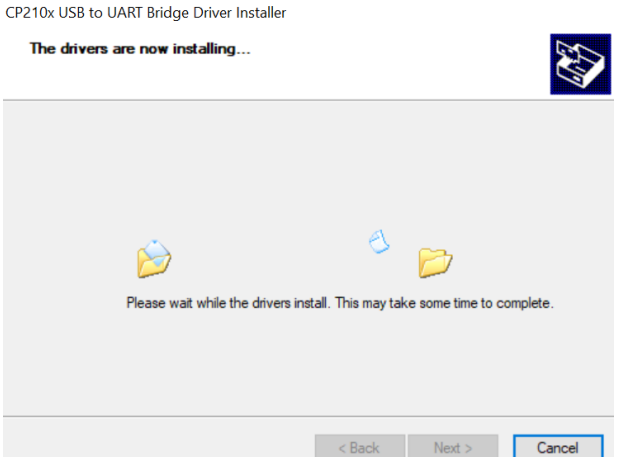
Follow the steps in Procedure .

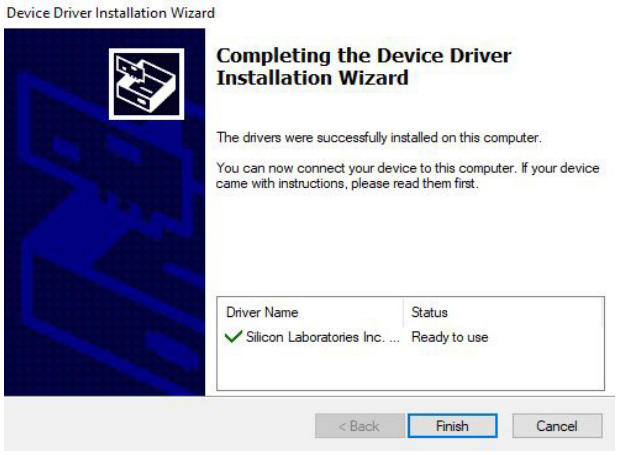
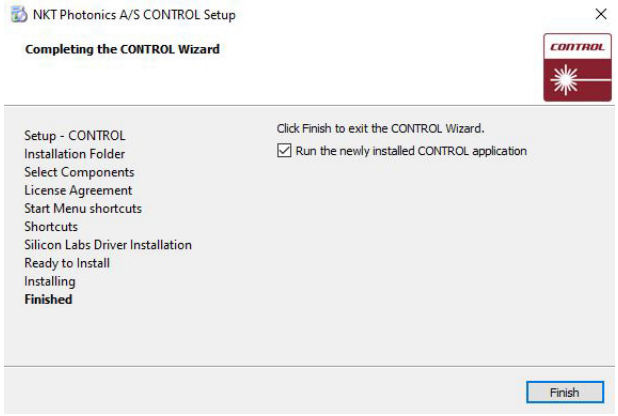
Procedure 10 Installing CONTROL

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

	Action	
4	Uncheck the components you do not require. By default, all components are installed. Click *Next* to continue.	
5	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.	
6	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	
7	Check the box to create a desktop shortcut to access Control. Click *Next* to continue	
8	Check the 'Run the Silicon Labs CP10x driver installation' box and click *Next*. **NOTE:** USB connectivity fails if you do not install the driver.	
9	Click *Install* to install NKTP CONTROL software on your PC. Click *Cancel* if you want to abort the installation.	

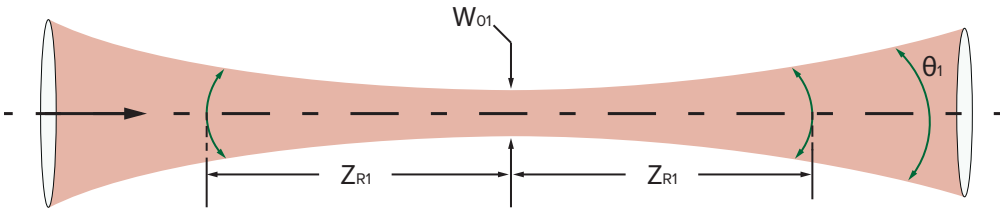
	Action	
10	.The wizard displays a progress meter for the installation. **NOTE:** A normal install should only take a few seconds.	
11	Click *Next* to install the UART drivers for the PC USB port.	
12	The drivers are installed. **NOTE:** Depending on your computer this occurs so fast you may not see this.	

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

G Collimator Output Beam Properties

Beam parameter definitions

Figure 71 Beam parameters



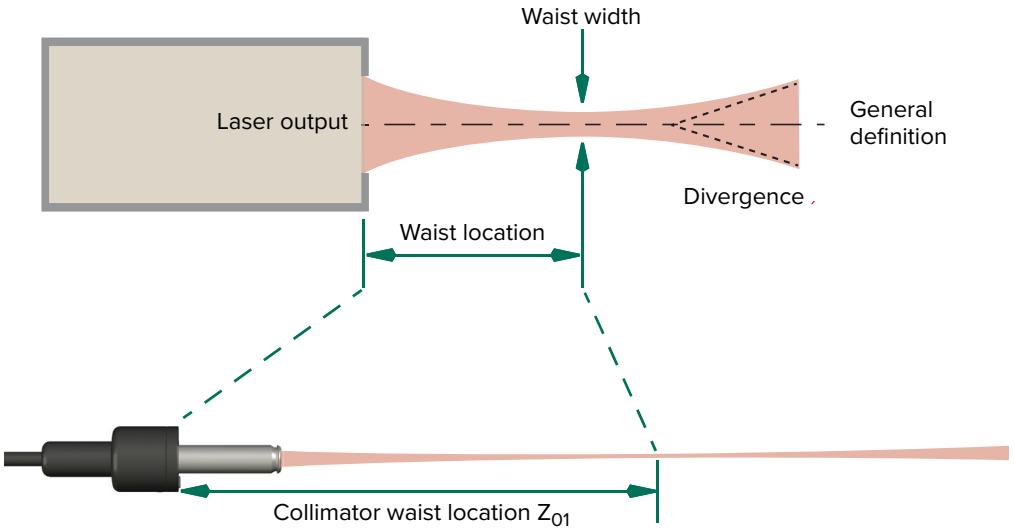
Definitions: W_{01}: Beam Diameter at waist location

θ_1: Full angle divergence after waist

Z_{R1}: Rayleigh length

Waist location

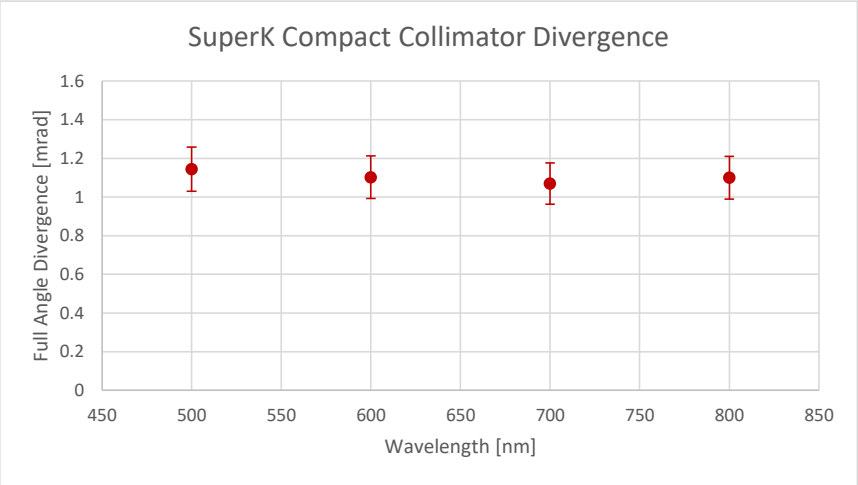
Figure 72 Beam waist location



Beam diameters in the visible range

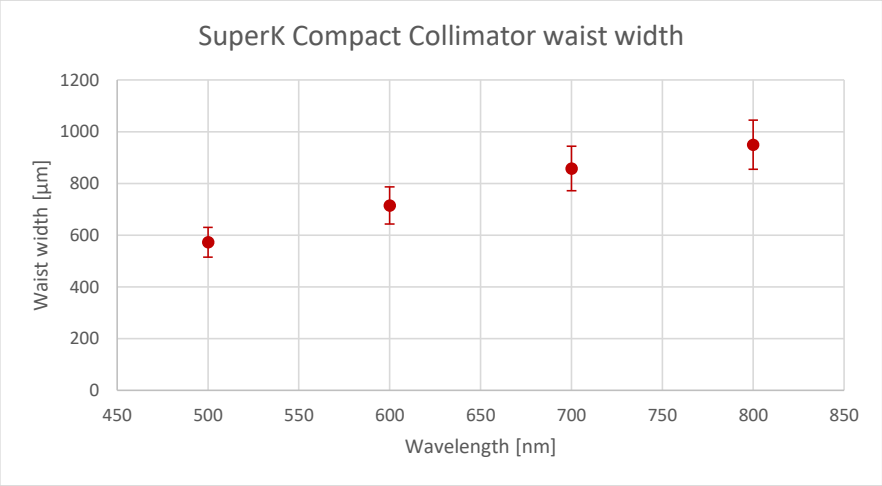
Full angle beam divergence θ_1

Figure 73 Full angle beam divergence θ_1



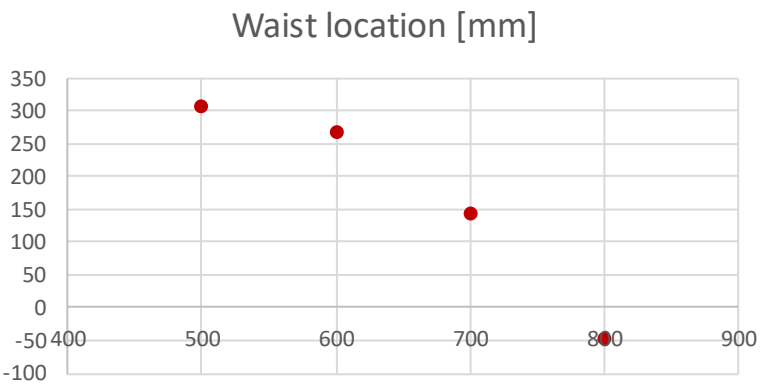
Beam diameter at waist location W_{01}

Figure 74 Beam diameter at waist location W_{01}



Waist location from collimator Z_{01}

Figure 75 Waist location from collimator collar face Z_{01}



Item: 800-629-01
Customer Revision: 1.5
NKT Photonics Revision: 5-1
Release Date: 02-2025

NKT Photonics A/S
Bregnerødvej 144, Birkerød-3460 Denmark

support@nktphotonics.com

NKT Photonics

A HAMAMATSU COMPANY