SUPERK EXTREME
White Light Laser

PRODUCT GUIDE
This guide includes the following NKT Photonics Lasers:

**SuperK Extreme**
Supercontinuum White Light Laser with optional Variable Repetition Rate

**SuperK Extreme OCT**
Supercontinuum White Light Laser with Low Noise Output for Optical Coherence Tomography
GUIDE OVERVIEW

This product guide is intended to provide functional, operational and installation information for the SuperK Extreme laser systems. The guide is divided into three sections:

- **SuperK Extreme Description** – introduces the laser’s theory and functionality, its features and interfaces, and describes the safety labels and their placement.

- **Operating the Laser** – provides information and procedures on how to configure communications with the laser and manage its operation.

- **Installing the Laser** – includes the details on how to install the laser chassis variants and connect it to the management platform and your application systems.

For information on how to safely deploy and operate the laser refer to the following documents:

- **SuperK Extreme Safety, Handling and Regulatory Information**

**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 Extreme 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 “Configuring External Control”** — This chapter provides the details to on how to implement external signals to modulate the output, enhance power stability and gate the output pulses.

- **Chapter 6 “Mechanical Installation”** — Includes information and procedures on how to correctly install the laser chassis. Procedures within this chapter focus on providing adequate temperature regulation.
• Chapter 7 “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, accessory descriptions and miscellaneous procedures supporting the laser operation and installation.

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

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

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

Warning: The laser safety warning alerts you to potential serious injury that may be caused when using the laser.

Revision The section records the document revision details.

<table>
<thead>
<tr>
<th>Release date</th>
<th>Version and changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019-December</td>
<td>1.00 first release - updated format and new material based on old manual versions and various other sources.</td>
</tr>
<tr>
<td>2020-September</td>
<td>1.1 release – removed legacy modes</td>
</tr>
</tbody>
</table>
## CONTENTS

Guide overview .................................................................................................................... 3

TABLES ........................................................................................................................... 11

FIGURES .......................................................................................................................... 13

PROCEDURES .................................................................................................................. 17

<table>
<thead>
<tr>
<th>Section 1</th>
<th>SUPERK EXTREME DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Laser description</td>
</tr>
<tr>
<td></td>
<td>Terminology</td>
</tr>
<tr>
<td></td>
<td>Accessories</td>
</tr>
<tr>
<td></td>
<td>CONTROL</td>
</tr>
<tr>
<td></td>
<td>Temperature regulation</td>
</tr>
<tr>
<td></td>
<td>Optical output</td>
</tr>
<tr>
<td></td>
<td>Supercontinuum</td>
</tr>
<tr>
<td></td>
<td>Spectral output</td>
</tr>
<tr>
<td></td>
<td>Collimator</td>
</tr>
<tr>
<td></td>
<td>Beam diameter</td>
</tr>
<tr>
<td></td>
<td>Factory test report</td>
</tr>
<tr>
<td></td>
<td>Output polarization</td>
</tr>
<tr>
<td></td>
<td>Polarization ring</td>
</tr>
<tr>
<td></td>
<td>Variable Repetition Rate</td>
</tr>
<tr>
<td></td>
<td>(Pulse Picker)</td>
</tr>
<tr>
<td></td>
<td>Repetition rates</td>
</tr>
<tr>
<td></td>
<td>Using VRR</td>
</tr>
<tr>
<td></td>
<td>Output power</td>
</tr>
<tr>
<td></td>
<td>Reflection monitor</td>
</tr>
<tr>
<td></td>
<td>Front panel controls</td>
</tr>
<tr>
<td></td>
<td>Operation LCD panel</td>
</tr>
<tr>
<td></td>
<td>Return button</td>
</tr>
<tr>
<td></td>
<td>Enter button</td>
</tr>
</tbody>
</table>
Section 2  OPERATING THE LASER  35

2 Front Panel Controls ................................................................. 37

Overview .................................................................................... 37

General operation ................................................................. 37

Menu items ........................................................................ 38

Output emission control .................................................. 38

Interlock ......................................................................... 38

Key switch ...................................................................... 38

Reset interlock .................................................................. 39

Operating mode ................................................................. 39

Repetition rate ................................................................. 40

Input readouts .................................................................. 41
5 Configuring External Control ......................................................................................... 69

   External feedback ....................................................................................................69
   Output control ........................................................................................................... 70
   Modulation input ...................................................................................................... 71

Section 3  INSTALLING THE LASER ........................................................................ 73

6 Mechanical Installation ........................................................................................... 75

   General installation ............................................................................................. 75
   Installing the laser chassis...................................................................................... 76

7 Connecting the Laser ............................................................................................... 77

   Connecting the safety interlock .............................................................................77
   Interlock operation .................................................................................................. 77
   Connecting power .................................................................................................... 79
   Connecting the optical output (collimator installation)....................................... 80
   Back reflection ........................................................................................................ 80
   Installing the collimator ..................................................................................... 80

Connecting Accessories with the External Bus ....................................................... 81

   External Bus .......................................................................................................... 81
   Connecting the External Bus .............................................................................. 82

Connecting synchronization ports ........................................................................... 83

   Terminating synchronization signals ............................................................... 84
   Example synchronization circuit ..................................................................... 84
   Seed Pulse ............................................................................................................85
   Gate Out ................................................................................................................85
   Pulse Monitor ....................................................................................................... 85
Appendices

A Specifications .................................................................................................................... 89

B Service and Support Information ...................................................................................91

Servicing the laser......................................................................................................... 91
Opening the laser chassis ......................................................................................... 91
WARRANTY VOID IF REMOVED label ........................................................... 91
Support contact details ........................................................................................... 91
Support email ........................................................................................................... 91
Online support web-page ....................................................................................... 91
Shipping address ................................................................................................. 91

C Accessories ........................................................................................................................93

Accessory descriptions........................................................................................... 94
Polarization Ring ...................................................................................................... 94
SuperK Varia .......................................................................................................... 94
SuperK Select ......................................................................................................... 95
SuperK LLTF .......................................................................................................... 96
SuperK Split ........................................................................................................... 97
SuperK Connect .................................................................................................... 98
SuperK Extend UV ...............................................................................................100

D Control Software ..............................................................................................................101

Installing CONTROL................................................................................................. 101

E Troubleshooting and Errors ......................................................................................... 107

Troubleshooting ...................................................................................................... 107
Alarms codes and recovery .................................................................................. 108
Possible fault causes .......................................................................................... 108
Table 1: Beam diameter (1/e limit) after collimator for three wavelengths ........... 24
Table 2: Frequency versus VRR factor ................................................................. 25
Table 3: Status LEDs ......................................................................................... 33
Table 4: Chassis labels ...................................................................................... 34
Table 5: Front panel menu items ....................................................................... 37
Table 6: Operating modes ............................................................................... 64
Table 7: Device Monitor parameters ................................................................. 66
Table 8: External Feedback Input parameters ............................................... 69
Table 9: Modulation input limitations .............................................................. 71
Table 10: Air flow considerations ..................................................................... 76
Table 11: External Bus connection mode ......................................................... 82
Table 12: Pulse synchronization signals ......................................................... 83
Table 13: NIM Pulse connection specification .............................................. 84
Table 14: Optical .............................................................................................. 89
Table 15: Interfaces ......................................................................................... 89
Table 16: Mechanical dimensions ................................................................. 90
Table 17: Electrical ......................................................................................... 90
Table 18: SuperK Extreme accessories ........................................................... 93
Table 19: Varia specifications .......................................................................... 94
Table 20: Select AOTF types .......................................................................... 96
Table 21: LLTF Contrast Model Specifications ............................................ 97
Table 22: SPLIT Wavelength ranges ............................................................... 98
Table 23: Fiber delivery specifications ............................................................ 99
Table 24: Extend UV specifications ................................................................. 100
Table 25: Laser troubleshooting ..................................................................... 107
Table 26: Errors codes and recovery action .................................................. 108
FIGURES

Figure 1: SuperK Extreme general view ................................................................. 21
Figure 2: Supercontinuum output of the laser ...................................................... 23
Figure 3: SuperK Extreme collimator ................................................................... 23
Figure 4: Polarization ring mounted on a collimator .......................................... 24
Figure 5: Front panel features ............................................................................. 26
Figure 6: Rear panel features and connectors .................................................... 28
Figure 7: Seed Pulse output .................................................................................. 29
Figure 8: NIM pulse output .................................................................................. 30
Figure 9: Pulse monitor output ............................................................................ 30
Figure 10: SuperK Extreme rear panel status LEDs ........................................... 33
Figure 11: SuperK Extreme Panels ....................................................................... 34
Figure 12: Constant current level adjustment ..................................................... 38
Figure 13: Interlock circuit open notification ....................................................... 38
Figure 14: Key switch off notification ................................................................ 39
Figure 15: Reset interlock request ...................................................................... 39
Figure 16: Operating mode selection – Constant current .................................. 40
Figure 17: Operating mode selection – External feedback ............................... 40
Figure 18: Operating mode selection – Modulated current ............................. 40
Figure 19: Operating mode selection ................................................................. 41
Figure 20: Input readouts – feedback signal level ............................................. 41
Figure 21: Status display sub-menu .................................................................. 42
Figure 22: Date and time configuration .............................................................. 42
Figure 23: Display contrast sub-menu ................................................................. 43
Figure 24: Display brightness setting ................................................................. 43
Figure 25: Serial number sub-menu ................................................................. 44
Figure 26: Firmware version sub-menu .............................................................. 44
Figure 27: CONTROL panel navigation .......................................................... 53
Figure 28: Dragging panels to a new location in the main window .................... 54
PROCEDURES

Procedure 1: Connecting a PC to the laser using a USB cable ............................... 48
Procedure 2: Turning ON the laser ................................................................................. 50
Procedure 3: Turning OFF the laser ................................................................................ 51
Procedure 4: Relocating panels ...................................................................................... 54
Procedure 5: Using the Key Updater tool ..................................................................... 60
Procedure 6: Using the Log Downloader ..................................................................... 62
Procedure 7: Connecting the door interlock circuit ................................................... 79
Procedure 8: Connecting power ..................................................................................... 79
Procedure 9: Installing the Collimator ............................................................................ 80
Procedure 10: Installing CONTROL .............................................................................. 101
SECTION 1

SUPERK EXTREME DESCRIPTION

This section provides a description of the laser and its features.

- “Laser description” on page 21
- “Optical output” on page 22
- “Reflection monitor” on page 26
- “Front panel controls” on page 26
- “Rear panel interfaces” on page 28
- “Configuration and operation overview” on page 31
- “Status LEDs” on page 33
- “Chassis labels” on page 34
1 Laser description

SuperK Extreme lasers are a series of white light lasers (WLL) systems that can generate a pulsed supercontinuum as a class 4 laser source. Using a 78 Mhz seed laser, light frequencies from 400 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 multiple output ports that transmit various synchronization signals at the laser pulse rate.

SuperK Extreme OCT

The SuperK Extreme can be specified as a supercontinuum source for ultra-high resolution Optical Coherence Tomography (OCT) and multi-modal applications. The OCT models include a 312 MHz seed which can be customized as is the case for all SuperK Extreme lasers.

Figure 1 SuperK Extreme general view

Terminology

The SuperK Extreme series includes the models listed in the “PRODUCT GUIDE” on page 2. This guide uses the term, “laser” to refer to all SuperK Extreme 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 C.

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 RS232, USB, or Ethernet 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 47.

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 from the vents on the left and right panels of the laser. The heated air is then blown out through the rear exhaust vents. The fan speed is automatically adjusted to maintain a stable laser temperature. To maintain air flow the laser must be installed with proper clearance as described in “Mechanical Installation” on page 75.

Optical output  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 below shows the output spectrum of a SuperK EXTREME at output power levels of:

A. 4.5 W
B. 2.8 W
C. 1.5 W
D. 1.0 W
Collimator  

The laser’s optical output uses a collimator (see Figure 3) where the laser beam is emitted from. The collimated beam exits the collimator from a hollow steel sleeve which is inserted into a receptacle of a target optical device such as for example, a SuperK accessory or an optical power meter.

**Figure 3** SuperK Extreme collimator

![Collimator Diagram](image)

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

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

Heat dissipation  

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

**Beam diameter** To maximize the output light coupling with a single mode fiber, the output beam is collimated with an achromatic lens. The lens is designed so the coupling is optimized for maximum average coupling across the visible spectrum. Consequently, the beam is slightly larger for infrared as compared with visible wavelengths, see Table 1.

**Table 1** Beam diameter (1/e limit) after collimator for three wavelengths

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>Beam Diameter at the collimator output</th>
<th>Beam Diameter 40 cm from the collimator</th>
<th>Beam Diameter 180 cm from the collimator</th>
</tr>
</thead>
<tbody>
<tr>
<td>480</td>
<td>0.49 mm</td>
<td>0.63 mm</td>
<td>1.62 mm</td>
</tr>
<tr>
<td>560</td>
<td>0.58 mm</td>
<td>0.78 mm</td>
<td>1.67 mm</td>
</tr>
<tr>
<td>800</td>
<td>1.06 mm</td>
<td>1.17 mm</td>
<td>1.94 mm</td>
</tr>
</tbody>
</table>

**Factory test report** The SuperK EXTREME laser systems can be specified in multiple configurations with different spectral- and power performance. The system performance of each laser is described in factory created test- and measurement report. Refer to this report for the spectral performance of the individual SuperK EXTREME system.

**Output polarization** At low output power, the supercontinuum output is elliptically polarized and the direction of the polarization vector and the degree of polarization varies with time. When increasing the output power, the degree of polarization decreases; at maximum output, the light is close to unpolarized.

**Polarization ring** A polarization ring must be combined with the collimator when it is inserted into the optical input of a SuperK accessory. The ring has an alignment pin to ensure correct polarization with the accessory. It also acts as a spacer to position the collimator correctly when inserted in the accessory input receptacle.

![Figure 4: Polarization ring mounted on a collimator](image)

**Note:** See “Polarization Ring” on page 94.
Variable Repetition Rate (Pulse Picker)

The Variable Repetition Rate (VRR) module option or Pulse-Picker is capable of suppressing output pulses, reducing the repetition rate of the system.

Repetition rates

When using VRR, the repetition rate can be lowered by a factor up to 40. Table 2 shows the repetition rates for a sample laser operating with a standard 78 MHz seed laser.

Table 2 Frequency versus VRR factor

<table>
<thead>
<tr>
<th>Seed Frequency MHz</th>
<th>VRR Factor</th>
<th>Seed Frequency MHz</th>
<th>VRR Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>78</td>
<td>1.1</td>
<td>4.9</td>
<td>1.16</td>
</tr>
<tr>
<td>39</td>
<td>1.2</td>
<td>4.3</td>
<td>1.18</td>
</tr>
<tr>
<td>26</td>
<td>1.3</td>
<td>3.9</td>
<td>1.20</td>
</tr>
<tr>
<td>19.5</td>
<td>1.4</td>
<td>3.5</td>
<td>1.22</td>
</tr>
<tr>
<td>15.6</td>
<td>1.5</td>
<td>3.1</td>
<td>1.25</td>
</tr>
<tr>
<td>13</td>
<td>1.6</td>
<td>2.9</td>
<td>1.27</td>
</tr>
<tr>
<td>11.1</td>
<td>1.7</td>
<td>2.7</td>
<td>1.29</td>
</tr>
<tr>
<td>9.8</td>
<td>1.8</td>
<td>2.4</td>
<td>1.32</td>
</tr>
<tr>
<td>8.7</td>
<td>1.9</td>
<td>2.3</td>
<td>1.34</td>
</tr>
<tr>
<td>7.8</td>
<td>1.10</td>
<td>2.1</td>
<td>1.37</td>
</tr>
<tr>
<td>6.5</td>
<td>1.12</td>
<td>2.00</td>
<td>1.40</td>
</tr>
<tr>
<td>5.6</td>
<td>1.14</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Other possible configurations of repetition rates may be available depending on the laser’s specifications. Contact NKT Photonics for further information.

Using VRR

If the repetition rate is changed while the system has emission on, the system momentarily shuts off emission, changes the repetition rate and turns on emission again. The complete sequence takes only a fraction of a second.

Output power

Increasing the repetition rate will increase the output power level. For example, if the repetition rate is changed from 2 MHz to 78 MHz, the output power increases by a factor of 40 (80/2). This is due to the laser being calibrated for constant pulse energy and not for constant average power.
Reflection monitor

The SuperK EXTREME is equipped with a reflection monitor to avoid damage from back reflections that can destroy the system. When the reflection monitor detects a back reflection that exceeds the limit, the laser shuts down and displays the error code: “Code 48, 5 0x65”. See “Alarms codes and recovery” on page 108.

Front panel controls

The front panel features are highlighted in Figure 5. The panel provides both user controls and displays to directly operate the laser.

Figure 5  Front panel features

1  Operation LCD Panel  5  Power LED
2  Return Button  6  Emission Indicator
3  Enter Button  7  Emission Button
4  Operation Dial  8  Key Switch
**Operation LCD panel**  The LCD panel displays a menu system used for front panel operation of the laser along with the operation dial and return/enter buttons. The menu system shown on the display can configure, operate and view the laser status.

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

**Enter button**  Enter and confirm function for the LCD menu system.

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

**Power LED**  Indicates AC mains power is connected and the laser is on when ON Green.

**Emission LED**  Indicates there is laser emission when ON Red.

**Emission button**  Button to turn on or off the laser emission.

**Key switch**  Key control of laser emission, when off emission is not permitted.
Rear panel interfaces

The rear panel houses the electrical ports and status LEDs. The panel and its components are depicted in Figure 6.

Figure 6 Rear panel features and connectors

1. Collimator and Armored Cable Assembly
2. Collimator Storage Receptacle
3. NIM Pulse – BNC connector
4. Pulse Monitor – BNC connector
5. Gate Output – BNC connector
6. Modulation Input – BNC connector
7. External Feedback BNC connector
8. Power Status LED
9. AC Power connector and power switch
10. External Bus - DB-15 connector
11. Output Control
12. Interlock – 2 pin LEMO connector
13. Status LEDs
14. USB serial port – type B USB connector
15. RS-232 serial port – DB-9 connector
16. Seed Pulse – BNC connector

i. Items 3, 4 and 5 only with VRR option

Output Control

This input for the Output Control feature provides a fast rise time ON/OFF control. A TTL or CMOS level square wave applied at the port, turns the booster ON when the signal is high and OFF when the signal is low.

Maximizing the laser warranty

The laser’s lifetime is influenced by the total usage of the main amplifier. When the application does not require the laser to be ON continuously. Laser lifetime can be optimized by minimizing the laser ON time.
**Warning:** When this feature turns off the laser booster, the laser seed is still ON and low level Class 4 emission is still present at the laser aperture.

**Warning:** The Output Control feature must not be used as a safety interlock.

For information on connecting the Output Control feature see “Output control” on page 70.

**Seed Pulse output**

The signal from the Seed Pulse Output (See Figure 6) can synchronize external devices to the seed frequency of the laser. This signal is synchronized with the fundamental laser seed pulse before the VRR module. The signal is an analog output that ranges from 0 to +0.7 V. See “Seed Pulse” on page 85.

**Figure 7** Seed Pulse output

![Seed Pulse Output](image)

**Post VRR synchronization interfaces**

These interfaces provide synchronization signals that match the pulse output from the VRR module (pulse picker).

**NIM Pulse**

The port outputs a NIM level signal that is synchronized with the laser pulse output after the VRR module. The signal is NIM compliant (see standard DOE/ER-0457) and range from 0 to approximately -1 V. A sample capture of the NIM Pulse signal is shown in Figure 8. For further information See “Connecting synchronization ports” on page 83.
Pulse Monitor
This signal represents the laser pulse output after the VRR module. The signal is intended for applications that require a positive bias synchronization signal for external devices. Its output level ranges from 0 to +1.2 V (approximately). For further information see “Connecting synchronization ports” on page 83.

Gate Out
The Gate output port is available with the laser when the VRR module (pulse-picker option) is included. It is an digital output signal from 0 to ~+1.2 V. A high logic signal indicates a pulse passed through the VRR, whereas a low level indicates pulses are suppressed. The output signal frequency is synchronized with the configured repetition rate of the laser. For further information see “Connecting synchronization ports” on page 83.

**Note:** Fiber and cable lengths used will cause delay between pulses measured on any of the pulse monitoring ports.
Modulation input

An analog signal applied to the optional Modulation input modulates the output amplitude of the laser by varying the current in the laser booster. For further information, refer to “Modulation input” on page 71. If the laser is equipped with this input, it must be configured to operate in Current Modulation mode (see “CONTROL – Operating mode” on page 64). In this mode, a maximum current set point is configured and current in the booster is modulated by a signal voltage applied to the Modulation input connector.

External Feedback (stabilization)

The output power of the laser emission can be controlled from an external feedback circuit connected to the External Feedback connector. The connector accepts an input voltage ranging from 0 to 4.1 V. An external detector can be employed to provide a varying input voltage level that is applied to the connector. The voltage level is then kept constant by regulating laser power—effectively providing a power lock.

Note: Feedback voltage variations above 100 Hz cannot be accurately detected by the sampling circuit. Refer to “External feedback” on page 69 for further information on how to employ a feedback circuit.

Note: Due to fiber and cable lengths a delay will be present between pulses measured on any of the pulse monitor ports.

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 available SDK. Control software is connected to the laser using one of the laser’s rear panel Ethernet or serial interfaces shown in Figure 6. To ensure safety, a key switch and door interlock circuit provides overriding control of the laser, preventing accidental exposure to emission.

CONTROL application

The laser is managed and configured from a PC with NKTP CONTROL application installed on it (CONTROL PC). The PC can be connected to the laser using either a serial or Ethernet connection.

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

Note: If both serial ports are connected, the USB2 port will have priority.

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

Once connected, you can use CONTROL to manage the laser’s emission and power settings. Further parameters such as line settings and bandwidths of various attached accessories can be configured using the platform. Additionally, CONTROL can be used to upload firmware or download the laser’s log file.
The Chapter “Connecting and turning ON the laser” on page 47 provides the details and procedures on how to connect CONTROL to the laser.

Advanced laser control
If required, the laser can be controlled from a custom platform connected to either the serial or Ethernet ports. To build your own custom control application, NKTP provides an SDK Kit which can be downloaded from:

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

Key switch and interlock safety
To enhance safety, the laser is equipped with an interlock interface (7) and a keyed switch. The two components work together to safely control laser emission. Both the interlock safety switch (door closed position) 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 will also open and laser emission is immediately shut down. “Connecting the safety interlock” on page 77 describes the details on how to connect the interlock.

Interlock Safety Reset
If the enclosure door opens and closes, the laser is shut down by the interlock. 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 (6) port connects optional SuperK Extreme accessories. The port provides a bus control interface and 12V DC power 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. Further, the bus extends the interlock safety circuit to the accessories. Because of this, the bus defeater must always be on the last open External Bus output otherwise the laser will not operate. For information on connecting the bus, see "Connecting the External Bus".

Note: The External Bus will only prevent the laser from operating when the Interlock circuit is connected as required by safety regulations either local or mandated.
Status LEDs

The rear panel houses four status LEDs as described in Table 3.

*Figure 10* SuperK Extreme rear panel status LEDs

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

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

The SuperK Extreme 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. Label locations are shown in Figure 11.

**Table 4** Chassis labels

<table>
<thead>
<tr>
<th>Label</th>
<th>Panel</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classification</td>
<td>Rear</td>
<td>Safety information stating the laser emission hazards and the laser’s class rating.</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>Rear</td>
<td>Manufacturing information including address, part and serial number, date manufactured and regulatory compliance.</td>
</tr>
<tr>
<td>Laser Radiation</td>
<td>Rear</td>
<td>Safety information alert indicating this area of the laser is near a source of dangerous laser emission.</td>
</tr>
<tr>
<td>Laser Aperture</td>
<td>Collimator</td>
<td>Safety information alert indicating the location of the aperture where laser radiation is emitted from the laser.</td>
</tr>
<tr>
<td>Laser Aperture</td>
<td>Rear</td>
<td>Safety information alert indicating the location of the aperture where laser radiation is emitted from, safety compliance information, and key emission specifications.</td>
</tr>
</tbody>
</table>

**Figure 11** SuperK Extreme Panels
This section describes how to manage and operate the laser and includes the chapters:

- “Front Panel Controls” on page 37
- “Connecting and turning ON the laser” on page 47
- “Turning on the Laser” on page 53
- “CONTROL Interface” on page 53
- “Configuring External Control” on page 69
2 Front Panel Controls

Overview

The front panel features an LCD system menu and controls that can be used to configure and operate the laser. The menu items available are listed in Table 5.

Table 5 Front panel menu items

<table>
<thead>
<tr>
<th>Menu Item</th>
<th>Function</th>
<th>See</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Emission Control</td>
<td>Sets the output level of the laser by adjusting either booster current or booster power emitted.</td>
<td>Output emission control on page 38</td>
</tr>
<tr>
<td>Interlock</td>
<td>Notification message indicating interlock open or short (not a sub-menu).</td>
<td>Interlock on page 38</td>
</tr>
<tr>
<td>Key Switch</td>
<td>Notification message indicating key switch in the OFF position (not a sub-menu).</td>
<td>Key switch on page 38</td>
</tr>
<tr>
<td>Reset Interlock</td>
<td>Notification message and option to indicate and reset the laser interlock (not a sub-menu).</td>
<td>Reset interlock on page 39</td>
</tr>
<tr>
<td>Operating Mode</td>
<td>Sub-menu to set the laser operation mode that controls the emission output power level.</td>
<td>Operating mode on page 39</td>
</tr>
<tr>
<td>Repetition rate</td>
<td>Sub-menu to select the repetition rate of the optional pulse picker.</td>
<td>Repetition rate on page 40</td>
</tr>
<tr>
<td>Input Readouts</td>
<td>Sub-menu that displays the voltage level of input control signals.</td>
<td>Input readouts on page 41</td>
</tr>
<tr>
<td>Status Display</td>
<td>Sub-menu to set the text string displayed on the LCD panel when the system menus are not accessed.</td>
<td>Status display on page 41</td>
</tr>
<tr>
<td>Date and Time</td>
<td>Sub-menu to set the time and date.</td>
<td>Date and time on page 42</td>
</tr>
<tr>
<td>Display Contrast</td>
<td>Sub-menu to set the display contrast.</td>
<td>Display contrast on page 43</td>
</tr>
<tr>
<td>Display Backlight</td>
<td>Sub-menu to set the display brightness.</td>
<td>Display backlight on page 43</td>
</tr>
<tr>
<td>Serial Number</td>
<td>Sub-menu to display the serial numbers of the laser modules and accessories.</td>
<td>Serial numbers on page 43</td>
</tr>
<tr>
<td>Firmware versions</td>
<td>Sub-menu to display the firmware revisions of the laser modules and accessories.</td>
<td>Serial number sub-menu on page 44</td>
</tr>
<tr>
<td>Emission Button</td>
<td>Turns on and off the laser emission.</td>
<td>Emission button on page 45</td>
</tr>
</tbody>
</table>

General operation

Accessing

If the panel is off – press the enter button.

Menu Selection

Turn the operation dial any direction to scroll up or down through the available menus. Press the enter button to select and access a sub-menu.
Exit menus
Press the return button to exit a sub-menu and return to the parent menu. To turn off the panel, press the return button while in the top menu.

Menu items

Output emission control
The operation dial can also be used to adjust the laser output emission level. To adjust the level:

1. Access the top menu and press the return button - i.e. exit all menus
2. The emission level can be adjusted using current level controls, to change the control type, skip to step 5.
3. The operation dial is now set to adjust the output level.
4. Turn the dial clockwise to increase the current level in the booster and counter-clockwise to decrease it – range 0 to 100% in increments of 1%. – END procedure.

Figure 12 Constant current level adjustment

Interlock
If the interlock circuit (See “Key switch and interlock safety” on page 32) is open or shorted to ground, the LCD menu displays one of the following notifications:

- External interlock – the external bus interlock circuit is open or shorted.
- Door interlock – the door interlock circuit is open or shorted.

Figure 13 Interlock circuit open notification

Key switch
If the laser key switch is set in the OFF position, a notification that the key switch is OFF is displayed.
**Figure 14** Key switch off notification

![Key switch off notification](image)

**Note:** When the key switch is in the OFF position, laser emission cannot be started. Emission is shut off if the switch is turned from ON to OFF.

**Reset interlock**

This menu notification request appears when the laser is restarted or the interlock circuit has been closed from a previous open or shorted state. The display shows:

- Reset interlock:

Press the Return button to reset the interlock to permit laser emission.

**Figure 15** Reset interlock request

![Reset interlock request](image)

**Operating mode**

Normally the laser operates in constant current mode. In constant current mode, the pump current in the booster is held constant at the set level. Two additional optional modes can also be accessed depending on the laser configuration from the factory. These modes use external input signals to control the laser’s emission level.

**Note:** NKT Photonics offers optional modes that can be added upon request. See “Configuring External Control” on page 69.

To set the operating mode:

1. Press the enter button to enter the laser control menus.
2. Turn the operation dial until the menu displays, “System menu - Operating Mode”
3. Press the enter button again to enter the operating mode selection menu.
4. Turn the operation dial to select either constant current or one of the optional modes as shown in Figure 17 or Figure 18. Press the enter button to set the operating mode.
External feedback mode
This is an optional mode where the set point is automatically set to 0%. In this mode, the set point can be adjusted from 0 to 90% when using the operation dial. The laser will lock to the external feedback signal (See “Configuring External Control” on page 69) 1.5 seconds after the set point level is configured.

**Warning:** When configured in external feedback mode, the laser requires a valid feedback signal to operate correctly. For example, an incorrect signal applied to the External Feedback connector may set the optical output power to its maximum level.

**Warning:** Before locking the laser to an External Feedback signal, it is recommended to monitor the External Feedback signal using the Input Readouts menu (See “Input readouts” on page 41).

Modulated current mode
This optional mode is used to modulate the current in the booster based on a varying analog input signal. Refer to “Modulation input” on page 71.

**Repetition rate**
If the laser includes the VRR (pulse-picker) option, the repetition rate is configured from this sub-menu (See “Repetition rates” on page 25).

To select and set the repetition rate:

1. Press the enter button to enter the laser control menus.
2. Turn the operation dial until the menu displays, “Repetition rate”

3. Press the enter button again to enter the Repetition rate selection menu.

4. Turn the operation dial to select the repetition rate.

5. Press the enter button to set the rate.

*Figure 19* Operating mode selection

![Figure 19 Operating mode selection](image)

*Warning:* When increasing the repetition rate, the output power increases proportionately.

*iNote:* If the VRR (pulse-picker) option is not included, the Repetition rate menu displays, “Feature unavailable”.

**Input readouts** Enter this sub-menu to view the levels of the following signals:

- Modulation – displays the modulation input voltage in millivolts (mV).

- Feedback – displays the voltage applied at the External Feedback connector in millivolts (mV).

*Figure 20* Input readouts – feedback signal level

**Status display** The status display sub-menu sets the front panel LCD to display optional text when the system menu is not entered. Using the sub-menu, the LCD panel can display the following options:

- User text – a user defined text string (for example the laser’s name; configured with NKT Photonics CONTROL software, see “View” on page 59.

- Date and time – the current system date and time, see “Date and time” on page 42

- Repetition rate – the configured repetition rate, see “Repetition rate” on page 40
Menu items

- Light source type – displays the laser model type.
- A blank line – i.e. no text is selected for display

To select and set the status display:

1. Press the enter button to enter the laser control menus.
2. Turn the operation dial until the menu displays, “System menu/Status display”
3. Press the enter button again to enter the “Status display” selection menu.
4. Turn the operation dial to select the status display option.
5. Press the enter button to set the display option.

**Figure 21** Status display sub-menu

**Date and time** The laser includes an internal clock with battery back-up. This sub-menu allows the date and time to be configured on the laser.

Set the date and time following the steps below:

1. Press the enter button to enter the laser control menus.
2. Turn the operation dial until the menu displays, “System menu/Date and time”
3. Press the enter button again to enter the “Date and time” selection menu.
4. Turn the operation dial to change the date or time set on the laser.
5. Press the enter button to switch the selection between the date and time parameters.

**Figure 22** Date and time configuration
**Display contrast**  This sub-menu adjusts the LCD panel contrast from 0 to 100%, in steps of 1%.

To change the contrast, follow the steps below:

1. Press the enter button to enter the laser control menus.
2. Turn the operation dial until the menu displays, “System menu /Display contrast”.
3. Press the enter button again to enter the “Display contrast” sub-menu.
4. Turn the operation dial to change the contrast set on the laser.
5. Press the enter button to set the display contrast to the selected percentage.

*Figure 23* Display contrast sub-menu

---

**Display backlight**  The display brightness of the LCD panel can be adjusted by varying the current in the back light from 0 to 30 mA in steps of 1 mA.

To set the brightness:

1. Press the enter button to enter the laser control menus.
2. Turn the operation dial until the menu displays, “System menu/Display backlight”.
3. Press the enter button again to enter the “Display backlight” sub-menu.
4. Turn the operation dial to adjust the display panel brightness.
5. Press the enter button to set the display brightness to the selected backlight current.

*Figure 24* Display brightness setting
### Serial numbers
Select this sub-menu to view the laser serial numbers. The serial numbers of the laser’s modules and connected accessories are displayed.

To display the serial numbers:

1. Press the enter button to enter the laser control menus.
2. Turn the operation dial until the menu displays, “System menu/Serial numbers.”
3. Press the enter button again to enter the “Serial numbers” sub-menu.
4. Turn the operation dial to scroll through the list of serial numbers.

*Figure 25* Serial number sub-menu

![Serial number sub-menu](image)

### Firmware versions
Select this sub-menu to view the laser firmware revisions. The firmware revisions of the laser’s modules and connected accessories are displayed.

To display the firmware revisions:

1. Press the enter button to enter the laser control menus.
2. Turn the operation dial until the menu displays, “System menu/Firmware versions.”
3. Press the enter button again to enter the “Firmware versions” sub-menu.
4. Turn the operation dial to scroll through the list of serial numbers.

*Figure 26* Firmware version sub-menu

![Firmware version sub-menu](image)
Emission button

Press the Emission button to turn laser emission ON and OFF. The Emission LED on the front will emit red light when the system has laser emission ON.

**Warning:** You must follow all safety regulations required for the location where the laser will be operated.

**Warning:** Turning on the laser will emit hazardous laser Class 4 radiation. Ensure to observe and implement all safety regulations, warnings and cautions in this guide and the *SuperK Extreme 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 Extreme 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 75 and “Connecting the Laser” on page 77. 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

The SuperK Extreme laser can be managed 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 D.

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 search feature to find the laser or its connected accessories.

Note: If necessary, it is also possible to connect the CONTROL PC to the RS-232 serial connection of the laser.

USB connection

Connect the PC directly to the laser using either the supplied USB cable or any USB Type A-B cable less than 3 meters long and follow the instructions in Procedure 1.
**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.  
   
2. Connect power to the Laser – see Connecting power on page 79.

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.

7. To manage the laser, click on the SuperK Extreme laser icon from the device selector list.

---

1. The PC can also be connected using a standard RS232 COM cable to the RS232 port on the laser. Turning On the Laser
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 Extreme Safety, Handling and Regulatory Information*

*Warning:* You must follow all safety regulations required for the location where the laser will be 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 75 and “Connecting the Laser” on page 77. This means the laser should be installed in the recommended environment with power applied and at the very minimum, the 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 47.

*Warning:* Turning on the laser will emit hazardous laser Class 4 radiation. Ensure to observe and implement all safety regulations, warnings and cautions in this guide and the *SuperK Extreme 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 Extreme 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 turn on the 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, the laser emission can be enabled from CONTROL software.

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

2. In the Control application, adjust the laser power.

3. If the reset interlock button is visible in the status panel

   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.

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

Turning OFF the laser

Follow the steps in Procedure 3 to turn off the laser emission.
### Procedure 3  Turning OFF the laser

<table>
<thead>
<tr>
<th>Action</th>
<th>ON</th>
<th>OFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Turn OFF laser emission by clicking on the software Emission button.</td>
<td><img src="image1.png" alt="Emission ON/OFF" /></td>
<td><img src="image2.png" alt="Emission ON/OFF" /></td>
</tr>
<tr>
<td>The Emission button light turns from RED (ON) to green (OFF).</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 2. Turn the key switch to the 0 position to disable the laser. | ![Laser On/Off](image3.png) |
| **Note**: If you plan to leave the laser unattended, it is recommended to remove and store the key in a secure location. | ![Laser On/Off](image4.png) |
Connecting the laser to a CONTROL PC
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 Window drop down menu, you can add or remove displayed panels. The panels can also be dragged within the main window or into separate windows. Figure 27 shows CONTROL’s main panels and menu; their functions are described in the table below.

<table>
<thead>
<tr>
<th>Panel</th>
<th>Function</th>
<th>See</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device Selector</td>
<td>Selectable list of connected devices (lasers and accessories) sorted by the PC port they are connected to.</td>
<td>Connecting the laser to a CONTROL PC on page 47.</td>
</tr>
<tr>
<td>Quick Connect</td>
<td>Provides a button when clicked, scans all available PC ports for connected NKTP products.</td>
<td>Connecting to the laser on page 55</td>
</tr>
<tr>
<td>Status Panel</td>
<td>This panel displays the selected device status, emission control and a CONTROL settings menu.</td>
<td>Status panel on page 56</td>
</tr>
<tr>
<td>Menu Items</td>
<td>Five drop down menus with multiple functions.</td>
<td>CONTROL menu on page 60</td>
</tr>
<tr>
<td>Control Panel</td>
<td>The control panel provides adjustable controls for the laser and accessories selected. The SuperK Extreme provides configuration controls for current, repetition rate and trigger delay.</td>
<td>CONTROL – Operating mode on page 64</td>
</tr>
<tr>
<td>Application Log</td>
<td>This panel displays a debugging log that can be saved to a file.</td>
<td>Application log panel on page 65</td>
</tr>
<tr>
<td>Device Monitor</td>
<td>To also help debugging issues, this panel displays multiple port and device module parameters.</td>
<td>Device monitor on page 66</td>
</tr>
</tbody>
</table>

Figure 27 CONTROL panel navigation
Relocating panels

The panels displayed by CONTROL can be dragged to any location within the main interface or into a separate floating panel. Procedure 4 describes how to move a panel:

**Procedure 4  Relocating panels**

<table>
<thead>
<tr>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Left Click and hold the top title bar of the panel.</td>
</tr>
<tr>
<td>2 While holding the left mouse button down drag the panel to another location in the main window.</td>
</tr>
<tr>
<td>3 When the area you drag the panel background turns blue, release the mouse button. (see Figure 28)</td>
</tr>
<tr>
<td>4 Alternatively drag the panel outside the main window and release the mouse button. A separate window for the panel will be created. (see Figure 29)</td>
</tr>
</tbody>
</table>

**Figure 28** Dragging panels to a new location in the main window

**Figure 29** Dragging panels outside the main window
Toggling panels
Use the Menu > Window drop down menu to check and uncheck panels to be viewed.

![Figure 30 Toggling panel visibility](image)

**Note:** Clicking the X in the upper right corner of any panel will also close it.

Connecting to the laser
When CONTROL is launched, the Welcome panel is displayed as in Figure 31. On the left is the Quick Connect panel. Click the “CONNECT” button and CONTROL will scan all available ports for NKTP devices that it can connect to. Once CONTROL finishes the scan, a list of the devices will be presented.

See either “Connecting a PC to the laser using a USB cable” on page 48

![Figure 31 Quick connect](image)

**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. For Ethernet connected lasers, the TCP/IP parameters must already be configured.
Status panel

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

Figure 32 Status Panel

![Status Panel Image]

Status indicators

The panel displays the following indicators:

**Interlock**
Indicates the status of the Interlock circuit and whether emission can be turned ON or not. The indicator will be 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 turned ON.
• ON RED – There is a fault, laser emission is shutdown and cannot be turned ON. A fault message will be displayed when this indicator turns ON RED:

<table>
<thead>
<tr>
<th>Fault Message</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interlock opened while emission on</td>
<td>a) Cycle the key switch to OFF and then ON</td>
</tr>
<tr>
<td></td>
<td>b) Close the external interlock circuit</td>
</tr>
<tr>
<td>Watchdog timeout</td>
<td>Reconnect NKTP CONTROL and reset the interlock by cycling the key switch.</td>
</tr>
</tbody>
</table>

See “Connecting the safety interlock” on page 77.

System info  The System Info section shows the following:

• Laser Serial Number

• Laser Firmware Revision

Measurements  The Measurements section displays the laser’s pump temperature.

Emission button The emission button turns the laser emission ON or OFF – See “Controlling the laser emissions” on page 53. The button indicator will turn ON RED when laser emission is generated. Otherwise, it will be OFF Grey.
Control settings

The CONTROL settings are accessible by clicking the gear icon \( \text{} \) in the upper right corner of the Status panel. Clicking the gear icon displays a menu of setting items as shown in Figure 33:

![Figure 33 CONTROL settings](image)

<table>
<thead>
<tr>
<th>Setting Item</th>
<th>Function</th>
<th>See</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watchdog</td>
<td>Enables or disables a watchdog between CONTROL and the connected devices.</td>
<td>Watchdog on page 58</td>
</tr>
<tr>
<td>Clock</td>
<td>Sets the time and date that CONTROL uses for time stamping log messages.</td>
<td>Clock on page 58</td>
</tr>
<tr>
<td>View</td>
<td>Enables and disables items displayed in the Status panel.</td>
<td>View on page 59</td>
</tr>
</tbody>
</table>

Watchdog

As an added safety feature, the watchdog will automatically turn OFF laser emission if communications with CONTROL is lost. The feature can be enabled or disabled and has an adjustable timeout. When communications are lost 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 will turn OFF the watchdog.

![Figure 34 Watchdog](image)

Clock

You can view and set CONTROL’s time and date using this settings. Click the “Set” button to synchronize the CONTROL clock with the PC time and date.
Figure 35  Clock settings

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

System info – check the box next to “System info” to toggle on displaying the system information within the status panel.

User text – enter a text string, of up to 240 characters, that is displayed on the front LCD panel when the system menu is not being accessed. The text is also shown next to the device icon in the Device selection window.

Figure 36  View
CONTROL menu

There are five drop down menus in the main control window as highlighted in Figure 37. Click on the items in the menu to reveal the drop down menus.

Figure 37  Menu items

<table>
<thead>
<tr>
<th>Menu Item</th>
<th>Function</th>
<th>See</th>
</tr>
</thead>
<tbody>
<tr>
<td>File</td>
<td>Exits the CONTROL program</td>
<td>N/A</td>
</tr>
<tr>
<td>Disconnect</td>
<td>Disconnects the currently connected device from CONTROL.</td>
<td>N/A</td>
</tr>
<tr>
<td>Tools</td>
<td>Select from one of three special tools to use with your laser. Tools available are:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Key Updater Tool</td>
<td>Key Updater tool on page 60</td>
</tr>
<tr>
<td></td>
<td>• Log Downloader</td>
<td>Log downloader on page 61</td>
</tr>
<tr>
<td></td>
<td>• Extensions Overview</td>
<td>Extensions overview on page 63</td>
</tr>
<tr>
<td>Window</td>
<td>Controls (toggles) which panels are displayed.</td>
<td>Toggling panels on page 55</td>
</tr>
<tr>
<td>Help</td>
<td>Displays the current version of CONTROL and provides access to the included CONTROL user help.</td>
<td>N/A</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Action</th>
<th></th>
</tr>
</thead>
</table>
| 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.
| 3      | Click “Apply”|
**Note:** Certain keys will 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 database on the CONTROL PC. However, certain NKTP modules, including the SuperK Extreme 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 will temporarily disable automatic log collection from all other devices. The CONTROL interface will turn grey (gray), and communication with the laser and log collection with all other modules will be 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.

3. To download and save a log file to the CONTROL PC, right click the percentage indicator and select either:
   - **Save log** – Immediately saves the file onto the CONTROL PC. If the percentage shows less than 100%, the log will be 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 log, a dialog box prompts for a filename and folder to store the log in.
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 will be launched as shown in Figure 38.

**Figure 38 Extensions Overview**

Note: To show a short description of the release notes as seen in Figure 38, hover the mouse pointer over the “Release notes” text.

The PubExtremeLib.dll details highlighted in Figure 38 shows the version of the .dll file (1.1.2.303), the included extensions (SuperK Extreme Extension) 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.
CONTROL – Operating mode

For SuperK Extreme the control panel can be configured to present different operating mode controls. Control of laser emission varies according to the mode chosen. To select one of the modes listed in Table 6, click on the operating mode drop down menu located on the right side of the panel (See Figure 39).

Figure 39 Operating mode

Table 6 Operating modes

<table>
<thead>
<tr>
<th>Mode</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant Current</td>
<td>Provides a slider that adjusts the pump current set point. Adjusting the pump current set point up or down will proportionally adjust the output power of the laser emission. The current control setting is stored in the memory when changing to another mode.</td>
</tr>
<tr>
<td>Current Modulation</td>
<td>In Current Modulation mode, the output power is modulated based on the voltage level applied at the Modulation Input. The voltage is supplied from a feedback circuit. (See Modulation input on page 71) The current set point should be adjusted to work in conjunction with the expected range of voltages that the feedback circuits will deliver.</td>
</tr>
<tr>
<td>Power Lock</td>
<td>In this mode, the output power is locked by applying a feedback voltage at the External Feedback Input. The voltage input is typically based on a feedback from a photodiode detector circuit (See External feedback on page 69). The set point should be adjusted to work in conjunction with the expected range of voltages that the feedback circuit will deliver.</td>
</tr>
</tbody>
</table>

Variable Repetition Rate (Pulse Picker) When the VRR feature is included with the laser, the repetition rate and NIM trigger delay is adjustable using the control panel sliders shown in Figure 40.
Repetition rate
The slider sets the output pulse frequency using the VRR feature – see “Variable Repetition Rate (Pulse Picker)” on page 64. Adjust the slider to the required output pulse frequency.

The Repetition Rate scale can be set to show units in MHz or by the division factor. Click the arrow as shown in Figure 40 to select the desired scale from the drop down menu. Select Rep rate for MHz or Rep rate divider for a scale shown as the division factor.

Figure 41 Repetition Rate scale selection

Note: When the scale is set to MHz (Rep rate), the slider will only snap to the values permitted by the pulse picker.

NIM trigger delay
The NIM Pulse output trigger pulse can be delayed up to 9200 picoseconds. Use the NIM Trigger delay slider to adjust the delay of the output trigger as required.

Note: If the trigger signal needs to be delayed longer than 9200 picoseconds, a longer cable can be used as an additional offset from the NIM Pulse output to the application.

Application log panel

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

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

- Port Scans
- Discovered Devices
- Closed Communication Ports
The panel includes three buttons in the upper left corner. You can use the buttons to clear, save or print the log. Click on the cross in the upper right corner of the Application Log window to close the Application Log.

**Figure 42 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 7**.

**Table 7 Device Monitor parameters**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface</td>
<td>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.</td>
</tr>
<tr>
<td>TxTlgsSec</td>
<td>The number of telegrams per second being transmitted to the connected device.</td>
</tr>
<tr>
<td>RxTlgsSec</td>
<td>The number of telegrams per second received from the connected device.</td>
</tr>
<tr>
<td>Addr</td>
<td>The address of the connected module.</td>
</tr>
<tr>
<td>Type</td>
<td>The type of the connected module read from the module.</td>
</tr>
<tr>
<td>SysType</td>
<td>The system type, default 0 – can be used to describe system variants and is read from the module.</td>
</tr>
<tr>
<td>Name</td>
<td>The name of the connected device module.</td>
</tr>
<tr>
<td>P/N</td>
<td>The device module part number.</td>
</tr>
<tr>
<td>Mode</td>
<td>The mode or status of the connected module: connected, disconnected, or disabled.</td>
</tr>
<tr>
<td>Status bits</td>
<td>The actual status bits read from the connected module.</td>
</tr>
<tr>
<td>Error code</td>
<td>The actual error code read from the connected module.</td>
</tr>
<tr>
<td>Access</td>
<td>Protected/Locked status of the module.</td>
</tr>
<tr>
<td>FW Ver.</td>
<td>The device module’s firmware release date.</td>
</tr>
<tr>
<td>Module Serial</td>
<td>The serial number of the device module.</td>
</tr>
<tr>
<td>PCB Serial</td>
<td>The device module’s printed circuit board serial number.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Description</td>
</tr>
<tr>
<td>---------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>PCB Ver,</td>
<td>The version of the device module’s printed circuit board.</td>
</tr>
<tr>
<td>Sp. Cap/</td>
<td>The module speed capability in bits per second as read from the module – Values: 0=(default) 115200, 1=230400, 2=460800, 3=921600</td>
</tr>
<tr>
<td>Pri Ext</td>
<td>Primary extension/GUI loaded for this module. Hover over the icon to list more details – Note that there can only be 1 primary.</td>
</tr>
<tr>
<td>Fast Log</td>
<td>0%-100% collected. Note only if the module has a fast log and only internal modules have fast and slow logs.</td>
</tr>
<tr>
<td>Slow Log</td>
<td>0%-100% collected. Note only if the module has a slow log.</td>
</tr>
<tr>
<td>Mainboard Log</td>
<td>0%-100% collected. Note only if the module has a main log. Only main boards have a main and system logs.</td>
</tr>
<tr>
<td>System Log</td>
<td>0%-100% collected. Note only if the module has a system log. Only main boards have a main and system logs.</td>
</tr>
<tr>
<td>Timeout</td>
<td>Time in milliseconds since the last telegram was received from the device module.</td>
</tr>
<tr>
<td>Nack</td>
<td>Total number of negative acknowledgments received from the device module.</td>
</tr>
<tr>
<td>CRC</td>
<td>Total number of received telegrams with CRC failures</td>
</tr>
<tr>
<td>COM</td>
<td>Total number of communication errors with framing or protocol errors. Hover over the icon to list more details.</td>
</tr>
<tr>
<td>Busy</td>
<td>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.</td>
</tr>
</tbody>
</table>
5 Configuring External Control

This chapter covers configuration details for:

- "External feedback" – describes how to connect a feedback circuit to the laser to stabilize the output power level.
- "Output control" – describes how to connect an external logic signal to the laser to turn ON or OFF the laser’s booster.
- "Modulation input" – describes the settings and signal levels required for modulating the laser output power in either current or power modulation modes.

External feedback

When a variable voltage is applied to the External Feedback connector and the connector is enabled within CONTROL, the output power level of the laser is directly varied.

Microprocessor control within the laser, samples the voltage at the External Control input and proportionally steps up or down the output emission level of the laser. A feedback circuit may employ a photodiode sensing device that generates a current proportional to the laser radiance. The current can be fed into an op-amp converting it into a voltage level measured at the External Control Input connector. The External Feedback input uses an internal 470k Ω pull-up resistor. If no signal is applied at the input, the output is set to the minimum level. The circuit output should be within the parameters specified in Table 8.

Table 8  External Feedback Input parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC Voltage Range</td>
<td>0 – 4.1 VDC</td>
</tr>
<tr>
<td>Maximum Modulation Rate</td>
<td>100 Hz</td>
</tr>
</tbody>
</table>

Note: The microprocessor detector samples at 200 Hz, therefore input modulations occurring faster than 100 Hz cannot be accurately detected.

Note: With a feedback signal at 0 VDC, laser output level is at the minimum, at 4.1 VDC, laser output level is at the maximum. For optimal performance, supply a feedback signal that varies in the upper scale of the input range. It is unsuitable to use a feedback signal at the limits of the input range, it results in incorrect operation. The output power is directly proportional to the input feedback voltage. When the laser is in feedback mode, the internal feedback circuit will vary the pump current in relation to the input feedback voltage.
Output control

You can apply a TTL or CMOS level logic signal at the Output Control Input to enable or disable laser emission using the Output Control feature. When the feature is enabled, a logic high applied at the port will enable laser emission with a fast rise time. When a logic low is applied, emission is disabled. The feature controls the main amplifier. Figure 43 shows a trigger signal applied to the Output Control connector. When the trigger signal rises to a logic high, the output emission shown by the detector output graph rises correspondingly with a fast rise time. The booster output can rise up to its 100% output power level within 80 ms, and without overshooting.

*Warning:* The laser emission is still ON when the booster is OFF and thus residual laser emission is still present.

*Figure 43* Output Control trigger vs optical output rise
Modulation input

To utilize this input, the laser must be configured in Current Modulation mode with an analog signal, as specified in the following, connected to the Modulation input connector.

To configure this mode see:

“Operating mode” on page 39 for front panel operation.

“CONTROL – Operating mode” on page 64 for CONTROL configuration.

Input signal

The Modulation input connector accepts a range from 0 to 10 volts. 0 V sets the output amplitude to minimum level and 10 V sets the output amplitude to the set point level. The signal frequency should not exceed the values in Table 9.

Table 9  Modulation input limitations

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage Range</td>
<td>0 to 10 V</td>
</tr>
<tr>
<td>Modulated Current mode</td>
<td></td>
</tr>
<tr>
<td>Bandwidth- 3dB</td>
<td>100 Hz (typ)</td>
</tr>
<tr>
<td>Rise and fall time</td>
<td>&lt;5 ms (typ)</td>
</tr>
</tbody>
</table>

Modulation input circuit

The signal applied to the Modulation input is terminated with a 5.6 kΩ resistor in series with a 3.9 kΩ resistor. The total input impedance is in the order of 10 kΩ. The 3.9 kΩ resistor functions as a pull-down resistor, if no signal is applied to the Modulation input, the system sets the output to the minimum value of the Current Modulation mode. If a voltage higher than 10 volts is applied to the Modulation input, the voltage across the pull-down resistor is clamped and the optical output from the SuperK EXTREME system is limited to the configured set point value.

Set point

You can view and configure the set point level from the front LCD panel (see “Output emission control” on page 38) or the CONTROL interface (see “CONTROL – Operating mode” on page 64). The set point is configured as the maximum current level in the laser booster.
SECTION 3

INSTALLING THE LASER

This section describes how to install the laser and includes the chapters:

- “Mechanical Installation” on page 75
- “Connecting the Laser” on page 77
SuperK Extreme lasers generate a substantial amount of heat that must be dissipated. To dissipate the heat, the SuperK Extreme is available in three different chassis versions defined by their temperature regulation system. This chapter provides information on how to mechanically install the laser with focus on ensuring optimal regulation of the laser’s temperature.

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

**General installation**
The laser must be installed on a level surface that is free from vibrations. The ambient temperature surrounding the laser should be stable and free from anything that could cause temperature fluctuations. Temperature changes and vibrations may affect the laser’s operation and result in abnormal operation.

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

The installation is described in “Installing the laser chassis” on page 76.
Installing the laser chassis

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

Figure 44  SuperK Extreme installation

Air flow considerations

The air cooled chassis must have sufficient clearance at the front and back panels for unobstructed air flow. The clearance and ambient operation temperature required is listed in Table 10. The surface the laser is placed on must be level and free of vibrations.

Table 10  Air flow considerations

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front Panel Gap</td>
<td>A minimum of 30 CM must be clear of obstructions</td>
</tr>
<tr>
<td>Rear Panel Gap</td>
<td>A minimum of 30 CM must be clear of obstructions</td>
</tr>
<tr>
<td>Ambient Operating Temperature</td>
<td>15°C to 35°C (32°F to 95°F)</td>
</tr>
</tbody>
</table>
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 77
- Power – see “Connecting power” on page 79
- The Optical Output – see “Connecting the optical output (collimator installation)” on page 80
- Accessories – see “Connecting Accessories with the External Bus” on page 81
- Synchronization ports – see “Connecting synchronization ports” on page 83
- External Control Interfaces - these are described in an earlier chapter – “Configuring External Control” on page 69

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 turns off laser emission. To prevent the laser immediately turning on when the door subsequently closes, the key lock must first be cycled (ON–OFF–ON). This resets the interlock relay to allow emission.

Interlock operation

The interlock circuit in simple terms is a closed loop. When the loop is broken, the laser control circuitry detects this and sends a shutdown signal to the laser. The loop can be broken by either the key switch relay, the door switch or the External Bus loop. In Figure 45, the key switch is turned to the ON position which the logic circuit detects and in turn energizes the key relay. Since the door switch is closed, and the external bus circuit is looped with the bus defeater, the laser control circuitry will permit laser emission.
Connecting the safety interlock

**Figure 45** Interlock connected to a door switch - Laser ON

Figure 46 shows the interlock loop broken by the door switch opening. The control circuitry detects this and immediately sends a shut down signal to the laser (the laser pump). In addition, the control circuitry sends a reset to the key switch logic circuit. The reset will cause the logic circuit to de-energize the Normally Open relay in the interlock circuit. The only way to close the relay again is to cycle the key to OFF and then ON. This sets the logic circuit (a D Flip-Flop) to energize the coil again closing the relay.

**Figure 46** Interlock connected to a door switch - Laser SHUTDOWN

**Caution:** Do not short-circuit the Interlock input. Short-circuiting the interlock cir-
cumvents safety regulations and NKT Photonics does not take liability for any in-
juries or damage caused by doing so.

Caution: The switch connected to the interlock must be of an approved type. Fur-
ther, 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 la-
sor radiation. To reduce the risk to personnel, the person or group responsible for
operation of the equipment must undertake a risk assessment and provide per-
sonnel 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 inter-
connecting the laser with a safety door switch circuit.

Procedure 7 Connecting the door interlock circuit

<table>
<thead>
<tr>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Install a switch that opens when the door accessing the laser enclosure is opened. The switch must comply with local regulations.</td>
</tr>
<tr>
<td>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.</td>
</tr>
</tbody>
</table>
| 3 Perform a continuity test using a multimeter:
  - First connect the multimeter leads to the interlock plug terminals.
  - Confirm when the enclosure door is closed, the meter shows the circuit as closed.
  - Confirm when the enclosure door opens, the meter shows the circuit as open. |
| 4 Insert the LEMO plug into the Interlock connector of the Laser (see item 12 - Figure 6) |

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

<table>
<thead>
<tr>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Connect the AC cable supplied with the laser to the rear 3-pin IEC power input connector.</td>
</tr>
<tr>
<td>2 Connect the AC cable to a local AC mains supply.</td>
</tr>
<tr>
<td>3 Press the power toggle button to the ON position. (The switch is next to the rear IEC power input connector.)</td>
</tr>
</tbody>
</table>
Connecting the Laser

Connecting the optical output (collimator installation)

**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.

**Automatic BR Cut-Off**
For protection, the laser is equipped with an automatic back-reflection cut off. For example, when you are aligning your optical path, your laser may automatically turn off. Before turning the laser on again, check the path for possible sources of back-reflection.

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

**Procedure 9** Installing the Collimator

<table>
<thead>
<tr>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Remove the yellow protective cap from the end of the collimator sleeve.</td>
</tr>
<tr>
<td>2 Carefully align the collimator sleeve with the target receptacle as shown in Figure 47.</td>
</tr>
<tr>
<td>3 Slide the collimator into the receptacle and then:</td>
</tr>
<tr>
<td>• 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.</td>
</tr>
<tr>
<td>• 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.</td>
</tr>
</tbody>
</table>
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 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.

---

**Figure 47** Inserting the Collimator into a Holder

**Figure 48** Collimator Installed into a SuperK Accessory Receptacle

**Figure 49** Collimator Installed in a Holder Receptacle
Connecting the External Bus

If no accessories are used with the laser, connect the External Bus port to the supplied bus defeater. If accessories are used, connect the accessories to the port in daisy chain configuration using the supplied External Bus cable. The last accessory in the chain must have the bus defeater connected to its output bus. Table 11 describes how the External Bus should be connected. The bus defeater must always be connected to the last open External Bus port for the laser to operate. (The bus defeater loops the circuit back Refer to Figure 50 and Figure 51 for connecting the port with and without accessories.

**Table 11** External Bus connection mode

<table>
<thead>
<tr>
<th>Laser Operation Mode</th>
<th>External Bus Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Accessories</td>
<td>External Bus – Bus Defeater</td>
</tr>
<tr>
<td>One Accessory</td>
<td>External Bus – External Bus cable – Accessory Input Accessory Output – Bus Defeater</td>
</tr>
<tr>
<td>2 or more accessories</td>
<td>External Bus – External Bus cable – Accessory Input Accessory 1 Output – External Bus cable – Accessory n input Accessory n Output – Bus Defeater</td>
</tr>
</tbody>
</table>

**Figure 50** External Bus circuit - with no accessories used
Connecting synchronization ports

The SuperK Extreme can supply up to 4 synchronization signals. The signals can synchronize external devices with the laser pulse at two stages within the laser. If the laser is fitted with a VRR (pulse picker) module, all 4 signals are available. Otherwise, only the fundamental seed pulse port is equipped. The rear panel houses the four synchronization ports depicted in Figure 52.

Table 12  Pulse synchronization signals

<table>
<thead>
<tr>
<th>Sync. Port</th>
<th>Pulse</th>
<th>Type</th>
<th>Level</th>
<th>See</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed Pulse</td>
<td>Fundamental Seed</td>
<td>Analog</td>
<td>0 to ~0.7V</td>
<td>Seed Pulse on page 85</td>
</tr>
<tr>
<td>Gate Out (optional)</td>
<td>Post VRR</td>
<td>Digital</td>
<td>0 to ~1.2V</td>
<td>Gate Out on page 85</td>
</tr>
<tr>
<td>Pulse Monitor (optional)</td>
<td>Post VRR</td>
<td>Analog</td>
<td>0 to ~1.2V</td>
<td>Pulse Monitor on page 85</td>
</tr>
<tr>
<td>NIM Pulse (optional)</td>
<td>Post VRR</td>
<td>Analog</td>
<td>NIM</td>
<td>Pulse Monitor on page 85</td>
</tr>
</tbody>
</table>

i. VRR - Variable Repetition Rate module or pulse picker
To obtain the best waveform of the signal, connect external devices using the specifications listed in Table 13.

**Table 13** NIM Pulse connection specification

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cable Type</td>
<td>Shielded Coaxial - use RG223 type or similar double shielded cable ≤ 3M ≤</td>
</tr>
<tr>
<td>Connector</td>
<td>BNC</td>
</tr>
<tr>
<td>Termination Impedance</td>
<td>50</td>
</tr>
</tbody>
</table>

As an example, the NIM Pulse signal could be used to synchronize emission with a subject under study. A general diagram of a synchronization circuit is shown in Figure 53.
Seed Pulse The seed pulse is a positive 0 to 0.7 V analog output signal synchronized with the laser seed. It is an analog signal representing the fundamental seed pulse. A typical output signal from the port is depicted in graph D of Figure 52.

Gate Out The Gate Out connector supplies a digital signal synchronized with the pulse after the VRR module (pulse picker). The port outputs a positive digital signal as shown in graph C of Figure 52.

The signal is a logic high when a pulse is permitted to pass the pulse picker. Otherwise, the signal is a logic low when pulses are suppressed from the pulse picker output. The signal rate matches the configured repetition rate in CONTROL or on the front panel.

Pulse Monitor The Pulse Monitor connector outputs a signal representing the pulse after the VRR module. The signal is a positive 0 to 1.2 V analog output signal as depicted in graph B of Figure 52. The signal rate matches the configured repetition rate in CONTROL or on the front panel.

NIM Pulse The connector provides a NIM level electrical signal representing the laser’s pulsed output post VRR. The signal conforms to DOE/ER-0457 and is synchronized with the laser pulse after the VRR module has modified the repetition rate. The output is an approximately 0 to -0.9 V analog signal. A typical output signal from the port is depicted in graph D of Figure 52.

Trigger delay
The NIM output pulse can be delayed up to 10000 picoseconds using the CONTROL interface. In the control panel of the laser’s graphical interface, slide the NIM Trigger Delay slider to the desired setting. The slider is highlighted in
Figure 54, set to 8650 picoseconds. In this case, the output pulse will be delayed 8650 picoseconds after the laser pulse.

**Figure 54** Pulse (NIM) trigger delay control

![NIM Trigger Delay Slider](image-url)
The appendices include:

- Appendix A on page 89: Specifications
- Appendix B on page 91: Service and Support
- Appendix C on page 93: Accessories
- Appendix D on page 101: Control Software
- Appendix E on page 107: Troubleshooting and Errors


A Specifications

Table 14 Optical

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetition rate</td>
<td>$78 \pm 0.5$ MHz</td>
</tr>
<tr>
<td>Spectral coverage</td>
<td>410 – 2400 nm</td>
</tr>
<tr>
<td>Total power</td>
<td>&lt; 10 W</td>
</tr>
<tr>
<td>Total VIS power</td>
<td>( \leq 2000 ) mW</td>
</tr>
<tr>
<td>Total power stability</td>
<td>&lt; ( \pm 0.5 )%</td>
</tr>
<tr>
<td>Polarization</td>
<td>Random</td>
</tr>
<tr>
<td>Beam output</td>
<td>Gaussian, Single Mode</td>
</tr>
<tr>
<td>Beam quality $M^2$</td>
<td>&lt; 1.1</td>
</tr>
<tr>
<td>Optical Output</td>
<td>Collimated</td>
</tr>
<tr>
<td>Collimated beam diameter</td>
<td>1 mm at 530 nm</td>
</tr>
<tr>
<td></td>
<td>2 mm at 1100 nm</td>
</tr>
<tr>
<td></td>
<td>3 mm at 2000 nm</td>
</tr>
<tr>
<td>Beam pointing accuracy$^1$</td>
<td>&lt; 1 mrad</td>
</tr>
<tr>
<td>Beam pointing stability</td>
<td>&lt; 50 ( \mu )rad</td>
</tr>
<tr>
<td>Beam divergence (over 400 - 1100 nm)</td>
<td>&lt; 3 milliradians</td>
</tr>
<tr>
<td>Beam diameter</td>
<td>~1 mm at 633 nm</td>
</tr>
<tr>
<td></td>
<td>~2 mm at 1060 nm</td>
</tr>
<tr>
<td>Typical single mode fiber coupling efficiency</td>
<td>&gt; 70%</td>
</tr>
</tbody>
</table>

\[ ^{i} \text{The table provides a general range of values for by the SuperK Extreme lasers. For exact optical specifications, refer to the test report that is shipped with your laser.}\]

Table 15 Interfaces

<table>
<thead>
<tr>
<th>PC and micro processor interfaces</th>
<th>RS-232 serial COM - 9 Pin D-Sub Female Connector USB 2.0 - Type B Female Connector</th>
</tr>
</thead>
<tbody>
<tr>
<td>External Pulse Control</td>
<td>External Feedback: BNC 0 to 4.1 V analog input – power stabilization</td>
</tr>
<tr>
<td></td>
<td>Output Control: BNC 0 to 5V TTL/CMOS input – on/off control</td>
</tr>
<tr>
<td></td>
<td>Modulation Input: BNC 0 to 10 V analog input – power modulation (VRR only)</td>
</tr>
<tr>
<td></td>
<td>Gate Output: BNC +5 V saw or square wave input – pulse picking (VRR only)</td>
</tr>
<tr>
<td>Pulse Synchronization</td>
<td>NIM Pulse: BNC – NiM synchronization pulse (VRR frequency)</td>
</tr>
<tr>
<td></td>
<td>Pulse Monitor – 0 to 0.9 V synchronization pulse (VRR frequency)</td>
</tr>
<tr>
<td></td>
<td>Seed Pulse – 0 to 1.2 V synchronization pulse (seed frequency)</td>
</tr>
<tr>
<td>External Bus</td>
<td>RS-485 Bus - 15pin D-Sub Female Connector</td>
</tr>
<tr>
<td>Door Interlock</td>
<td>2 pin Connector - LEMO Part Number FGG.0B.302</td>
</tr>
</tbody>
</table>
Table 16  Mechanical dimensions

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size (H x W x D)</td>
<td>443 x 252.3 x 376.8 mm (3.15 x 7.87 x 14.65 in)</td>
</tr>
<tr>
<td>Weight</td>
<td>18 kg / 19 kg with VRR option (39.7 lb / 41.8 lb)</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>18°C to 30°C (59°F to 86°F)</td>
</tr>
<tr>
<td>Operating Humidity (non-condensing)</td>
<td>20 to 80%</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-10°C to 55°C (14°F to 140°F)</td>
</tr>
<tr>
<td>Maximum Operating Altitude</td>
<td>2000 m</td>
</tr>
<tr>
<td>Output Cable Length</td>
<td>1.5 m (59 in)</td>
</tr>
</tbody>
</table>

Table 17  Electrical

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Power</td>
<td>Input 100-240 VAC 50-60 Hz</td>
</tr>
<tr>
<td>Maximum Power Consumption</td>
<td>Less than 100 W (or 120 W with VRR)</td>
</tr>
</tbody>
</table>

CE Mark – Declaration of Conformance for EMI, Safety (EEC) and ROHS
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 channels in section “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.

The laser may experience damage during shipping. To minimize the chance of shipping damage, follow the packing procedures in Appendix F.

WARRANTY VOID IF REMOVED label

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

Support contact details

For technical or general support, NKT Photonics can be contacted for help regarding issues and questions with your SuperK Extreme laser or its accessories.

Support email support@nktphotonics.com

Online support web-page http://www.nktphotonics.com (click on support)

Shipping address NKT Photonics A/S
Blokken 84
DK-3460 Birkerød
Denmark
This appendix provides a brief overview of the accessories available for your laser. Table 18 lists the accessories and their functions and provides a link to descriptions of the SuperK Extreme advanced accessories.

<table>
<thead>
<tr>
<th>Advanced accessories</th>
<th>Function</th>
<th>Part number</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varia</td>
<td>Variable bandpass filter</td>
<td>A301-100-000</td>
<td>“SuperK Varia” on page 94</td>
</tr>
<tr>
<td>Select</td>
<td>Multi-wavelength AOTF</td>
<td>A203-XXX-000 or A203-XXX-010</td>
<td>“SuperK Select” on page 95</td>
</tr>
<tr>
<td>LLTF</td>
<td>Narrow laser line filter</td>
<td>A371-500-000 or A371-200-000</td>
<td>“SuperK LLTF” on page 96</td>
</tr>
<tr>
<td>Split</td>
<td>Broadband filter</td>
<td>A102-200-000 or A102-500-000</td>
<td>“SuperK Split” on page 97</td>
</tr>
<tr>
<td>Connect</td>
<td>Delivery fiber</td>
<td>A401-000-000 or A401-200-000 or A401-500-000</td>
<td>“SuperK Connect” on page 98</td>
</tr>
<tr>
<td>Extend UV</td>
<td>Tunable UV Source</td>
<td>A351-100-000 or A351-300-000</td>
<td>“SuperK Extend UV” on page 100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other accessories</th>
<th>Function</th>
<th>Part number</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polarizing Lock Ring</td>
<td>Aligns and positions the collimator properly in an accessory optical input</td>
<td>M0073-0002-00</td>
<td>“Polarization Ring” on page 94</td>
</tr>
<tr>
<td>Connect Holder</td>
<td>Optical table mount for Connect Accessory</td>
<td>000-000-003</td>
<td></td>
</tr>
<tr>
<td>Collimator Holder</td>
<td>Receptacle for laser or accessory collimator</td>
<td>M0002-4041-00</td>
<td></td>
</tr>
<tr>
<td>External Filter Holder</td>
<td>Beam path 1” filter mount for any filter accessory.</td>
<td>A000-000-004</td>
<td></td>
</tr>
<tr>
<td>TL30 mm Adapter</td>
<td>Accessory adapter for Thorlabs 30 mm cage system</td>
<td>A000-000-005</td>
<td></td>
</tr>
<tr>
<td>USB Adapter Kit</td>
<td>USB to RS485 adapter, used to connect accessories to a PC</td>
<td>A911-100-103</td>
<td></td>
</tr>
<tr>
<td>Key</td>
<td>Spare key for the laser’s key switch</td>
<td>A911-100-009</td>
<td></td>
</tr>
<tr>
<td>External Bus Defeater</td>
<td>Spare bus defeater for the External Bus ports</td>
<td>A911-100-007</td>
<td></td>
</tr>
<tr>
<td>Door Interlock Connector</td>
<td>Spare Lemo connector assembly for the door interlock circuit.</td>
<td>A911-100-005</td>
<td></td>
</tr>
<tr>
<td>Bus Cable</td>
<td>Used to connect the laser to any accessories.</td>
<td>A911-100-006</td>
<td></td>
</tr>
<tr>
<td>USB Cable</td>
<td>Spare Type A to B USB cable</td>
<td>A911-100-004</td>
<td></td>
</tr>
<tr>
<td>BNC Cable</td>
<td>Used to connect External Control Input or Pulse Output.</td>
<td>A911-100-008</td>
<td></td>
</tr>
</tbody>
</table>
Accessory descriptions

**Polarization Ring**  This is a spacer and alignment ring that fits onto the laser collimator. It MUST be used when inserting the collimator into an accessory optical input receptacle. The ring has an alignment pin which aligns the polarization of the laser emission properly with the accessory optics. As a spacer, the polarization ring positions the collimator correctly in the optical input receptacle.

*Caution:* Do not insert the collimator into an accessory without the polarization ring installed on the collimator. Doing so may damage the accessory.

**SuperK Varia**  The Varia accessory acts as a bandpass filter when connected to the collimator of the SuperK Extreme laser. A portion of the beam from the SuperK Extreme 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. The CONTROL PC connected to the SuperK Extreme 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 can be output from the auxiliary optical output of the Varia. A diagram of the main accessory connections is shown in Figure 55.

**Figure 55** Varia

<table>
<thead>
<tr>
<th>Specification</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandpass Filter Range (wavelength)</td>
<td>400 to 800 nanometers</td>
</tr>
<tr>
<td>Linewidth</td>
<td>0.02</td>
</tr>
<tr>
<td>Transmission Efficiency</td>
<td>Approximately 80%</td>
</tr>
<tr>
<td>Filter Suppression</td>
<td>Approximately 50 dB</td>
</tr>
</tbody>
</table>

*Note:* For further detailed information regarding the SuperK Varia refer to the Varia Instruction Manual.
SuperK Select  

A SuperK Select accessory can be fitted to extract multiple specific light wavelengths from the broadband spectrum output of the SuperK Extreme laser. The Select accessory uses Acousto-optic Tunable Filter (AOTF) technology which uses a tellurium dioxide crystal that diffracts the desired beam wavelength. The specific wavelength diffracted by the crystal is tuned by applying an RF signal to it. A single Select crystal filter can output up to eight tunable wavelengths that can be configured from the SuperK CONTROL application. The Select accessory can be fitted with up to two AOTF crystal filters resulting in a maximum of 16 specific wavelengths that can be tuned and extracted from the laser’s broadband output. A diagram of the main accessory connections is shown in Figure 56.

**Figure 56  Select**

Output apertures with Connect accessory

Output delivery

The beam delivery from the Select output can be either a free space collimated beam or fiber coupled using Fiber Deliver (FD) with a SuperK Connect (fiber coupling connector). The AOTF crystal output naturally includes power from numerous sidebands, see Figure 57 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 deliver system such as SuperK Connect, a small aperture is not required; the delivery system aperture will provide the suppression.

Output beam specifications

AOTF types must be specified when ordering a SuperK Extreme. The type of AOTF determines the possible wavelength range and bandwidth that can be diffracted from the crystal. Table 20 lists the available AOTFs that can be used with the SuperK Select.
As noted earlier, the tuned beam which is defracted from a Select crystal filter will also include a number of n’th order side lobes. A typical example is shown in the output spectrum graph of Figure 57. 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 57** Select AOTF example output - 640nm central wavelength

---

### Table 20  Select AOTF types

<table>
<thead>
<tr>
<th>AOTF type</th>
<th>Wavelength range (nm)</th>
<th>Bandwidth (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UV-VIS</td>
<td>400-650</td>
<td>1.8-8.5</td>
</tr>
<tr>
<td>VIS (1x)</td>
<td>430-700</td>
<td>0.5-1.85</td>
</tr>
<tr>
<td>VIS (4x)</td>
<td>450-700</td>
<td>2.5-8.5</td>
</tr>
<tr>
<td>VIS-nIR</td>
<td>500-900</td>
<td>3.5-14</td>
</tr>
<tr>
<td>nIR1</td>
<td>640-1100</td>
<td>1.5-5</td>
</tr>
<tr>
<td>nIR2</td>
<td>800-1400</td>
<td>2.6-9.6</td>
</tr>
<tr>
<td>IR</td>
<td>1100-2000</td>
<td>6.4-19.8</td>
</tr>
</tbody>
</table>

---

**Note:** For further detailed information regarding the SuperK Select refer to the Select Instruction Manual.

---

**SuperK LLTF**

The 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 can be continuously tuned over the entire spectrum of the supercontinuum laser, converting the wide band beam to a finely tuned picoseconds 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 provide a specific tuning range as shown in table Table 21. Depending on the tuning range required, the LLTF accessory supports filters that cover both visible and NIR tuning ranges. Further, a separate PC-based GUI application is required to provide filter tuning control through USB 2.0 connectivity. A diagram of the main accessory connections is shown in Figure 58.
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 58* SuperK LLTF Contrast

![Image of SuperK LLTF Contrast with labels](image)

Table 21 LLTF Contrast Model Specifications

<table>
<thead>
<tr>
<th>LLTF Model</th>
<th>Wavelength Range (nm)</th>
<th>Spectral Bandwidth (nm)</th>
<th>Maximum Power (Watts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LLTF Contrast VIS HP8</td>
<td>400-650</td>
<td>1.8-8.5</td>
<td>8</td>
</tr>
<tr>
<td>LLTF Contrast SWIR HP8</td>
<td>430-700</td>
<td>0.5-1.85</td>
<td>8</td>
</tr>
<tr>
<td>LLTF Contrast VIS HP20</td>
<td>450-700</td>
<td>2.5-8.5</td>
<td>20</td>
</tr>
<tr>
<td>LLTF Contrast SWIR HP20</td>
<td>500-900</td>
<td>3.5-14</td>
<td>20</td>
</tr>
</tbody>
</table>

**SuperK Split**

Use the SuperK Split to divide the SuperK Extreme emission into two separate spectral outputs. The 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:* The Split can also be ordered with custom wavelength splits, see Table 22 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 the CONNECT accessory for beam delivery.

A diagram of the main accessory connections is shown in *Figure 59.*
SuperK Split specifications
The specifications of the Split are shown in Table 22.

Table 22 SPLIT Wavelength ranges

<table>
<thead>
<tr>
<th>Model</th>
<th>Wavelength Ranges</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIR/IR</td>
<td>400-830 and 915-2400 nanometers</td>
</tr>
<tr>
<td>nIR/IR</td>
<td>400-1120 and 1180-2400 nanometers</td>
</tr>
</tbody>
</table>

Note: For further detailed information regarding the SuperK Split refer to the Split Instruction Manual.

SuperK Connect
The CONNECT is a single mode fiber coupling device which can terminate to a collimator or either FC/PC or FC/APC connectors. As a fiber deliver 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. It can be disconnected and reconnected to a photonic system without needing to realign the coupling. The specific CONNECT model used is dependent on the emission characteristics of the application. Table 23 lists the models available and their specifications.

A general view of the Connect accessory showing the location of the collimator input is shown in Figure 60.
Connect specifications
The bandpass filter specifications of the Connect are shown in Table 23.

Table 23  Fiber delivery specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>Single Mode Cutoff Wavelength</th>
<th>Transmission</th>
<th>Typical Peak Transmission</th>
</tr>
</thead>
<tbody>
<tr>
<td>FD1-PM</td>
<td>425±25 nm</td>
<td>&gt;60% (425-775 nm)</td>
<td>75% @ 650 nm</td>
</tr>
<tr>
<td>FD2</td>
<td>450±25 nm</td>
<td>&gt;60% (450-775 nm)</td>
<td>80% @ 650 nm</td>
</tr>
<tr>
<td>FD3</td>
<td>630±20 nm</td>
<td>&gt;60% (630-1100 nm)</td>
<td>80% @ 800 nm</td>
</tr>
<tr>
<td>FD3-PM</td>
<td>580±40</td>
<td>&gt;65% (580-950 nm)</td>
<td>85% @ 650 nm</td>
</tr>
<tr>
<td>FD4</td>
<td>730±30 nm</td>
<td>&gt;70% (730-1150 nm)</td>
<td>80% @ 950 nm</td>
</tr>
<tr>
<td>FD4-PM</td>
<td>710±60 nm</td>
<td>&gt;65% (710-1100 nm)</td>
<td>70% @ 900 nm</td>
</tr>
<tr>
<td>FD5</td>
<td>930±40 nm</td>
<td>&gt;50% (930-1550 nm)</td>
<td>65% @ 1350 nm</td>
</tr>
<tr>
<td>FD5-PM</td>
<td>900±70 nm</td>
<td>&gt;50% (900-1500 nm)</td>
<td>60% @ 1200 nm</td>
</tr>
<tr>
<td>FD6</td>
<td>1260±40 nm</td>
<td>&gt;30% (1260-1900 nm)</td>
<td>40% @ 1650 nm</td>
</tr>
<tr>
<td>FD6-PM</td>
<td>1200±70 nm</td>
<td>&gt;30% (1200-1900 nm)</td>
<td>35% @ 1700 nm</td>
</tr>
<tr>
<td>FD7</td>
<td>400 nm</td>
<td>&gt;70% (450-1050 nm)</td>
<td>80% @ 750 nm</td>
</tr>
<tr>
<td>FD7-PM</td>
<td>400 nm</td>
<td>&gt;70% (450-950 nm)</td>
<td>80% @ 600 nm</td>
</tr>
<tr>
<td>FD8</td>
<td>800 nm</td>
<td>&gt;40% (800-1700 nm)</td>
<td>55% @ 1300 nm</td>
</tr>
<tr>
<td>FD9</td>
<td>500 nm</td>
<td>&gt;50% (500-1300 nm)</td>
<td>60% @ 900 nm</td>
</tr>
<tr>
<td>FD10</td>
<td>NA</td>
<td>&gt;80% (500-1100 nm)</td>
<td>90% @ 750 nm</td>
</tr>
</tbody>
</table>

Note: For further detailed information regarding the SuperK Connect refer to the Connect Instruction Manual.
SuperK Extend UV

The Extend UV accessory can extend laser emission into the ultraviolet range from 265-480 nm. It can output 2 to 12 nm wide collimated pulses down to 20 picoseconds. The output can be coupled into another accessory to tune it for the required application. The accessory comes in two models listed in Table 24 with their specifications.

A general view of the Extend UV accessory is shown in Figure 61.

Figure 61 Extend UV

Table 24 Extend UV specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>DUV</th>
<th>UV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuning Range</td>
<td>265 to 365 nanometers</td>
<td>350 to 480 nanometers</td>
</tr>
<tr>
<td>Output Interface</td>
<td>Near-collimated free space</td>
<td>Near-collimated free space</td>
</tr>
<tr>
<td>VIS pass-through range</td>
<td>400 to 850 nanometers</td>
<td>400 to 1500 nanometers</td>
</tr>
<tr>
<td>IR pass-through range</td>
<td>850 to 2400 nanometers</td>
<td>1050 to 2400 nanometers</td>
</tr>
</tbody>
</table>

Note: For further detailed information regarding the SuperK Extend UV refer to the Extend UV Instruction Manual.
Installing CONTROL

Download the software from:

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

Follow the steps in Procedure.

**Procedure 10** Installing CONTROL

<table>
<thead>
<tr>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. On the PC, launch the installer package and then click the Run button.</td>
</tr>
<tr>
<td>2. The installation wizard appears. Click Next to continue.</td>
</tr>
</tbody>
</table>
3. Accept to use the default installation directory or select another directory by clicking the Browse button.

   Click Next to continue.

4. Uncheck the components you do not require. By default, all components will be installed.

   Click Next to continue.

5. Read the End-User License Agreement, and select: “I accept the license.”.

   Selecting: “I do not accept the license” will end the installation wizard.

   Click Next to continue.
6 The wizard will create a start menu folder with program short-cuts.

Use the default name or enter a new name for the folder.

Click Next to continue.

7 Check the box to create a desktop shortcut to access Control.

Click Next to continue.

8 Check the Silicon Labs driver installation (recommended) and click Next.
9 Click Install to install NKTP CONTROL software on your PC.

Click Cancel if you want to abort the installation.

The wizard displays a progress meter for the installation.

Note: a normal install should only take a few seconds.

10 Click Next to install the UART drivers for the PC USB port.

11 Read the End-User License Agreement, and select “I accept this agreement”.

Selecting “I don’t accept this agreement” will abort the driver installation. Otherwise, check the agreement accept button and click Next to install the driver.
12 The drivers will be installed.

13 The Silicon Labs drivers is installed successfully.
   Click Finish to end the installation wizard.

14 CONTROL is now installed.
   Check the Run box to launch CONTROL when the Finish button is clicked.
   Click Finish.
## Troubleshooting and Errors

### Troubleshooting

**Table 25** Laser troubleshooting

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible cause(s)</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laser Disabled</td>
<td>Interlock signals shorted to ground.</td>
<td>1. Disconnect the power to the laser. Locate and remove the interlock circuit short to ground.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Turn on the SuperK Extreme system and reset the interlock with the key switch.</td>
</tr>
<tr>
<td>No Communication with CONTROL</td>
<td>1. No Power</td>
<td>1. Check the AC Mains and the AC power cable.</td>
</tr>
<tr>
<td></td>
<td>2. COM port setting incorrect</td>
<td>2. Check that the PC has assigned a COM port to the laser.</td>
</tr>
<tr>
<td></td>
<td>3. Defective USB Cable</td>
<td>3. Check the USB cable condition or swap it with a known working cable.</td>
</tr>
<tr>
<td>No Emission</td>
<td>1. Key Switch is OFF</td>
<td>1. Turn the Key to the ON position</td>
</tr>
<tr>
<td></td>
<td>2. Interlock Circuit is open</td>
<td>2. Correct the circuit open and reset the key switch. The circuit open could be one of the following:</td>
</tr>
<tr>
<td></td>
<td>3. The laser experiences a failure due to an alarm condition.</td>
<td>• External Bus Defeater loose or not connected</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• External Bus Accessory cable loose or defective</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Door switch defective or an open in its connecting cable to the LEMO plug.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• LEMO plug loose or defective</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Check the laser alarms and refer to Table 26, “Errors codes and recovery action,” on page 108.</td>
</tr>
</tbody>
</table>
Alarms codes and recovery

Table 26 lists the alarms and their appropriate responses.

### Table 26 Errors codes and recovery action

<table>
<thead>
<tr>
<th>Error code</th>
<th>Recovery action</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Check if the interlock has been activated, otherwise turn the key switch to the on position to enable the laser.</td>
</tr>
<tr>
<td>5</td>
<td>Check the communication links between the PC and CONTROL software. Enable the laser by clicking the Emission button OFF/ON.</td>
</tr>
<tr>
<td></td>
<td><strong>If the problem persists</strong> – disable watchdog mode.</td>
</tr>
<tr>
<td>7,12</td>
<td>Ensure the ambient temperature in the environment surrounding the laser is within the specified range. See Appendix A. Also ensure the cooling requirements such as air or water flow are met depending on the chassis. See “Mechanical Installation” on page 75.</td>
</tr>
<tr>
<td>17-23</td>
<td>Laser calibrating - informational only; to clear the error, enable emission.</td>
</tr>
</tbody>
</table>
| 48         | 1. Move the beam delivery collimator head against a power meter.  
            | 2. Set to 0% power (slider all the way to the left in Control software)  
            | 3. Enable the laser by clicking the Emission button on.  
            | 4. Slowly increase power to 100%. |
|            | **If the alarm clears:**  
            | Before returning the laser to normal operation, check the installation for back reflections to the laser (e.g. from a lens mounted in front of the collimator). See “Connecting the optical output (collimator installation)” on page 80 |
|            | **If the alarm persists:**  
            | – or –  
            | **If the laser emission is disabled:**  
            | Contact NKT Photonics. See Appendix B. |
| 3,49,50,55 | 1. Set to 0% power (slider all the way to the left in Control software)  
            | 2. Enable the laser by clicking the Emission button on.  
            | 3. Slowly increase power to 100%. |
|            | **If the problem is not resolved** contact NKT Photonics. See Appendix B. |

Other codes: contact NKT Photonics. See Appendix B.

**Possible fault causes**

**External reflection**

An optical reflection from an external component may affect the laser system. For example, a mirror or shutter inserted into the beam path could cause a reflection sent back into the system causing an alarm to appear.

**High power**

The system may raise an alarm if it detects internal reflections. An internal reflection can be generated when the output power level is too high.