

SuperK EXTREME

High Power Supercontinuum Laser Series

Instruction Manual



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US7346249; WO2004083919; GB2407390; US7224873; CN1143147; US6334019; JP2002506533; GB2341457; WO9900685; EP0991967; EP1443347; AU8116998; DE0991967; GB0991967; US6603912; AU763796; RU2226705; PL197264; NO20014740; JP2002541507; HK1046037; EP1166160; DE60029315; CN1353824; CN1192261; CA2368778; AU3827400; AT333103; GB2350904; US6985661; US6888992; WO03062160; US2006008218; WO03058308; WO03058309; AU2003201996; AU2003201650; WO03058310; AU2003201638; AU2003201638; GB2389915; WO03093884; AU2003226571; WO2004001461; AU2003236903

WO2004001465; AU2003244812; WO2004057392; AU2003290312; US2005117841; WO0186347; EP1279065; AU53240001; EP1460460; WO2004053550; AU2003302807; WO2004049025; US2007122095; US2006067632; AU2003281985; WO03078338; AU2003226893; WO2004019092; AU2003254639; WO03100488; AU2003229545; WO03079074; AU2003226890; WO0239159; US6856742; GB2384323; AU1494402; CA2334510; DE60217684; DE60025766; GB2408812; GB2386435;

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1 General

Introduction

Please take the necessary time to read this manual. It contains important information on safety issues concerning the usage of the SuperK EXTREME laser.

Warning: safety might be seriously impaired if the instructions are not followed carefully.

This manual covers the SuperK EXTREME laser series, with the product numbers beginning with S4x2, where x indicates what type of spectrum the system provides.

The SuperK EXTREME comprises a Class 4 laser and only persons who are familiar with laser safety regulations are allowed to operate any of these systems.

This product is not UL-approved but all safety components are UL-approved.

If you have any questions concerning this product, please do not hesitate to contact us at support@nktphotonics.com. Please refer to section 10 for further information regarding support for the SuperK Extreme.

Description

SuperK Extreme is a range of ultra broadband supercontinuum lasers with the spectral brightness of a laser and the bandwidth of a lamp – all delivered in a single mode fiber.

The SuperK supercontinuum laser system and accessories features unrivaled reliability in an industrial turn-key format with market leading performance. These high-brightness low-noise supercontinuum sources can be operated with a touch of a button and requires no warm-up time.

The SuperK EXTREME is a quasi CW single-mode supercontinuum white light laser with excellent power density. The system is a complete stand-alone unit with everything required integrated.

The SuperK Accessories product range completes the SuperK system with plug-and-play filters and fiber delivery systems providing robust filtering and routing options in an easy-to-use format. All accessories are source-independent, and can be used with any of the SuperK EXTREME models.

The graphical user interface SuperKontrol 2.0 software makes it very easy to control the SuperK EXTREME. See the SuperKontrol 2.0 Software Manual for more information about how to use the graphical user interface.

It is recommended to keep this manual in the area close to the SuperK EXTREME system, so operators if required can use it as reference book.

2 Laser Safety

Never switch on or attempt to operate the SuperK EXTREME before reading, understanding and fully familiarizing yourself with the contents of this chapter.

Introduction

This chapter is divided into four sections:

- **General Safety Aspects**
Explains aspects relating to the safe operation of the laser device. See section [General Safety Aspects](#).
- **Special Safety Aspects**
Outlines the risks specific to working procedures with and on this laser device. See section [Specific Safety Aspects](#).
- **Safety compliance list**
See section [Safety Compliance List](#).
- **Overview of safety-relevant labels**
Shows the design and describes the safety labels. See section [Labels](#).
- **Laser goggles.**
See section [Laser protective goggles](#).

2.1 General Safety Aspects

2.1.1 Basic Operation and Designated Use

Basic Safety

The SuperK EXTREME has been designed in accordance with state-of-the-art standards and the recognized safety rules. Nevertheless, its use can constitute a risk to the user or third parties or cause damage to other material property.

The SuperK EXTREME system and Accessories are not approved nor tested for use in treatment or diagnostics of human and animals and does not comply with European, US or Rest of World requirements for medical device lasers.

Warning: Potential eye and skin burns! Only use the laser in accordance with its designated use.

The SuperK EXTREME must only be used in technically perfect conditions and in accordance with its designated use.

Follow the instructions in this manual, and let only safety conscious persons, who are fully aware of the risks involved, operate the SuperK EXTREME.

Any functional disorders, especially those affecting the safety of the SuperK EXTREME, must be rectified immediately.

2.1.2 Organizational Measures

Laser Safety Officer

In accordance with the valid national regulations for prevention of accidents, appoint a responsible person as the Laser Safety Officer (LSO).

His responsibility is to effect the knowledgeable evaluation of laser hazards and to monitor and enforce their control.

The instruction manual must always be at hand where the SuperK EXTREME is used. In addition to the operating instructions, observe and instruct the user in all other generally applicable legal and other mandatory regulations relevant to accident prevention.

Protective Equipment

These compulsory regulations also deal with the issuing and/or wearing of personal protective equipment. The necessity of reading the instruction manual applies especially to persons working only occasionally on the SuperK EXTREME.

Use protective equipment, wherever required by the circumstances or by law.

Warning: Risk of serious injury through incorrect operation! Personnel entrusted to operate the SuperK EXTREME must have read the instruction manual and in particular the safety instructions.

Safety Labels

Ensure that all safety-relevant labels are attached to the laser device in accordance with the label location diagrams in Section [Labels](#) and local regulations. Make sure that these labels are always complete and perfectly legible.

If any labels are missing, immediately inform NKT Photonics A/S. In the event of safety relevant modifications or changes in the behavior of the SuperK EXTREME during operation, stop the laser device immediately and report the malfunction to NKT Photonics A/S.

Never make any modifications, additions or conversions which might affect safety. This also applies to the installation and adjustment of safety devices.

2.1.3 Selection and Qualification of Personnel – Basic Responsibilities

Qualified Personnel

Make sure that only authorized personnel work on or with the SuperK EXTREME. Statutory minimum age limits must be observed. Employ only trained or instructed staff and set out clearly the individual responsibilities of the personnel for operation and set up.

2.1.4 Safety Instructions Governing Specific Operational Phases

Precautions

Take the necessary precautions to ensure that the SuperK EXTREME is used only when in a safe and reliable state.

In the event of malfunctions, stop the laser device immediately and lock it. Have any defects rectified immediately.

Before starting the SuperK EXTREME ensures that nobody is at risk. Brief operating personnel before beginning special operations, and appoint a person to supervise the activities. Ensure that the operations area is adequately secured.

2.2 Specific Safety Aspects

Specific safety aspects are:

- Physical hazards related to the system. See Section [Physical Hazards](#).
- Protection of the users of the system against these hazards. See Section [Personnel Safety](#).
- Constructive protective measures against these hazards. See Section [Constructive Safety Features](#).

Within this classification, the SuperK EXTREME is Class 4 (high power) laser, and must therefore be regarded as a potential hazard to the human operator. The laser beam must also be regarded as a potential fire hazard. Class 4 is the most powerful (and potentially hazardous) category of lasers. Direct and scattered radiation from Class 4 products is considered an acute hazard to the eyes and skin. Precautions include eye and skin protection, remote interlocks and warning labels.

2.2.1 Physical Hazards

Warning

The laser beam is very dangerous to the eyes and skin!

The following are hazardous,

- Direct radiation-light as it leaves the laser.
- Reflected radiation-light which has hit a surface and bounced off.
- Diffuse radiation-light, which has hit a surface, bounced off, and scattered.

Light

In case of malfunction the SuperK EXTREME may provide laser radiation with power levels up to 20 Watt and operating wavelength of from 300 nm up to 3000 nm is emitted from the output aperture of the SuperK EXTREME. The output is a collimated exit beam from a fiber delivery cable. The beam diameter of the output is less than 3 mm. Despite the non-ionizing nature of the operating wavelengths, damage can still occur to living tissue as a result of heat produced during radiation absorption. Part of the radiation of the SuperK EXTREME lies outside the visible range. Suitable beam dumps must be used at all times when the laser product is operating.

In general, the maximum permissible radiation exposure for the skin is several times greater than for the eye. Safety measures with regard to the radiation hazard are therefore mainly based on dangers for the eye. Not only are the direct laser beam hazardous, but unchecked reflections of laser light also constitute a potential hazard.

2.2.2 Personnel Safety

Personnel Protection The SuperK EXTREME is a class 4 laser.

Warning:

Risk of serious injury! Always wear protective eyewear when there is a chance of exposure to radiation from the laser. Before putting on the protective eyewear, check them for any obvious defects. As the filter in the protective eyewear provides protection for only a narrow band of wavelengths, make sure you are wearing the appropriate protective eyewear for the laser device in question. Check with your Laser Safety Officer or other safety personnel for guidance in selecting the appropriate eyewear.

Radiation Safety

The SuperK EXTREME emits high power visible and near-infrared radiation, which constitutes a hazard to personnel during periods of operation.

Protective Eyewear

The ANSI (American National Standards Institute) standard for safe use of lasers requires that a set of protective goggles blocking the appropriate laser wavelength should be worn while operating or servicing class 4 lasers. However, since the SuperK EXTREME covers the full visible spectrum with a very high spectral power density, it is not possible to achieve full protection without totally limiting the visual brightness through the laser goggles.

NKT Photonics recommends using a combination of several different filter-technologies (absorption and interference). The IR5D filter from NoIR Laser Company, LLC is currently the most suitable product available. Full protection is not achieved, but the alternatives are significantly worse; see section [Laser protective goggles](#) for details.

Clearly label the goggles with an optical density and the specified wavelength. To avoid confusion, keep these goggles separate from other safety glasses and personal protective equipment.

Using the wrong type of goggles is dangerous. It can be worse to have improper eyewear and a false sense of security than to have no eyewear and take precautions based on the absence of protection. Even if you are wearing protective goggles, never look directly into the beam; intense laser radiation is capable of destroying the protective filter.

Warning:

Protective eyewear can only provide partial protection from the hazardous radiation of a supercontinuum laser source.

Eye Protection

Warning:

Potential eye burns! Only use the laser in accordance with its designated use. Safety interlocks are only to be overruled by authorized personnel.

The following guidelines describe some of the actions necessary to avoid injury caused by the laser beam. Always follow these guidelines and take additional precautions if necessary.

- When eyewear is necessary, make sure it has the proper optical density for the laser wavelength.
- All other personnel in the vicinity of the laser to wear protective eyewear.
- Permit only qualified personnel to operate the laser.
- Never intentionally look directly into any laser beam.
- Avoid indirect viewing of direct or reflected laser radiation. Specular reflections (from reflective surfaces) can be as dangerous as the direct laser beam. Do not view the beam through optical instruments unless the optics is designed to filter the laser wavelength.
- Take precautions to ensure that there are no reflecting objects in the path of the laser beam.

- Do not deviate from standard operating procedures when working with class 3B and class 4 laser equipment.
- Use lasers only in approved applications and locations. Take adequate precautions to prevent unauthorized personnel from entering the area where a class 4 laser is operating. Do not use lasers around untrained personnel. Ensure that all personnel in the area observe proper safety precautions.
- Report all incidents of exposure to your supervisor.
- Clearly display warning signs indicating the laser enclosed area with an additional warning light outside the door.
- Adhere to local and national regulations governing the safe use of lasers.

Skin Protection

Warning:

Potential skin burns! Direct and reflected laser radiation can burn exposed skin. Only use the laser in accordance with its designated use. Safety interlocks are only to be overruled by authorized personnel.

- Although the skin can withstand considerably higher radiation intensity than the eyes, tissue may be burned to a greater or lesser degree, depending on the radiation time and the irradiation intensity.
- Avoid contact between the skin and the beam, or specular reflections of the beam. Reflections of the beam may be as dangerous as the beam itself. Wear appropriate protective clothing to protect the skin whenever necessary.

Fire Protection

Warning:

Fire hazards! Class 4 lasers are, by definition, fire hazards. The laser beam can cause flammable materials to ignite or explode. Always keep a fire extinguisher in the laser area in case a fire occurs.

Because of the high output power from the class 4 laser, a wide range of materials can be set on fire. Therefore, take appropriate fire prevention measures when the beam path is open:

- Combustible materials may be ignited by the laser beam or by electrical components inside the laser system. Flammable items must be isolated from the laser beam and from the laser system.
- Paper (circuit diagrams, leaflets, or even posters on the wall), curtains that are not coated with fire retardant, wooden panels or similar materials can be easily set on fire by direct or reflected laser radiation.
- Use only beam stops made of non flammable materials (not asbestos!).
- Many fluids and solvents (e.g. cleaning agents used for maintenance) are combustible. The intense beam of the laser can ignite vapors from these materials. Prevent the laser beam from contacting flammable materials used in the laser area.
- Move containers of flammable materials as far from the laser system as possible and shield them from the beam with opaque materials. Place these solutions and vapors under no circumstances in the beam path or near the system.

2.2.3 Constructive Safety Features

Safety Features

The laser device is equipped with the following constructional safety features:

- Appropriate Class 4 label affixed to laser device enclosure (see section [Labeling](#)).
- All parts of the laser where laser radiation may possibly escape are marked with the appropriate adhesive danger signs (according to IEC 60825).
- The SuperK EXTREME is provided with a connector ("Interlock") on the rear panel of the laser housing, where an external interlock switch can be installed. The interlock switch shuts down the laser remotely, for instance, if a door connected with the switch is opened.

2.2.4 General Safety Features

General Safety

The SuperK EXTREME has key switch controlled laser operation. The laser device can only be switched on with the key-switch. This prevents inadvertent or unauthorized starting of the laser. It cannot be operated with the key in the OFF position and the key cannot be removed in the ON position.

2.3 Safety Compliance List

CE Approval

The SuperK EXTREME is CE-marked and has been tested for FCC and VCCI compliance as well.

FDA Approval

The SuperK EXTREME complies with FDA part 1040 except for deviations provided in laser notice 50.

UL and CSA Approval

The equipment is not UL- or CSA-approved. However, the power supply itself is UL- and CSA-approved, and all mains wiring (including the power inlet) is enclosed in the power supply. No voltages outside the power supply are higher than 24 VDC (nominal). Datasheet and conformity documents for the power supply can be delivered on request.

2.4 Labeling

This section contains a description of the safety labels on the SuperK EXTREME and shows their location on the equipment. Ensure that all warning labels are affixed to the system as outlined in this chapter prior to operating the system.

2.4.1 Labels used on SuperK EXTREME

The SuperK EXTREME contains the following labels:

- Visible and Invisible Classification label, see figure 2-1.
- Laser label, see figure 2-2.
- Laser Aperture label, see figure 2-3.
- Item label, see figure 2-4.
- Laser Aperture sign, see figure 2-5.

Visible and Invisible The visible and invisible classification label informs about visible and invisible laser radiation from the SuperK EXTREME system that it is a Class 4 laser product and exposure to eye and skin must be avoided from both direct and scattered radiation.



Figure 2-1: Visible and Invisible Classification label

Laser Source The Laser label indicates that SuperK EXTREME is a laser source.



Figure 2-2: Laser label

Laser Aperture The Laser Aperture label provides information about where the Laser Aperture is located, what kind of laser emission is radiated from the Laser Aperture and that the SuperK EXTREME product complies with the IEC 60825-1 standard.

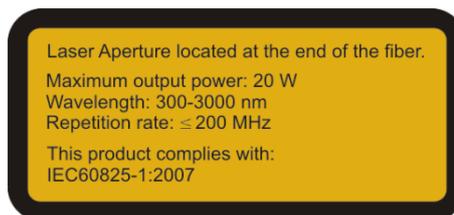


Figure 2-3: Laser Aperture label

Item

The Item label provides information about:

- the manufacturer of the system (NKT Photonics, Blokken 84, DK-3460 Birkerød)
- a short name of the SuperK EXTREME variant, e.g. SuperK EXTREME 80 MHz PP
- the product number (P/N) for the actual system, e.g. S442-125-030
- the serial number (S/N) for the actual system 8 digits, e.g. 10030192
- the design version (Ver), e.g. 01
- when the actual system was manufactured, e.g. 01-2011 for January 2011
- that the system meets the EU consumer safety and environmental requirements (CE-mark).
- the Laser Notice No. 50,,: indicates that the product complies with FDA requirements.

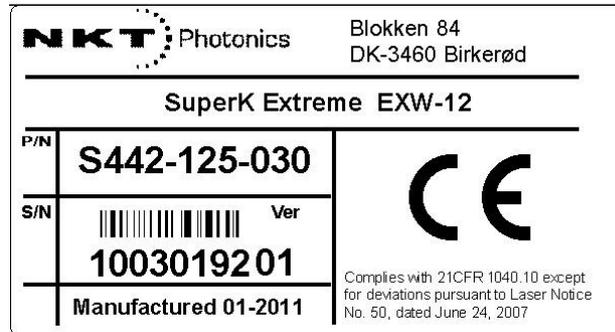


Figure 2-4: Item label

Aperture Sign

The Laser Aperture sign is attached to the output fiber close to the Laser Aperture (the collimator). The Laser Aperture sign is to warn users about the high laser emission from this collimator (Laser Aperture).

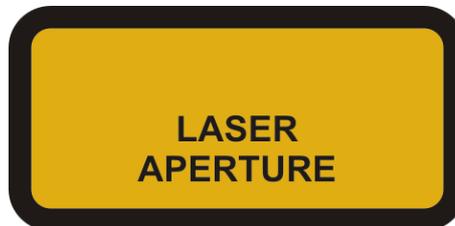


Figure 2-5: Laser Aperture sign

2.4.2 Label Positions

The positions of safety labels on the back plate and collimator are shown on figure 2-6 and 2-7.



Figure 2-6: Labels on the back of the SuperK EXTREME.



Figure 2-7: Laser Aperture sign on collimator.

2.5 Laser protective goggles

As mentioned earlier in this manual, it is not possible to achieve full protection from laser protective goggles since the SuperK EXTREME covers the full visible spectrum with a very high spectral power density.

- Accordingly, utmost care must be taken when operating this light source and there is direct access to the full emission of the output fiber. Only authorized personnel must operate the laser source.
- However, significant protection can be achieved by choosing the correct laser goggles. We recommend using a combination of several different filter-technologies (absorption and interference). Absorption filters can be edge filters as well as band pass filters. Only the combination of these filters makes it possible to solve complex requirements for broadband light source laser applications. The IR5D filter from NoIR Laser Company, LLC is currently the most suitable product available. Full protection is not achieved, but the alternatives are significantly worse.

The Optical Density as a function of wavelength for the IRD5 is shown in the figure below.

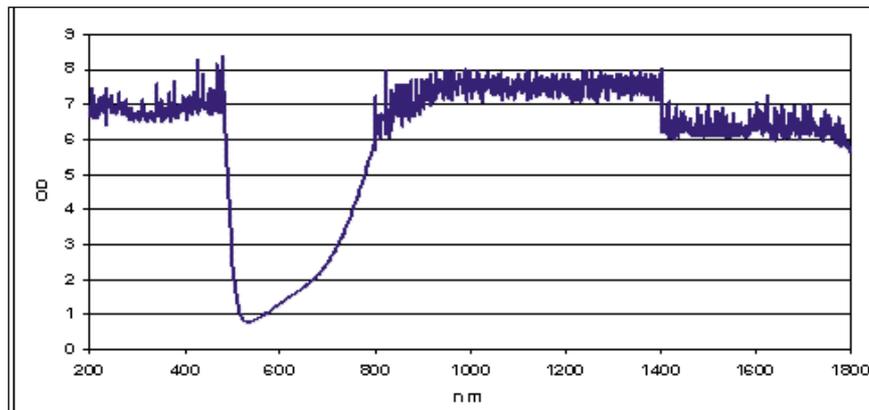


Figure 2-9: Optical Density (OD) as a function of wavelength

Note: More information can be found at: <http://www.noirlaser.com/filters/ird5.html>

3 Requirements

3.1 Installation Requirements

Mechanical Specs

- For installation, maintenance and transport the SuperK EXTREME requires entrances with inside spans of minimum 700 mm
- Shipment casing: 610 x 650 x 680 (w x h x d) mm
- Total shipment weight including casing and SuperK EXTREME: 33-41 kg
 - Shipment casing weight: 16 kg
 - SuperK EXTREME weight: 17-25 kg
- SuperK EXTREME dimensions: 444 x 223 x 377 (w x h x d) mm



Figure 3-1: Transport casing

Ambient Conditions

- Allowable operating temperature range: +18 to +30 °C
- Protection from dust (Pollution degree 2, Office environment)
- Allowable relative humidity: 20 to 80 % (non-condensing)
- Vibration should be minimized. An optical table is not needed and the source can be placed on an ordinary table or on the floor.
- Keep a back plate distance to wall or equipment of 100 mm to ensure free access to all ventilation openings.

3.2 Operating Conditions

Facility Requirements

The SuperK EXTREME is a Class 4 laser product and the operation facility and conditions need to comply with the following requirements:

- CFR21 1040.10 & Laser Notice LN50
- IEC / EN 60825-1

Or the SuperK EXTREME should be operated in accordance with local regulations for a Class 4 laser source.

Warning

Make sure that at all times during system operation the beam path is known and controlled. Wear suitable protection and make sure everybody in the laser area is aware of the fact that the system is being operated.

Electrical Supply Requirements

- Supply voltage: 100-240 VAC, 50/60 Hz
- The supply connections must be a 3 wire connection with one Phase, Neutral and Earth connections (standard IEC socket, type C13). Earth connection must be connected to earth.
- Maximum power consumption: up to 400 Watt (dependent on system variant and accessories)

4 Installation

Unpacking the SuperK EXTREME

Check the shipment case for any visible damage before unpacking the system from the shipment casing (see figure 4-1).

Be careful not to drop or bump the system while unpacking it from the shipment casing, as the laser system is shock sensitive and might be activated.

Note

Do not dispose any of the shipment materials as these must be used in case it is required to return the product. The warranty and service only covers if the unit is returned in the original packaging and packed according to the instruction in this manual.

1. Remove the lid of the transport casing.
 - a. Use torx bit (T20) enclosed in the shipping folder.



Figure 4-1: Side view of shipment casing

- b. Unscrew the screws in the top of the box, on the sides of the shipment casing and remove the lid.

2. Remove the cardboard boxes with enclosed manuals, cables, accessories, etc.



Figure 4-2: Cardboard boxes with manuals, cables, etc.

Note

Do not dispose the shipment materials as these must be used for any further shipments of the system.

3. Remove the techno foam and open the cardboard box containing the SuperK EXTREME.



Figure 4-3: Top view of the SuperK EXTREME in the open cardboard box

4. Lift the SuperK EXTREME out of the cardboard box with the techno foam on the two sides.

Please notice that the system weighs about 20 kg, so be careful when lifting the system. One person must not lift or carry the system alone. Two persons, one on each side of the shipping box, can lift up the system from the crate.

5. Carefully place the SuperK EXTREME on the position where it is intended to be used. Ensure that the system is positioned solidly without risk of falling down

before continuing. Remove the techno foam from the two sides by lifting one side with one hand and removing the foam with the other.

6. Open the plastic bag from the SuperK EXTREME.



Figure 4-4: SuperK EXTREME in plastic bag

Carefully remove the plastic bag without bumping the SuperK EXTREME on the table. Remove the Silica Gel Desiccant placed on top of the SuperK EXTREME, which has avoided moisture to get into the system during shipment.

The beam delivery fiber is fixed to the back plate using non-marking Kapton tape. Remove the Kapton tape from the back plate to free the beam delivery fiber.

7. The collimator output is equipped with a black protecting holder. The collimator holder is made out of metal and it is fixed to the back plate of the SuperK EXTREME with two screws. Do not release the collimator before the SuperK EXTREME is at its operational position. To release the collimator from the collimator holder, gently release the two plastic screws on the collimator holder, see figure 4-6.



Figure 4-6: Collimator holder (A) and collimator (B)

The SuperK EXTREME is now fully unpacked and the set-up procedure can be initiated.

Note

The collimator holder is the recommended protective location for the collimator when this is not in use. If desired, the collimator holder can be released from the SuperK by removing the four screws attaching the collimator holder to the back plate of the SuperK unit.

Warranty Label

It is not allowed to open the SuperK EXTREME. Thus the SuperK EXTREME is equipped with a warranty label on the top cover, see figure below. The warranty void if the system is opened.



Figure 4-7: Warranty label

Securing Output Beam

Before turning on the system please observe the following:

- Ensure that the collimator has been removed from the collimator holder.
- Ensure that all optical cables are free of kinks, sharp bends and mechanical damage.
- Ensure that the collimator (output aperture) enters an appropriate beam dump capable of handling the emitted power.

Warning

Make sure the beam path is known and controlled at all times during system operation. Wear suitable protection and make sure everybody in the laser area is aware the system is being operated.

Reach Room Temperature

The SuperK EXTREME is specified to an operating range from +18 to +30 °C. Immediately after receipt the laser system might have a temperature outside the specified range. Please allow the system to reach room temperature before starting it up.

Warning

Please ensure that the temperature of the SuperK EXTREME is within the specified range before starting it up.

5 Interface

5.1 Front Panel

The front panel of the SuperK EXTREME contains display and buttons for control of the system.

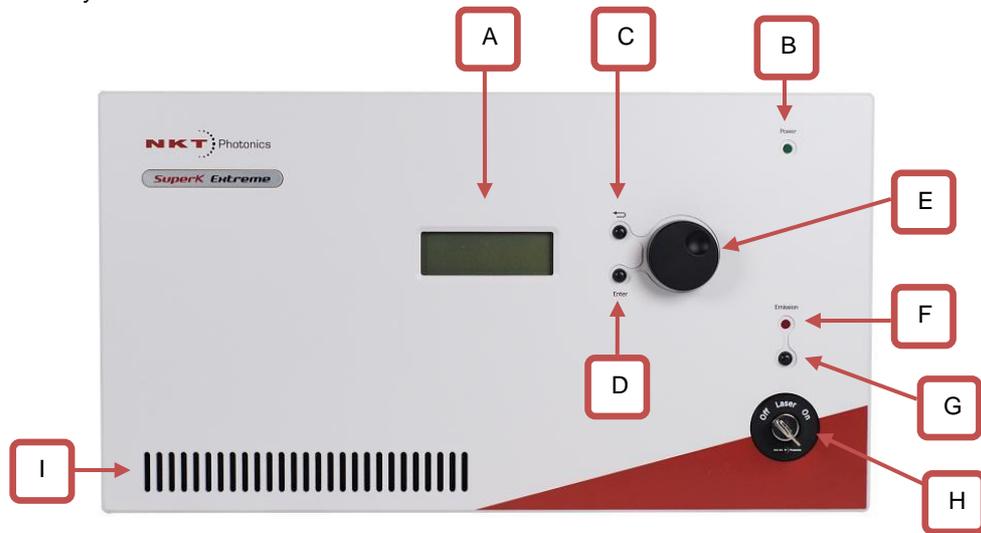


Figure 5-1: Front panel of SuperK EXTREME

Front Panel Functions

- A. Display: Displays the state of the system and the operating level. The display is also used for the front panel menu system and to display any error messages on the system.
- B. Line Power indicator: Green emitted light verifies that the system is powered up.
- C. Return button [↵]: Escape function for the menu and “NO” button.
- D. Enter button: Enter function for the menu and “YES” button.
- E. Turning wheel: Adjustments and scrolling up and down in the menu.
- F. Emission indicator: Red emission verifies that there is light emission from the system.
- G. Emission button: Button to turn emission ON/OFF.
- H. Key switch: Must be turned ON before system is operational.
- I. Air inlet: Together with inlet on both sides of the system, the inlet on the front panel provides the air inlet for the thermal cooling of the SuperK EXTREME. Do not cover or block the air inlet.

5.2 Back Panel

The back panel features all electrical connections, optical output and air outlet on the SuperK EXTREME.

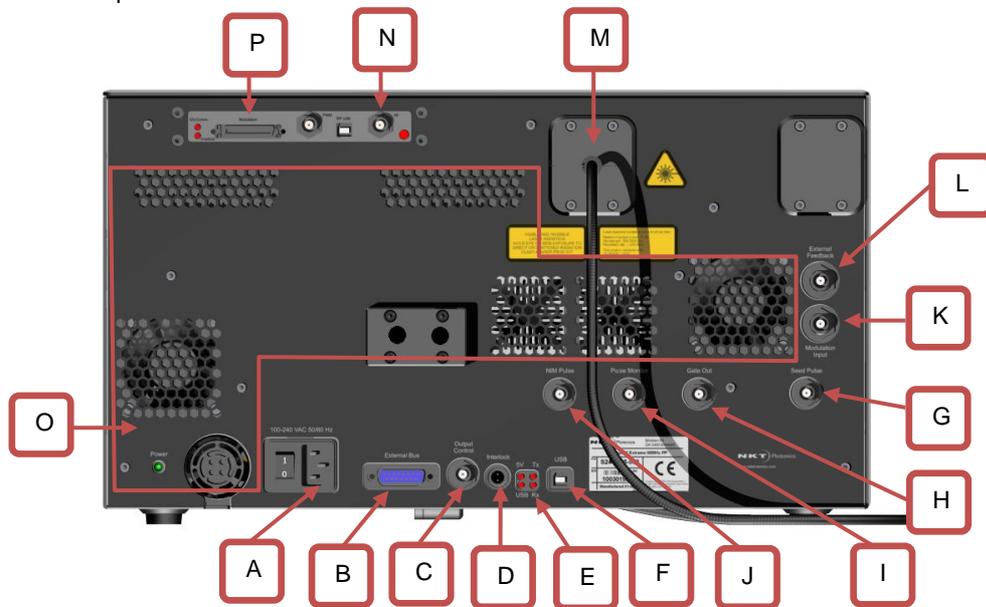


Figure 5-2: Back panel of SuperK EXTREME

Back Panel Interfaces

- A. Power inlet and Main power switch
- B. External Bus
- C. Output Control
- D. Interlock
- E. LEDs
- F. USB
- G. Seed Pulse
- H. Gate Out (Only systems featuring Pulse-Picker)
- I. Pulse Monitor (Only systems featuring Pulse-Picker)
- J. NIM Pulse (Only systems featuring Pulse-Picker)
- K. Modulation Input (Option)
- L. External Feedback (Option)
- M. Optical Output
- N. RF-Driver Interface (Option)
- O. Air outlet
- P. SuperK COMMAND Interface (Option)

5.2.1 Power Inlet and Main Power Switch

Power Inlet

The system has a universal main input allowing from 100 to 240 VAC, 50/60 Hz, IEC socket, type C13. The system must be connected to protective earth.

The system with possible accessories powered via the External Bus dissipates in total maximum 400 W.

Main Power Switch

The main power switch turns the SuperK EXTREME ON/OFF.

Power LED

The Power LED emits green light when the SuperK EXTREME is turned on.

5.2.2 External Bus

The External Bus on the back of the SuperK EXTREME system is a digital bus interface and 12 volt supply for external accessories.

Pin Connections

The table below provides the pin-out on the External Bus.

Pin no.	Name	Description
1	NC	Not connected.
2	RS485-	The negative/inverted part of the RS485 communication signal.
3	Interlock loop+	Positive connection of interlock loop. Should be connected to Interlock loop- (pin no, 4) to enable laser emission from the system.
4	Interlock loop-	Negative connection of interlock loop. Should be connected to Interlock loop+ (pin no. 3) to enable laser emission from the system.
9	Emission	Logic output. High when the SuperK EXTREME system has laser emission. With an 240 Ω internal series resistor the Anode from a LED can be connected directly to this pin and the Cathode to GND (pin no. 5,6, 13 or 14) to indicate laser emission externally.
10	RS485+	The positive/non-inverted part of the RS485 communication signal.
11	Not in use	For future use. Do not connect anything to this pin.
12	Interlock	Logic output. High (5V) when interlock circuit is not open and has been reset. This signal can be used to control safety related precautions on the External bus.
5, 6, 13, 14	GND	0 volt / ground.
7, 8, 15	+12 V	+ 12 volt supply voltage for external accessories.

Table 5-1: External Bus pin-out

External Bus Defeater

If no accessories with bus interface are used, the bus has to be terminated with an External Bus defeater providing a short connection on pin 3 and 4 (Interlock loop).

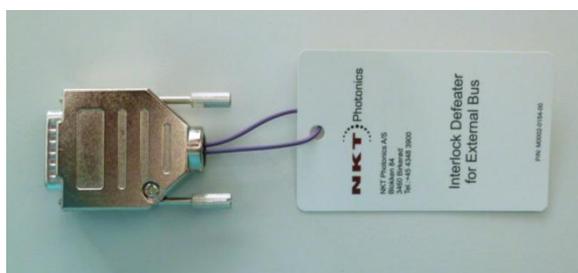


Figure 5-3: External Bus defeater

Cable

The External Bus can be connected to multiple external accessories. Each External Bus cable length must be 3 meter long or less. All External Bus cables must be shielded.

5.2.3 Output Control

Output Control

The warranty of the unit is measured by the usage of the booster incl. non-linear fiber.

For some application high output power is not required at all time, but fast turn on time is important. For these applications the external enable option allows the user to obtain light when required, which increases the number of usage hours of the system.

The Output Control feature allows the user to switch the booster ON and OFF with a fast rise time. Powering OFF only powers down the booster, i.e. not the rest of the system. Hence a small amount of infrared light is still emitted from the laser aperture. Notice that the Output Control is NOT a safety interlock feature! The Output Control connection is accessed through the BNC-connector on the back panel.

Electrical circuit-wise the Output Control input is a logical "sink" input, which can be controlled by an open collector/drain output, a 5 volt TTL/CMOS signal or a simple switch. The pull-up impedance is 4.7 kOhm.

The Output Control can be operated by connecting the input to an electrical switch. When the switch is open the booster output is enabled. When the switch is closed the booster output is disabled.

The booster output can rise up to 100% power level within 80 ms without overshooting. See figure 5-4.

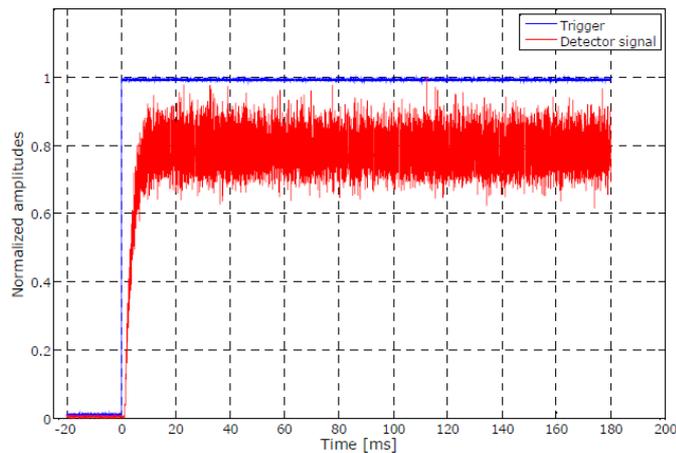


Figure 5-4: Start-up example with Output Control

Alternatively the output power can be turned ON and OFF via the USB interface using the SuperKontrol 2.0 software.

Cable

The Output Control cable must be less than 3 meter long. A standard single-shielded RG-58 cable may be applied.

5.2.4 Interlock

The SuperK EXTREME is a class 4 laser. Thus it is equipped with a door switch interlock connection in accordance with the laser safety regulations. The “Interlock” connector on the back panel contains terminals for an external door switch or interlock.

Warning

The SuperK EXTREME is a class 4 laser. Due to safety regulations it must be connected to a door switch interlock to prevent accidents.

The figure below shows a diagram of a door switch interlock system. When the door is open (A) the electrical circuit is open, and the laser emission is shut off. When the door is closed (B) the circuit is closed and it is possible to have laser emission.

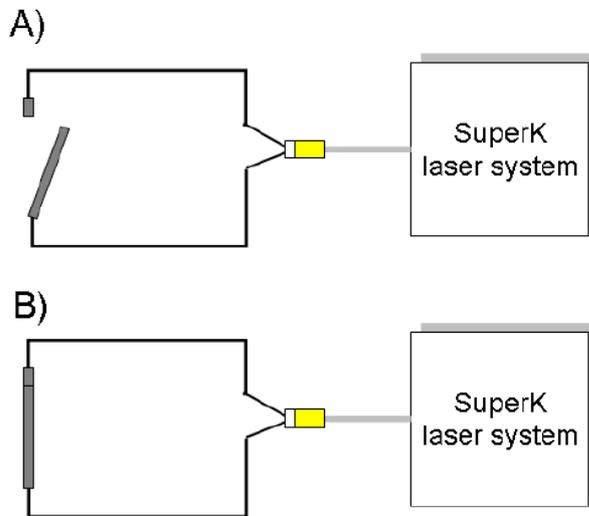


Figure 5-5: Diagram of door switch interlock circuit

The door switch interlock enhances safety, as it shuts off laser emission if the door to the room where the system is located is opened.

Closing the door again within 4 seconds will not require that the interlock circuit is reset. If the door is kept open for a longer period of time, the interlock circuit must be reset before laser emission can be initiated again.

Notice

Do not short-circuit the Interlock input. This will allow laser emission from the SuperK EXTREME without the door switch interlock, which is against the safety regulations. NKT Photonics does not take liability for any issues due to bypassing the Interlock safety mechanism.

Interlock connector

A cable connector for the Interlock interfacing on the back of the system is provided with the SuperK EXTREME. This plug is a LEMO connector type FGG.0B.302.



Figure 5-6: Interlock plug

Interlock Power Fail

Please ensure that there is no short connection from the interlock signals to ground/chassis as this will generate an Interlock power fail, which will disable the system. If there is an Interlock power fail, then switch off the mains supply, locate the short connection from the interlock signal to ground and remove it. Turn on the SuperK EXTREME system and reset interlock.

Assembly

For assembly of the LEMO connector with an interlock system please follow the procedure described in the table below.

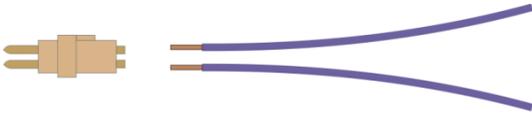
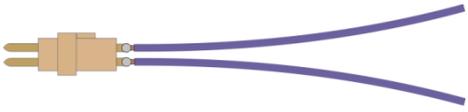
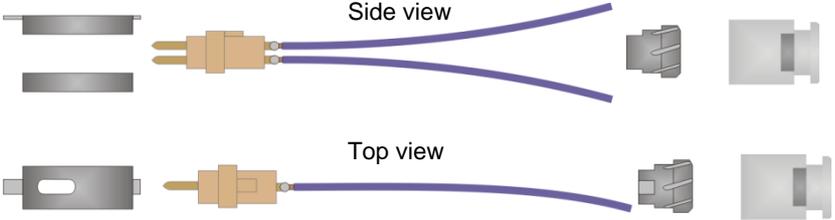
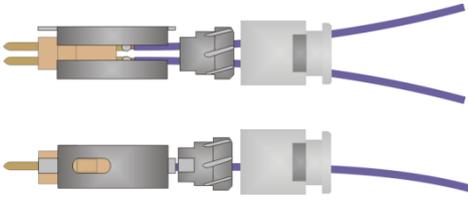
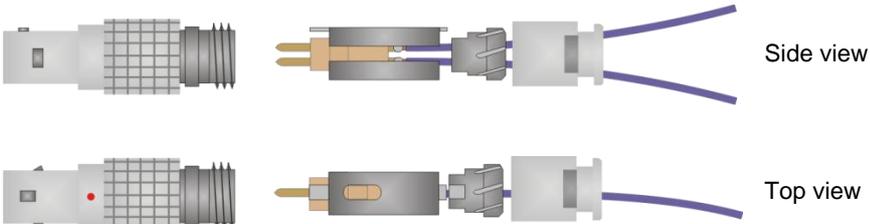
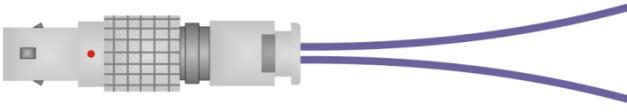
Step	Illustration
<p>1: Strip cable and prepare soldering.</p>	
<p>2: Solder wire to connector pins (two gold deposited pins).</p>	
<p>3: Assemble soldered parts with strain relief and the two cuff parts. The slotted hole in the one half cuff part should be aligned with the slot on the pin fitting.</p>	
<p>4: Side and top view of assembled parts.</p>	
<p>5: Align and assemble all parts into the connector housing. They will only fit into one position. Ensure that parts fit before tightening the strain relief!</p>	
<p>6: Assembled interlock connector.</p>	

Table 5-2: assembly of the LEMO interlock connector

Cable

The Interlock cable can be up to 5 meters long and it can be a non-shielded type. If a cable longer than 5 meters is required we recommend using a shielded type of cable.

5.2.5 LEDs

Four Light Emitting Diodes (LEDs) sitting next to each other in the bottom of the back panel provides information about the supply voltage and USB connection.

- 5 V** The 5 V LED on the back of the SuperK EXTREME is an indicator for the 5 volt supply voltage on the mainboard inside the SuperK EXTREME. When the system is powered up and if the supply voltage is correct the LED emits a green color. If the LED emits a red color, this indicates something is wrong with the internal 5 volt supply voltage.
- USB** The USB LED provides information about the USB connection on the SuperK EXTREME. When the system is powered up and no light is emitted from the USB LED, this indicates that there is no physical USB connection between the SuperK EXTREME and a computer. If there is a physical connection, but the driver is not correctly installed or configured, then the USB LED emits a yellow-orange color. If there is a physical connection and the driver is correctly installed and configured the USB LED emits a green color.
- Tx** When communication is established on the USB interface between SuperK EXTREME and an interfacing computer, the Tx LED flashes green light when the SuperK EXTREME is transmitting data to the computer.
- Rx** The Rx LED flashes orange light when the SuperK EXTREME is receiving data on the USB interface from an interfacing computer.

5.2.6 USB

- USB** The USB connection on the back of the SuperK EXTREME is for external control and monitoring of the system, e.g. with the SuperKontrol 2.0 software. The USB connector is a type B connector, which makes it possible to use a standard type A-B cable between computer and SuperK EXTREME.
- Read the SuperKontrol 2.0 manual for instructions how to install driver and software, and how to use the SuperKontrol 2.0 software. The SuperKontrol 2.0 manual is included on the SuperKontrol 2.0 CD-rom.
- Cable** The USB cable must be less than 3 meters long. A standard USB cable can be used.

5.2.7 Seed Pulse

- Seed Pulse** The Seed Pulse output is an analog output (0 to approx. +0.4 V) providing a signal from the seed laser inside the SuperK EXTREME. The SuperK EXTREME is pulsed laser source, and the Seed Pulse output provides a signal with a frequency of the SuperK EXTREME.
- The frequency is dependent on the seed laser inside the SuperK EXTREME, e.g. 80 MHz. The Seed Pulse output should be terminated into 50 Ohm in order to obtain the best waveform.
- Note** Because of fiber and cable lengths the phase between measured seed pulses on the Seed Pulse output may not match actual pulses out of the Optical Output.
- Cable** The Seed Pulse cable must be less than 3 meters long and a double-shielded type like e.g. RG-223 must be used.

5.2.8 Gate Out

- Gate Out** Systems featuring the Pulse-Picker option have the Gate Out output, which is an analog output (0 to +1 V). A high signal level indicates that pulses are passed through the Pulse-Picker, whereas a low level indicates that pulses are blinded off. The frequency of the signal will be identical to the chosen repetition rate of the

SuperK EXTREME.

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

Cable The Gate Out cable must be less than 3 meters long and a double-shielded type like e.g. RG-223 must be used.

5.2.9 Pulse Monitor

Pulse Monitor Systems featuring the Pulse-Picker option have the Pulse Monitor output, which is an analog output (0 to approx. +1 V). The Pulse Monitor output provides a signal corresponding light emitted from the system after the Pulse-Picker.

Note Due to fiber and cable lengths there will be a delay between the trigger signal and the optical output.

Cable The Pulse Monitor cable must be less than 3 meters long and a double-shielded type like e.g. RG-223 must be used.

5.2.10 NIM Pulse

NIM Pulse Systems featuring the Pulse-Picker option have the NIM Pulse output, which is an analog output (0 to approx. -0.9 V). The NIM Pulse output is similar to the Pulse Monitor output, but with the signal inverted, i.e. -0.9 volt on the signal indicates a pulse of emitted light.

Delay With the graphical user interface SuperKontrol 2.0 the NIM Pulse output can be delayed up to 9.2 ns in steps of 10-15 ps in order to match the electrical signal exactly with emitted light from the Optical Output.

Cable The NIM Pulse cable must be less than 3 meters long and a double-shielded type like e.g. RG-223 must be used.

5.2.11 Modulation Input (Option)

Modulation Input A standard SuperK EXTREME system features two operating modes: Current mode and Power mode. Systems featuring the Modulation Input have the possibility to operate the system in two additional modes: Modulated Current and Modulation Power. In these two additional modes it is possible to modulate the output amplitude with an analog signal applied to the Modulation Input.

For further information on how to utilize the modulation input on the SuperK Extreme system, please refer to our "Fast Wavelength Switching Using the SuperK SELECT and COMMAND" which may be found on our webpage.

Current and Power In Modulated Current mode the pump current in the booster is modulated as function of the electrical signal applied to the Modulation Input. In Modulated Power mode it is the power coming out of the booster that is modulated as function of the Modulation Input.

Setpoint and Input Signal The Modulation Input is a 0 to 10 volt input, i.e. 0 volt will turn down the output amplitude to minimum level and 10 volt will turn it up to what level is defined by the Setpoint level, which can be seen on the front of the SuperK EXTREME system. So if the Setpoint for example is set to 50 % in Modulated Power mode and the voltage on the Modulation Input is 5 volt, then the output power from the SuperK EXTREME system will be at 25 %.

Input Circuit The signal applied to the Modulation Input looks into a 5.6 k Ω resistor in series with 3.9 k Ω , i.e. the total input impedance is in the order of 10 k Ω . The 3.9 k Ω resistor acts like a pull-down resistor, which means that if no signal is applied to the Modulation Input then the system turns down to minimum in Modulated Current and

Modulated Power modes. If a voltage higher than 10 volt is applied to the Modulation Input, then the voltage across the 3.9 k Ω clamped and the optical output from the SuperK EXTREME system is limited to the Setpoint value.

Pulse-Picker

On SuperK EXTREME systems also featuring the Pulse-Picker option, the output power is scaled automatically with the repetition rate.

Useable Frequencies

In Modulated Current mode the bandwidth of the Modulation Input is 100 Hz, i.e. with a sinusoidal input signal the applied signal should not exceed 100 Hz. In Modulated Power mode the bandwidth is reduced to 50 Hz. For signals other than a sine wave, such as square, sawtooth, etc., the frequency must be limited accordingly. As an alternative to apply a square signal to the Modulation Input, it could be considered to apply a square signal to the Output Control Input on the back of the system.

5.2.12 External Feedback (Option)

External Feedback

Systems featuring the External Feedback input have the possibility to operate the system in an additional mode where it is possible to lock the output power to an external power sensing device, such as the External Power Monitor on e.g. SuperK SELECT or other NKT Photonics accessories.

For further information on how to utilize external feedback on the SuperK Extreme system, please refer to our “Application Note for External Modulation and Feedback” which may be found on our webpage.

Input Signal

The External Feedback input is an up to 4.1 volt input, i.e. the signal from the external power sensing device should provide a voltage within this range. For the feedback circuit to work as good as possible it is recommended to provide a feedback signal in the high end of the input range, but not at the limit as it will make it impossible for the feedback circuit to operate correctly.

The input voltage is relative to the output power. This means that no calibration is required of the feedback signal and the feedback will just lock to the actual voltage on the input when the locking mechanism is activated.

Setpoint

As headroom is required for stabilization, the setpoint can be set to any value between 0 and 90% (and not 100%).

The Setpoint is defined as operation in Current mode, so when the system is set up, it is recommended to operate it in Current mode and then find out what Setpoint level should be used in External Feedback mode.

Input Circuit

The External Feedback input is equipped with an internal 470 k Ω pull-up resistor, which will turn the output down to minimum level if no signal is applied to the input.

Implementation

The External Feedback stabilization is implemented digitally in an internal microcontroller, which means the output on the SuperK EXTREME is stepped up or down if the monitored power is observed to decrease or increase. The sample rate is approximately 200 Hz, which means that the circuit cannot suppress any variations at 100 Hz or above.

5.2.13 Optical Output

The SuperK EXTREME has an armored fiber delivery, terminated by a collimator, see figure below. The collimator consists of two parts:

- Collimator housing: outer diameter 28 mm
- Collimator tube: outer diameter 12 mm

Please refer to section 12.1 for further details regarding collimator dimensions..



Figure 5-7: The optical output with collimator.

Warning

Do not open the collimator. This might destroy the entire laser system. The warranty is void if the collimator is opened.

Warranty Sign

The output collimator is equipped with a “Warranty Void if removed” sign (figure 5-8). The sign indicates that the collimator should under any circumstances be attempted to be taken apart. There are no serviceable parts inside the collimator.



Figure 5-8: Warranty Void sign on collimator

The output beam is collimated with an achromatic lens to maximize coupling of light into a single mode fiber. However, with a single lens it is impossible to simultaneously maximize the coupling at all wavelengths of the output spectrum. Per default the coupling is optimized for maximum average coupling across the visible spectrum. Consequently, the beam is slightly larger for the infrared than for the visible wavelengths; see table below for details.

Wavelength	Beam size at collimator	Distance from collimator to where beam has expanded to 1 cm
600 nm	Approx. 1 mm	Approx. 4 m
1500 nm	Approx. 3 mm	Approx. 6 m

Table 5-2: Beam size after collimator for two wavelengths

During operation the collimator must be fixed for safety. NKT Photonics recommends gentle fixation on the collimator tube using plastic screws instead of metal screws to minimize risk of scratches on the collimator.

Warning

If the collimator is scratched it might not fit into the collimator input in the SuperK accessories.

A small fraction of the beam power is dumped in the collimator. If the thermal contact between the collimator and the surroundings is poor the collimator can become significantly warmer than the surroundings. Thus, it is recommended to enable firm thermal contact between the collimator and the surroundings.

The figure below shows an example of mounting the collimator unit. The collimator (A) is fixed inside a cylindrical sleeve (B) having an outer dimension of 24.9 mm so it fits with both 25.0 and 1-inch holders. The cylindrical sleeve is mounted in a XY-stage (C). In this example the rail is from OWIS, however, similar equipment from other suppliers such as Thorlabs or Newport may also be applied.

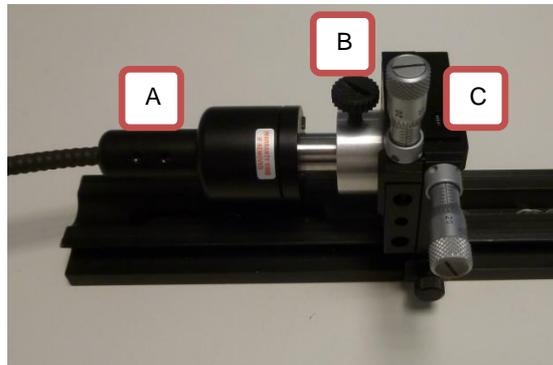


Figure 5-9: Example of mounting of the collimator unit

The collimator could also be fixed in a 1/2-inch mount.

5.2.14 RF-Driver Interface (Option)

On SuperK EXTREME systems with internal RF-Driver for SuperK Select or SuperK Cross, the system will have the following additional RF-Driver interface on the back.

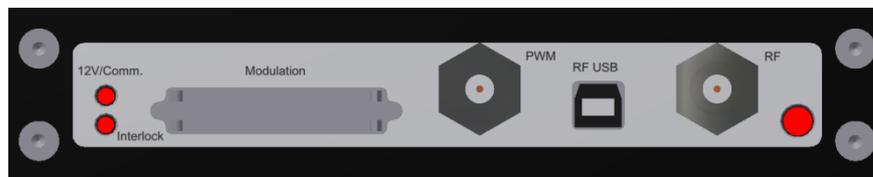


Figure 5-10: RF-Driver interface

12V/Comm

This LED indicates status for the supply voltage and the communication from the RF-Driver. The 12V/Comm LED emits green light when the 12 volt supply voltage is present and accurate. The LED emits red light if the 12 volt supply voltage is too low. When the 12 volt supply voltage is present and the RF-Driver transmit on the digital bus the 12V/Comm LED emits yellow light.

Interlock

The Interlock LED shows the status of the Interlock signal. When the Interlock LED emits green light the Interlock signal is present and the system may be able to provide laser emission. If the Interlock LED emits red light, the Interlock chain is broken and the system cannot provide laser emission.

Modulation

The Modulation input option is for amplitude modulation (AM) and frequency shift keying (SUPERK COMMAND) of the eight individual RF-Driver channels.

RF USB

Direct USB connection to the internal RF-Driver. Under normal operating circumstances this USB interface should not be used. All communication between the user interface SuperKontrol 2.0 and the SuperK EXTREME system is provided via the other USB connection (F).

The USB cable must be less than 3 meters long. Please use the USB cable provided with the SuperK Extreme system.

RF

High frequency output for connection to the RF input on the SuperK Select or SuperK Cross. This output can provide watts of RF-power and must be terminated into a proper load, e.g. SuperK Select or SuperK Cross.

The red LED indicates when the RF-driver output is active. With RF-power on the output the cable between the RF-output on the RF-Driver interface and the external accessory must not be disconnected as this may damage the RF-driver.

When connecting the RF driver please use the RF cable shipped along with the SuperK Extreme system. The cable should be connected before initiating the RF driver. The cable should never be de-attached during operation as the driver may be seriously damaged.

5.2.15 Air Outlet

The SuperK EXTREME is cooled down with air pulled in from the air inlet on the two sides and the front panel and blown out via the air outlet on the back. The system features five fans, one small fan in the bottom and four larger fans above. The four larger are all electrically controlled, i.e. air flow is adjusted as needed. Common for all air in- and outlets are that they must not be blocked.

6 Operation

6.1 Precautions

Warning

Make sure at all times during system operation that the beam path is known and controlled. Wear suitable protection and ensure everyone in the laser area is aware that the system is being operated. Ensure that door interlock is in place.

6.2 Turning ON the SuperK EXTREME for the first time

Turning On

Use the following procedure to turn the system on.

Step	
1.	Connect the Interlock according to safety regulations. Please refer to the Interlock section.
2.	Insert the optical output from the SuperK EXTREME into the intended application. Please take time to ensure that the optical output is properly fixed and that the optical patch is well known.
3.	Connect 100/240 VAC, 50/60 Hz to the power inlet.
4.	Turn on the system by switching the main power switch on the back of the system.
5.	Verify that the green Power LED on the front panel is on.
6.	Turn the key switch on the front panel to 'On' position.
7.	Click on the Return button [↵] in order to reset the Interlock.
8.	The power level of the system is indicated in the display. The output level is adjustable between 0% and 100%. Set the power level to 0% by turning the turning wheel counter-clock wise.
9.	Click on the Emission button to start up laser emission. The red Emission indicator turns on.
10.	The output power may now be increased by turning the turning wheel clockwise. The power level is shown in percentage in the display. Be aware that several watts of visible and invisible laser radiation are emitted from the system when the power is turned to 100% (max.).
11.	Clicking on the Emission button again will turn off laser emission.
12.	Clicking on the Emission button again will turn on laser emission with the same power level as before turning off.

Table 6-1: First time installation and start-up procedure for the SuperK Extreme

The SuperK EXTREME is now ready for use.

6.3 Everyday Operation via the Front Panel

Turning On

Follow these steps for turning the system on:

Step	
1.	Switch the main power switch on the back panel on.
2.	When prepared for emission, turn the key-switch on the front panel to "ON" position.
3.	Click on the return button [↵] to reset the Interlock.
4.	Initiate emission by clicking on the Emission button.
5.	Adjust the output power using the turning wheel.

Table 6-2: Procedure for turning the system "ON"

Turning Off

Follow these steps for turning the system off:

Step	
1.	Click on the emission button to switch off laser emission.
2.	Turn the key-switch on the front panel to "OFF" position.
3.	Switch the main power switch on the back panel to "OFF" position.

Table 6-3: Procedure for turning the system "OFF"

Notice

The key-switch is to be regarded as a safety switch and removing the key ensures no emission from the laser source. Hence it should be used during "light off" alignment. Furthermore, it serves the purpose of allowing only trained personnel to use the source.

7 System Menu

Menu-driven Interface

The SuperK front panel has a system menu, which allows various changes to the system.

System Menu

The system menu is entered by clicking on the Enter button. Following the turning knob is used to scroll through the system menu. Turning the turning knob clockwise (clockwise) scrolls forward in the system menu and turning the turning knob counter-clockwise (counter-clockwise) scrolls backward.

Following options are possible in the system menu:

1. Operating mode
2. Pulse picker ratio
3. Status display
4. Date and time
5. Display contrast
6. Display backlight
7. Serial numbers
8. Firmware versions

To select an option in the system menu, click on the Enter button. To return to the main menu from a sub-menu, click on the return button. To leave the main menu, click on the return button.

Output Power Adjustment

When the system is not in its main menu or any of its sub-menus, the turning knob is directly used for output power adjustments. Turning the turning knob clockwise increases the output power and turning the turning knob counter-clockwise decreases the output power. Adjustments are made between 0 and 100 %, in increments of 1 %.

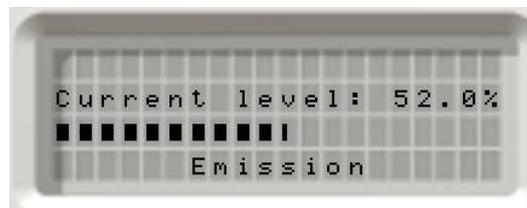


Figure 7-1: Output adjustment

Dependent on whether the system is operating in Constant current or Constant power mode, the adjustment will change the pump current in the booster or the power emitted from the booster.

If the interlock signals in the External Bus and Interlock connectors on back of the SuperK EXTREME are not closed/short connected as described in section [External Bus](#) and [Interlock](#), then the display will show up with following messages respectively:

- External interlock
- Door interlock

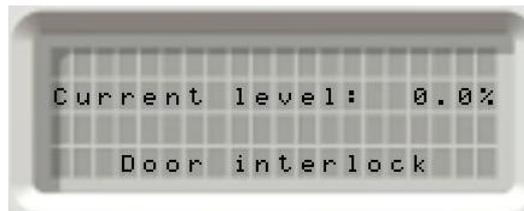


Figure 7-2: Interlock circuit open

Key Switch

Laser emission cannot be initiated if the key switch on the front of the SuperK EXTREME is in OFF position, and laser emission will be shut off immediately when the key switch is moved from ON to OFF position.

To help to operate the system as smoothly as possible, the display informs the operator if the key switch is in OFF position.

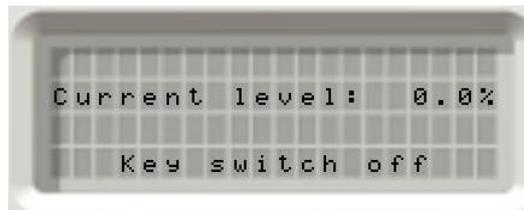


Figure 7-3: Key switch in OFF position

Reset Interlock

If the interlock circuit has been activated, either via the External Bus or the Interlock on the back of the system or the system has been powered down and up again, the interlock circuit must be reset in order to obtain laser emission. In this case the display will say Reset interlock: ↵ as shown on the picture below.

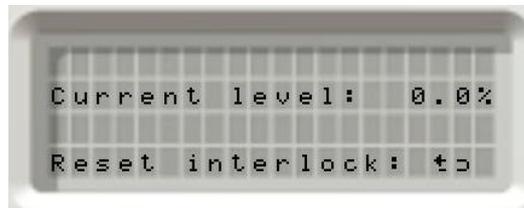


Figure 7-4: Reset interlock

Click on the Return button (↵) to reset Interlock.

Emission

Click on 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.

7.1 Operating Mode

The SuperK EXTREME can be operated in either Constant current or Constant power mode. In Constant current mode the pump current in the booster is held constant at the desired level, whereas the output power is held constant at the desired level in Constant power mode.

Three additional modes are optional and can be added to the system if requested. See section [Modulation Input](#) and [External Feedback](#) for details.

Change Operating Mode

To change the operating mode, click on the Enter button to enter the system menu. Turn the turning knob until the display says System menu → Operating mode and click the Enter button. Turn the turning knob to shift between Constant current and Constant power.

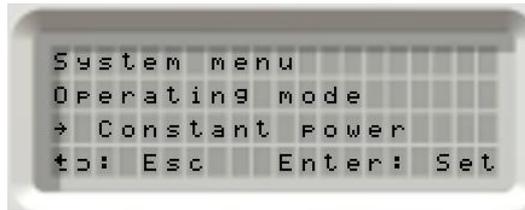


Figure 7-5: Changing operating mode

Click on the Enter button to choose the desired mode. Click on the Return button (↵) in order to leave the system menu.

External Feedback If the system features External Feedback and this mode is chosen, the setpoint is automatically set to 0 %. By turning the turning knob on the front plate the setpoint can be set to any value between 0 and 90 %. One and a half second after the Setpoint has been set the system starts to lock to the feedback signal that is provided to the External Feedback input.

Warning It is very important that the SuperK EXTREME system has a valid feedback signal as it otherwise cannot operate correctly. If an incorrect signal is applied to the External Feedback connector and the system is set to lock to this signal it may turn up the optical power to its maximum level. Before locking to an External Feedback signal it is recommended to monitor the External Feedback signal via the Input Readouts menu. Please refer to section: [Input Readouts](#) for further details.

7.2 Pulse-Picker Ratio

Pulse-Picker In SuperK EXTREME systems featuring the Pulse-Picker option, the Pulse-Picker ratio can be selected from the front panel. Please refer to the [Pulse-Picker](#) section for further details about e.g. what ratios (repetition rates) are available.

No Pulse-Picker SuperK EXTREME systems that do not have the Pulse-Picker option, will read out Feature unavailable in the display, if the Pulse picker item is chosen in the system menu.

Change Pulse-Picker Ratio To change the Pulse picker ratio, click on the Enter button to enter the system menu. Turn the turning knob until the display says System menu → Pulse picker ratio and click the Enter button. Turn the turning knob clockwise to increase the ratio (lower the repetition rate) or counter-clockwise to decrease the ratio (increase the repetition rate).

Warning **When increasing the pulse repetition rate, the output power will increase accordingly!**

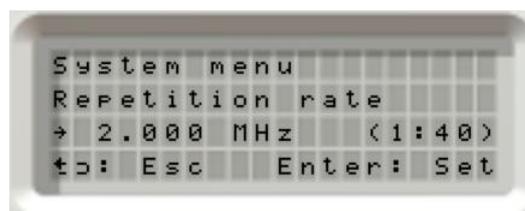


Figure 7-6: Changing Repetition rate

Click on the Enter button to choose the Repetition rate. Click on the (↵) Return button to leave the system menu.

7.3 Input Readouts

In the Input Readouts menu it is possible to monitor a few signals that at some situations may be interesting to monitor. Turn the turning knob to shift between the different parameters.

Modulation

The voltage on the Modulation Input is monitored in millivolt (mV), when the parameter Modulation is chosen.

Feedback

Similar the voltage on the External Feedback is monitored in millivolt (mV), when the parameter Feedback is chosen.

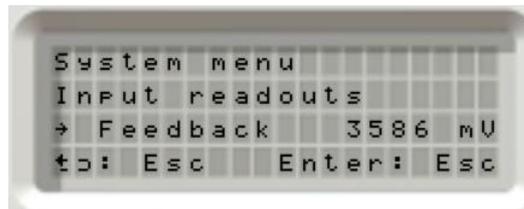


Figure 7-7: Monitoring Input Readouts

Click twice on the (↵) Return button to leave the system menu.

7.4 Status Display

When the system has not entered the main menu or any sub-menus, the top line in the display can be configured to be used for:

- Nothing, i.e. blank line (default)
- User text
- Date and time
- Repetition rate

User-Text

With the SuperKontrol 2.0 software a user-text can be written to the SuperK EXTREME. This user-text can be used to e.g. name the SuperK EXTREME to distinguish between different systems if multiple systems are in use. Please read the SuperKontrol 2.0 manual about how to install and use the SuperKontrol 2.0 software.

Date and Time

If Date and time is chosen in the Status display sub-menu, the SuperK EXTREME will read out current date and time from the systems internal clock.

Change Status Display

To change the status display, click on the Enter button to enter the system menu. Turn the turning knob until the display says System menu → Status display and click the Enter button. Turn the turning knob to shift between None, User-text and Date and time.

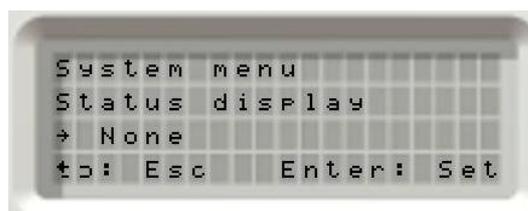


Figure 7-8: Changing status display

Click on the Enter button to choose the desired mode. Click on the (↵) Return button to leave the system menu.

7.5 Date and Time

The system contains an internal clock with battery back-up. The clock was set automatically during manufacturing of the system to Central European Time. If desired the date and time can be adjusted.

Change Date and Time

To change the date and time, click on the Enter button to enter the system menu. Turn the turning knob until the display says System menu → Date and time and click the Enter button. Turn the turning knob to change the setting. Click on the Enter button to jump from year, month, date and time.

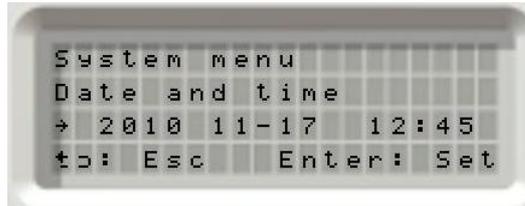


Figure 7-9: Changing date and time

Click once more on the Enter button to use the new Date and time or the (↶) Return button to escape without saving. Click on the (↶) Return button to leave the system menu.

7.6 Display Contrast

The contrast of the characters can be adjusted from 0 to 100 %, in steps of 1 %.

Change Display Contrast

To change the display contrast, click on the Enter button to enter the system menu. Turn the turning knob until the display says System menu → Display contrast and click the Enter button. Turn the turning knob clockwise to increase the contrast and counter-clockwise to decrease the contrast.

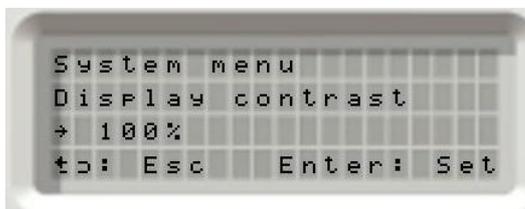


Figure 7-10: Changing display contrast

Click on the Enter button to use the new contrast setting. Click on the (↶) Return button to leave the system menu.

7.7 Display Backlight

The electrical current in the backlight on the front panel display can be adjusted from 0 to 30 mA, in steps of 1 mA.

Change Display Backlight

To change the display backlight, click on the Enter button to enter the system menu. Turn the turning knob until the display says System menu → Display backlight and click the Enter button. Turn the turning knob clockwise to increase the backlight and counter-clockwise to lower the backlight.

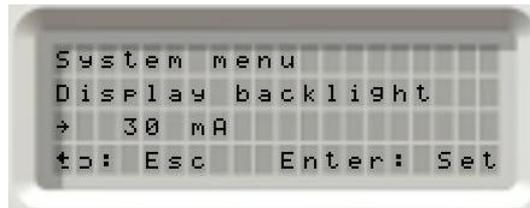


Figure 7-11: Changing display backlight

Click on the Enter button to use the new backlight setting. Click on the (↵) Return button to leave the system menu.

7.8 Serial Numbers

View Serial Numbers

The SuperK EXTREME consists of a number of modules. To view the serial numbers of these modules and possible external accessories connected to the External Bus, click on the Enter button to enter the system menu. Turn the turning knob until the display says System menu → Serial numbers and click the Enter button.

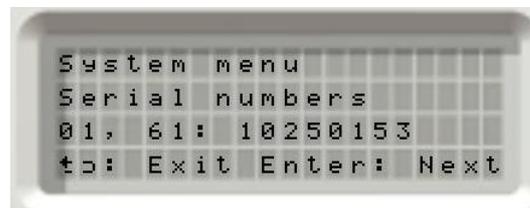


Figure 7-12: Viewing serial numbers

Click on the Enter button to view the next serial number. Click twice on the (↵) Return button to leave the system menu.

7.9 Firmware Versions

View Firmware Versions

As for the serial numbers, it is possible to view the firmware revisions in the internal modules and on external accessories connected to the External Bus. To view the Firmware versions, click on the Enter button to enter the system menu. Turn the turning knob until the display says System menu → Firmware versions and click the Enter button.

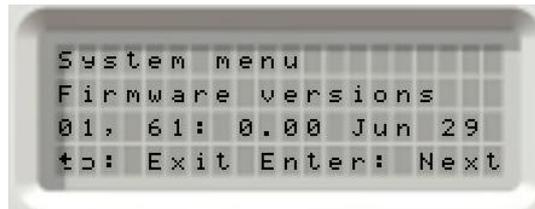


Figure 7-13: Viewing firmware versions

Click on the Enter button to view the next serial number. Click twice on the (←) Return button to leave the system menu.

8 Computer Controlled Operation

SuperKontrol 2.0

It is possible to remotely control the SuperK EXTREME from a computer via the SuperKontrol 2.0 software.

Essentially, the SuperKontrol 2.0 contains the same features as available from the front panel on the SuperK system but with some additional features.

Additional Features

Examples of additional features are:

- Firmware upload
- Log file download
- Control of external accessories

Please read the SuperKontrol 2.0 Software Manual for details on installing and operating this software. The SuperKontrol 2.0 Software Manual is included on the SuperKontrol 2.0 CD-rom.

Protocol

The SuperK EXTREME utilizes a binary protocol. For detailed information about how to communicate with the system via this binary protocol, please refer to a separate document that can be requested from NKT Photonics.

Labview VI

NKT Photonics has developed a driver for Labview in order to facilitate customers for development of their own Labview based interface to the SuperK System. The driver is available through our Software Development Kit (SDK).

USB Cable

To connect the SuperK EXTREME to a computer, a standard USB cable A to B should be used.



Figure 8-1: USB cable A to B

USB Driver

Before installing and trying to run the graphical user interface SuperK EXTREME, it is recommended to install the USB driver first, which is available in the CP210x VCP driver folder on the SuperKontrol 2.0 Installation CD.

9 Supercontinuum Generation

Supercontinuum Supercontinuum generation is the formation of broad continuous spectra by propagation of high power optical laser pulses through non-linear media. In principle supercontinuum can be generated in many materials but in order to achieve a very broad spectrum the exact optical properties of the laser pulses and the non-linear fiber must be matched.

Photonic Crystal Fiber The SuperK laser series is a fiber based supercontinuum source, where the non-linear media consist of a photonic crystal fiber (PCF).

For more information about supercontinuum generation:
<http://www.nktpotonics.com/side5412-cid-5242.html>

9.1 Spectrum vs. Output Power

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

Spectral output The figure 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

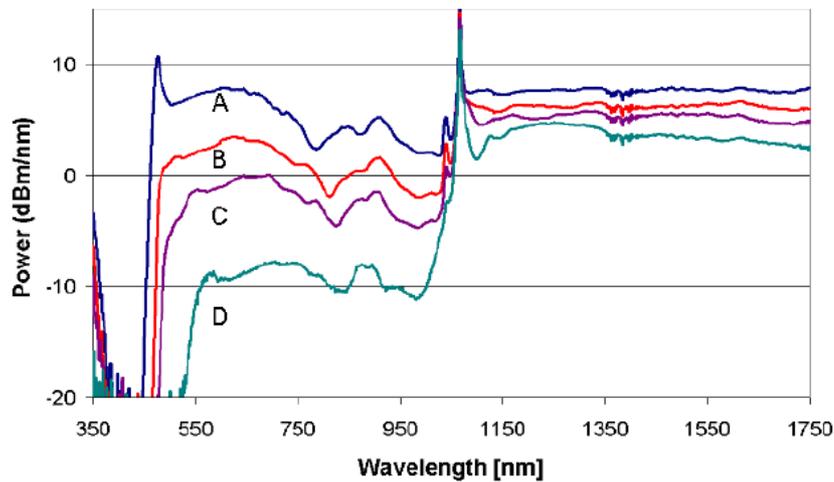


Figure 9-1: Example of supercontinuum output on a SuperK EXTREME

9.2 Polarization of 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 and at maximum output the light is close to unpolarized.

9.3 Pulse-Picker

The SuperK EXTREME can be purchased with or without the Pulse-Picker option. The Pulse-Picker is capable of shutting off pulses and hereby reduces the repetition rate of the system.

Possible Repetition Rates

The repetition rate can be lowered with a factor of up to 40. Below are the possible repetition rates indicated as an example for a system with a seed laser at 80 MHz.

- 80.0 MHz (1:1)
- 40.0 MHz (1:2)
- 26.7 MHz (1:3)
- 20.0 MHz (1:4)
- 16.0 MHz (1:5)
- 13.3 MHz (1:6)
- 11.4 MHz (1:7)
- 10.0 MHz (1:8)
- 8.89 MHz (1:9)
- 8.00 MHz (1:10)
- 6.67 MHz (1:12)
- 5.71 MHz (1:14)
- 5.00 MHz (1:16)
- 4.44 MHz (1:18)
- 4.00 MHz (1:20)
- 3.64 MHz (1:22)
- 3.20 MHz (1:25)
- 2.96 MHz (1:27)
- 2.76 MHz (1:29)
- 2.50 MHz (1:32)
- 2.35 MHz (1:34)
- 2.16 MHz (1:37)
- 2.00 MHz (1:40)

Other possible configurations of repetition rates may be available depending on system specifications. Please consult NKT Photonics for further information.

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

Please notice that increasing the repetition rate will increase the output power level accordingly. So if for example the repetition rate is changed from 2 MHz to 80 MHz, then the output power increases with a factor of 40 (80/2). Hence, the system is calibrated for constant pulse energy and not for constant average power.

9.4 Reflection monitor

Reflection

The SuperK EXTREME is equipped with a reflection monitor to avoid that a back reflection can damage or destroy the system. In case the detection on the reflection monitor exceeds the present limit, the system will shut down and error code "Code 48, 5 0x65" appears on the display.

Possible Problem

Possible origins of the problem:

- The system is disturbed by an optical reflection from an external component. If a mirror or shutter is inserted into the beam path, a reflection could be sent back into the system and an alarm will appear.
- The output power is too high, resulting in an alarm from an internal reflection.

Safemode operation

If a reflection occurs the system will enter safe mode operation where the output power is limited. There is no physical damage to the system and the condition can be reset by following these steps in the SuperKontrol software:

- Start SuperKontrol
- Go to the "About" Panel
- Click "Reset current limit"

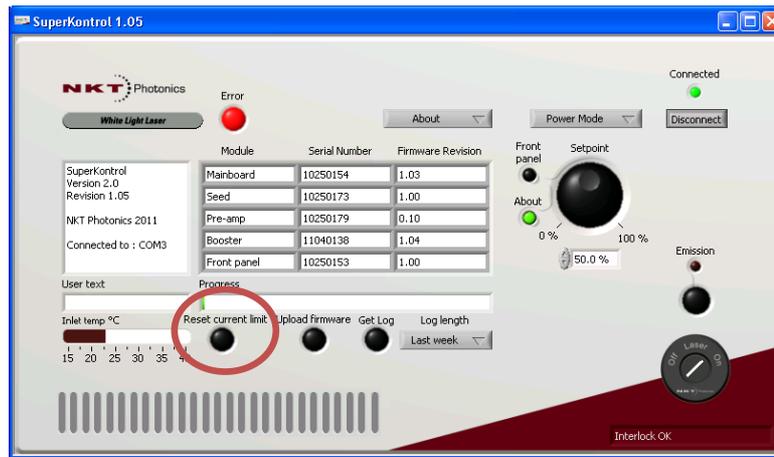


Figure 9-2: Safe mode operation. Click on the “Reset current limit”.

Before proceeding please make sure that an external reflection cannot re-enter the system. Remove all components after the collimator. Be sure to dump the output power in an appropriate beam dump, e.g. a large power meter. If the alarm shows up again, the reflection problem is internally in the SuperK EXTREME. Please note the set point value where the alarm appears.

If no alarms are observed, the reflection probably came from the external beam path. Rebuild the external beam path, one component at a time to locate the position of the reflection. If the problem persists, please contact the NKT Photonics service line.

9.5 Constant Power and Constant Current mode

The SuperK EXTREME has the option of operating in either “Constant Power” or “Constant Current” mode.

Constant Power

In Constant Power mode the output power of the system is locked to a signal from an optical monitor in the beam path. Per default the power locking detector is set up to detect a fraction of the visible part of the emitted supercontinuum light. This makes it possible to keep the power level stable at a desired level for the visible part covered by the detector.

Constant Current

In Constant Current mode the current in the booster pumps is held constant at a selectable level. Environmental factors such as temperature might cause the output power to drift during operation.

Notice

Each SuperK EXTREME is manufactured to power lock on either the visible or infrared light. It is not possible for the user to change the wavelength range used for power lock.

Advantages and Disadvantages

Each mode of operation has its advantages and disadvantages.

Constant Power mode is an advantage for applications requiring the visible power to be stable. The option is not recommended at low power levels where the supercontinuum spectrum is strongly dependent on pump current. Reflections in the beam path below the reflection threshold is also detected by the output power monitor, which will make the system turn down the actual output power, so the sum of reflected power and output power is equal to the setpoint value.

Constant Current mode is simple and independent of the supercontinuum spectrum as well as any external sub-systems.

Default Setting

The default setting is Constant Power mode. For details on switching between the two modes, please refer to section [Operating Mode](#).

10 Service & Support

- Service** There are no user serviceable components inside the SuperK Extreme. In case of malfunction, NKT Photonics should be consulted.
- The unit is sealed with a label "WARRANTY VOID IF REMOVED" and it is thus strictly prohibited to remove the chassis cover.
- Storage** If required the SuperK Extreme should be stored in a dry and cool place (15-20°C). The optical output should be protected using the collimator holder on the backside of the SuperK Extreme unit. Avoid exposing the unit to vibrations or mechanical shock.
- Chassis Cleaning** If cleaning of the SuperK unit is required the chassis may be cleaned with a damp cloth.

10.1 Support

- Support** **Technical support**
NKT Photonics can be contacted for technical information regarding issues with use of the SuperK Extreme or associated accessories. Our support hotline is available in the hours between 9 and 16 Central European Time (CET).
- Contact Information** **Contact information:**
NKT Photonics A/S
Blokken 84
DK-3460 Birkerød
Denmark
-  Phone (support): +45 4578 7787
 Phone (general): +45 4348 3900
 Fax (general): +45 4348 3901
-  E-mail:
support@nktphotonics.com
- Online support page:**
<http://www.nktphotonics.com/> (click on support)

11 Literature

[1]

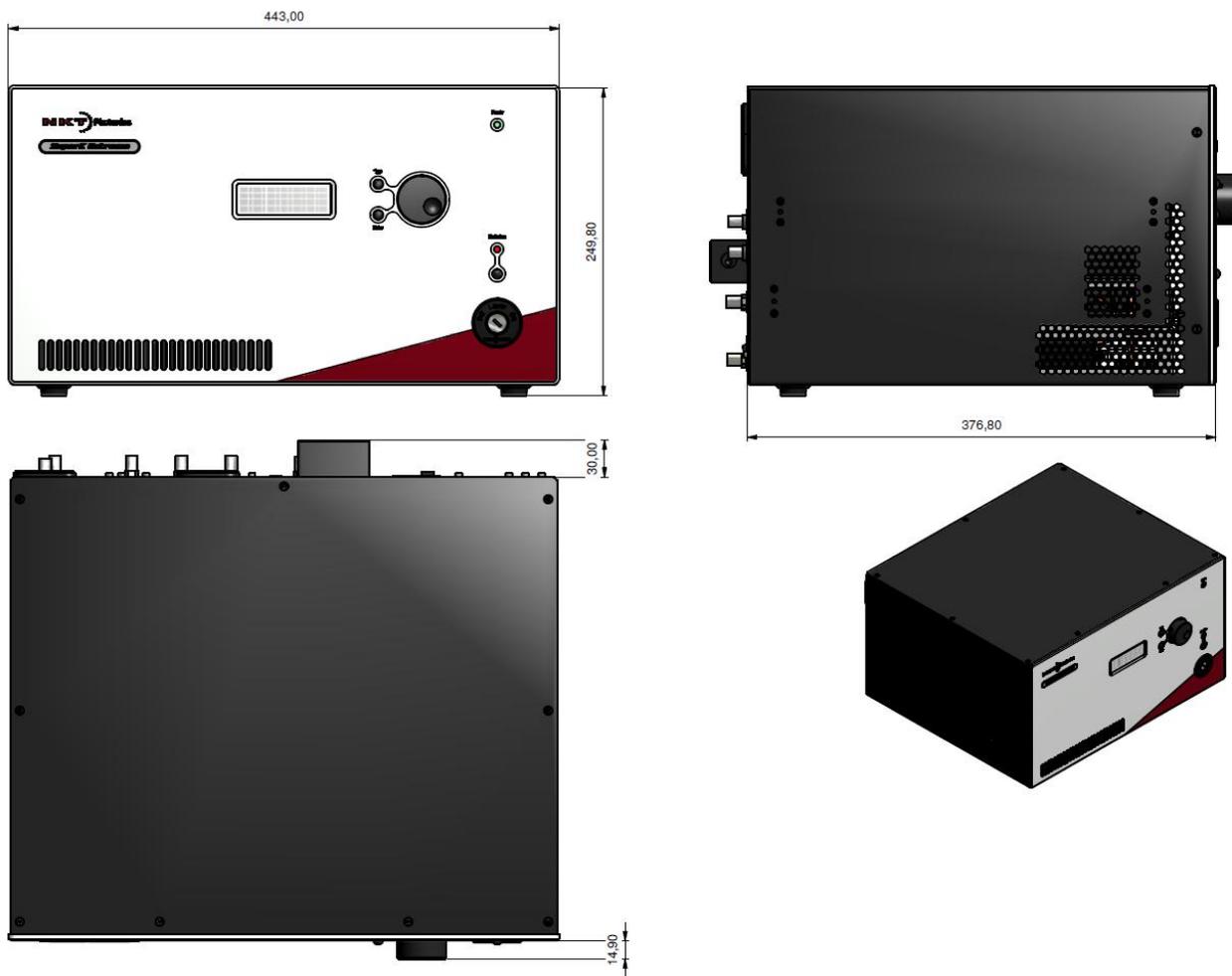
Supercontinuum generation in photonic crystal fiber. John M. Dudley et al.
Reviews of Modern Physics, Vol. 78, Oct-Dec 2006, page 1135-1184

A topical review of numerical and experimental studies of supercontinuum generation in photonic crystal fiber is presented over the full range of experimentally reported parameters, from the femtosecond to the continuous-wave regime. Results from numerical simulations are used to discuss the temporal and spectral characteristics of the supercontinuum, and to interpret the physics of the underlying spectral broadening processes. Particular attention is given to the case of supercontinuum generation seeded by femtosecond pulses in the anomalous group velocity dispersion regime of photonic crystal fiber, where the processes of soliton fission, stimulated Raman scattering, and dispersive wave generation are reviewed in detail. The corresponding intensity and phase stability properties of the supercontinuum spectra generated under different conditions are also discussed.

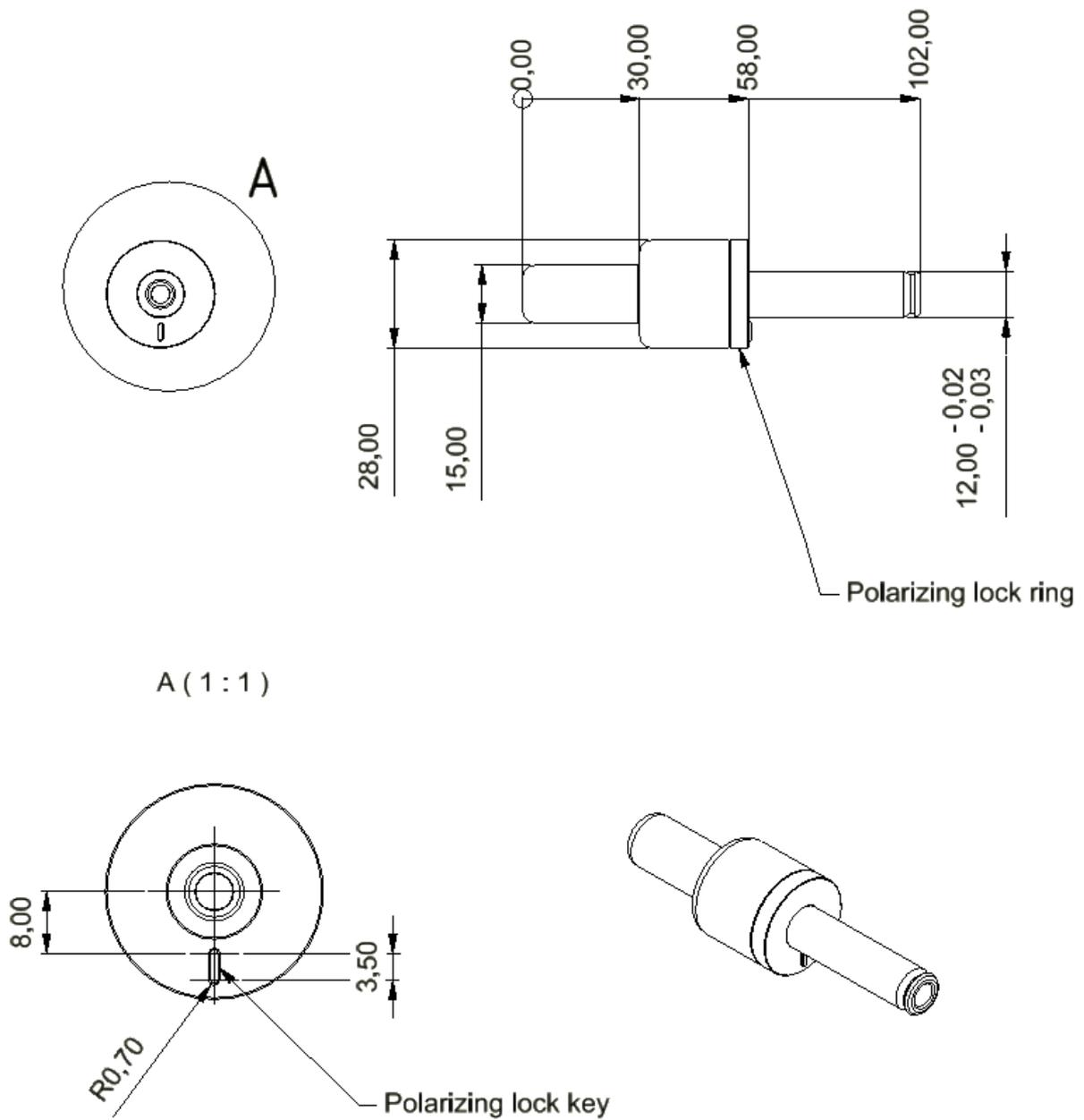
12 Electrical and Mechanical Specifications

Parameter	Conditions	Value	Unit
Temperature range	Ambient temperature	15 to 37	°C
Humidity	Non condensing	20 to 80	%RH
Supply voltage		100 to 240	VAC
Power dissipation		Max. 400	W
Height	See drawing below	249.8	mm
Width		443.0	
Depth		376.8	
Weight	Dependent on variant	17 – 25	kg
Optical fiber cable length		App. 1.3	m

12.1 System Dimensions



12.1 Collimator Dimensions



13 Accessories for the SuperK Extreme

SuperK SELECT

SuperK Select is a tuneable wavelength filter based on Acousto-Optic Tuneable Filter Technology (AOTF). AOTFs tune over one octave of optical frequency and the SuperK SELECT allows the integration of two AOTF crystals to provide wide spectral coverage. Together with a range of unique features, the SuperK SELECT provides an easy to use, flexible and accurate tuning accessory to access any wavelength in the SuperK spectrum.



SuperK VARIA

SuperK Varia is a cost effective and flexible alternative to a monochromator, effectively turning the SuperK supercontinuum white light source into a powerful single-line laser with a 450 nm tuning range and variable bandwidth. The center wavelength of the pass band can be tuned anywhere between 400 and 850 nm and the bandwidth is variable between 2 and 100 nm, making the SuperK VARIA the most flexible filter solution on the market. Increasing the bandwidth of the filter has the added advantages of higher power throughput and reduced speckle in imaging applications. Moreover, a high out-of-band suppression of up to 50dB makes the SuperK VARIA an ideal tool for FLIM and other applications using high sensitivity detectors.



SuperK GAUSS

SuperK Gauss is a dual-output filter that transforms the wide spectral bandwidth of the SuperK EXTREME supercontinuum lasers and provides a Gaussian-like spectrum. For OCT, the SuperK GAUSS provides two high power spectral outputs centered at 800nm and 1300nm, with bandwidths of up to 200nm, through single mode fiber using the SuperK Fiber Delivery system. Similar configurations are also available for WLI applications. The two Gaussian shaped spectra with can be used simultaneously but interdependent from each other due to its unique design. The SuperK GAUSS even allows the tuning of the center wavelength of each band over 200nm. Connecting the GAUSS to the SuperK EXTREME is very simple and shares the same *Plug'n'Play* platform common to all SuperK accessories.



SuperK SPLIT

SuperK Split is a passive filter accessory which allows the SuperK spectrum to be divided into two spectral outputs. This is important in applications where light from one sub-area of the spectrum is desired and light outside this spectrum is parasitic. In its standard form, the SuperK SPLIT provides two outputs: Visible and nIR. However, the choice of the “split” in the spectrum can be user-defined to be anywhere in the SuperK spectrum. Additionally, standard mounts within the Split allow the insertion of narrow band filters, polarisers or attenuators at each output exit for further flexibility. As standard, the SuperK SPLIT provides collimated, free-space output at each exit, however for lower power systems such as the SuperK COMPACT or the lower power EXTREME variants, a fiber coupled exit is also an option using the SuperKFDS.



SuperK FDS

The self-aligning **SuperK Fiber Delivery** ensures “Plug & Play” interfacing to all SuperK accessories and effortless coupling of supercontinuum light with highest efficiency back into single mode fibers.

A complete suite of standard single mode fibers covering VIS, nIR or IR spectral ranges are available with standard FC termination for patch cord fiber connection (PM or non-PM).

For broadband fiber transmission, unique endlessly single mode fibers are available with full spectral coverage and standard FC connectors for free space output. All SuperK Fiber Delivery fibers are also available with output collimators.

SuperK CONNECT

SuperK Connect is a new type of easy to use, highly stable fiber manipulator ensuring precise control of the coupling efficiency when using the SuperK Fiber Delivery.

The robust opto-mechanical design ensures the CONNECT will remain locked in place, ensuring stable optimal SuperK Fiber Delivery output performance.

The SuperK FD can be removed and inserted repeatedly without loss of alignment providing true “plug and play” operation.



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