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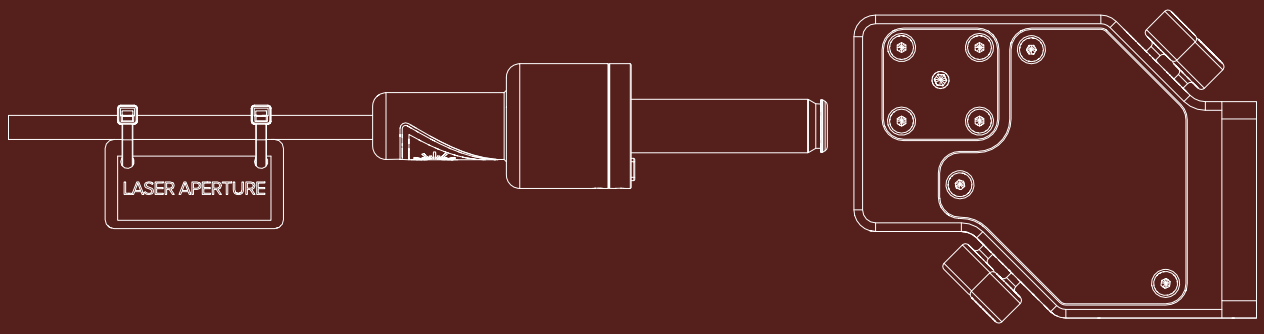
SuperK
CONNECT

Product Guide

Revision 1.2 10-2023



NKT Photonics

PRODUCT GUIDE

This guide includes information for the following NKT Photonics products:

CONNECT connection and alignment block (VIS or IR)
Emission path adapter with alignment screws
Item number: A401-X00-000

FDS standard fiber FD1-FD6, or FD10 w/ FC/APC or FC/PC connector
Collimator to fiber to FC/APC or FC/PC connector
Item number: A502-0(1-6/10)0-0(0/1)0

FDS standard fiber PM FD1-FD6, or FD10) w/ FC/APC or FC/PC connector
Collimator to PM fiber to FC/APC or FC/PC connector
Item number: A502-0(1-6/10)0-1(0/1)0

FDS standard fiber (FD1-FD6, or FD10) with Collimator
Collimator to fiber to collimator
Item number: A502-0(1-6/10)0-020

FDS standard fiber PM (FD1-FD6 and FD10) with Collimator
Collimator to PM fiber to collimator
Item number: A502-0(1-6/10)0-120

FDS LMA fiber (FD7-FD9) with FC/APC or FC/PC connector
Collimator to LMA fiber to FC/APC or FC/PC connector
Item number: A502-0(7-9)0-0(0/1)0

FDS LMA fiber PM (FD7-FD9) with FC/APC or FC/PC connector
Collimator to LMA PM fiber to FC/APC or FC/PC connector
Item number: A502-0(7-9)0-1(0/1)0

FDS LMA fiber (FD7-FD9) with Collimator
Collimator to LMA fiber to collimator
Item number: A502-0(7-9)0-020

FDS LMA fiber PM (FD7-FD9) with Collimator
Collimator to LMA PM fiber to collimator
Item number: A502-0(7-9)0-120

Manufactured by:

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Guide Overview

This product guide is intended to provide functional, operational and installation information for the SuperK Fiber Delivery System and specifically the CONNECT adapter. The guide includes information that covers the Fiber Delivery System component descriptions, installation, and adjustment.

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

SuperK {Model Name} Safety Handling and Regulatory Information

The paper copy of this guide is included with your laser; it can also be downloaded from:

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

Documentation

A USB memory stick is included with your SuperK laser. It contains documentation for NKT Photonics products including this accessory.

Terminology

The guide may refer to the SuperK CONNECT as just the CONNECT and a Fiber Delivery collimator with fiber may be referred to as an FD. Both the CONNECT and Fiber Delivery together are referred to as the Fiber Delivery System or FDS.

Target Audience

This guide is for technical personnel involved in the selection, planning and deployment of lasers and photonic equipment 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 "Description" — Describes the accessory including its general operational principles, management and interfaces.
- Chapter 2 "Installation" — Includes information and procedures on how to correctly install the FDS.
- Chapter 3 "Optical Alignment" — Information and procedures on how to align the accessory output emission beam with a Fiber Delivery using a CONNECT.
- Chapter 4 "Notes on Fiber Delivery" — Information on the selection and care of the Fiber Delivery.
- Specifications — Includes specifications and support contact details.

Added information and Safety Notices

Lasers with their accessories are highly dangerous devices that can cause serious injury and property damage. This guide uses 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 NKTP 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 a laser with the accessory.

Revision

This section records the document revision details.

Release date	Version and changes
2021-August	1.00 revised format updated from earlier manuals and documents.
2022-March	Revision 1.1 • Minor changes to language throughout to improve clarity. • Changed figure arrows and other figure highlights throughout.
2023-October	Revision 1.2 – updated the style of the document.

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FIGURES

PROCEDURES

1 Description

Fiber Delivery System (FDS)

A complete Fiber Deliver System (FDS) consists of a specially prepared fiber and input coupler termed a fiber delivery (FD) paired with a SuperK CONNECT beam alignment device. The CONNECT is designed to align a beam from a free-space aperture so that it enters into the FD fiber with the maximum coupling efficiency.

Operation

A CONNECT is mounted directly over an accessory output aperture port where it can direct the emission beam from the port to the input coupler of an FD. Using two adjustable mirrors, the CONNECT steers the beam so that it enters the FD fiber with minimum loss at the input coupler[i]. Steering of the beam is achieved through manual adjustment using thumbscrews that pivot the mirrors on two axes perpendicular to each other. Depending on the FD model, the beam exits the FD from either a fiber connector or collimator. Multiple FD models are available, these are characterized by their exit connectors and fiber type as shown in Table 1.

NOTE: A SuperK CONNECT of an FDS is specified for either IR or VIS wavelength bands.

NOTE: When using an FDS mounted to an exit aperture, it is important to properly mount the SuperK CONNECT to the device before enabling emission from the laser system.

i. Although the input coupler appears to be an NKTP collimator, it is not a collimator.

Figure 1 Fiber Delivery System – CONNECT and Fiber Delivery

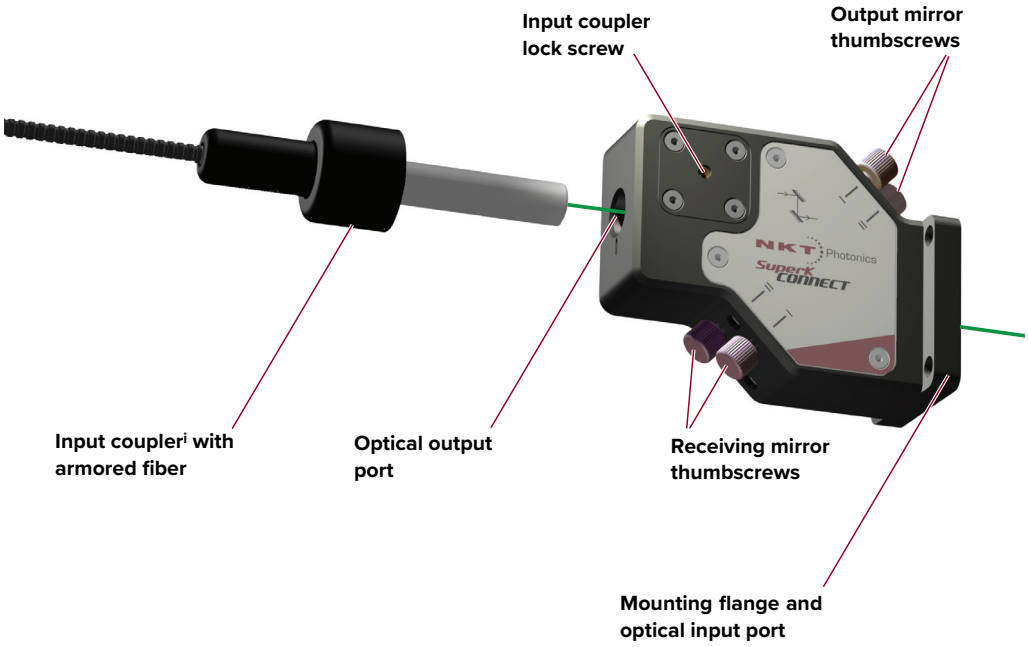


Table 1 Fiber delivery models - single mode cut off

Fiber type[i]	Exit connector
Standard[ii] fiber	FC/APC
Standard fiber	FC/PC
Standard PM fiber	FC/APC
Standard PM fiber	FC/PC
Standard fiber	Collimator
Standard PM fiber	Collimator
LMA[iii] fiber	FC/APC
LMA fiber	FC/PC
LMA PM fiber	FC/APC
LMA PM fiber	FC/PC
LMA fiber	Collimator
LMA PM fiber	Collimator

i. For further fiber specifications, see Table 2.
ii. Standard Single Mode (SM) step index fiber
iii. Large Mode Area fiber (Photonic Crystal fiber)

FD fiber characteristics

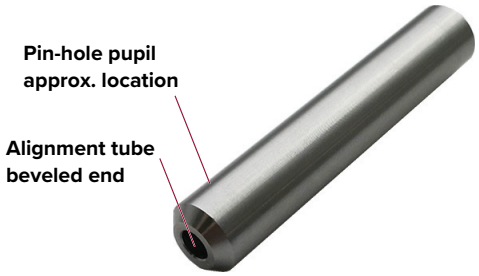
A variety of fiber options are available and must be specified when ordering an FDS. See Table 2 on page 35 for a list of fibers and their specifications. Selection of fibers is based on your light requirements and delivery connection. Refer to section “Selecting standard or photonic crystal fiber delivery” on page 31 for further information on selecting fibers.

Features

Thumbscrews Within the CONNECT, are two spring mounted mirrors that pivot on their X and Y axes using two pairs of thumbscrews. Each mirror is mounted against two thumbscrews set apart by 90 degrees. To prevent corrosion with the CONNECT body, the thumbscrews are composed of bronze and feature knurled knobs. When a thumbscrew is turned, the mirror pivots on one of the two axes. In this way, a light beam entering the CONNECT is steered by turning the thumbscrews until the coupling efficiency of the light entering the fiber is optimized – see the chapter “Optical Alignment” on page 21 on how to align the beam.

Alignment tool An alignment tool is included with the Fiber Delivery System. It can help accurately align the CONNECT emission to center it with the fiber input coupler. The tool is a steel shaft, with a center tube that has a pinhole pupil near the beveled end of the shaft. When the tool is inserted in the output port of the CONNECT, the emission beam is steered until it completely passes through the alignment tool pupil. The effect of this, is to center the beam path towards the FD input coupler and its fiber facet– see “Aligning the FDS” on page 21.

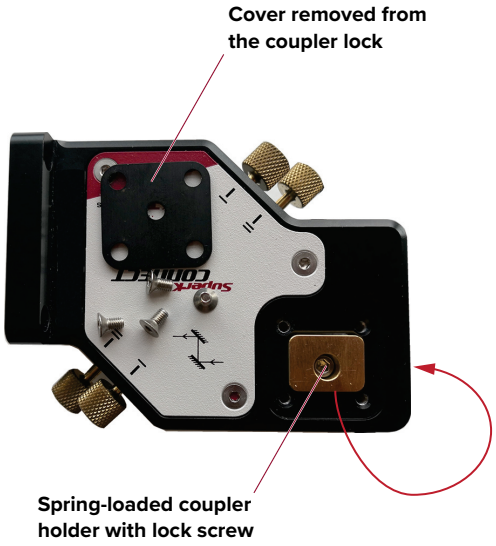
Figure 2 Alignment tool



Horizontal and vertical mounting A SuperK CONNECT is mounted either horizontally or vertically onto a device output aperture, see “VIS or IR SuperK CONNECT orientation” on page 17.

Reversible coupler holder The input coupler of an FD is inserted into the CONNECT output port and clicks in place against a spring-loaded holder. Once inserted, you can secure the coupler by tightening the holder lock screw. For some mounting orientations, the lock screw access could be blocked. In this case, you can re-position the holder on the opposite side of the CONNECT by unfastening its lock screw and moving the holder assembly to the opposite side of the CONNECT.

Figure 3 Input coupler – spring-loaded lock



Armored cable For rugged applications, armored fiber is equipped on FD models with an exit collimator mounted.

Safety labels

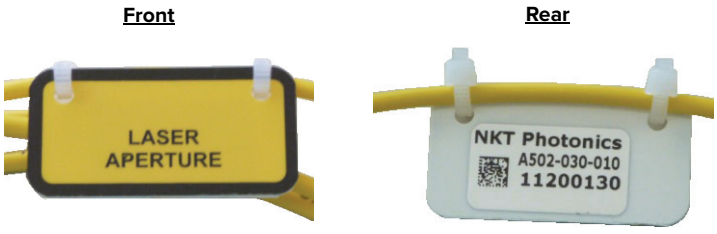
A SuperK Fiber Delivery (FD) system includes labels that indicate hazards, safety information, and product information. An FD includes the following label types:

- Input power level warning
- FD type and wavelength coverage
- Laser aperture labels with serial number on backside

Laser Aperture

A laser aperture label is tagged to the fiber cable. The serial and product number of the FD is printed on the back of the label.

Figure 4 FD laser aperture label – front and rear



Wavelength Coverage
Each fiber covers a certain part of the spectrum. The fiber spectral range and FD type is specified by a label on the cable.

Figure 5 Fiber spectral range and FD type label

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

Figure 6 Input coupler: input power warning label

2 Installation

Mounting the CONNECT

NOTE: Ensure to mount and fasten the SuperK CONNECT to your accessory before turning on your laser.

WARNING: The input power to the fiber delivery system (FDS) should always be limited to below 500 mW.

NOTE: Ensure to select the correct SuperK CONNECT model (VIS or IR) that matches with your accessory output port.

To mount a SuperK CONNECT to a laser accessory, follow the steps in Procedure 1 below.

Procedure 1 Mounting a SuperK CONNECT to an optical output port.

1. Turn off the SuperK laser and ideally, disconnect power from it.
2. Locate the optical output port on your accessory to which the FDS will be attached.
3. If the port has a cover plate, remove it.
4. Using four M3 x 6mm machine screws, select a vertical or horizontal orientation (see "VIS or IR SuperK CONNECT orientation" below) and fasten the SuperK CONNECT to the port.
5. Install the FD following the steps in Procedure 2.

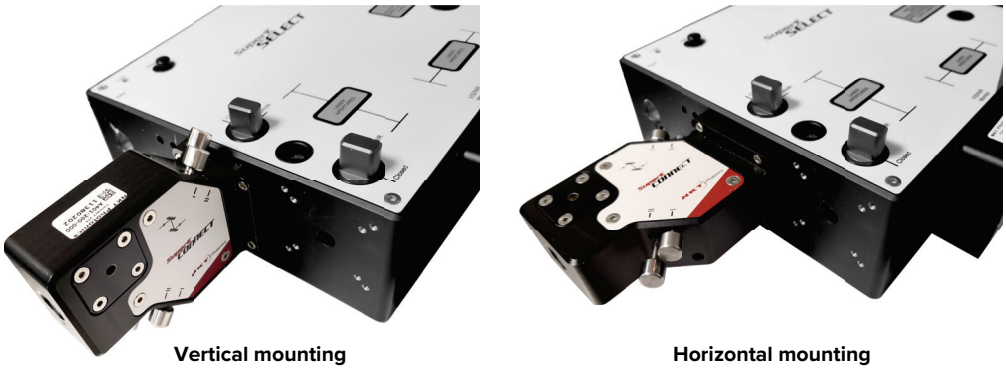
VIS or IR SuperK CONNECT orientation

The correct orientation of a SuperK CONNECT with respect to the optical output port of the CONNECT depends on whether or not the output is coupled to a polarization maintaining fiber (PM).

- **For non-PM fiber** – the orientation of the CONNECT is not critical and you can orient it in any direction (horizontal or vertical). However, ensure to consider access to the SuperK CONNECT alignment screws and the input coupler locking screw in the final installation.
- **For PM fiber** – you must mount the SuperK CONNECT in the horizontal orientation in order to couple the polarization of the visible beam to the slow-axis of the fiber.

Figure 7 shows examples of a SuperK CONNECT mounted in both horizontal and vertical mounting orientations.

Figure 7 SuperK CONNECT mounting orientations – visible port

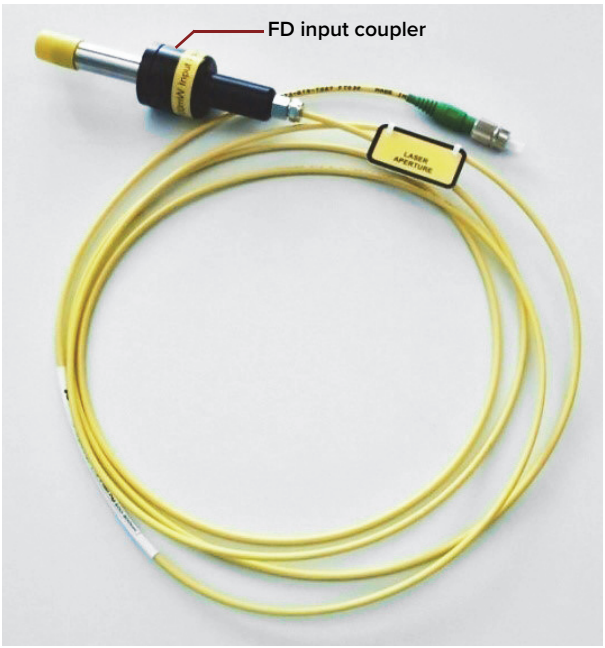


Vertical mounting | Horizontal mounting

Procedure 2 Installing an FD module

Install the FD module (Figure 8) following the steps below.

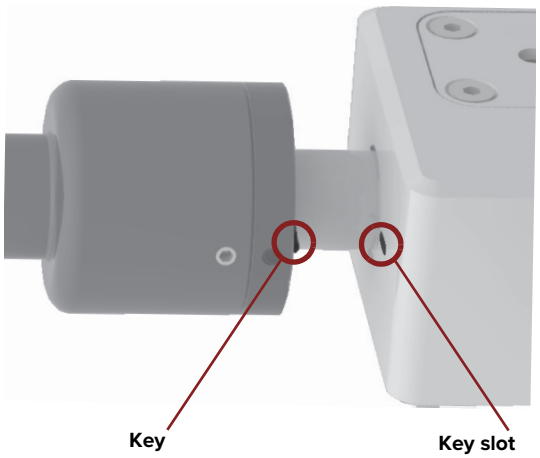
Figure 8 Fiber delivery unit – input coupler to FC/APC output



1. Ensure the SuperK laser is still off and if possible, disconnect its power source.

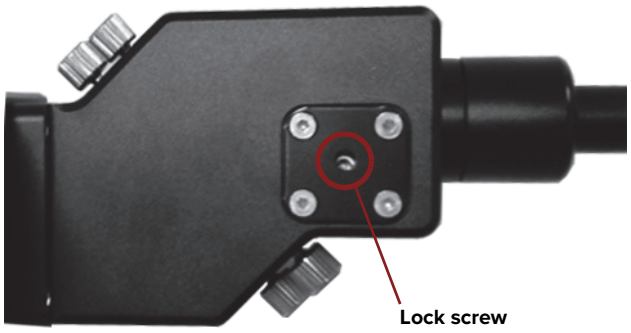
2. Insert the FD coupler into the CONNECT output port until its collar is flush against the SuperK CONNECT. To insert the coupler completely, align the key on the collar of the coupler with the slot on the CONNECT output aperture as shown in Figure 9.

Figure 9 Aligning the coupler key



3. Once the coupler is inserted with its key in the chassis alignment slot, secure it by tightening the lock screw shown in Figure 10.

Figure 10 SuperK CONNECT lock screw



NOTE: You can position the lock screw on either side of the SuperK CONNECT. If you cannot access the screw, unfasten and remove the lock screw assembly and install it on the opposite side of the CONNECT. You may need to remove the CONNECT from its mounting location to gain access. See “Reversible coupler holder” on page 13.

3 Optical Alignment

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

WARNING: The SuperK CONNECT together with a SuperK laser system constitutes a Class 4 laser source and must be regarded as a potential hazard to the operator. Make sure to wear laser protective eyewear when operating a laser with the SuperK CONNECT and when aligning its optical output.

Aligning the FDS

Overall process

Before using a newly installed FDS system, it requires alignment. When the FDS is aligned, emission coupling efficiency from the free-space output beam to the fiber is maximized. The FDS includes an alignment tool which is inserted into the output port of the CONNECT during coarse alignment. If necessary follow the three procedures below to align and couple the beam with the fiber of the FDS:

1. Procedure 3 “Pre-alignment”
2. Procedure 4 “Coarse alignment”
3. Procedure 5 “Fine Alignment of the assembled Fiber Delivery System”

CAUTION: FDS system pre-alignment and coarse alignment is already completed at the factory. These procedures are only necessary if there has been a drastic
alteration to the alignment.

NOTE: For laser operating instructions, refer to your SuperK laser’s *Product Guide*.

Tools list

- Alignment tool (see “Alignment tool” on page 13)
- Power meter and a fast response sensor
- Laser viewing card[I]

I. Also known as a “Detector card”.

Pre-alignment

CAUTION: Before shipping, all SuperK CONNECTs are pre-aligned and coarse aligned at the factory. ONLY perform the coarse alignment procedure if the alignment has been drastically altered.

Procedure 3 Pre-alignment

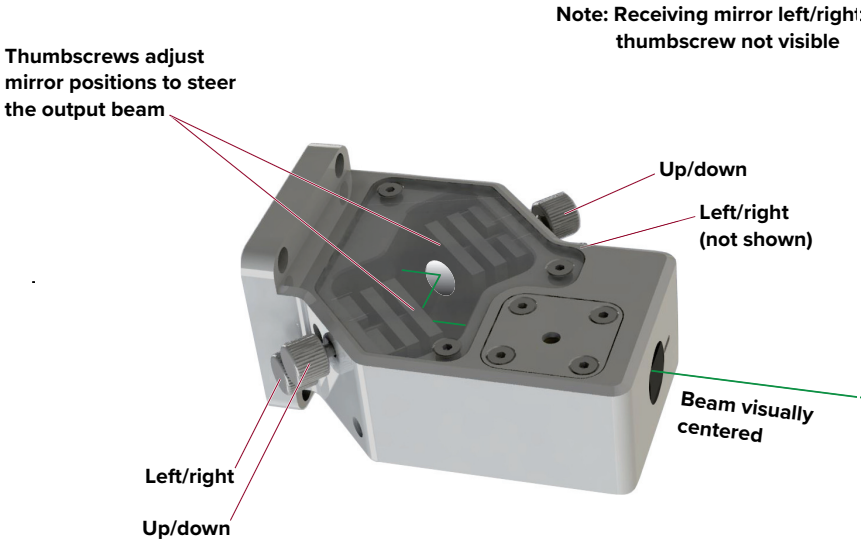
Before using the alignment tool, roughly center the output beam from the CONNECT using the following pre-alignment steps:

1. Remove the FD from the CONNECT so that its output port is empty.
2. On the SuperK accessory, set the output to a visible wavelength e.g. 630 nm and set the power to a low level. (If the accessory allows it, set the laser to a green color for best visual sensitivity.)
3. Open the aperture shutter (if equipped) on the device the SuperK CONNECT is mounted to.
4. Enable the SuperK laser emission and adjust its power until you can easily see the output beam in the CONNECT output port.

NOTE: To help visualize the beam location, it can be helpful to place some translucent tape such as a typical office tape with a matte finish over the CONNECT output.

5. Adjust the CONNECT thumbscrews, steering the beam until it is visually centered in the output port as shown in Figure 6. (Refer to "How to use the thumbscrews" on page 26.)

Figure 11 Pre-alignment - horizontal mount[II]



6. Disable emission.

II. Steering directions for a horizontal installation

Coarse alignment

CAUTION: Before shipping, all SuperK CONNECTs are pre-aligned and coarse aligned at the factory. ONLY perform the coarse alignment procedure if the alignment has been drastically altered.

WARNING: Disable laser emission (at the laser) each time the alignment tool is removed from the optical beam path. Disabling emission DOES NOT mean blocking emission by closing the CONNECT port shutter.

NOTE: Refer to the information in section "Tips for steering the beam path" on page 26 for tips on how to adjust the beam path. Disable the laser emission and insert the alignment tool, with the beveled-end inserted half-way into the output port of the SuperK CONNECT.

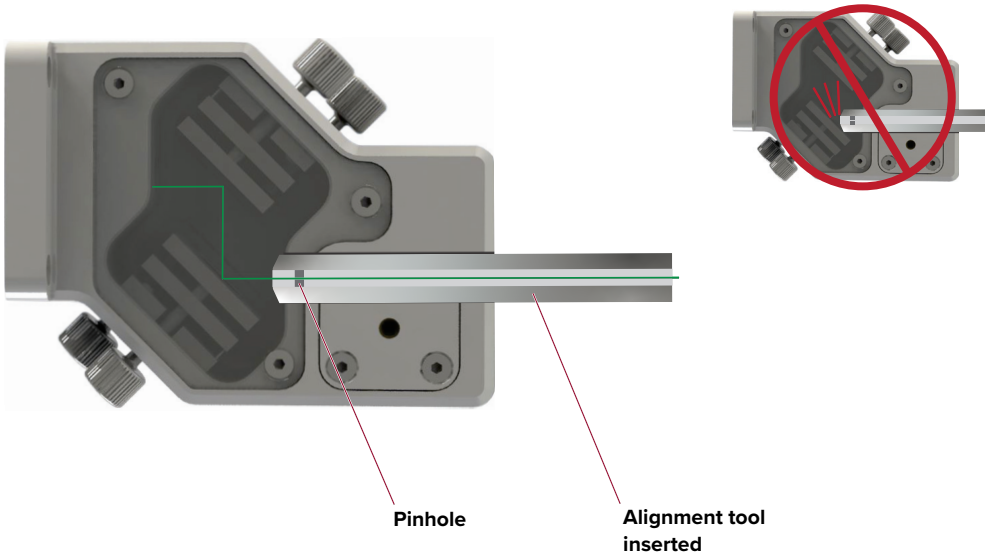
NOTE: Insert the alignment tool gently. The tool can damage the optics if inserted entirely and with force.

Procedure 4 Coarse alignment

In this procedure, the Alignment tool is inserted into the CONNECT output port. The tool has a pinhole within it that the beam is aligned with during the procedure.

1. Insert the Alignment tool with the beveled-end inside the CONNECT. Figure 12 shows a cutaway view of the Alignment tool inserted.

Figure 12 Coarse alignment – Alignment tool inserted



2. Tighten the lock screw so that the alignment tool is firmly held in the output port. This increases the accuracy of the alignment.

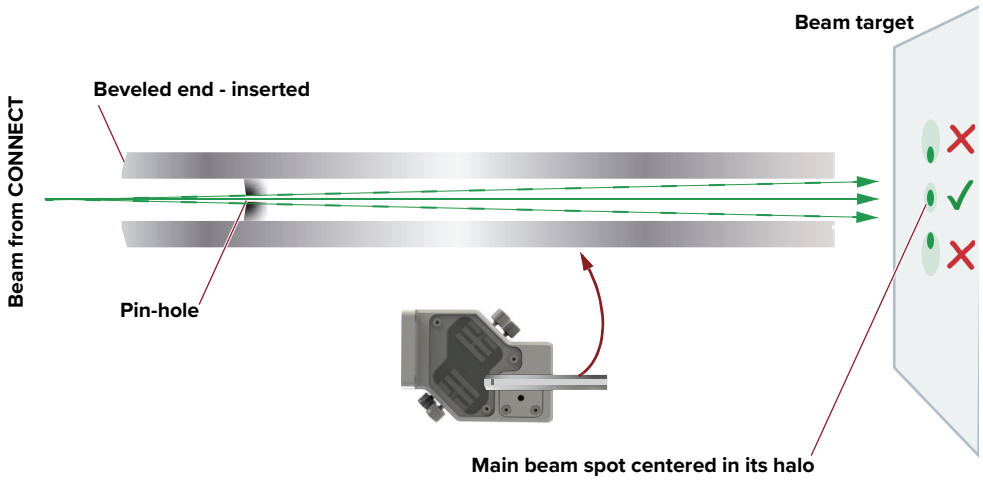
3. Enable emission from the SuperK laser.

4. The beam enters the alignment tool. In order to exit the alignment tool, you must center the beam (step 5) with the pinhole sized pupil machined inside the tube, see Figure 12 which shows the beam passing through the pinhole.

5. With a laser viewing card suitable for the beam color, adjust the beam path, using the CONNECT thumbscrews, until a spot on the target is centralized within a minimized halo and with the maximum brightness as shown in Figure 13. If the spot is offset within its halo, the beam path is incorrect, and not centered in the pinhole.

NOTE: Refer to the following section “Tips for steering the beam path” on page 26.

Figure 13 Coarse alignment - spot adjustment



6. Disable emission.

7. Remove the alignment tool from the CONNECT and reinstall it in the reverse direction. The distance from the output mirror to the pinhole is increased thus reducing the acceptance angle tolerance. Reducing the acceptance angle increases the accuracy of the alignment.

8. Enable emission again from the SuperK laser.

9. Repeat the spot adjustment as described in step 5 to obtain the best spot brightness and minimized halo.

10. Disable emission.

Fine alignment of the FDS

Conducting the fine alignment procedure optimizes output power. Fine alignment of the optical beam is adjusted by fine tuning of the alignment thumbscrews in pairs while measuring the output from the FD.

The pairs are indicated by either an “I” or “II” symbol (see Figure). The alignment thumbscrews can steer the beam path along the vertical and horizontal directions (direction I and direction II). Follow the steps in Procedure 5 to fine align the CONNECT.

WARNING: Do not operate the SuperK system at full power if the fiber coupling efficiency to its fiber delivery system (FDS) has not been optimized. Operating a fiber delivery system in a poor coupling state for extended periods of time may be detrimental to the performance of and/or permanently damage the fiber delivery system.

WARNING: With an optimized coupling to the fiber delivery system, limit the input power to the fiber delivery system (FDS) below 500 mW.

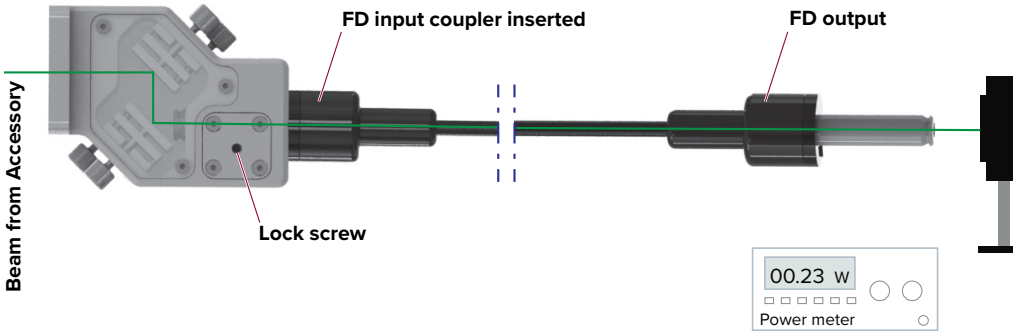
Procedure 5 Fine Alignment of the assembled Fiber Delivery System

1. Remove the alignment tool from the CONNECT and insert the FD input coupler into the CONNECT output port. Ensure to align the key with the slot so that it is fully inserted.
2. Tighten the lock screw so that the FD is firmly held in the CONNECT port.
3. To align the FD output, setup a power meter. (You can also use a spectral analyzer.)
4. Enable emission on the SuperK laser with the output power set to a low level (See the Warning above.)
5. Check there is an optical beam emerging from the output using a detector card.
6. Confirm the power meter measures a weak output level at the distal end of the FDS. If not, disable the SuperK laser and repeat the coarse alignment, Procedure 4.
7. If after repeating the coarse alignment still no output is achieved, see “No power measured at start of fine alignment” on page 29.
8. To achieve the best output level, adjust the optical alignment using the four alignment thumbscrews on the CONNECT as described in steps 9 and 10. Also refer to the section “Tips for steering the beam path” on page 26.
9. Adjust the alignment thumbscrews pairs marked “I”, one after the other until the maximum output level is achieved. Once pair “I” is aligned i.e. at maximum power, repeat the same adjustment using the pairs marked “II”.
10. Repeat step 8 adjusting the thumbscrew pairs iteratively until the optimum alignment has been achieved when no further power increase can be realized.
11. The SuperK CONNECT is now aligned with the FD.

NOTE: When using a power meter to measure the light from the FD connector, it is recommended to use a sensor with a fast response time. Having instantaneous feedback is advantageous when making fine adjustments using the CONNECT thumbscrews.

NOTE: If possible, set the power meter to display the power level using either a meter view or graph view. Visually monitoring the output level this way, can facilitate locating the optimum beam position.

Figure 14 Fine alignment - power measurement



Tips for steering the beam path

This section includes information on beam path adjustment using the CONNECT and certain conditions that can result in weak or no output power from the FDS.

How to use the thumbscrews

The thumbscrews rotate the mirrors on two separate axes perpendicular to each other. It is suggested that when making adjustments to the beam path, that you always adjust the knobs in pairs. This means for example, referring to Figure 15, adjust thumbscrews marked **I** until the best beam is achieved, then repeat for pair **II**. Repeat this, over and over, until you cannot further improve the beam position. One method for obtaining the optimum beam position is described in Procedure 6.

The thumbscrews pairs move the beam either left/right or up/down, but this depends on the CONNECT mounting orientation as described in the following.

CONNECT mounted horizontally

- *Thumbscrew pair I* – each mirror pivots such that the beam is steered up and down (y-axis) perpendicular to its longitudinal axis.

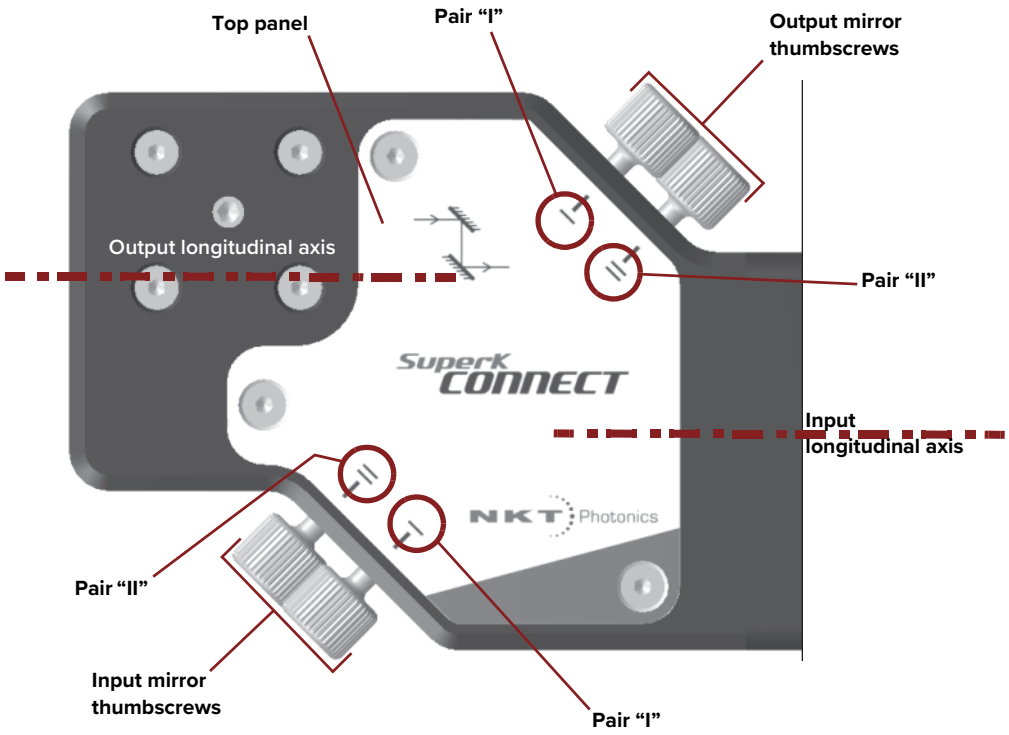
- *Thumbscrew pair II* – each mirror pivots such that the beam is steered left and right (x-axis) perpendicular to its longitudinal axis.

CONNECT mounted vertically

- *Thumbscrew pair I* – each mirror pivots such that the beam is steered left and right (x-axis) perpendicular to its longitudinal axis.

- *Thumbscrew pair II* – each mirror pivots such that the beam is steered up and down (y-axis) perpendicular to its longitudinal axis.

Figure 15 Alignment screw pair markings



Procedure 6 Obtaining the optimum beam pattern and/or power

1. With the beam output being monitored, turn either the I or II output mirror thumbscrews an eighth to a half turn to improve the beam pattern or power.

2. Using the matching pair of thumbscrews on the input mirror, counter the change from the output mirror screw as follows:

   - For pair I, turn the input mirror thumbscrew the same direction that the output mirror thumbscrew was turned.

   - For pair II, turn the input mirror thumbscrew the opposite direction that the output mirror thumbscrew was turned.

3. Repeat and note the peaks and values in the beam pattern quality and/or power as you move the beam across the mirrors.

4. From your observations, set the thumbscrews of the axis to the best pattern quality and/or power

5. Repeat steps 1 to 4, using the thumbscrews of the other axis.

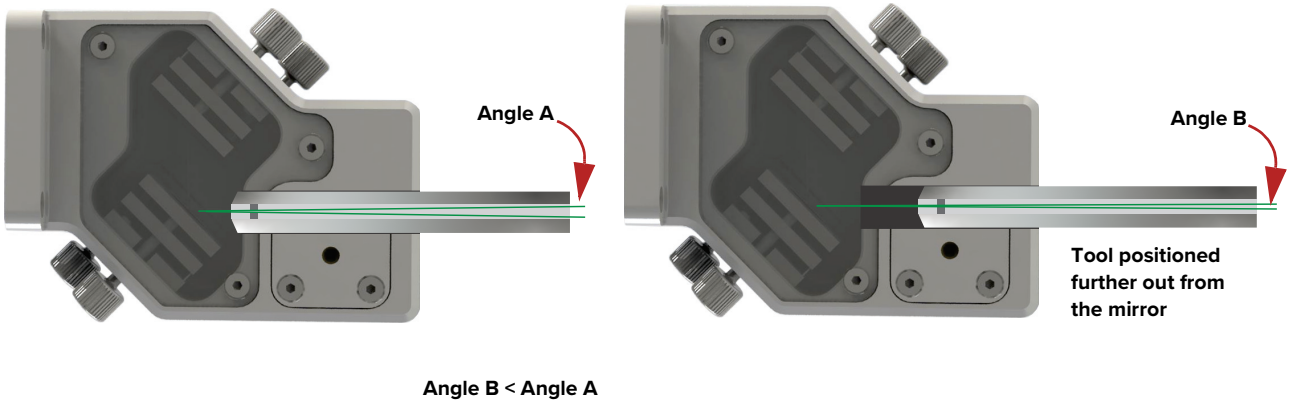
NOTE: As you move from coarse alignment to fine alignment, the sensitivity of the thumbscrews increases. Therefore when performing a fine alignment with a

power meter only, turn the thumbscrews in smaller increments.

Pinhole sliding

When performing the coarse alignment procedure with the pinhole positioned near to the CONNECT output mirror, you can additionally loosen and manually slide the alignment tool further away from the mirror. Moving the pinhole further out, tightens (improves) the accuracy of the alignment spot. This is because, the pin hole physically limits the angle of acceptance, which decreases the further the pinhole is away from the mirror - see Figure 16 below. If the beam is off-center, and you slide the tool out, the beam will eventually be cutoff by the pinhole. However, if the beam is centered, no matter how far out you slide the tool, the beam will continue to pass through the pinhole. Try to slide the tool in and out from the CONNECT, and note if any major modulation of the spot pattern occurs.

Figure 16 Sliding the alignment tool



Weak power level

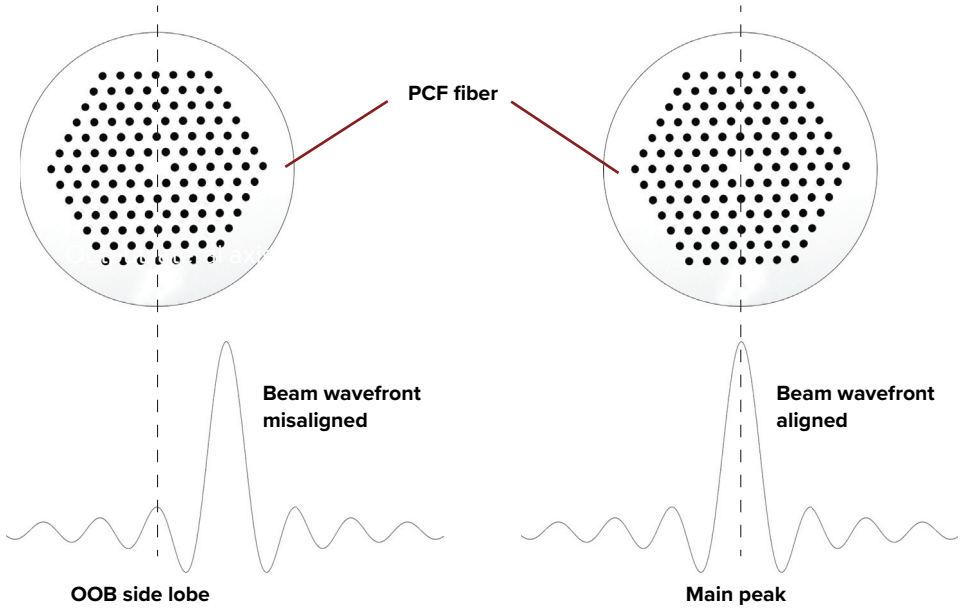
The wavefront of the beam from a typical accessory is composed of a main peak and it's associated out-of-band (OOB) side lobes. OOB side lobes may occur due to diffraction effects from the accessory optics. The center and side lobes are distributed spatially on the beam front.

False peak

Because of this spatial distribution, the first order side lobe may have been inadvertently coupled to the fiber instead of the main peak. This means when. for example, performing Procedure 5 on page 25, fine alignment, you are measuring the power of a weaker side lobe instead of the main peak.

Figure 17 illustrates this case. On the left, the beam is misaligned and the first order side lobe is spatially located so that it's peak is coupled with the fiber. On the right, the beam is aligned correctly so that the main peak is centralized on the fiber face.

Figure 17 Side lobe vs main peak fiber coupling



Recovering the main peak

If you suspect a side lobe has been coupled, then follow the steps in the coarse alignment procedure. The procedure will recover and centralize the main peak of the beam on the fiber face, see Procedure 3 on page 22.

Procedure 7 Improving the coarse alignment

1. Once a partial beam appears, use a beam target to compare the orientation of the halo which appears around the center spot. Typically the spot is offset as Figure 13 shows. The offset halo is created by a misaligned beam shown as a dashed line in the illustration.

2. Align the mirrors so that the spot is centralized within its halo; shown with a check mark in Figure 13. At the optimum alignment point, the halo will be minimized.

3. Once the spot is centralized, the mirrors are correctly aligned, the beam exits the pupil of the offset pin-hole with the least loss.

No power measured at start of fine alignment

In the event, that even after coarse alignment, no beam emerges from an FD inserted into the CONNECT, do the following:

1. While holding a beam detector card in front of the FD output, turn slightly back and forth either a I or II thumbscrews on the output or input mirror, checking for light with the detector card.

2. If light appears, stop and return to the fine alignment Procedure 5.

3. If no light appears, do the same using the other axis's thumbscrew.

4. Go back to the fine alignment procedure as soon as a beam appears on the detector card.

Fiber facet position

In certain cases, the beam maybe be centered from the CONNECT output, but the centering of the fiber facet is mounted slightly out of positional tolerance within the input coupler. In these cases, you must use the thumbscrews to move the beam slightly, positioning the beam onto the fiber facet. Once on the facet, you can use the power meter and the mirror thumbscrews to position the beam to the optimal acceptance angle.

4 Notes on Fiber Delivery

NKT Photonics can supply multiple Fiber Delivery types which are characterized by their fiber and connector types. This chapter includes information discussing fiber types, coupler and collimator keying, mating fibers, cleaning fiber facets and protecting them from contaminants.

Selecting standard or photonic crystal fiber delivery

Selection of the Fiber Delivery model depends on the application delivery requirement and the transmission characteristics of each fiber type. Each FD model is characterized by its output connector and fiber type. Table 2 on page 35 lists fiber models with their transmission characteristics. Selection of the fiber depends not only on the transmission characteristic required but also the type of connector delivery to the end-application.

Wavelength transmission

Standard Single Mode Fiber
Standard SMF grade fiber is a type of step-index fiber where the high-index core is surrounded by low-index cladding. At the fiber's cut-off wavelength, higher order modes may be transmitted, contaminating the output light and possibly causing unwanted inter-mode interference. This reduces the possible single-mode transmission bandwidth. However, SMF fiber is flexible in that is supports coupling with subsequent fibers through butt joints using FC type connectors.

Photonic Crystal Fiber
A key property of Photonic Crystal Fiber (PCF) is that it only allows transmission of single mode wavelengths. Higher order modes are leaked due to a special hollow channel arrangement that surrounds the central light guiding core. PCF fiber is applicable where broadband single-mode guidance is required. It is, however, not possible to butt joint PCF fiber, therefore coupling with subsequent fibers is not possible using PCF as explained in the following section.

Connectors and mating fiber light guides

Output coupling

Standard Single Mode Fiber
The Numerical Aperture (NA) of single mode (SM) fiber facets is well-defined. Because of this, SM fiber can be coupled using butt joints with a subsequent fiber of an end-application, Connector types such as FC/APC, FC/PC and SMA can be requested upon order.

Photonic Crystal Fiber
The air channels within a PCF fiber are subject to capillary effects which tends to attract moisture into them. To avoid this, the ends of PCF fibers are fused together sealing the channels off. The fused end section of fiber is approximately 100 µm long. This causes the light guided within the core to

scatter with a wide diverging field. The wide divergence means that a standard butt joint cannot be used with subsequent fiber delivery systems due to the coupling loss. Therefore PCF is only suitable when the FD is fitted with an output collimator which can adequately refocus the light with its achromatic lens. Put another way, if a PCF fiber is butt coupled facet to facet using an FC/APC connector to another fiber, the light delivery essentially fails due to the scattering at the fused PCF end.

PM Fibers and keying

Fibers are keyed by measuring the Polarization Extinction Ratio (PER) to find both the slow and fast axis of the fiber. The fiber key location is determined by the fast axis.

Key alignment For PM Fiber Delivery, the output key on the FD has been actively aligned to the true fast axis of the fiber. The slow axis is close to parallel with the stress rod structure (e.g. PANDA structure) and the fast axis is close to perpendicular with the stress rod structure. On a non-PM fiber the key is not aligned but arbitrarily set. The key on the input coupler is aligned correspondingly with the key on the output connector.

Fiber and connector care

The fiber and its connectors are inspected and sealed in a clean environment before shipping. For optimum system performance, follow the guidance below:

- Avoid removing the connector or collimator/coupler caps when the FD is not in use and stored.
- When connecting the FD, avoid:
  - Excessive strain on the fiber through stretching or twisting.
  - Fiber bend diameters < 10 cm
  - Exposing the fiber and its facets to contaminants.
- Carefully and gently handle the FD to prevent damage to the fiber and its facets.
- Before using the FD, inspect the fiber and its facets for damage and contaminants - if they need cleaning see.“Cleaning of fiber facets” on page 33.

Cleaning of fiber facets

The fiber connector on the FD may occasionally require some cleaning of the fiber tip. Before making any fiber connections, always inspect the fiber facet of all connectors using an inspection scope. A scope with both coaxial and oblique illumination is useful in exposing any contaminants or defects in the facet. Further, rotating the fiber while under illumination may be necessary to discover irregularities often hidden under certain angles of light.

WARNING: Ensure the laser is disabled before inspecting fiber facets.

Cleaning tools

When cleaning the facet, only use cleaning tools that are specifically designed to be used with optical fibers. Always use extreme caution when cleaning fibers.

Examples of appropriate cleaning tools are: a lens cleaning tissue (lint free wipes) as shown in Figure 18 or an optical fiber cleaning tool as shown in Figure 19.

Figure 18 Lint-free wipe example

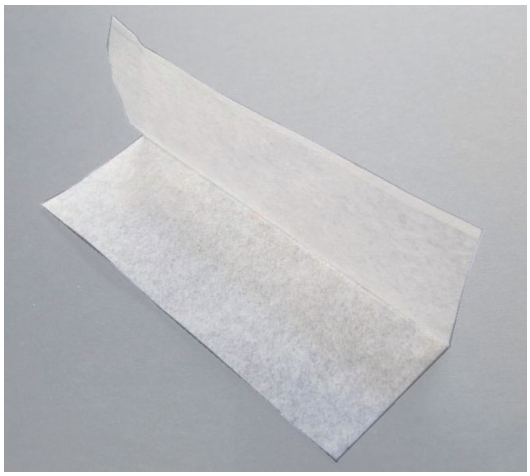
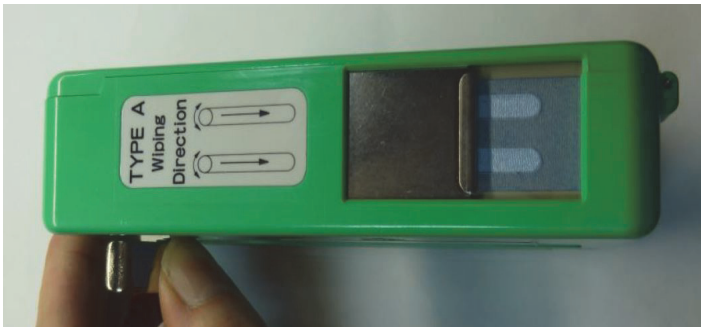


Figure 19 Example of a fiber cleaning cartridge



A Specifications

Table 2 FD Fiber wavelength and transmission characteristics

FD fiber type	Cut-off λ	% Transmission	Typical peak % transmission
FD1-PM	425±25 nm	> 60% from 425 to 775 nm	75% @ 650 nm
FD2	450±25 nm	> 60% from 450 to 775 nm	80% @ 650 nm
FD3	630±20 nm	> 60% from 630 to 1100 nm	80% @ 800 nm
FD3-PM	580±40 nm	> 65% from 580 to 950 nm	85% @ 650 nm
FD4	730±30 nm	> 70% from 730 to 1150 nm	80% @ 950 nm
FD4-PM	710±60 nm	> 65% from 710 to 1100 nm	70% @ 900 nm
FD5	930±40 nm	> 50% from 930 to 1550 nm	65% @ 1350 nm
FD5-PM	900±70 nm	> 50% from 900 to 1500 nm	60% @ 1200 nm
FD6	1260±40 nm	> 30% from 1260 to 1900 nm	40% @ 1650 nm
FD6-PM	1200±70 nm	> 30% from 1200 to 1900 nm	35% @ 1700 nm
FD7*	< 400 nm	> 70% from 450 to 1050 nm	80% @ 750 nm
FD7-PM*	< 400 nm	> 70% from 450 to 950 nm	80% @ 600 nm
FD8*	< 800 nm	> 40% from 800 to 1700 nm	55% @ 1300 nm
FD9*	< 500 nm	> 50% from 500 to 1300 nm	60% @ 900 nm
FD10**	NA	> 80% from 500 to 1100 nm	90% @ 750 nm

B Service and Support Information

Servicing

The accessory has no user serviceable components. In case of malfunction, contact NKT Photonics using the support channels in section “The unit is sealed with a label “WARRANTY VOID IF REMOVED”. It is strictly prohibited to remove the chassis cover”.

CAUTION: Do not open the accessory chassis. The accessory is equipped with warranty labels (see Figure 20) on the covers of the its chassis. The warranty is void if the system is opened.

Figure 20 Warranty seal

CAUTION: The accessory contains electro-static discharge (ESD) sensitive components. To avoid permanent ESD damage, use ESD protection precautions when handling the accessory. Always connect the accessory’s earth point to a ground earth within your facility.

Opening the chassis

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

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

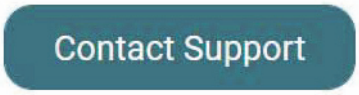
If you need help or have questions regarding your SuperK CONNECT and/or FD, contact NKT Photonics through our support website below:

Support website

1. Go to:

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

2. Scroll down and click or press:

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

Shipping address

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Blokken 84
DK-3460 Birkerød
Denmark

Item: 800-630-01
Customer Revision: 1.2
NKT Photonics Revision: 3-0
Release Date: 10-2023

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