HighFinesse
The Standard of Accuracy

Multichannel Photonic Crystal Fiber Switch

Manual

Document Version 2025-01 002

HighFinesse
The Standard of Accuracy

Neckarsulmer Str. 5
72072 Tübingen
Germany

Phone: +49 (0)7071 539180
Fax: +49 (0)7071 968517
info@highfinesse.de

1 Introduction

The HighFinesse multichannel fiber switch is made to measure multiple lasers with a HighFinesse wavelength meter with a high measurement rate quasi-simultaneously.

The multichannel fiber switch is fully controlled by the HighFinesse wavelength meter software which makes it very convenient to use. With the “Switch mode” the software automatically switches through the channels facilitating the consecutive measurements of multiple lasers. Via the graphical user interface and the API the switching process is customizable.

Contents

2 Unit description and installation

2.1 Safety instructions and warnings

Before using the multichannel fiber switch please read and follow the following safety instructions and warnings.

The following safety terms are used in this manual:

DANGER! ⚠	This symbol in this manual should draw attention to immediate danger that could result in personal injury or death.
CAUTION! ⚠	This symbol in this manual should draw attention to possible resulting hazards that could result in personal injury or death.
ATTENTION! ⚠	This symbol in this manual should draw attention to hazards that could damage the instrument.
NOTE! ⓘ	This symbol in this manual should draw attention to information that may be beneficial in the use of the instrument.

2.1.1 General safety terms

DANGER! ⚠	Before operating the multichannel fiber switch please read this manual carefully to avoid personal injury
CAUTION! ⚠	Prevent personal injury and damage to the electronics. The following safety instructions must always be followed.
CAUTION! ⚠	Wherever this symbol is attached, read and understand the manual before operating the instrument. The manual must be consulted in order to find out about the potential **HAZARDS** leading to personal injury or death and how to avoid them.
ATTENTION! ⚠	Wherever this symbol is attached, read and understand the manual before operating the instrument. The manual must be consulted in order to find out about the potential **HAZARDS** for the equipment and how to avoid them.
DANGER! ⚠	Do not position the instrument in a way that it is difficult to disconnect it.
DANGER! ⚠	If the instrument is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.
DANGER! ⚠	Use the supplied power supply only. Improper power supplies may cause personal injury or damage of the instrument
DANGER! ⚠	Operation of this electrical equipment in outdoor areas, wet or dirty atmosphere can cause unwanted behavior.
CAUTION! ⚠	Potential explosive atmosphere, corrosive atmosphere, and other environments that deviate from normal environmental conditions (IEC 61010-1 clause 1.4.1) are not allowed.

DANGER! ⚠ Do not open the multichannel fiber switch during operation. Only authorized and specially trained service personnel should maintain and repair components. Never open the external power supply. To make sure that there is no mains connection disconnect the power supply.

CAUTION! ⚠ Do not cover or use the instrument outside the specified operation conditions.

2.1.2 Safety features

2.1.2.1 AC mains voltage for external power supply

CAUTION! ⚠ Do not open up the power supply.

ATTENTION! ⚠ The instruments external power supply is designed to operate on the mains voltage of either 115 V or 230 V.

2.1.2.2 Power supply specifications

Input Voltage	115 V or 230 V
Input frequency	50 Hz / 60 Hz
Output	5 V / 1 A
Power consumption	< 450 mW

2.1.2.3 Laser safety features

CAUTION! ⚠ The multichannel fiber switch is designed to handle laser power up to the specified maximum cw input power and peak power. No laser light or laser stray light can leave the multichannel fiber switch enclosure when used as intended (fiber input and output connections correctly attached).

ATTENTION! ⚠ Do not exceed the maximum cw input power of < 400 nm: 0.5 mW and > 400 nm: 5 mW to prevent damage to the multichannel fiber switch.

ATTENTION! ⚠ Do not exceed the maximum peak input power of < 400 nm: 0.2 W and > 400 nm: 2 W to prevent damage to the multichannel fiber switch.

ATTENTION! ⚠ Do not input radiation with wavelengths outside the specified wavelength range. See Section 4.2.

2.2 Package content

ATTENTION! ⚠ Please wait 24 h after receiving the multichannel fiber switch before unpacking and connecting it to the wavelength meter/power. This makes sure that it has warmed up enough to prevent condensation of water vapor which might damage the multichannel fiber switch.

- Optical multichannel fiber switch unit
- N x APC/APC fused silica PCS input fibers (complete)
- N x coupling optics
- TTL Communication cable

- Power supply.
- Fiber cleaning tool (In a set with the wavelength meter only 1 cleaning tool is included.)

N is the number of channels ordered. Please check for the completeness of the delivery before setting up the units.

2.3 Multichannel Photonic Crystal fiber switch description

2.3.1 Operating principle

The multichannel fiber switch is based on a micro-mechanical/micro-optical design and is supported by the HighFinesse wavelength meter software enabling quasi-simultaneous wavelength characterization of multiple lasers. The optics and mechanics are housed in a compact and robust tabletop casing.

The multichannel fiber switch is shown in Figure 1. At the inputs of the multichannel fiber switch optical fibers transporting the laser light are connected. The optics and mechanics inside the multichannel fiber switch make sure that only one of these inputs can pass the multichannel fiber switch at a time. The wavelength meter software ensures correct assignment of the measurements to the individual input channels at the fastest possible rate.

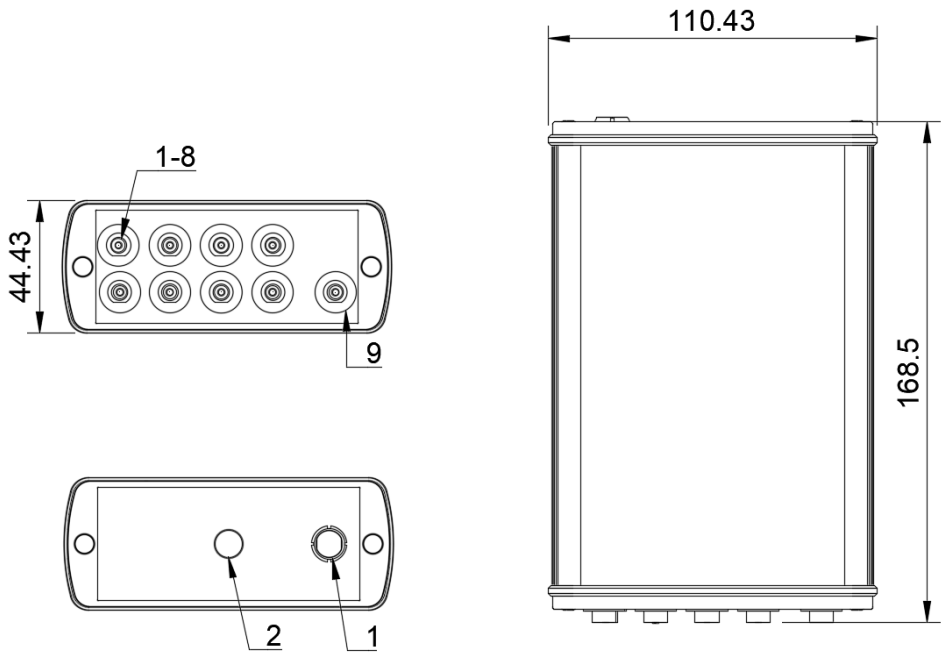

Figure 1: Drawing of the multichannel fiber switch.

2.3.2 Front panel

At the front panel you will find the fiber output port to the wavelength meter, the laser fiber inputs. The front panel is shown in Figure 2.

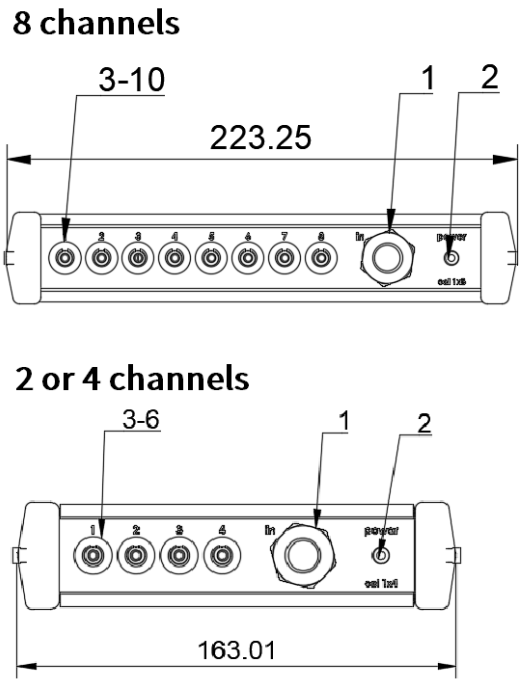

Figure 2: The front panel of the multichannel fiber switch, see Table 1 for descriptions.

Table 1: Functionality of the front panel, see Figure 2 for positions.

Number	Function	Description
1	Fiber output to wavelength meter	The output fiber is permanently attached. It is used to connect the multichannel laser controller to the wavelength meter. This fiber has a FC/PC connector on the wavemeter side. For protection, this fiber is surrounded by a metal jacket.
2	Power/ connection indicator	LED indicating if the connection to power/ the wavelength meter is established. When on the connection is established. The wavelength meter has to be turned on.
3-10	Inputs	Fiber-inputs with FC/APC connector.

CAUTION! ⚠ The multichannel fiber switch is designed to handle laser power up to the specified maximum cw input power and peak power. No laser light or laser stray light can leave the multichannel fiber switch enclosure when used as intended (fiber input and output connections correctly attached).

ATTENTION! ⚠ Do not exceed the maximum cw input power of < 400 nm: 0.5 mW and > 400 nm: 5 mW to prevent damage to the multichannel fiber switch.

ATTENTION! ⚠ Do not exceed the maximum peak input power of < 400 nm: 0.2 W and > 400 nm: 2 W to prevent damage to the multichannel fiber switch.

ATTENTION! ⚠ Do not input radiation with wavelengths outside the specified wavelength range. See Section 4.2.

ATTENTION! Use fibers with FC/APC connectors at the inputs only.

NOTE! The pure silica PCS input fibers provided with the multichannel fiber switch for connecting to the input ports are optimized for transmission over the whole wavelength range of the wavelength meter. These fibers are not single mode for wavelengths lower than 1250 nm. However, the optics in the multichannel fiber switch will ensure that the output is always singlemode. It is recommended to use these provided fibers. Alternatively, existing SM fibers with FC/APC connectors can be used as input fibers to the multichannel fiber switch.

2.3.3 Rear panel

At the rear panel you will find the TTL connection to the wavelength meter and the power input.

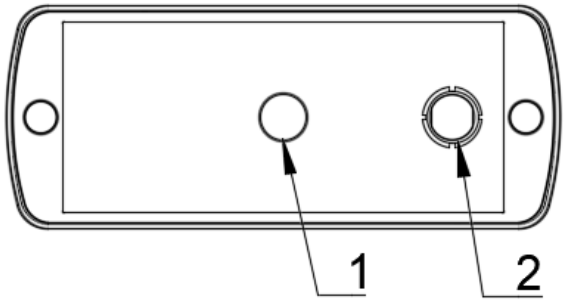

Figure 3: The rear panel of the multichannel fiber switch, see Table 2 for descriptions.

Table 2: Functionality of the rear panel, see Figure 2 for positions.

Number	Function	Description
1	TTL socket	The TTL communication cable has to connect this socket with the wavelength meter for controlling the switch from a HighFinesse wavelength meter.
2	Power input	Connect the power supply here. See Section 2.1.2.2 for specifications of the power supply.

2.3.4 Bottom

The label is located on the bottom of the casing.

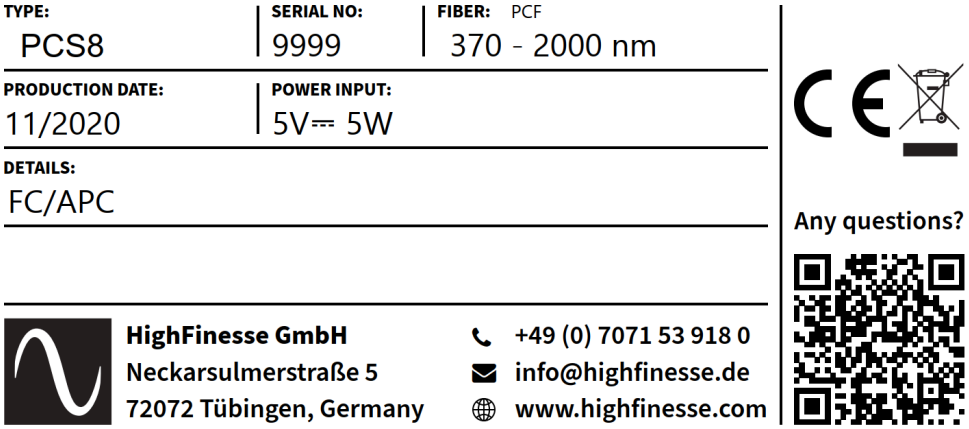

Figure 4: The label has the size 74 x 24 mm and color silver/gray.

3 Getting started

Safety regulations:

The usage of the instrument is restricted to authorized personnel, who have familiarized themselves with the content of this manual and the operation of the instrument. Methods of operation that compromise safety must be avoided.

The user must inspect the instrument for visible defects before operation to ensure it is in perfect condition before using it.

Do not remove or disable any security features. Only authorized and specially trained service personnel should maintain and repair components.

Disconnect the instrument from the wavelength meter and from power and make sure no laser light is reaching the instrument before carrying out maintenance work. The only maintenance work which can be carried out by the user is the cleaning of fiber port and fiber output described in Section 3.3.1 paying attention to all laser safety regulations.

It is strictly forbidden to modify the instrument.

3.1 Wavelength meter software installation and settings

When receiving the multichannel fiber switch as an upgrade option you will receive new software for your wavelength meter on a USB flash drive which lets you control the instrument.

Recommended specifications for a suitable computer are:

- Windows 7, 64 bit or higher
- Intel® Core™ i3 equivalent or better
- Memory 8 GB or better
- At least one USB 2.0 port

Insert the USB flash drive into the target computer.

Run the installation executable in the USB root directory as administrator (necessary for installing the required drivers). It is recommended to install the software to a folder with write permission.

Before starting the software ensure that the wavelength meter is connected to the computer.

Start the software, for example using the shortcut created by the setup on the desktop executable.

- Browse in the wavelength meter software to Settings -> Switch Settings -> Switch Port. . . and check if the protocol is set to “WLM TTL S”.
- Browse in the wavelength meter software to Settings-> Switch Settings -> Switch Parameters . . . and check if the delay is set to 12 ms.

3.2 Hardware installation

- Inspect the package content after delivery for any damage.

ATTENTION! ⚠ Please wait 24 h after receiving the multichannel fiber switch before unpacking and connecting it to the wavelength meter/power. This makes sure that it has warmed up enough to prevent condensation of water vapor which might damage the multichannel fiber switch.

- See Section 2.3 for the positions of the in- and outputs of the instrument and Figure 5 for an overview of fiber and electrical connections.
- Connect the TTL socket using the TTL communication cable with the switch socket on the wavelength meter.
- Connect the multichannel fiber switch to power using the power supply in the scope of delivery.

NOTE! ⓘ In case the multichannel fiber switch is not used for a long time (for example overnight or longer) please disconnect it from the power to avoid degradation of switching mechanics which may occur if the instrument is kept fixed at a certain channel for a long time. In case the instrument is not used for a short amount of time it is recommended to leave the wavemeter in automatic switch mode to avoid long times where the instrument is kept fixed to one channel only which would otherwise lead to a faster degradation of the switching mechanics.

ATTENTION! ⚠ For pulsed and/or high power lasers take special care not to exceed the damage thresholds specified in section Section 3.2.2 and follow the recommendations given there.

ATTENTION! ⚠ Use the correct FC/APC fiber connector at the multichannel fiber switch inputs to avoid damage to the internal fiber connectors.

- Connect the fused silica PCS input fibers to the fiber coupled laser/coupling optics. Alternatively single-mode fiber with FC/APC connector at the input can be used. See Section 3.2.1 for details.
- Verify with a powermeter that the damage thresholds for power and peak power are not exceeded. Please see Section 3.2.2 for thresholds. Usually far less power than the specified damage threshold is required to obtain a measurement. Start with a power of 10-100 µW coupled in the fiber.
- Connect a suitable powermeter at the laser output fiber. Unblock the laser and confirm that the power is in the required range.
- Block the laser light and connect the fibers to the inputs at the multichannel fiber switch.
- Connect the output fiber of the multichannel fiber switch to the wavelength meter. Unblock the laser. Check in the wavelength meter software in continuous mode with automatic exposure activated if the input power leads to a valid measurement. For pulsed lasers it is recommended to set a fixed exposure and varying it manually until obtaining a

valid measurement instead. For laser wavelength at the edge of the range of the wavelength meter it might be required to increase the power and for laser wavelength in the center of the range it might be required to reduce the power based on the wavelength meter reading.

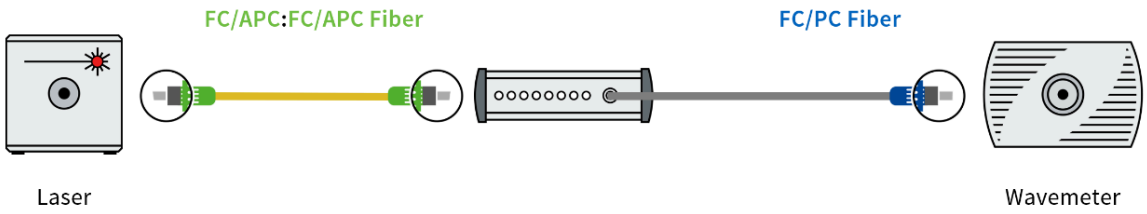

Figure 5: Interfacing the multichannel fiber switch with lasers and wavelength meter.

3.2.1 Input fibers at the photonic crystal switch

The pure silica PCS input fibers provided with the multichannel fiber switch for connecting to the input ports are optimized for transmission over the whole wavelength range of the wavelength meter. The typical NA is 0.13 - 0.15 and the typical mode field diameter 8.3 - 9.6 µm at 1550 nm.

These fibers are not single mode for wavelengths lower than 1250 nm. However, the optics in the multichannel fiber switch will ensure that the output is always single-mode. It is recommended to use these provided fibers. Alternatively, existing single-mode fibers with FC/APC connectors can be used as input fibers.

3.2.2 Recommended input power and damage thresholds

HighFinesse multichannel fiber switches use micro-mechanical technology which allows almost unlimited switch cycles, but limits the laser power the instrument can endure. To avoid damaging the multichannel fiber switch especially with short pulses, please use the wavelength meter in CW mode and use a long exposure time (at least >100 ms). This way you can integrate over several pulses and keep the peak power low. The following limits should not be exceeded:

- CW lasers: The limit is 5 mW for wavelength >400 nm. For lasers with wavelength < 400 nm the limit is 0.5 mW. HighFinesse wavelength meters usually only need a few µW, this should be more than sufficient, even when transmission losses through the multichannel fiber switch are taken into account.
- Pulsed lasers: For the average power of pulsed lasers, the same limits as for the CW case apply. Besides that, a maximum peak power during the pulse of 2 W (0.2 W for wavelength < 400 nm) should not be exceeded.

NOTE! ⓘ 2 W peak power equals 2 µJ for 1000 ns pulses, 0.2 µJ for 100 ns pulses, and 0.02 µJ for 10 ns pulses! For measurements of short pulses please use long exposure times and integrate over several pulse trains to get the required power for a valid measurement. The average power of such a pulsed laser depends on the duty cycle D and is given by D x 2 W.

NOTE! Fiber connectors can be damaged by too much laser power. Be especially careful when using pulsed (and/or ultraviolet) lasers and calculate the peak power to minimize the risk of reaching the damage threshold of the fiber used.

ATTENTION! Do not apply force when fixing the fiber connectors to the instrument to avoid damaging the fiber ends.

3.2.3 Fiber coupling using the HighFinesse coupling optics

The HighFinesse coupling optics has the following specifications:

- Focal length: 50mm (adjustable with the M3 bolt)
- NA: 0.15
- Spectral range: the material is UV grade fused silica, it has >90% transmission between 200 nm and 1000 nm (>80% transmission below 2000 nm).
- Clear aperture: 15 mm.

Its dimensions are shown in Figure 6.

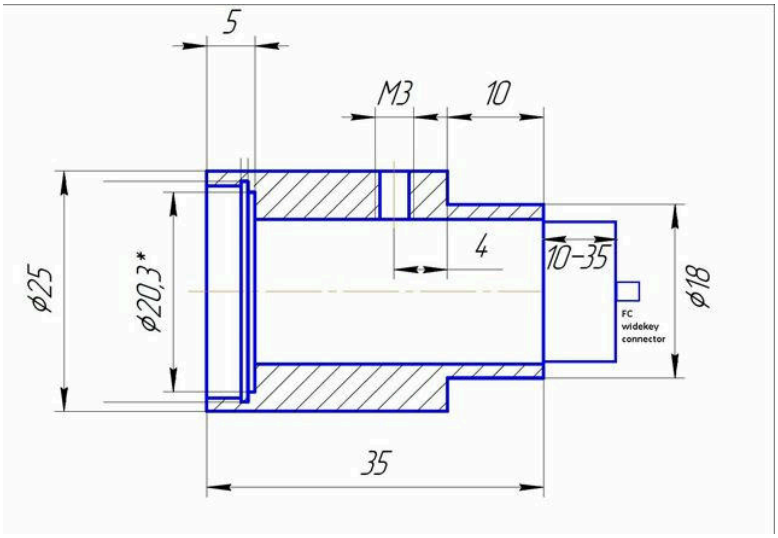

Figure 6: Dimensions of the fiber coupling optics.

It can be mounted on a 1″ optics mount. The coupling optics is intended for coupling free beam lasers into fibers as an input for HighFinesse wavelength meters and multichannel fiber switch. The coupling optics is optimized for its broad wavelength range. Thus, the coupling efficiency is low compared to optics optimized for a specific wavelength.

ATTENTION! Usually the available power / pulse energy is much higher than actually needed. See also Section 3.2.2. Use beamsplitters to reduce the power/pulse energy at the coupling optics if possible.

NOTE! The length of the coupling optics should be adjusted to match the focal length at the laser wavelength. It is preadjusted to the focal length at 633 nm.

3.3 Maintenance and service

ATTENTION!

When using the multichannel fiber switch which with input wavelength < 400 nm it is recommend to perform the inspection for cleanliness and cleaning procedure described in Section 3.3.1 once every 4 weeks even if the fibers were not disconnected in the meantime. A built up of a pollution my harm the multichannel fiber switch and especially at the output fiber towards the wavelength meter cause wrong wavelength readings

NOTE!

Dust on fiber ends can diminish the transmission significantly and can also cause the wavelength calculation to be incorrect. Heavily increasing laser power to compensate can result in permanent transmission loss, by melting dirt onto the fiber end or even damaging it.

Inspect the fiber in- and outputs for cleanliness before connecting to the laser/wavelength meter and in case a mal function of the wavelength meter is observed using a fiber microscope.

Do not attempt to open the housing. There are no user-serviceable parts inside and the warranty is void, if the seal is broken. If the instrument appears to be working incorrectly, check the following:

- Inspect the instrument for scratches, dents or signs of damage due to handling.
- Verify that the housing has not been opened.
- Is the power supply connected to the multichannel fiber switch? Is the power supply OK and delivers 5 V?
- Is the switch connected with the TTL communication cable to the wavelength meter and does the TTL communication cable show any sign of damage?
- Browse in the wavelength meter software to Settings-> Switch Settings-> Switch Port. . . and check if the protocol is set to “WLM TTL S”.
- Browse in the wavelength meter software to Settings-> Switch Settings-> Switch Parameters . . . and check if the delay is set to 12 ms.
- Clean the fibers at the in and outputs as well as the fiber ports at the multichannel fiber switch following the procedure described in Section 3.3.1.
- Verify that you are using the fibers delivered with the multichannel fiber switch or other appropriate fibers.

If the solutions suggested above do not solve your problem, please contact HighFinesse service for further assistance.

3.3.1 Cleaning fibers and fiber ports

The fiber cleaning tool delivered with the HighFinesse wavelength meters can be used to clean both fibers and the ports at the instruments. Figure 7 shows how to clean a fiber.

Remove only the lit of the gray cap. Plug in the fiber into the cleaning tool just as you would plug in a fiber into a fiber port. Press gently with the cleaning tool until you feel a strong resistance and hear a “click” sound. Repeat this 3 times.

Figure 7: Cleaning fibers with the fiber cleaning tool.

Figure 8 shows how to clean a fiber port. Remove the whole gray cap. Then plug in the cleaning tool into the port. Press gently with the cleaning tool until you feel a strong resistance and hear a “click” sound. Repeat this 3 times.

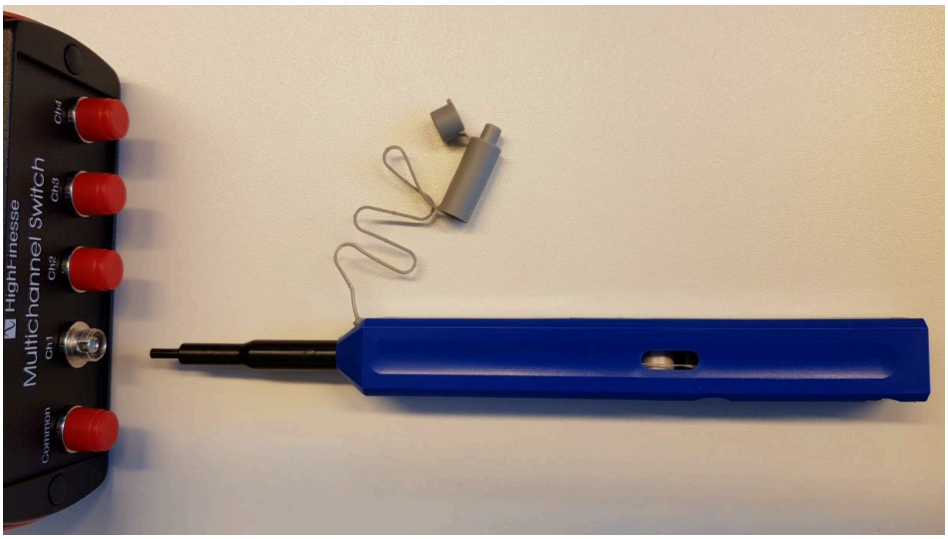

Figure 8: Cleaning fiber ports with the fiber cleaning tool.

Some pollution like grease or oil cannot be removed using the fiber cleaning tool. In order to remove grease or oil please use a drop of pure isopropanol (99.99%, optics grade) and an appropriate towel to wipe the tip of the fiber.

In some cases it is necessary to iteratively repeat dry and wet cleaning multiple times.

4 General Information

4.1 Operating conditions

Operation	
Temperature	15 °C – 28 °C
Humidity	35 % – 55 %
Altitude	0 m – 2000 m
Storage	
Temperature	15 °C – 30 °C
Humidity	35 % – 55 %
Altitude	0 m – 2000 m

4.2 Specifications

Optical input	
Number of input channels	2,4 or 8
Fiber connector	FC/APC
Wavelength range	370 nm – 2000 nm
Maximum cw input power	< 400 nm: 0.5 mW, > 400 nm: 5 mW
Maximum peak power	< 400 nm: 0.2 W, > 400 nm: 2 W
Switching	
Guaranteed transmission	15 % at 633 nm
Cross talk	< −55 dB
Return loss	< 40 dB
Switching time	typically <12 ms
Electrical	
Standard interface	TTL (Lemo 6-pin) to wavelength meter
Optional interface	RS232
Power supply	5 V / 1 A
Power consumption	< 450 mW
Dimensions and weight	
Dimensions	2 and 4 channels: 165 mm x 242 mm x 43 mm 8 channels: 222 mm x 200 mm x 43 mm
Weight	1 kg

4.3 Declaration information on disposal at end of lifetime

HighFinesse Laser and Electronic Systems GmbH (hereinafter referred to as HighFinesse) conforms to the EU legislation for electrical and electronic equipment (EEE), which includes the Waste Electrical and Electronic Equipment Directive (WEEE). Assigned duties affect product design of the equipment, disposal of used appliances as well as organizational responsibilities, i.e. product registration.

There are different requirements for household WEEE and that which is sold business to business (B2B).

All equipment HighFinesse handles is classed as B2B. HighFinesse is registered at the Competent Authority (Stiftung Elektro-Altgeräte Register EAR) under No. DE 14593317.

At end-of-life return your product back to HighFinesse. HighFinesse will dispose used equipment in such a manner as to meet all relevant local, country and EU requirements and guideline.

To return products please mark them clearly with “intended for disposal”. Contact HighFinesse prior to shipping and send them to the following address mentioned in Section 6.

5 Declaration of CE conformity

CE Konformitätserklärung / Declaration of CE Conformity WS-Series / Declaraction de Conformité

CE

Wir / We / Nous	**HighFinesse Laser and Electronic Systems GmbH**
Anschrift / Address / Adresse	**Wöhrdstraße 4** **72072 Tübingen** **Germany**

Erklären in alleiniger Verantwortung, dass das Produkt / declare under our sole responsibility, that the product / declarons sous notre seule responsibilité, que le produit

Bezeichnung / Name / Nom	**WS-Serie / WS-Series, WF-Serie / WF-Series, WR-Serie / WR-Series**
Artikelnr. / Article No. / No. d'Article	**WS5, WS6-600, WS6-200, WS7-60, WS7-30, WS8-10, WS8-2, WF6-600, WF6-200, WF7-60, WR6-600, WR6-200, WR7-60, WR7-30, WR8-10, WR8-2**
Beschreibung / Description / Description	**Wellenlängenmessgerät / Wavelength Meter**

Mit den grundlegenden Anforderungen der Richtlinien / fullfills the requirements of the standard and regulations oft he directives / satisfait aux exigences des normes et directives

2014/30/EU (Elektromagnetische Verträglichkeit), 2011/65/EU (RoHS-Richtlinie)

übereinstimmt und damit den Bestimmungen entspricht. / and therefore corresponds to the regulations of the directive. / et, ainsi, correspond au regiments de la directive.

Angewendete harmonisierte Normen / Applied harmonized standards / Normes harmonisées appliquées:

DIN EN 61326-1	VDE 0843-20-1:2022-11 Elektrische Mess-, Steuer-, Regel- und Laborgeräte – EMV-Anforderungen – Teil 1: Allgemeine Anforderungen (IEC 61326-1:2020); Deutsche Fassung EN 61326-1:2021 Electrical equipment for measurement, control, and laboratory use – EMC requirements – Part 1: General requirements (IEC 61326-1:2020); German version EN 61326-1:2021
DIN EN 61010-1	Sicherheitsbestimmungen für elektrische Mess-, Steuer-, Regel- und Laborgeräte – Teil 1: Allgemeine Anforderungen (IEC 61010-1 + COR:2011 + A1:2016, modifiziert + A1:2016/COR1:2019); Deutsche Fassung EN 61010-1:2010 + A1:2019 + A1:2019/AC:2019 Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements (IEC 61010-1 + COR:2011 + A1:2016, modified + A1:2016/COR1:2019); German version EN 61010-1:2010 + A1:2019 + A1:2019/AC:2019
DIN EN 63000	Technische Dokumentation zur Beurteilung von Elektro- und Elektronikgeräten hinsichtlich der Beschränkungen gefährlicher Stoffe; Deutsche Fassung EN 63000:2018 Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances; German version EN 63000:2018

Durch nicht von uns autorisierte Änderungen am Produkt verliert diese Erklärung ihre Gültigkeit. / Non authorized changes at the product result in the invalidity of this declaration. / Changements au produit, qui ne sont pas autorisées par nous, ont pour conséquence l'invalidité de cette declaration.

Tübingen, den 08.05.2024	Dr. Thomas Fischer CEO & President
	Thomas Fischer
Ort und Datum der Austellung Place and date of issue Lieu et date d'établissement	Name und Unterschrift des Befugten Name and signature of authorized person Nom et signature de la personne autorisée

6 HighFinesse Information / Service

HighFinesse
The Standard of Accuracy

Wöhrdstr. 4
72072 Tübingen
Germany

Phone: +49 (0)7071 539180
Fax: +49 (0)7071 968517

www.highfinesse.com
info@highfinesse.com

Document version 2025-01 002

7 Changelog

Changes Multichannel Photonic Crystal Fiber Switch Manual, Document Version 2024-11 0003:

Section 3.3.1	Updated cleaning procedure

Changes Multichannel Photonic Crystal Fiber Switch Manual, Document Version 2024-06 0002:

Section 4.1	Updated operation temperature.