HBK FIBERSENSING

ENGLISH

User Manual

MXFS

QuantumX BraggMETER Module

HBM

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1 TECHNICAL DETAILS

1.1 General Information

The MXFS is a module from the QuantumX family for measuring Fiber Bragg Grating (FBG) based sensors. It is based on the well-established BraggMETER technology from HBK FiberSensing, that employs a continuous swept laser scanning for measuring reflected Bragg peaks. It includes a traceable wavelength reference that provides continuous calibration to ensure system accuracy over long term operation. The high dynamic range and high output power allow high resolution to be attained even for long fiber leads and lossy connections.

The module allows two operating modes with different sweeping speeds that correspond to the actual sampling rates as below.

	MXFS DI
Low speed mode	100 S/s
High speed mode	2000 S/s
Sensors/connector (max.)	16
Sensors/device (max.)	128

Filtering and down sampling are available on both modes.

All fiber Bragg grating peaks connected in series to each of the 8 optical connectors are acquired in parallel totalling an impressive number of 128 channels on MXFS DI QuantumX BraggMETER module with simultaneous acquisition.

The modular QuantumX family is designed for universal applications. The modules can be individually combined and intelligently connected according to the measurement task. MXFS allows PTPv2 synchronization.

MXFS BraggMETER module is delivered with catman Easy software, including a 12 month maintenance license.

General details on the QuantumX modules operation can be found on its own document. Please refer to this document that is available on our website..

The current document applies to the following equipment:

Material Numbers	Description
1-MXFS8DI1/FC	Dynamic QuantumX BraggMETER Module with 8 FC/APC optical connectors

1.2 System components

The MXFS set includes:

Material Numbers	Quantity	Description
1-MXFS8DI1/FC	1	MXFS DI interrogator
	1	catman Easy software licence

Power and communication will depend on the desired mounting scheme and setup.

To operate the modules as stand alone, you will need to additionally consider:

Material Numbers	Quantity	Description
1-KAB271-3	1	Power cord
1-NTX001	1	Power adapter
1-KAB239-2	1	Ethernet crossover cable 2 m

1.3 Software

MXFS is an open data acquisition system. It can be integrated into many operating, analysis and automation software packages.

Available for download are:

- MX Assistant and Common API: modern and free device assistants that support the module acquisition and data functions;
- catman Easy/AP: the powerful, professional software for acquiring measurement data up to 20,000 channels. catmanEasy is provided together with MXFS without any extra cost;
- Drivers for LabView;
- Windows device driver for IEEE1394b FireWire.

1.4 Synchronization

MXFS follows the available synchronization methods of the QuantumX family:

- NTP;
- PTPv2;
- EtherCAT (via CX27);
- IRIG-B (via MX440B or MX840B).

Information

Please refer to the QuantumX user manual (A03031) for more details on synchronization methods and setup.

2 REGULATORY AND CERTIFICATION CONSIDERATIONS

2.1 Environment Considerations

2.1.1 Disposal of your Old Appliance

When the attached symbol combination - crossed-out wheeled bin and solid bar symbol is attached to a product it means the product is covered by the European Directive 2002/96/EC and is applicable in the European Union and other countries with separate collection systems. All electrical and electronic products should be disposed of separately from the municipal waste stream or household via designated collection facilities appointed by the government or the local authorities. The correct disposal of your old appliance will help prevent potential negative consequences for the environment and human health.

For more detailed information about disposal of your old appliance, please contact your city office, waste disposal service or distributor that purchased the product. HBK FiberSensing is a manufacturer registered in the ANREEE - "Associação Nacional para o Registo de Equipamentos Eléctricos e Electrónicos" under number PT001434. HBK FiberSensing celebrated a "Utente" type contract with Amb3E - "Associação Portuguesa de Gestão de Resíduos de Equipamentos Eléctricos e Electrónicos", which ensures the transfer of Electrical and Electronic appliance waste management, i.e. placing Electronic and Electrical appliances in the Portuguese market, from the manufacturer HBK FiberSensing to Amb3E.

2.2 Laser Safety

The MXFS Interrogator contains a laser in its core. A laser is a light source that can be dangerous to people exposed to it. Even low power lasers can be hazardous to a person's eyesight. The coherence and low divergence of laser light means that it can be focused by the eye into an extremely small spot on the retina, resulting in localized burning and permanent damage. The lasers are classified by wavelength and maximum output power into the several safety classes: Class 1, Class 1M, Class 2, Class 2M, Class 3R and Class 4.

2.2.1 Symbols

Warning symbol

Class 1 Laser symbol

2.2.2 Class 1 Laser

The MXFS is a Class 1 laser product: ≪Any laser or laser system containing a laser that cannot emit laser radiation at levels that are known to cause eye or skin injury during normal operation.≫ It is safe under all conditions of normal use. No safety requirements are needed to use Class 1 laser devices.

Laser Safety	
Laser Type	Fiber Laser
Laser Class (IEC 60825-1)	1
Typical Output Power per channel	≈ 0.3 mW (-5 dBm)
Max Output Power per channel	≈ 0.5 mW (-3 dBm)
Wavelength	1500-1600 nm

2.2.3 General Precautions Considerations

Everyone who uses a laser equipment should be aware of the risks. The laser radiation is not visible to the human eye but it can damage user's eyesight. The laser is enabled when the interrogator is turned on.

Users should never put their eyes at the level of the horizontal plane of the optical adapters of the interrogator or uncovered optical connectors. Adequate eye protection should always be required if there is a significant risk for eye injury. When an optical channel is not in use (no optical connector plugged to the interrogator), a proper connector cap must be used. The optical connectors are subjected to maintenance and/or inspection. Please refer to *section 3.9 "Measurement troubleshooting", page 41* for maintenance procedure.

Do not attempt to open or repair a malfunction interrogator. It must be returned to HBK for repair and calibration.

2.3 Certification

2.3.1 CE Marking

This product carries the CE marking and complies with the applicable international requirements for product safety and electromagnetic compatibility, according to the following Directives: Low Voltage Directive (LVD) 2014/35/EU – Electrical Safety Electromagnetic Compatibility (EMC) Directive 2014/30/EU. The corresponding Declaration of Conformity is available upon request.

2.3.2 UKCA Marking

This product carries the UKCA marking and complies with the applicable international requirements for product safety and electromagnetic compatibility, according to the following Directives: Low Voltage Directive (LVD) 2014/35/EU – Electrical Safety Electromagnetic Compatibility (EMC) Directive 2014/30/EU. The corresponding Declaration of Conformity is available upon request.

2.3.3 ATEX Marking

This product is ATEX certified and complies with the requirements of the ATEX Directive 2014/34/EU. This product carries the Ex marking and is approved according to IEC/EN 60079-28 for:

- Zone 0 for gas group IIC;
- Zone 20 for dust group IIIC;
- Zone M1 for mining.

The ATEX certification applies to the use of this product to interrogate optical sensors in potentially explosive atmospheres. Explosive atmospheres are areas where there is a risk of explosion due to flammable gases, vapors, liquids, or combustible dusts. This product has been designed to safely interrogate optical sensors in explosive atmospheres. It is therefore important to follow the instructions in this manual to ensure safe use.

⚠ CAUTION

Information for "Optical safety"
Install the device outside hazardous areas. The optical radiation was evaluated according to EN60079-28:2015. The optical radiation can be irradiated in all areas of group I, II and III. The maximum output optical power per connector is < 15 mW.

2.3.3.1 Laws and directives

Observe the test certification, provisions, and laws applicable in your country during connection, assembly and operation. These include, for example:

- National Electrical Code (NEC - NFPA 70) (USA);
- Canadian Electrical Code (CEC) (Canada):

Further provisions for hazardous area applications are for example:

- IEC 60079-14 (international);
- EN 60079-14 (EC).

2.3.3.2 Nameplate MXFS DI

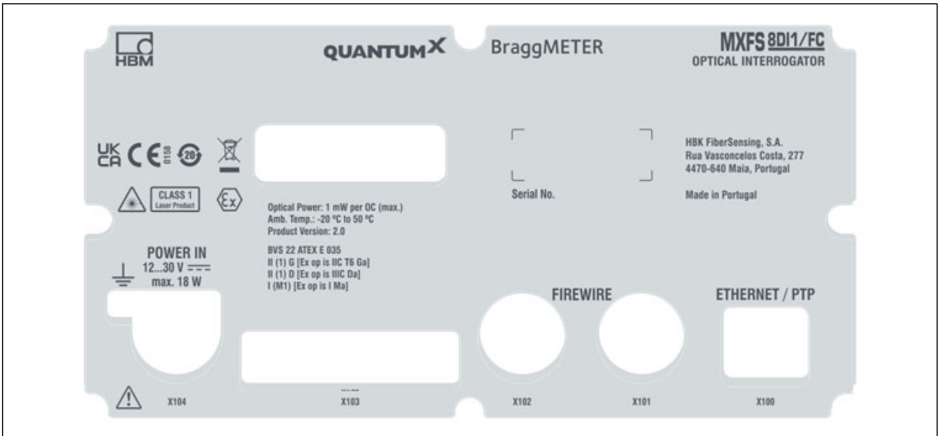


Fig. 2.1 MXFSDI Back Label

2.3.4 Fire Safety

This product complies with EN 45545-2:2016 and EN 45545-2:2020 for the hazard levels HL1, HL2, and HL3. When installing the MXFS without the X frame, no combustible mass has to be taken into account according to the grouping rules in section 4.3 of DIN EN 45545-2.

2.3.5 Marking of pollutant emission limit values (for deliveries to China)

Statutory marking of compliance with emission limits in electronic equipment supplied to China.

2.4 Marking used in this document

Important instructions for your safety are specifically identified. It is essential to follow these instructions in order to prevent accidents and damage to property.

Symbol	Significance
⚠ CAUTION	This marking warns of a *potentially* dangerous situation in which failure to comply with safety requirements *can* result in slight or moderate physical injury.
Notice	This marking draws your attention to a situation in which failure to comply with safety requirements *can* lead to damage to property.
Important	This marking draws your attention to *important* information about the product or about handling the product.
Tip	This marking indicates application tips or other information that is useful to you.
Information	This marking draws your attention to information about the product or about handling the product.
Emphasis *See …*	Italics are used to emphasize and highlight text and identify references to sections, diagrams, or external documents and files.
▶	This marking indicates an action in a procedure.

3 OPERATION

3.1 Connectors

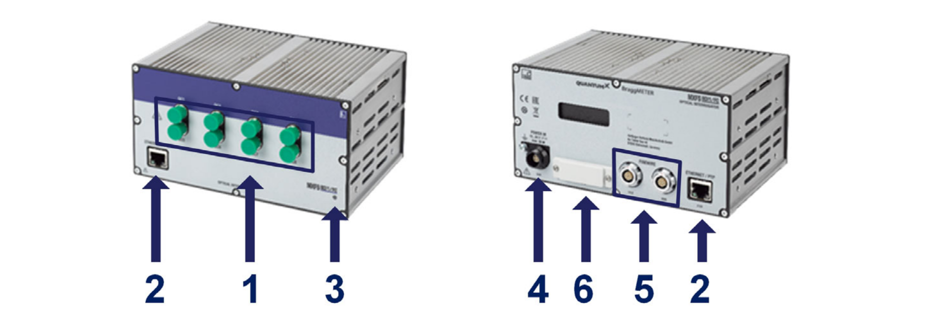


Fig. 3.1 Front and back view of the MXFS

1 Optical Connectors (FC/APC);

2 Ethernet Connectors;

3 STATUS LED;

4 Power connector;

5 Firewire connectors;

6 Backplane connector.

3.2 Setting up

3.2.1 Power supply

Connect the modules to a DC voltage. The power consumption and accepted supply voltage range of a module depends on the model.

	MXFS DI
Maximum power consumption	30W
Supply voltage	12 V ... 30 V

Important

The following rule of thumb applies to power distribution via FireWire:
“An external voltage supply with the same voltage potential is required on every 3rd module“.

Notice

Defects in the module cannot be excluded if the supply voltage limits above are not respected. If the supply voltage drops below the lower limit, the modules will switch off.

We recommend installing an uninterruptible power supply (UPS) in vehicles with battery operation between battery and module to compensate for voltage drops during start procedures.

If several modules are connected to each other via *FireWire* for time-synchronous data acquisition, the supply voltage can be looped through. The power pack used must be able to provide the appropriate output.

The maximum permissible current on the IEEE1394b FireWire connection cable is 1.5 A. If the chain is longer, *repeating the supply connection is mandatory*.

If several amplifiers are operated non-synchronously (*see Fig. 3.2*), they must be supplied separately.

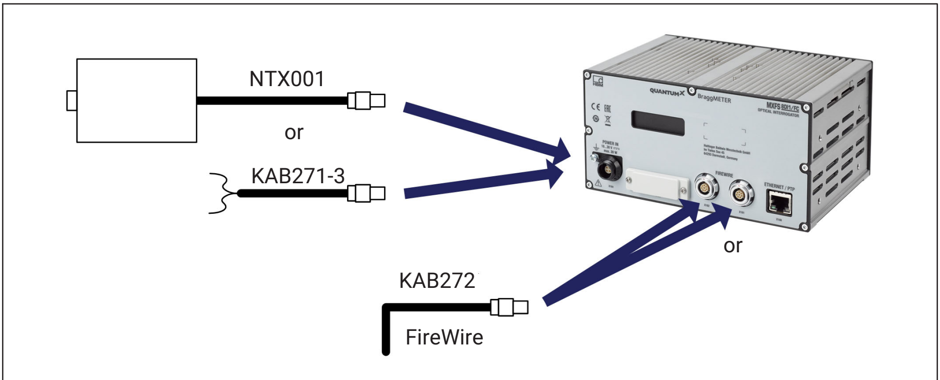


Fig. 3.2 Connecting options for power supply

3.2.2 Connection and Syncronization to PC and Other Modules

The QuantumX MXFS module is designed to synchronize with other QuantumX/SomatXR modules of the same family, allowing for simultaneous data acquisition. This synchronization can be achieved by connecting the modules through FireWire or Ethernet interfaces. Alternatively, the MXFS module can function as a gateway, collecting synchronized data from multiple modules via FireWire and transmitting it to the PC using an Ethernet interface cable. It is essential to ensure proper synchronization between the MXFS module and other devices to maintain accurate timing. For more detailed information on synchronization methods and specific product combinations, please consult the Catman software product manual (A05566 02, Page 104, “3.2.6 Synchronizing several devices”).

Changing synchronization method via Catman, MXAssistant, or API: When NTP or PTP synchronization is activated or deactivated, there is a short period of up to 20 seconds for equipment resynchronization. During this period, the unit performs a relock, the system LED color changes to orange, and the measured value for all channels goes to overflow. After this period, the interrogator returns to normal operation.

3.2.2.1 Single Ethernet connection

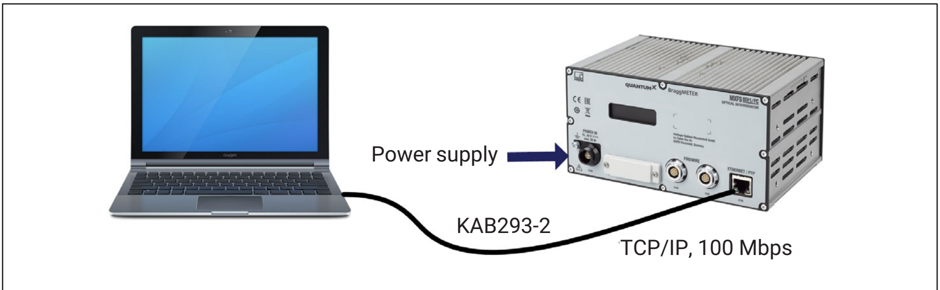


Fig. 3.3 Single Ethernet connection

Notice

You must use an Ethernet crossover cable with older computers. Newer PCs/laptops have Ethernet interfaces with autocrossing function. You can also use Ethernet patch cables for this purpose.

3.2.2.2 Multiple Ethernet connection with PTP synchronization

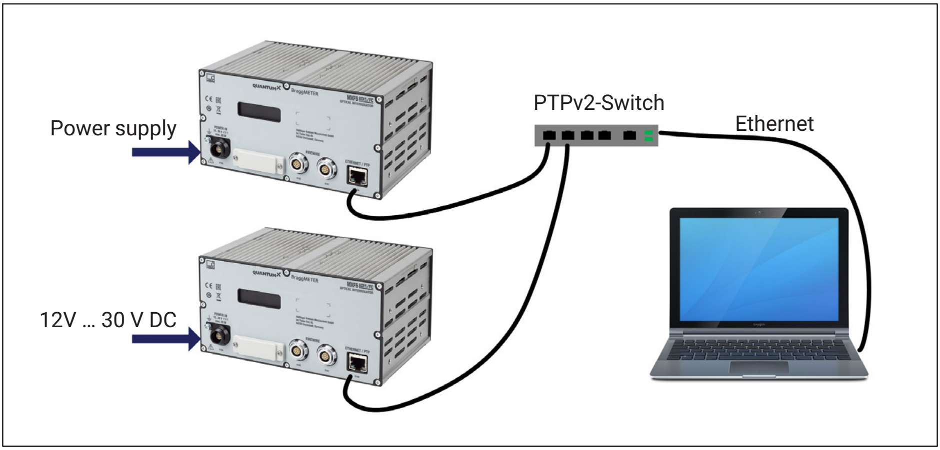


Fig. 3.4 Multiple connection via Ethernet and synchronization via PTPv2

Modules can be connected to the PC via Ethernet PTPv2-compliant switches. We recommend patch cables.

Here are some examples:

- EX23-R from HBM;
- Scalance XR324-12M from Siemens;
- RSP20 or MACH1000 from Hirschmann;
- Ha-VIS FTS 3100-PTP from Harting;
- Stratix 5400 from Rockwell.

PTP Grandmaster Clock examples:

- LANTIME M600 from Meinberg;
- OTMC 100 from Omicron.

With the star structure displayed here, measurement data from other modules is not lost if the Ethernet cable is broken!

3.2.2.3 Multiple Ethernet connection and FireWire synchronization

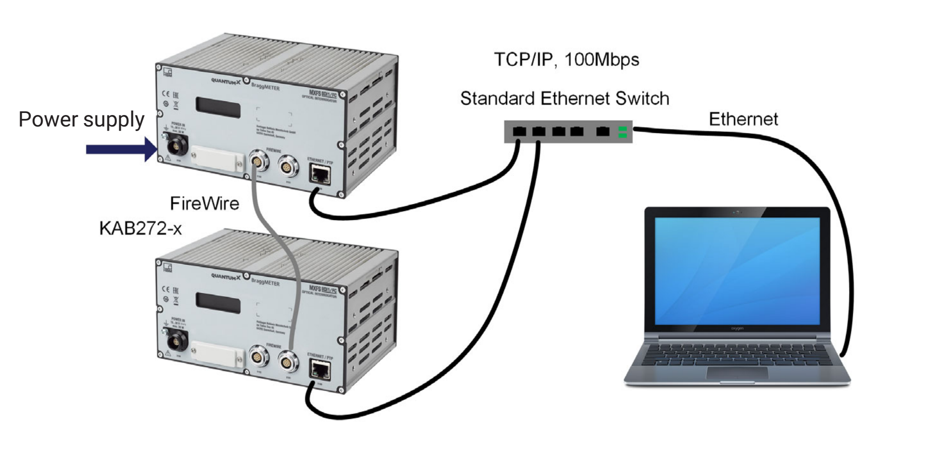


Fig. 3.5 Example of multiple connection via Ethernet with synchronization

The supply voltage for the modules is looped through FireWire in the configuration shown above (max. 1.5 A through FireWire; for power consumption of the modules, *see chapter 3.2.1 “Power supply”, page 13*).

Advantage of this connection structure: The other modules remain active if the Ethernet cable is broken.

3.2.2.4 Other possible connections

There are several other possibilities of connection between MXFS modules or MXFS and other QuantumX modules:

- Connection of a single module via FireWire;
- Connection of several modules via FireWire;
- Connection to a CX22 data recorder;
- Connection for CAN bus output signals;
- Connection for analog outputs;
- Connection for real time outputs via EtherCAT or PROFINET IRT;
- Etc. …

Please refer to the generic QuantumX user manual (document A03031 available for download on our website).

3.2.3 Communication settings to the PC

Modules can be connected to a standard PC via Ethernet (up to 100 m), via FireWire (electrically, up to 5 m, optically up to 300 m), or via EtherCAT.

The following must be noted for TCP/IP communication via Ethernet:

- We recommend that you retain the default setting (DHCP/APIPA), so that the software can find the modules that are in the network, or directly connected. You can, of course, also parameterize the modules with a fixed, static IP address. This also applies to the PC or notebook. Advantage: this allows notebooks in particular to be quickly and automatically integrated without re-configuration into the company network (DHCP). But direct operation between the notebook and the modules (peer-2-peer) is also very quick, using automatic addressing (APIPA).
- The Ethernet network adapter of the PC or modules can also be manually configured with a specific IP address and subnet mask, of course.

Please refer to the generic QuantumX user manual (document A03031 available for download on our website) when configuring direct IP-over-FireWire via FireWire connection.

To configure the IP address of the module

▶ Activate DHCP/APIPA for automatic configuration. Please set any PC directly connected to QuantumX to DHCP as well.

▶ Manual configuration: Deactivate DHCP and enter the same subnet mask address as used with your PC. Change the IP address of your module so that it permits communication (see example below).

Example

Setting the IP address manually – module side

Settings	IP address	Subnet mask
Module before	169.1.1.22	255.255.255.0
PC / notebook	172.21.108.51	255.255.248.0
Module after	**172.21.108.1**	**255.255.248.0**

The first *three* digit groups of the PC and module IP addresses should be the same.

The subnet mask address digit groups must be identical in the module and PC!

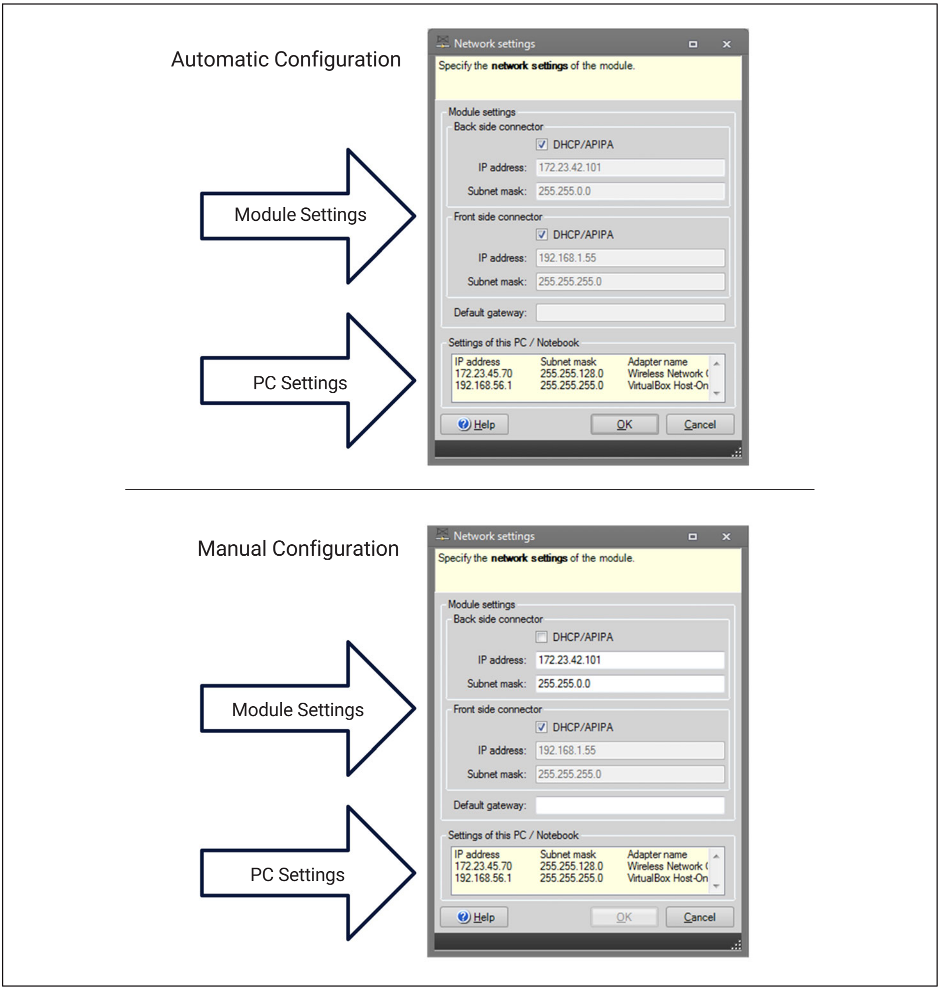


Fig. 3.6 Example of settings for a direct connection

Ethernet settings: adjust the IP address of your PC

If you want to operate the modules with a fixed, static IP address, you should use the **Alternative Configuration** (fixed IP address and subnet mask, user-defined) in the Ethernet adapter properties under TCP/IP the **Alternative Configuration** in the TCP/IP properties (fixed IP address and subnet mask, user-defined)!

- On the control panel choose **Network Connections**.
- Select the LAN connection. The window displayed in *Fig. 3.7* will appear. Click on **Properties**.

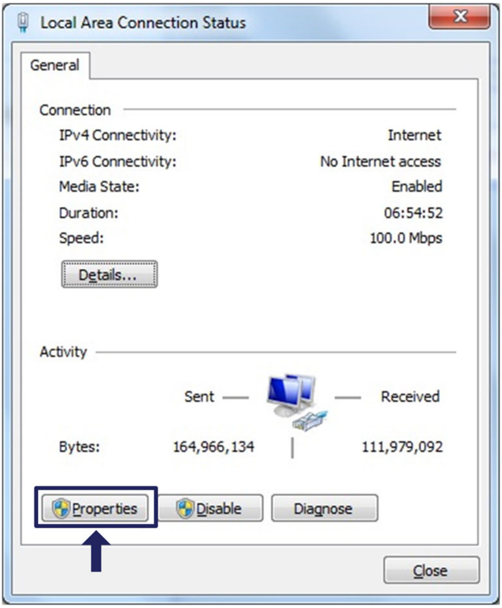


Fig. 3.7 Network properties

▶ Select the Internet Protocol (TCP/IP) and click on the **Properties** button (*Fig. 3.8*).

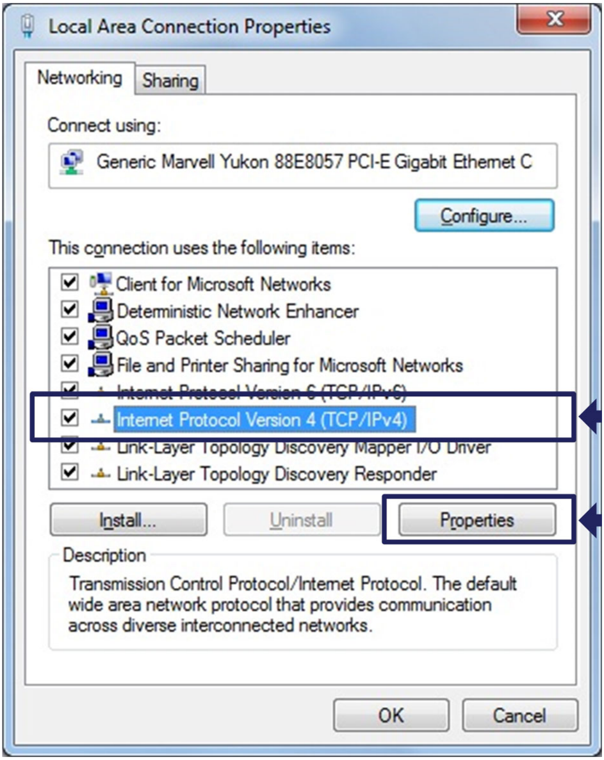


Fig. 3.8 TCP/IPv4

▶ Set the **IP address** and the **Subnet mask** (*Fig. 3.9*).

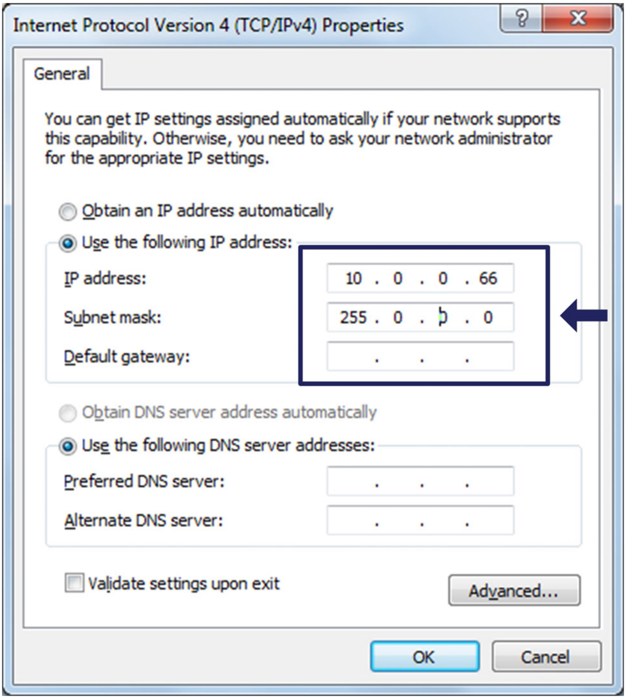


Fig. 3.9 IP and Subnet

▶ Press **OK**.

Integrating modules in an Ethernet network

▶ Activate the DHCP checkbox and click on **OK**. The following confimation window then appears:

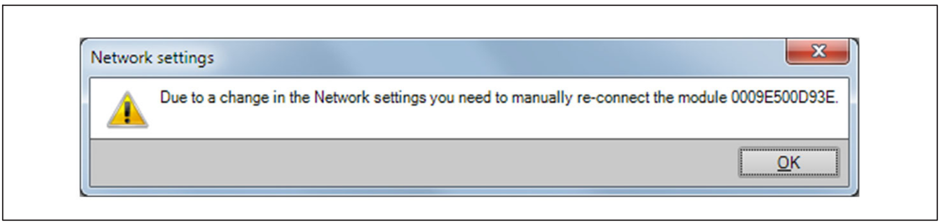


Fig. 3.10 DHCP confirmation window

- Confirm the settings with the **Yes** button. The module will then be restarted with the current settings.

Notice

Please note that with the Ethernet setting DHCP/APIPA, the DHCP server requires a certain amount of time to assign an IP address to the QuantumX module. After connecting the hardware to the network or PC, wait about 30 seconds before starting catman. Otherwise the device may not be found.

3.3 Mounting

3.3.1 MXFS Positioning

When installing the MXFS interrogator, please exercise caution regarding its placement. The MXFS interrogator does not have active ventilation, so it is important to choose a well-ventilated location to prevent overheating.

The MXFS interrogator can be positioned in any orientation without impacting its functionality. However, it is essential to handle the fiber optic cables connected to the optical channels with care to avoid strain or damage.

In Quantum system assemblies, we recommend placing the MXFS interrogator on top, as it may generate more heat compared to other equipment.

If you have questions or require assistance, please reach out to HBK Fibersensing for support.

3.3.2 Mounting case clips

The module electronics are integrated in a metal housing that is surrounded by a case protection (CASEPROT). This also serves for centering when several devices are stacked on top of each other and offers a certain degree of protection against mechanical damage.

Fig. 3.11 MXFS with case protection

1 MXFS housing;

2 Case protection;

3 Top side cover;

4 Bottom side cover.

Models can be secured together via a clip-on connection (order number 1-CASECLIP).

▶ Remove the X frame case protection (number 2 in Fig 1) using a 2.5 hexagonal screwdriver (number 1 in Fig 2). Screws are accessible from the bottom of the device.

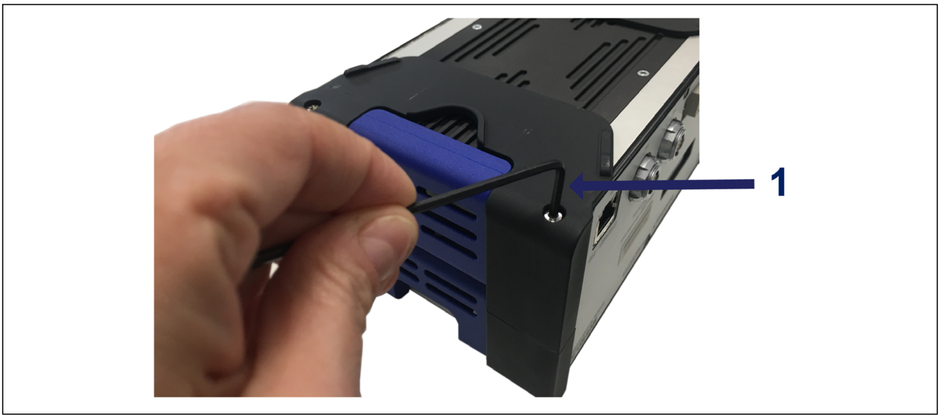


Fig. 3.12 Removing case protection

Information

The mounting of the housing clips shown in the following pictures must be implemented on both sides of the housing. Only one CASECLIP set is needed for both sides.

Fig. 3.13 MXFS without case protection

▶ Remove the bottom side cover (number 4 in *Fig. 3.11*) using a 2.5 hexagonal screwdriver. Keep the top side cover in place.

Fig. 3.14 Removing the bottom side cover

- Mount the CASECLIP as a replacement of the bottom side cover, using a 2.5 hexagonal screwdriver and the delivered screws and washers.

Fig. 3.15 Mounting the CASECLIP

Fig. 3.16 MXFS with CASECLIP on

- Optionally, reattach the X frame protection. The interrogator can now be clipped to another module or to a CASEFIT (order number 1-CASEFIT) as any other QuantumX Module.

3.4 Status indicators

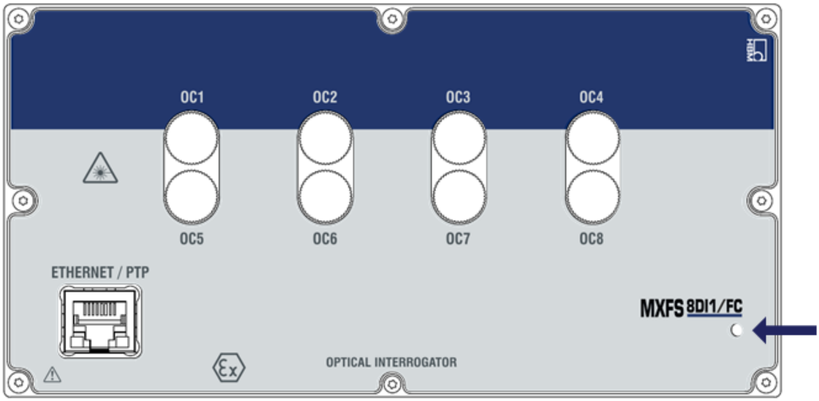


Fig. 3.17 MXFS front view

The MXFS presents a system Led on the front panel that lightens with different colors:

System LED	
Green	Error-free operation
Orange	System is not ready, boot procedure running - Optical Module is warming up - Optical Module is busy - NTP/PTP out of synch
Flashing orange	Download active, system is not ready - Firmware upgrade
Red	Error

3.5 Maintenance

3.5.1 Wear parts

HBK Optical Interrogators have wear parts (such as ventilation fans, optical connector adapters and batteries) that require minimum running conditions to ensure a correct operation of the equipment.

Wear parts are covered by a limited warranty as they are components that depend on the usage and on the environmental conditions the equipment operates in, such as humidity, temperature, and dust.

A periodic maintenance should be planned and managed by the customer considering the actual operation conditions. Warranty will only be applied to wear parts if the cause of the defect can be clearly traced back to the material or manufacturing fault.

3.5.2 Ventilation

The MXFS is an electronic equipment without active ventilation, meaning that it does not use fans for thermal control of the device. Dissipation area should not be subjected to temperatures outside the operating temperature of the devices.

3.5.3 Optical connectors

Optical connectors of the interrogator are subject to degradation and can actually break upon misusage (*see section 3.9.2. "Broken connector"*). If this happens, the interrogator must be sent back to HBK FiberSensing for repair.

3.5.4 Calibration

BraggMETER interrogators have a built-in NIST traceable gas cell that ensures calibrated measurements at all time. For this reason, a compulsory periodic calibration is not required. Nevertheless, for regulatory reasons or internal rules, a periodic certified calibration procedure is sometimes required. For those cases, the calibration service is available (Order Number S-FS-CAL) and can be requested to HBK.

3.5.5 Firmware update

We recommend that the firmware and software used to operate QuantumX are always kept up to date.

▶ Download the latest firmware from the HBM website. If you do not work with catman, please download the QuantumX software package from the HBM website.

Please save the firmware under ...\HBM\catmanEasy\Firmware\QuantumX-B, or on C:\Temp.

▶ Start catman, scan the network for modules and carry out the recommended firmware update. catman comes with the firmware included. This is usually stored under: C:\Program Files\HBM\catman\Firmware\QuantumX-B.

Please refer to the generic QuantumX user manual (document A03031 available for download on our website) for further options on updating the module's firmware if not using catman.

3.6 Factory reset

It is possible to reset the MXFS module to its factory settings which will delete the configuration in use by the device:

- Deactivates all channels;
- Deletes all configured bands;

- Changes all sensor types to wavelength relative;
- Deletes zero balance value.

Reset can be performed via MX Assistant, Common API or catman software (see detailed information in *section 4.3 “Reset the device”, page 70*).

3.7 Connecting to optical sensors

3.7.1 Concepts and definitions

3.7.1.1 Connectors

The MXFS has 8 FC/APC optical connectors located on its front panel (*see Fig. 3.1*).

The device is ready to receive several Fiber Bragg Grating (FBG) sensors connected in series on the same optical fiber.

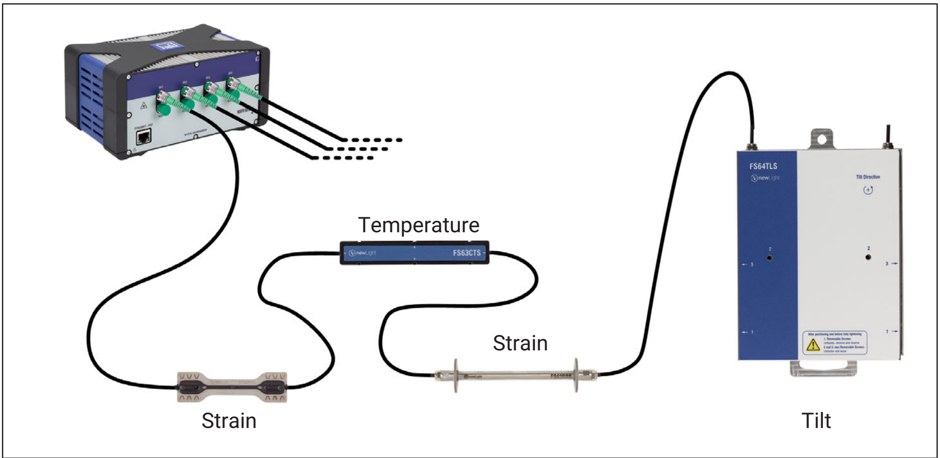


Fig. 3.18 Typical sensing network

3.7.1.2 Channels

Each optical connector accommodates 16 channels. This means that the device can read a maximum of 16 fiber Bragg grating peaks per optical connector.

The channels of the device can be configured by defining the range of wavelength (the band) they occupy and their reference wavelength (*Fig. 3.19*).

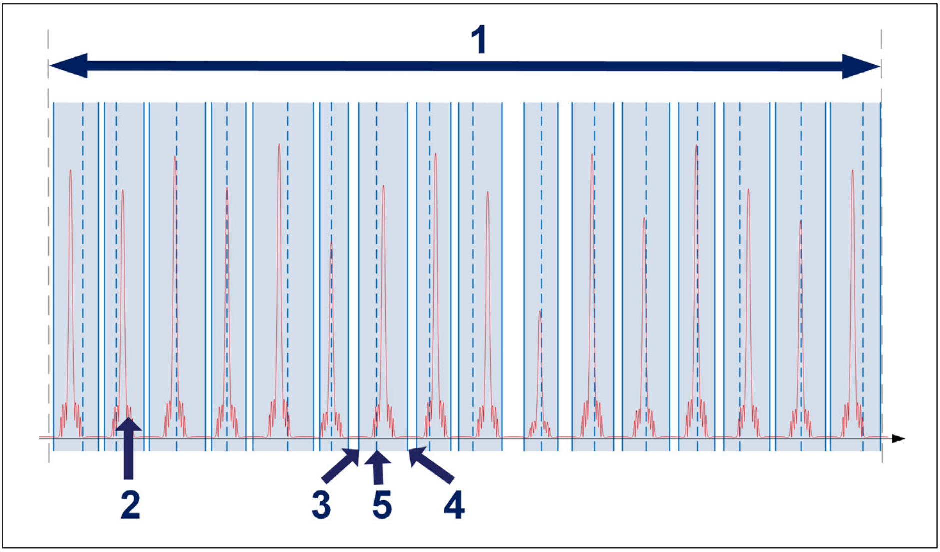


Fig. 3.19 Channels and ranges

1 Available wavelength range per optical connector (from 1500 nm to 1600 nm);

2 Measured spectrum of the connected fiber (reflection);

3 Minimum wavelength in nm;

4 Maximum wavelength in nm;

5 Reference wavelength in nm (value against which relative wavelength measurement is taken for that channel).

Each channel can correspond to one range of the depicted above, regardless of the order. Ranges cannot overlap.

Tip

Automatic detection and definition of ranges is possible to execute in MX Assistant or catman®. However, it is not possible to visualize the spectrum nor edit/create the ranges by hand on the first. To visualize the spectrum and/or manually adjust the defined ranges use the provided catman®Easy software.

Information

The minimum distance between ranges is of 0.5 nm. Smaller distances between ranges limits is considered an overlap.

A measurement is only taken when a fiber Bragg grating peak is found inside the range. If no peak is found inside a defined range an overflow value is given.

3.7.1.3 Wavelength

The wavelength value corresponds to the wavelength at the peak of the fiber Bragg grating reflection spectrum, commonly referred as Bragg wavelength.

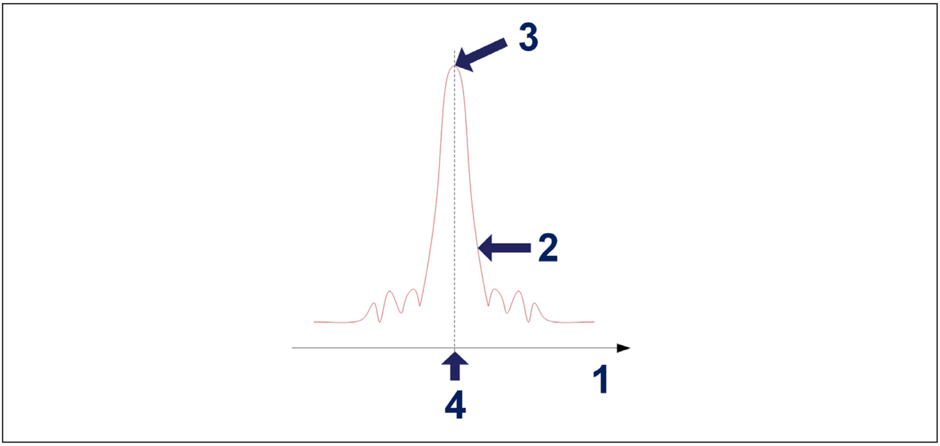


Fig. 3.20 Wavelength

1 Wavelength axis in nm;

2 FBG reflected spectrum;

3 FBG peak;

4 Wavelength value in nm.

Reference Wavelength

The wavelength value to which every measurement is compared to is called the reference wavelength. Per each defined channel, one reference wavelength has to be fixed between the minimum and maximum wavelength values of the channel.

The reference wavelength is, for non calibrated sensors, the zero value of the measurement. For calibrated sensors, the reference wavelength should be defined as stated on their calibration sheets.

Measured Wavelength

Wavelength value of the FBG peak at each acquired sample.

3.7.1.4 Power

The power value corresponds to the optical power reflected by the fiber Bragg grating at peak wavelength.

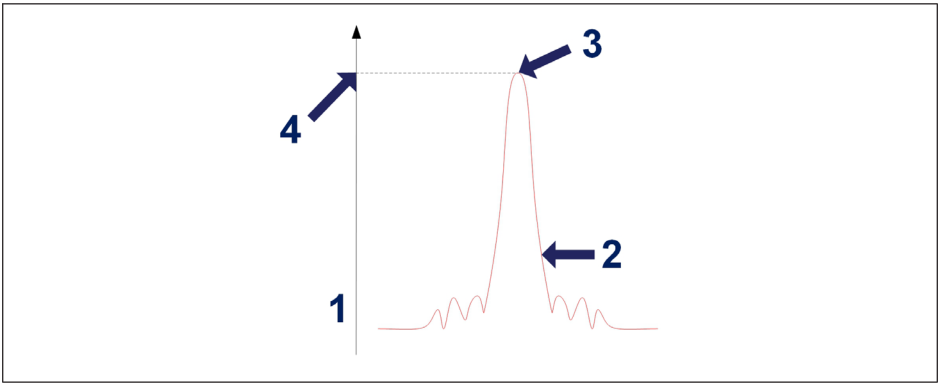


Fig. 3.21 Power

1 Power axis in dBm;

2 FBG reflected spectrum;

3 FBG peak;

4 Power value in dBm.

3.7.1.5 Dynamic Range

The dynamic range on an optical interrogator is referred as the range of power values in between a fiber Bragg grating can be correctly identified and measured.

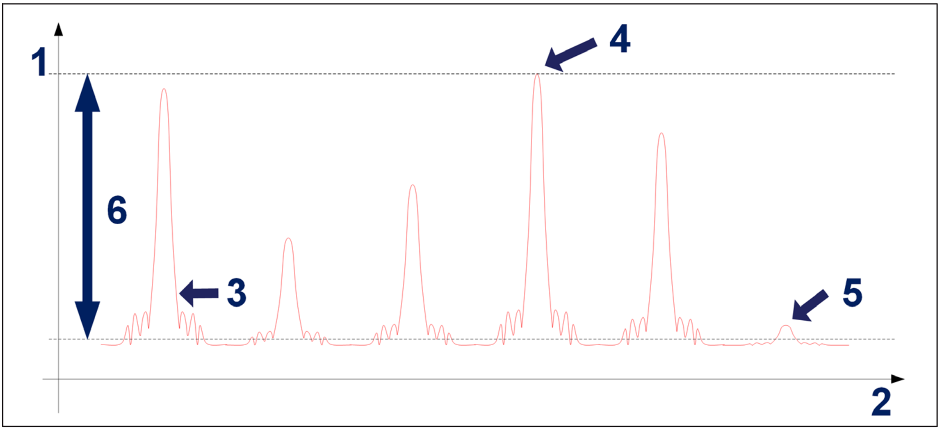


Fig. 3.22 Dynamic Range

1 Power axis in dBm;

2 Wavelength axis in nm;

3 FBG reflected spectrum;

4 Maximum measurable power;

5 Minimum measurable power;

6 Dynamic Range in dB.

3.7.1.6 Smart peak detection (SPD)

SPD allows the effective use of the high dynamic range offered by the interrogator through the introduction of the individual measurement of an FBG peak inside each configurable band.

MXFS DI considers a fixed threshold value of 3 dB, easing the configuration of the device (*Fig. 3.23*). Every wavelength value is calculated considering the area of the FBG peak above half its power.

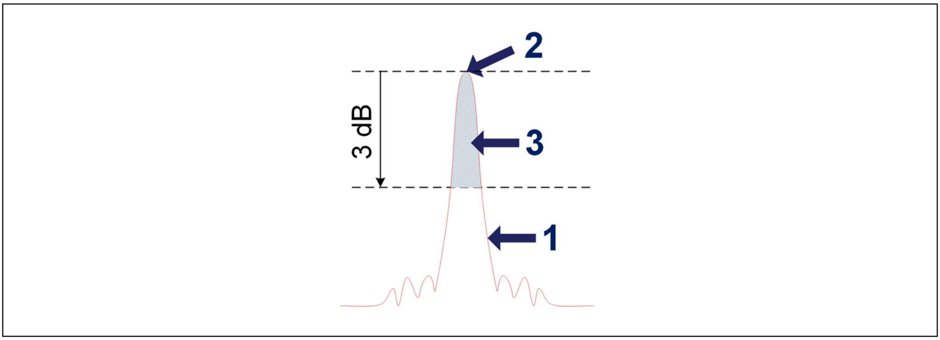


Fig. 3.23 Smart Peak Detection concept

1 FBG reflected spectrum;

2 FBG peak;

3 Used area for wavelength computation.

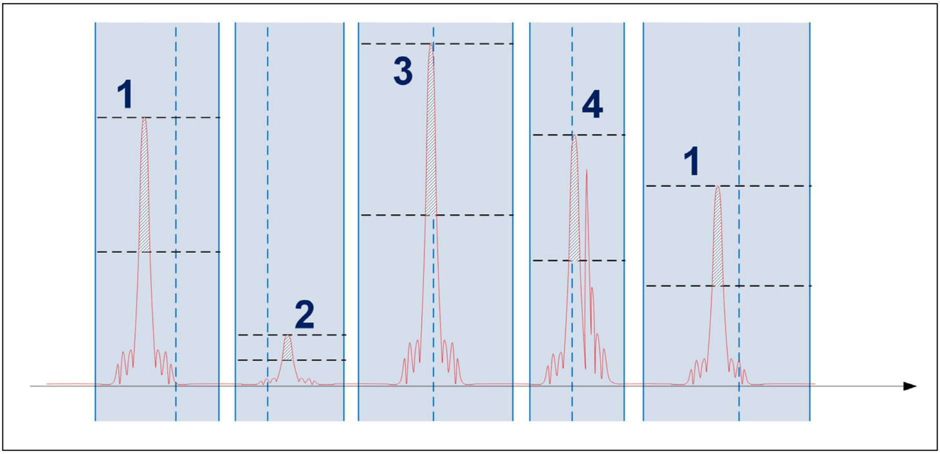


Fig. 3.24 Smart Peak Detection in action

Within each sensor range only one FBG sensor will be computed. Regular signals (1), low power signals (2) and high-power signals (3) can coexist on the same optical connector without compromising any measurement. It can happen, either permanently or occasionally, that multiple peaks overcome the threshold (4) and SPD eliminates problems on the measurements also for this situation.

Summarily, the increased robustness provided is especially suited to overcome the limitations found in the conventional methods where low and high reflectivity FBGs coexist and signal losses are often a problem. SPD therefore improves the stability and accuracy of the measurements, contributing to the system's efficiency, even at high acquisition speeds.

3.7.1.7 Signals

The changes on the peak wavelength constitute the signal from the optical interrogator, which can be scaled to physical values.

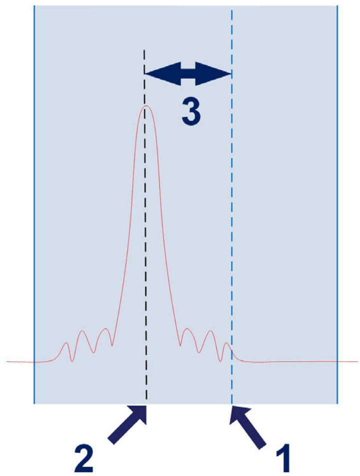


Fig. 3.25 Signal

1 Reference wavelength defined for the channel (λ_0) in nm;

2 Measured wavelength within the channel (λ) in nm;

3 Wavelength variation within the channel, in nm. If the peak falls out of the defined bands for the channel, an overflow value is presented.

The wavelength variation relates to the signals via conversion factors.

Available sensor types

Sensor Type	Description	Output
Wavelength absolute	Wavelength absolute sensors output is the wavelength measured on the FBG peak (number **2** in *Fig. 3.19*)	λ
Wavelength relative	Wavelength relative sensors output is a wavelength variation measured on the FBG peak (number **3** in *Fig. 3.25*)	$\lambda - \lambda_0$
Strain	Converted wavelength variation into strain measurement based on the sensors' k-factor (*k*). Strain measurements on the device level are not temperature compensated.	$\frac{\lambda - \lambda_0}{k \cdot \lambda_0}$
Temperature	Converted wavelength variation into temperature based on calibration coefficients (S_2, S_1 *and* S_0). Conversion formula is a second order polynomial.	$S_3 (\lambda - \lambda_0)^3 + S_2 (\lambda - \lambda_0)^2 + S_1 (\lambda - \lambda_0) + S_0$

Sensor Type	Description	Output
Acceleration	Converted wavelength variation into acceleration based on calibration coefficients (S). Conversion formula is linear.	$s \cdot (\lambda - \lambda_0)$
Generic Polynomial	Converted wavelength variation into a general output following a second order polynomial conversion formula. Can be used for sensors from other suppliers or different types of sensors from the defined above.	$a\,(\lambda - \lambda_0)^3 + b\,(\lambda - \lambda_0)^2 + c\,(\lambda - \lambda_0) + d$

Absolute vs Relative Wavelength

On MXFS and in catman®, the sensor measurement can be displayed in either absolute or relative wavelengths. Absolute wavelength refers to the actual value of the wavelength being measured, while relative wavelength refers to the difference in wavelength between two adjacent peaks or features.

Both values can be transmitted using 9 characters. When displaying data in absolute wavelength the precision of the measurement is up to the fourth digit after the comma, as we are operating on the range of 1500 nm to 1600 nm. On the other hand, when displaying data in relative wavelength, the value can be displayed with more digits after the comma, up to 7 digits, depending on the reference that the variation is calculated upon. This means that with a relative wavelength measurement it is possible to reach more precise measurements than with absolute wavelength measurements.

It is important to note that the choice between absolute and relative wavelength display should be based on the specific requirements of the measurement task and the characteristics of the sensor being used. Both methods have their advantages and limitations, and the appropriate method should be selected to ensure accurate and reliable measurement results.

MXFS signals have a one to one relationship with the FBG peak. This means that complex sensors that use more than one FBG, or computations performed using values from two FBG are not possible to be performed within the device.

3.8 Acquisition rate

3.8.1 Speed mode

MXFS DI operates with two different speed modes that correspond to two sweeping laser speeds:

	MXFS DI
Low speed mode:	100 S/s
High speed mode:	2000 S/s

Information

Changing the speed mode will restart the device.

It can operate at these data rates or considering a lower number of samples by filtering or down sampling.

Please check *section 4.2.1 "Sample rates", page 48* for more details.

3.8.2 Distance effect

For sweeping laser based Optical Interrogators, such as the BraggMETER from HBK FiberSensing, there is an effect of the length of cabling between the interrogator and the sensor on the measured of the reflected measurement.

This effect is a constant shift in the wavelength measurement that depends on the actual sampling rate of the optical module. The shift on the measured wavelength is negligible for low acquisition rates or short distances but becomes important for high sampling rates or long distances.

Sweeping laser measuring principle

This is so because of the increasing speeds of the sweeping laser needed for a faster acquisition. The sweeping laser emits a varying wavelength in time. The method for measuring the reflected wavelength from the fiber Bragg grating sensor identifies the wavelength that is being emitted at the time the reflected peak from the FBG is detected. As the acquisition rate grows, the effect of the delay caused by the distance the light needs to travel both ways gets higher and absolute wavelength gets less accurate. The same effect appears if the distances increase.

Absolute wavelength measurement error

Wavelength shift caused by acquisition rate and distance is:

Wavelength shift due to sweeping laser speed
$$\Delta\lambda = \frac{d \cdot 2 \cdot n \cdot RepRate \cdot FullRange}{DutyCycle \cdot c}$$
Where: $\Delta\lambda$ is the wavelength "error", in nm; *d* is the distance (in m) between the sensor and the measurement unit; *n* is the refraction index of the fiber (1.446 for standard SMF28 fiber); *RepRate* is the optical module actual acquisition scan (for BraggMETER interrogators it it the selected acquisition rate, in S/s); *FullRange* is the length of the range of measured wavelengths (102 nm for BraggMETER interrogators); *DutyCycle* is a constant for the acquisition period (0.85 for MXFS interrogators); *c* is the speed of light ($3 \cdot 10^8$ m/s).

This means that for MXFS, the shift in wavelength is given by a function of the distance and the acquisition rate defined on the interrogator:

Wavelength shift due to sweeping laser speed in MXFS
$$\Delta\lambda = \frac{2 \cdot 1.446 \cdot 102}{0.85 \cdot 3 \cdot 10^8} \cdot d \cdot RepRate = 1.1568 \cdot 10^{-6} \cdot d \cdot RepRate$$

Next tables aim to illustrate the difference in a sensor readout (wavelength shift in pm) caused by the distance between the Interrogator and the sensor for the different devices and options.

Distance (m)	Acquisition rate (S/s)	
	100	**2000**
10	1.2	23.2
50	5.8	115.9
100	11.6	231.7
150	17.4	347.6
200	23.1	463.4
500	57.8	1158.5
1000	115.7	2317.0
1500	173.5	3475.5
2000	231,4	4627,2
5000	578,4	11568,0

Tab. 3.1 Shift in wavelength (pm)

Distance compensation

The distance compensation is advised for optical sensor measurements where the two below conditions are true:

- The pair distance/acquisition rate causes an error bigger that the interrogator´s “accuracy”;
- The measurement is based on an absolute wavelength measurement, which is true for the temperature sensors only. The remaining sensor measurements are based either on a variation of wavelength to a reference value or on two FBG that are very close to each other.

Physically determining the cabling distance between the interrogator and the sensor can be difficult sometimes. But distance can be easily computed by, for example, measuring the sensor with two different acquisition rates.

Distance calculation using two different acquisition rates while acquiring the same sensor
$d = \frac{\lambda_{RepRate1} - \lambda_{RepRate2}}{RepRate1 - RepRate2} \cdot \frac{DutyCycle \cdot c}{2 \cdot n \cdot FullRange}$
Where: *d* is the distance (in m) between the sensor and the measurement unit; $\lambda_{RepRate1}$ is the sensor wavelength (in mm) measured with an acquisition rate RepRate1 (in Hz); $\lambda_{RepRate2}$ is the sensor wavelength (in mm) measured with an acquisition rate RepRate2 (in Hz); *DutyCycle* is a constant for the acquisition period (0.85 for MXFS Interrogators); *c* is the speed of light ($3x10^8$ m/s); *n* is the refraction index of the fiber (1.446 for standard SMF28 fiber); *FullRange* is the length of the range of measured wavelengths (102 nm for BraggMETER interrogators);

For MXFS distance computation can be done by using the two speed modes.

Distance calculation using the two speed modes
$d = \frac{\lambda_{2000\ S/s} - \lambda_{100\ S/s}}{2000 - 100} \cdot \frac{DutyCycle \cdot c}{2 \cdot n \cdot FullRange}$ $= \frac{\lambda_{2000\ S/s} - \lambda_{100\ S/s}}{2000 - 100} \cdot \frac{0.85 \times 3 \times 10^8}{2 \times 1.446 \times 102} = (\lambda_{2000\ S/s} - \lambda_{100\ S/s}) \times 454.98$
Where: *d* is the distance (in m) between the sensor and the measurement unit; $\lambda_{100\ S/s}$ is the sensor wavelength measured at low acquisition speed (100 S/s); $\lambda_{2000\ S/s}$ is the sensor wavelength measured at high acquisition speed (2000 S/s);

With the distance rightly calculated, the systematic error on the wavelength measurement can be determined and taken into consideration on the sensor’s computation.

Tip

In catman use a computational channel to get the distance correction.

3.8.3 Filters

MXFS supports low-pass filtering, as any other QuantumX Module. Available filters are Bessel, Butterworth, linear phase.

Please check *chapter 4.2.1.2 “Sampling rate and filters”, page 49* for more details.

3.9 Measurement troubleshooting

3.9.1 Dirty connector

It is very important that the connectors are cleaned prior to any connection. Otherwise, dust and moister can be deposited in the interrogator's optical adaptors, which will compromise measurements. In *Fig. 3.26* a picture of a magnified connector is presented. The dark gray circle corresponds to the fiber cladding and the small light gray circle is the core of the fiber. One picture of a clean connector and one picture of a dirty connector are presented.

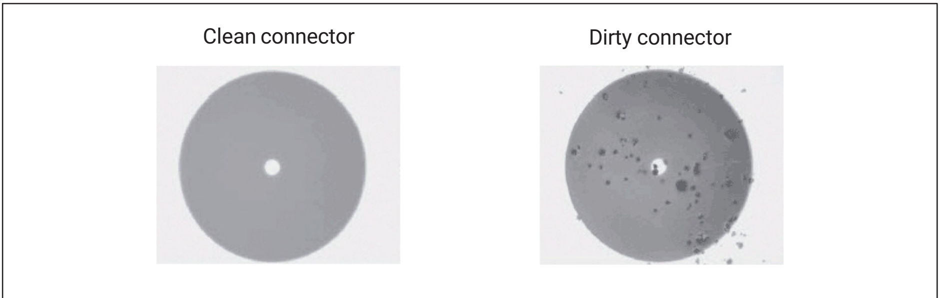


Fig. 3.26 Magnified view of a clean and a dirty connector

The most common effect of dirt on the connections is a large amount of broad band light being reflected at the connection, in both directions, meaning that the dynamic range for measurements becomes smaller.

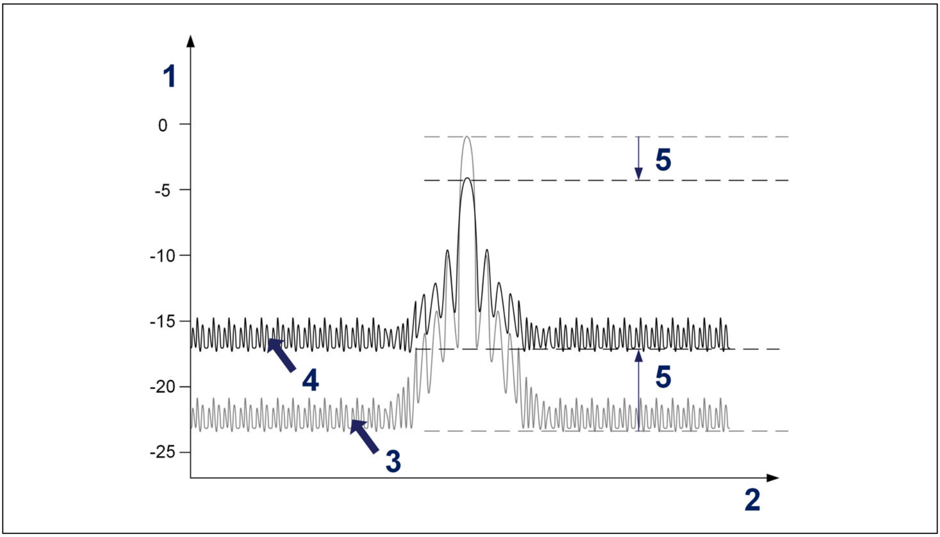


Fig. 3.27 Effect of a dirty connector on the signal

1 Power in dBm;

2 Wavelength in nm;

3 Clean connector spectrum;

4 Dirty connector spectrum;

5 Dynamic range reduction.

To clean an optical interrogator adapter, use an appropriate cotton swab (there are several cleaning swabs in the market frequently used for telecom fibers) embedded in isopropyl alcohol. Insert it in the optical adapter as in *Fig. 3.28* and rotate the swab always in the same direction.

Fig. 3.28 Cleaning the connector adapter of the interrogator

3.9.2 Broken connector

It may also occur that the interrogator adapter sleeve breaks. In this case, when an optical connector is inserted, it will not get proper alignment and measurements will be compromised. A broken sleeve will look as shown in *Fig. 3.29*.

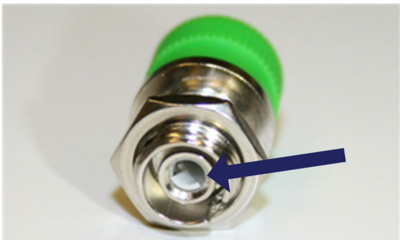


Fig. 3.29 Broken connector

To solve this problem you should contact HBK FiberSensing.

3.9.3 Transitory measurement overflows

During its operation, MXFS may need to readjust some internal parameters. During this action, the unit will temporarily return an overflow value for all sensors in all channels. The probability of this event to happen increases for large temperature variations and higher sampling rates. It is expected that after temperature stabilization the measurement runs without any disruption.

Tip

To avoid confusing this event (overflow) with a sudden change in measurement signals, which can generate false alarms if, for example, high or low level crossing alarms have been set in catman, it is advisable to set a waiting time when defining the alarms. Further details on alarms and waiting times in catman can be found on catman operating manual A05566 (available on the website) - pages 214 and 215.

4 CATMAN SOFTWARE

MXFS includes one license for catman Easy software which should be used to configure the device.

MXFS is compatible with catman versions 5.4.1 or above.

4.1 Starting a project with MXFS

- Launch catman software.
- On the start menu select a QuantumX/SomatXR the device type.

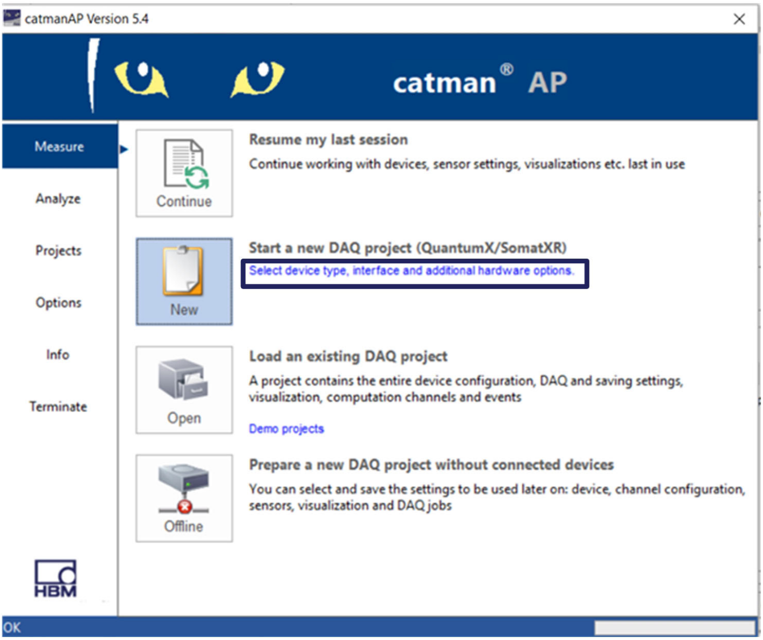


Fig. 4.1 Start menu

- Select QuantumX/SomatXR device type.
- Select the connection method (search ports).
- Select the desired module.

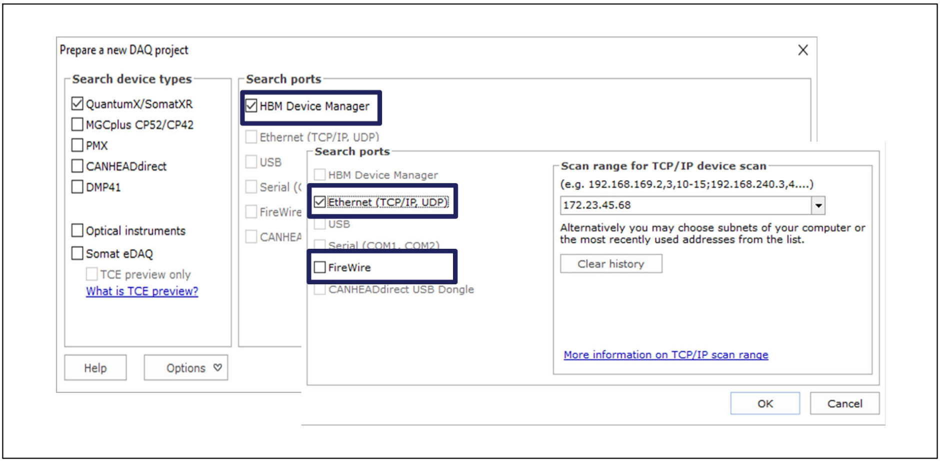


Fig. 4.2 Connectivity

▶ Start a new measurement project.

Information

MXFS gateway functionality is not supported in catman. Please switch it off with MX Assistant before using MXFS with catman.

4.1.1 Synchronization

Different synchronization methods for MXFS are available. Please refer to catman user manual (A05566) for more details on how to setup these.

4.2 Catman project for MXFS

When a new project is started with an MXFS device, catman starts by populating the channel list with all channels from MXFS.

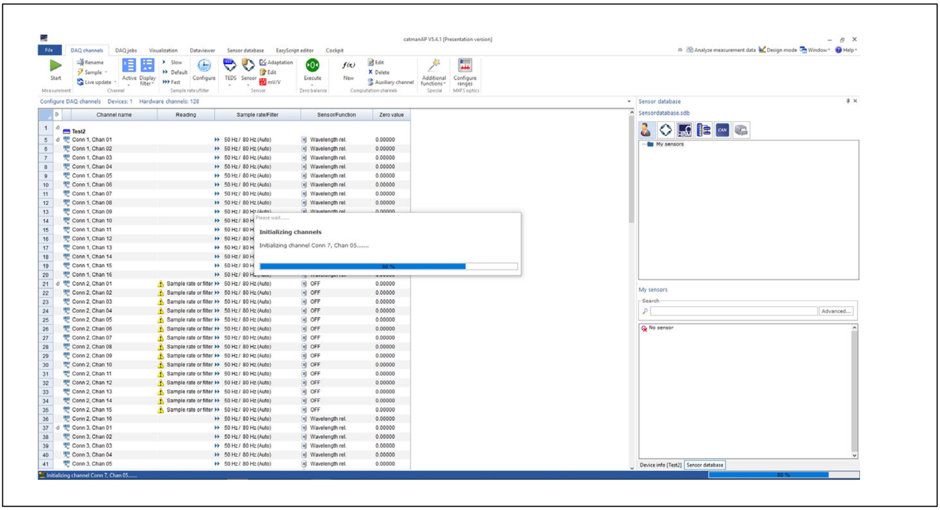


Fig. 4.3 DAQ channels

Channels that have defined bands - ranges of wavelength - on the device are seen as **active** and non defined channels are seen as **inactive**. See *section 4.2.2 “Configuring ranges of wavelength”, page 51* for further information on defining channels.

Tip

You can hide inactive channels by opening the display filter, ticking **Hide inactive channels** *and pressing* **Apply** *(Fig. 4.4).*

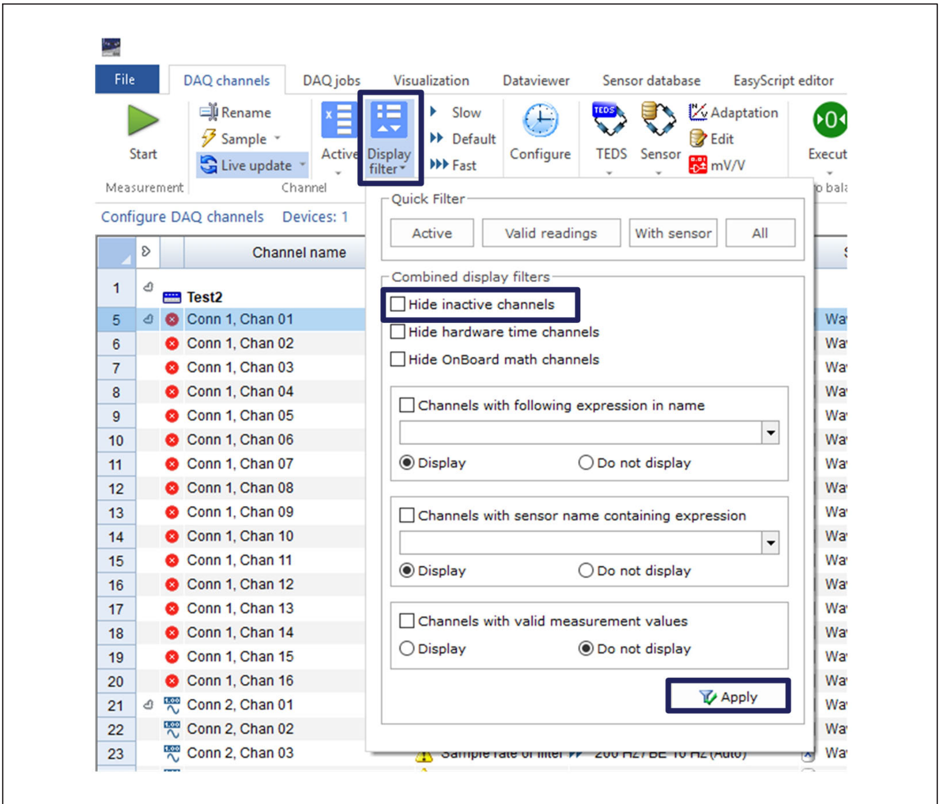


Fig. 4.4 Hiding inactive channels

4.2.1 Sample rates

4.2.1.1 Acquisition rate

MXFS operates with two different speed modes that correspond to two sweeping laser speeds, which can be set in catman:

	MXFS DI
Low speed mode:	100 S/s
High speed mode:	2000 S/s

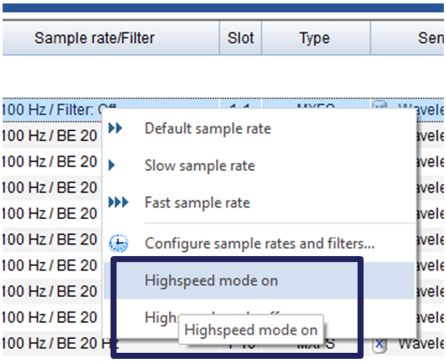


Fig. 4.5 Acquisition rate

- Right click over any MXFS channels' sampling rate column.
- Select High Speed mode on or off.

Information

Changing the speed mode will restart the device.

Important

In sweeping laser based Optical Interrogators the length of cabling between the interrogator and the sensor can cause a shift on the measurement.
Please refer to chapter 3.8.2 "Distance effect", page 38 for details.
In catman use a computational channel to get the distance correction, when needed.

4.2.1.2 Sampling rate and filters

Regardless of the acquisition speed, down sampling and filtering is available on the module, as any other QuantumX module. Available sampling rates and filters are:

MXFS DI Low speed mode (100 S/s)

Filter cut-off frequency (Hz)	Available sample rates									
0.1	0.1	0.2	0.5	1	2	5	10	20	50	100
0.2	0.1	0.2	0.5	1	2	5	10	20	50	100
0.5	0.1	0.2	0.5	1	2	5	10	20	50	100
1	0.1	0.2	0.5	1	2	5	10	20	50	100
2	0.1	0.2	0.5	1	2	5	10	20	50	100
5	0.1	0.2	0.5	1	2	5	10	20	50	100
10	0.1	0.2	0.5	1	2	5	10	20	50	100

MXFS DI High speed mode (2000 S/s)

Filter cut-off frequency (Hz)	Available sample rates													
0.1	0.1	0.2	0.5	1	2	5	10	20	50	100	200	500	1000	2000
0.2	0.1	0.2	0.5	1	2	5	10	20	50	100	200	500	1000	2000
0.5	0.1	0.2	0.5	1	2	5	10	20	50	100	200	500	1000	2000
1	0.1	0.2	0.5	1	2	5	10	20	50	100	200	500	1000	2000
2	0.1	0.2	0.5	1	2	5	10	20	50	100	200	500	1000	2000
5	0.1	0.2	0.5	1	2	5	10	20	50	100	200	500	1000	2000
10	0.1	0.2	0.5	1	2	5	10	20	50	100	200	500	1000	2000
20	0.1	0.2	0.5	1	2	5	10	20	50	100	200	500	1000	2000
50	0.1	0.2	0.5	1	2	5	10	20	50	100	200	500	1000	2000
100	0.1	0.2	0.5	1	2	5	10	20	50	100	200	500	1000	2000
200	0.1	0.2	0.5	1	2	5	10	20	50	100	200	500	1000	2000

4.2.2 Configuring ranges of wavelength

To configure the bands (ranges of wavelength for each channel)

▶ Press the configure ranges button available on the top ribbon of catman to open the configure ranges window.

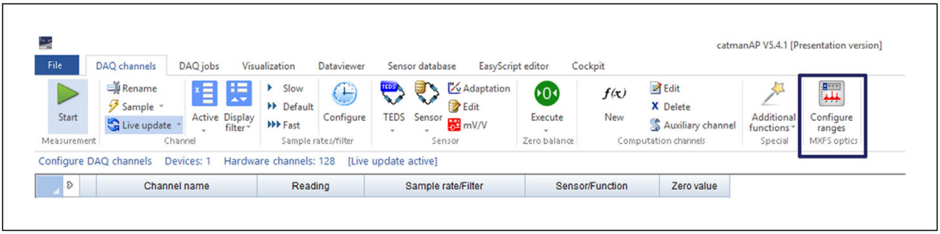
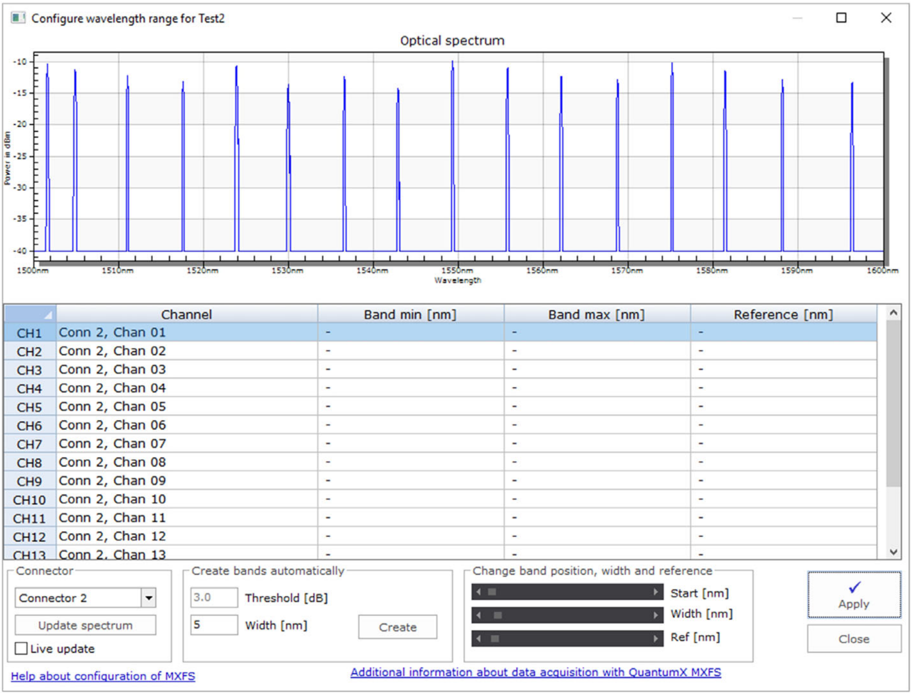


Fig. 4.6 Configure ranges button

Important

All changes performed on the configure ranges interface will only become active after pressing the Apply button. If you exit without applying the changes these will not be visible on the device not the channel list.



	Channel	Band min [nm]	Band max [nm]	Reference [nm]
CH1	Conn 2, Chan 01	-	-	-
CH2	Conn 2, Chan 02	-	-	-
CH3	Conn 2, Chan 03	-	-	-
CH4	Conn 2, Chan 04	-	-	-
CH5	Conn 2, Chan 05	-	-	-
CH6	Conn 2, Chan 06	-	-	-
CH7	Conn 2, Chan 07	-	-	-
CH8	Conn 2, Chan 08	-	-	-
CH9	Conn 2, Chan 09	-	-	-
CH10	Conn 2, Chan 10	-	-	-
CH11	Conn 2, Chan 11	-	-	-
CH12	Conn 2, Chan 12	-	-	-
CH13	Conn 2, Chan 13	-	-	-

Fig. 4.7 Ranges configuration window

Visualization and band editing must be performed one connector at a time:

▶ Change the selected connector on the connector box (*Fig. 4.8*).

Spectrum is displayed as measured on the moment the configure ranges window is called.

▶ To update the optical spectrum press the **Update spectrum** button (*Fig. 4.8*).

▶ For a continuous update check the **Live update** tick (*Fig. 4.8*).

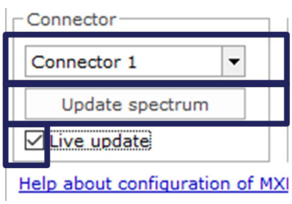


Fig. 4.8 Update Spectrum

Channels on the selected connector can be configured in different ways.

4.2.2.1 Automatically define bands for the detected peaks

The device can detect peaks on the reflected spectrum and automatically configure bands for each found peak. Automatic band detection will detect a peak and define the possible range of wavelength centered at the peak (*number **1** in Fig. 4.9*), with half band width to each side (*number **2** in Fig. 4.9*).

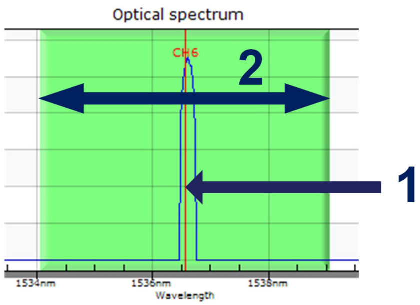


Fig. 4.9 Automatic band definition

On the bottom of the window

- Define band width, in nm. The band width corresponds to the full wavelength range of the channels.
- Press **Create**.

Fig. 4.10 Auto detection

Automatically detected bands can be adjusted by:

- Selecting the desired channel line (line will be highlighted in blue on the table and the band will be highlighted in green on the graph) - number **1** in *Fig. 4.11*.
- Writing on the table the minimum band value, maximum band value and reference wavelength - number **2** in *Fig. 4.11* .
- Or adjusting the minimum band value, maximum band value and reference wavelength with the scroll bars at the bottom - number **3** in *Fig. 4.11*.

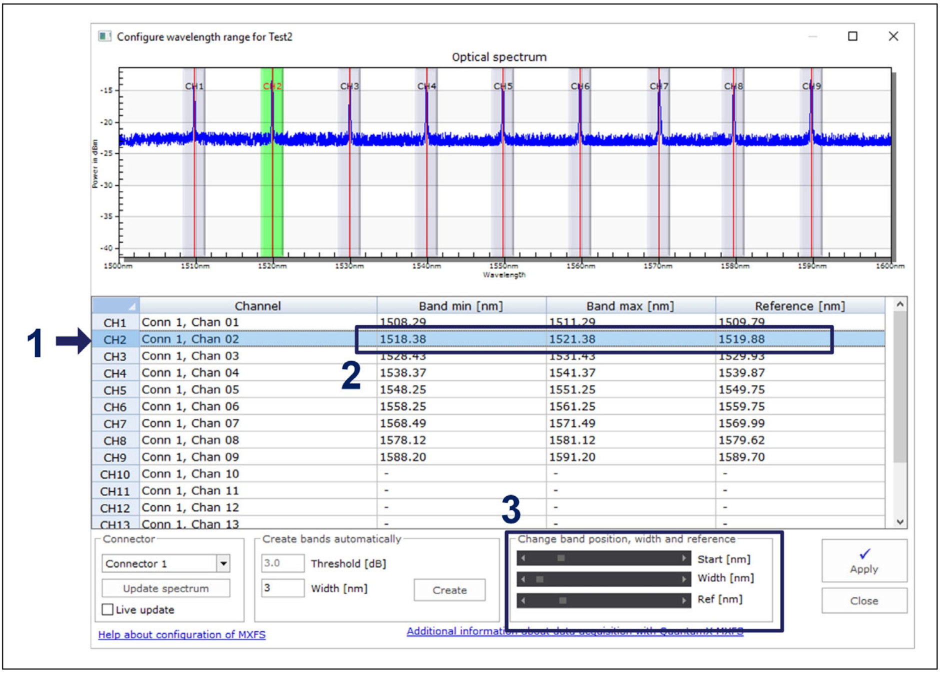


Fig. 4.11 Adjusting the bands

As the changes performed on the configure ranges interface are initially done only on the software level, there is the need to transfer the definitions to the device once ready.

▶ Press **Apply** for the changes to be transferred to the device (*Fig. 4.12*).

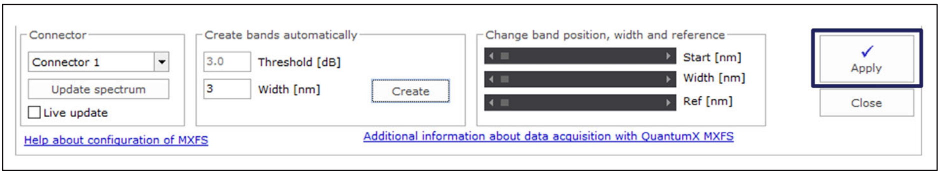


Fig. 4.12 Apply definitions to the device

4.2.2.2 Individually define bands by hand

Bands can be created by editing their information on the table.

To select a channel:

▶ Select the line on the table (line will be highlighted in blue on the table and the band, if already defined, will be highlighted in green on the graph).

The actions that can be performed upon a selected channel are:

- Delete.
  By right click and selecting **Delete**.
- Create or edit.
  By double click on cell to fill in or edit:
  - Channel name;
  - Band minimum wavelength in nm;
  - Band maximum wavelength in nm;
  - Reference wavelength in nm.

Information

Minimum space between bands is 0.5 nm.

There is also the possibility to right click on the graph over the position where you want to define the band and choose the option **Create band in this place**. This will define a band centered at the clicked pixel, with the defined settings for the automatic detection of bands, for the selected channel.

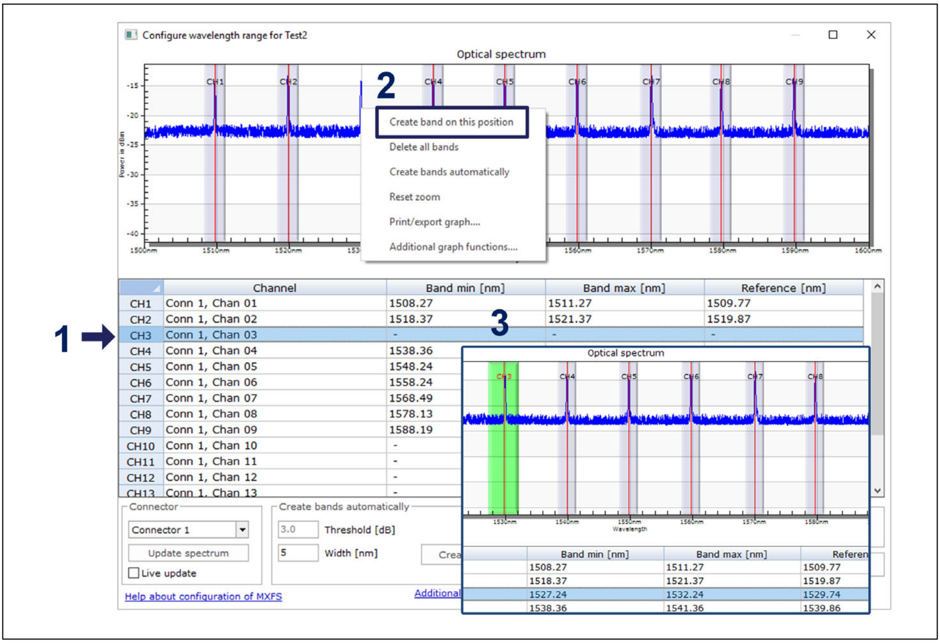


Fig. 4.13 Editing or creating bands

When all the desired bands are defined, click on **Apply** button and close the configuration window.

4.2.3 Sensors on the device

Tip

For cleaning the initial channel settings of the device, select sensors and select **Disconnect and reset sensor**.

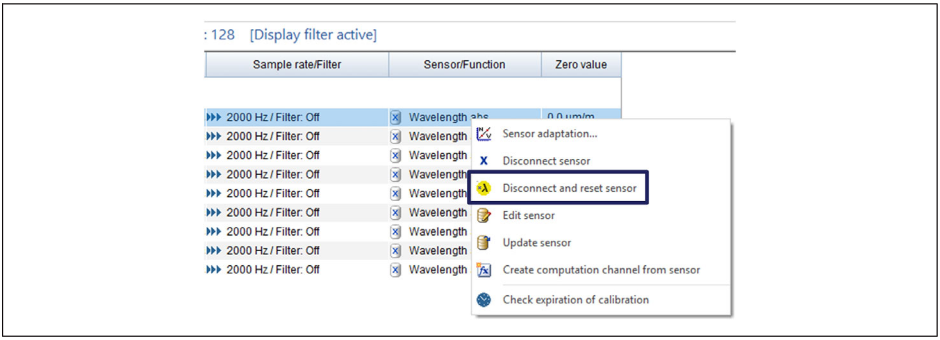


Fig. 4.14 Disconnect sensors

There are different types of sensors that can be configured into the device (for more details please refer to *section 3.7.1.7 "Signals", page 35*).

▶ Double-click on the Sensor/Function column for changing or configuring sensors into the device.

4.2.4 Sensors on the software

Optical sensors for MXFS are available on catman database under **General Sensors > MXFS**.

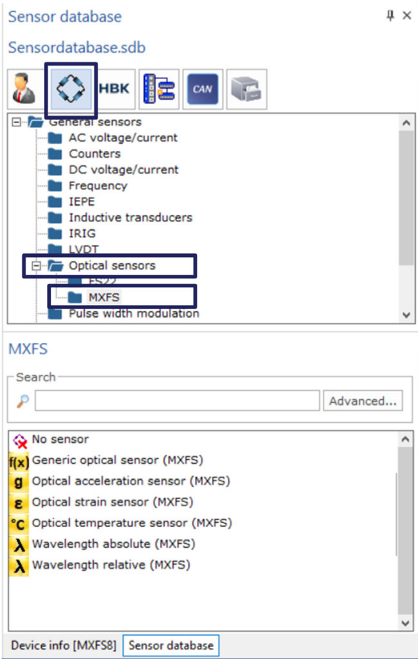


Fig. 4.15 Optical sensors on sensors database

4.2.4.1 Wavelength

Sensors defined as wavelength will show wavelength in nm as an output. Both absolute wavelength values or relative wavelength values can be chosen:

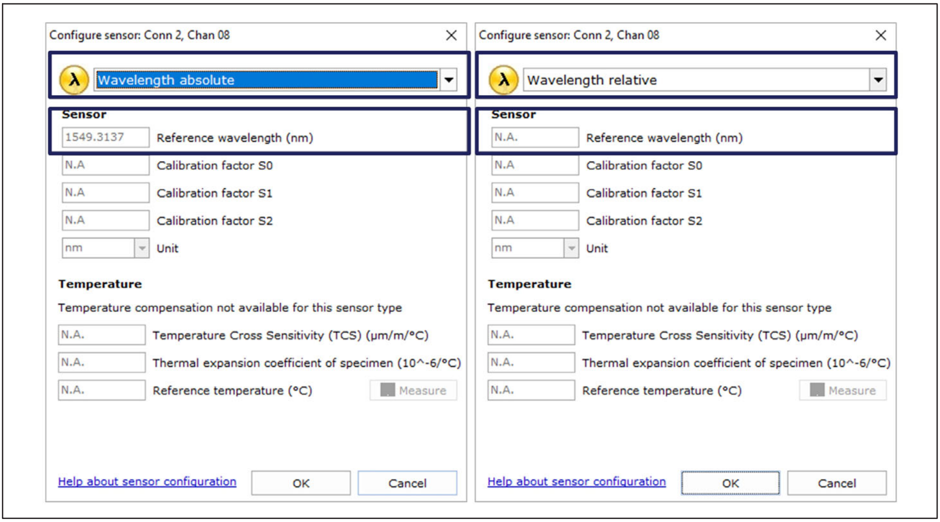


Fig. 4.16 Wavelength Absolute and Wavelength Relative sensor types

Wavelength Relative is the “raw” value out of MXFS device. That means that it is the wavelength variation of the FBG peak in that channel. No calculation is performed on the signal, as all is processed inside the device (see *section 3.7.1.7 “Signals”, page 35* for more details).

Wavelength Relative	$\lambda - \lambda_0$

Wavelength absolute computes the absolute FBG peak value based on the Wavelength relative and the defined reference wavelength. The reference wavelength is retrieved from the channel properties of the device:

Wavelength Absolute	$(\lambda - \lambda_0) + \lambda_0 = \lambda$

4.2.4.2 Strain

By assigning Strain Sensors to a channel, data is converted into strain. Values for filling in the relevant information for strain computation are delivered with the documentation of the sensors.

Strain sensors can be defined without or with thermal compensation.

Strain without compensation

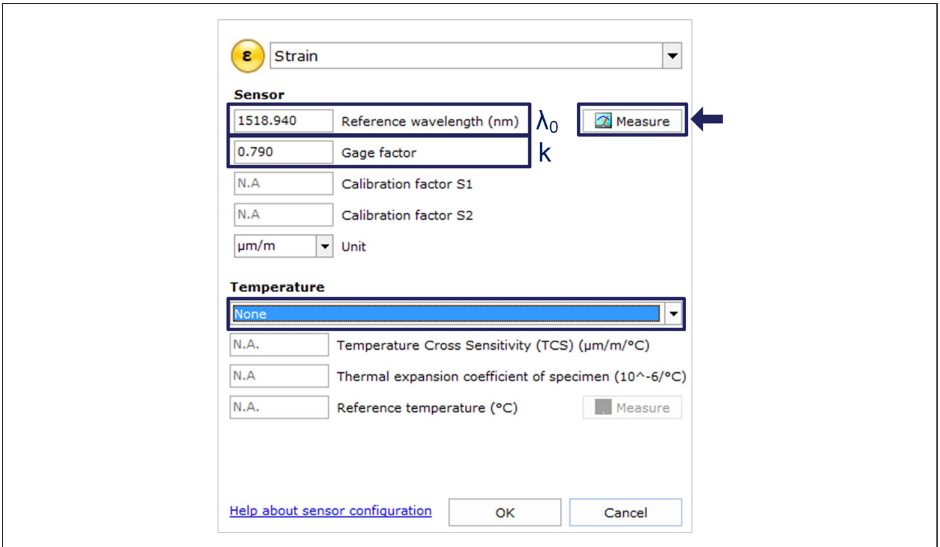


Fig. 4.17 Strain without compensation

The gauge factor (k) of FBG strain gauges is given in their documentation.

The reference wavelength of the FBG strain senor (λ_0) should correspond to the sensor's wavelength at the zero strain instant. This should be measured after installation. It can be filled by hand or automatically defined by an actual measurement using the **Measure** button.

Strain	$\frac{\lambda - \lambda_0}{k \cdot \lambda_0}$

Strain with temperature compensation

Using a temperature sensor

When using a temperature channel to compensate for the effect of temperature on the strain measurement, it must be ensured that the changes in temperature felt by the two sensors is the same. The selected channel for temperature compensation with this method must be configured as a temperature sensor.

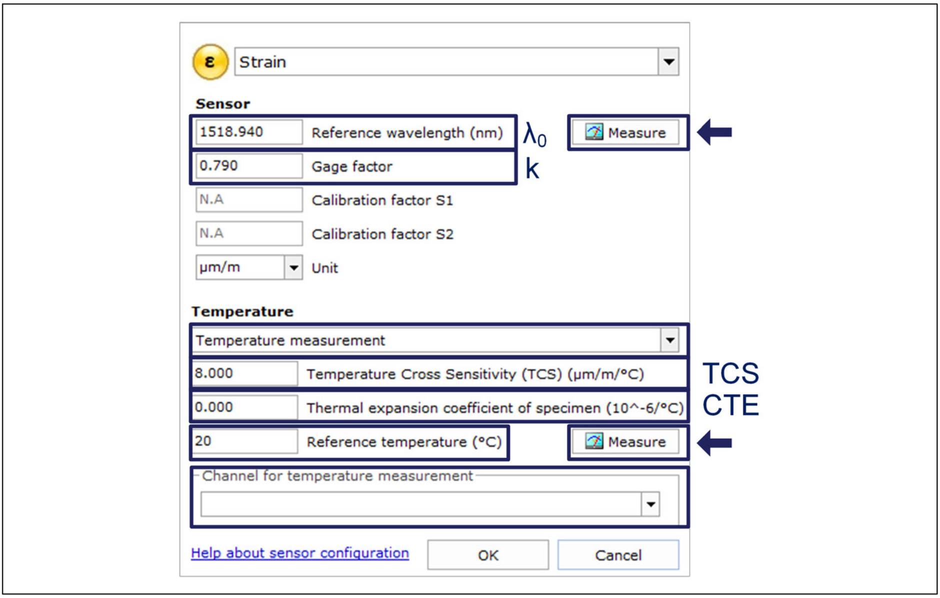


Fig. 4.18 Strain with compensation using a temperature sensor

The gauge factor (k) of FBG strain gauges is given in their documentation.

The Temperature Cross Sensitivity (TCS) corresponds to the effect of temperature on the strain sensor, meaning the induced strain to the sensor after installation due to a change of 1°C on its temperature. It is a value given on the sensor's documentation.

The Thermal Expansion Coefficient (CTE) to use must be the one of the material the strain sensor is attached to. This will eliminate the effect of the thermal expansion of the material of the strain measurement. In case this expansion is not to be corrected, the value to use should be zero (0.0).

The reference wavelength of the FBG strain senor (λ_0) and the Reference Temperature (T_0) should correspond to the strain sensor's wavelength at the zero strain instant and to the temperature measured by the temperature sensor at that same instant. These values should be measured after installation. They can be filled by hand or automatically defined by an actual measurement using the **Measure** button.

Strain with compensation using a temperature sensor	$\frac{\lambda - \lambda_0}{k \cdot \lambda_0} - (CTE + TCS)(T - T_0)$

Using a compensation FBG

This compensation method should be selected when using another strain sensor of the same type is attached to the same material, but only experiencing the temperature changes and no mechanical strain, for temperature compensation. The selected channel for temperature compensation with this method must be an absolute wavelength channel (λ_{TC}).

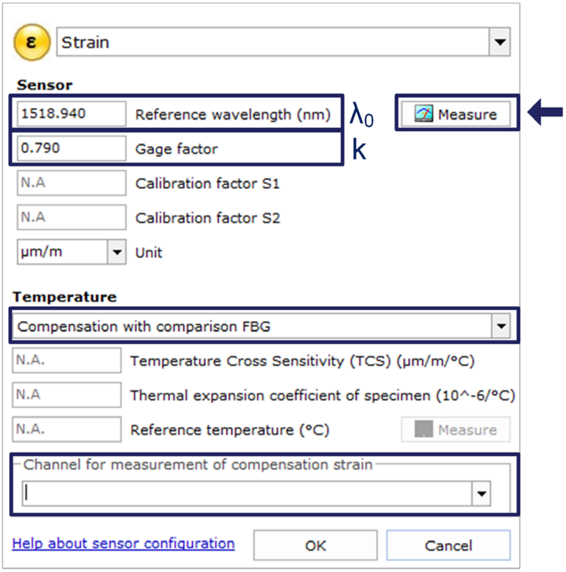


Fig. 4.19 Strain with compensation using compensation FBG

This value should be measured after installation. It can be filled by hand or automatically defined by an actual measurement using the **Measure** button.

Strain with compensation using a compensation FBG	$\frac{\lambda - \lambda_0}{k.\lambda_0} - \frac{\lambda_{TC} - \lambda_{0TC}}{k.\lambda_{0TC}}$

4.2.4.3 Temperature

HBK FiberSensing temperature sensors are delivered with a calibration sheet. They show a polynomial behavior with temperature.

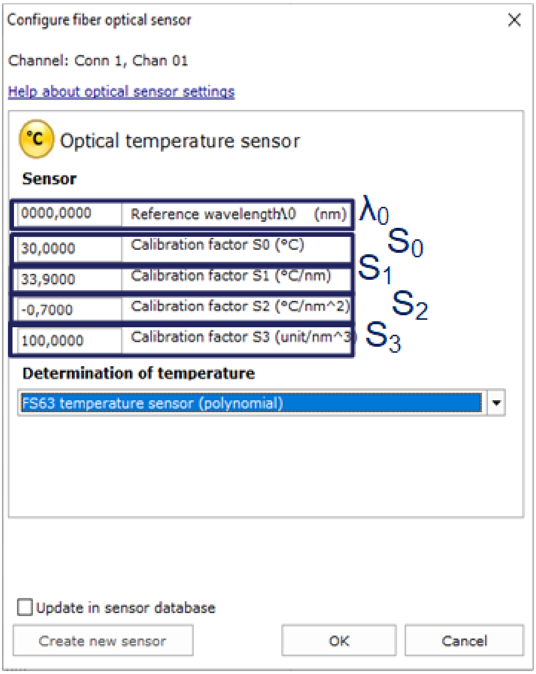


Fig. 4.20 Temperature sensor

The S_n coefficients are the values given on the sensors' documentation.

Important

For sensors with a second order calibration polynomial ensure that S_3 is set as zero.

The reference wavelength of the temperature sensor (λ_0) must correspond to the reference wavelength stated on the sensor documentation.

Temperature	$S_3\,(\lambda-\lambda_0)^3+S_2\,(\lambda-\lambda_0)^2+S_1\,(\lambda-\lambda_0)+S_0$

4.2.4.4 Acceleration

HBK FiberSensing acceleration sensors are delivered with a calibration sheet. They show a linear behavior with acceleration.

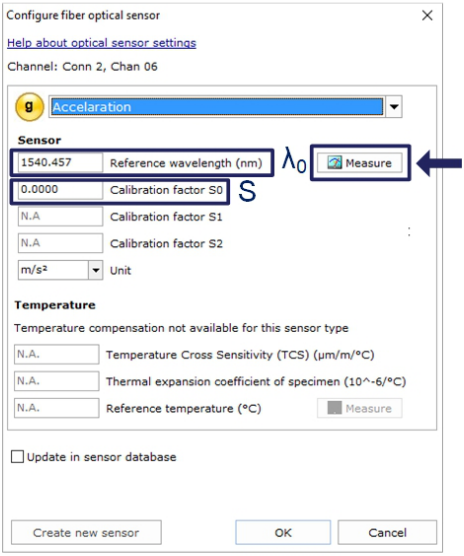


Fig. 4.21 Acceleration sensor

The calibration coefficient (S) is the value given on the sensors' documentation.

The reference wavelength of the FBG acceleration senor (λ_0) should correspond to the sensor's wavelength at the zero instant. This should be measured after installation. It can be filled by hand or automatically defined by an actual measurement using the **Measure** button.

Acceleration	$S \cdot (\lambda - \lambda_0)$

4.2.4.5 Generic Polynomial

Catman also allows the configuration of general FBG based transducers that have only one FBG.

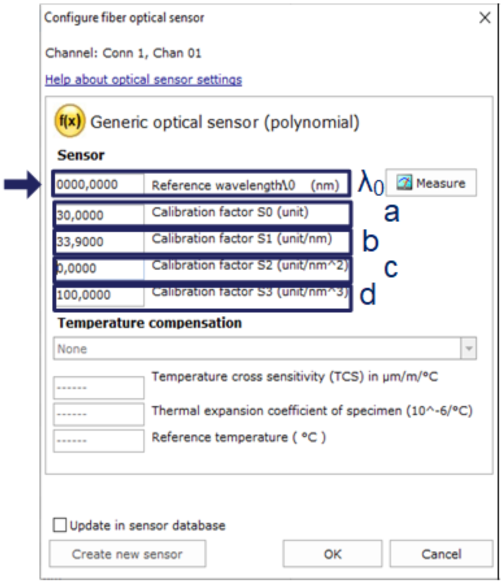


Fig. 4.22 Generic optical sensor

The generic optical sensor computes the measurement as a second order polynomial function (a, b and c coefficients) of the wavelength variation (λ-λ_0) of the FBG.

The reference wavelength (λ_0) can be filled by hand or automatically defined by an actual measurement using the **Measure** button.

Generic (polynominal) optical sensor	$a\,(\lambda - \lambda_0)^3 + b\,(\lambda - \lambda_0)^2 + c\,(\lambda - \lambda_0) + d$

4.2.4.6 Computational channels

Catman allows the creation of computational channels that can replace the adaptation performed on top of the actual device channel, hence allow the recording of raw data, and create more complex computations, for example involving several channels measurements.

Single FBG sensor computation

Computational channels for strain, temperature, acceleration, or polynomial optical sensors can be created in a very similar way to the sensors on the database (*see chapters 4.2.4.1 to 4.2.4.5 above*).

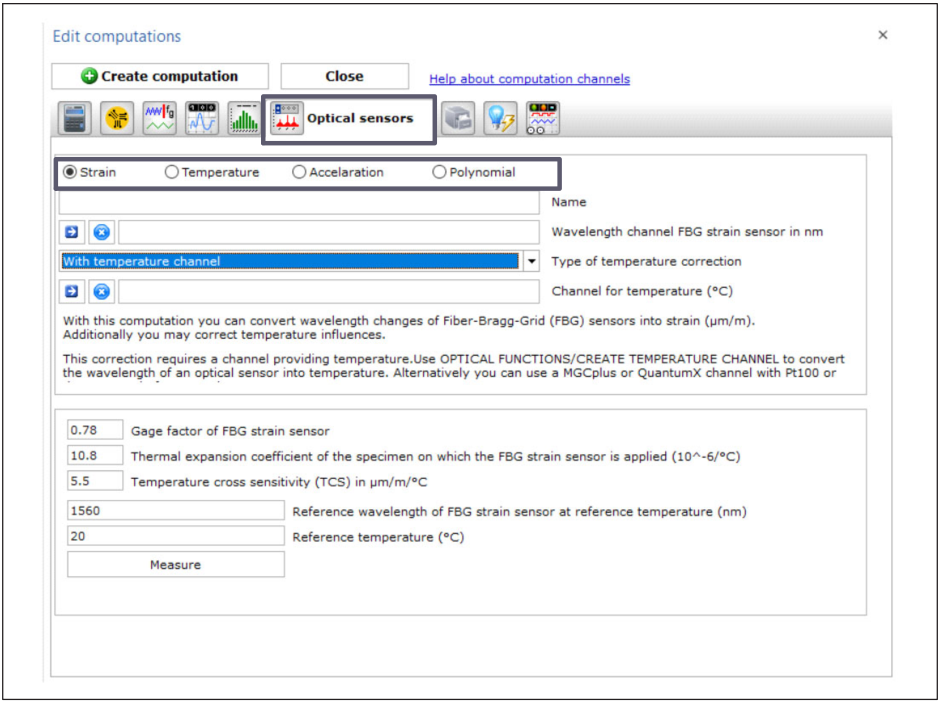


Fig. 4.23 Computational channels Optical sensors menu

Dual FBG sensor computation

Many FBG based sensors have 2 gratings for a temperature corrected measurement. Tilt sensors, displacement sensors, load sensors from HBK standard sensor portfolio are examples of these. For converting wavelength measurements into engineering values in catman® a computational channel must be used.

Tip

Define channels as “Wavelength Relative” (see chapter 4.2.4.1 “Wavelength”, on page 59) to simplify the formula to type in. In this case, ensure that reference wavelength values of each band are updated to the reference wavelength values given on the sensors calibration sheets.

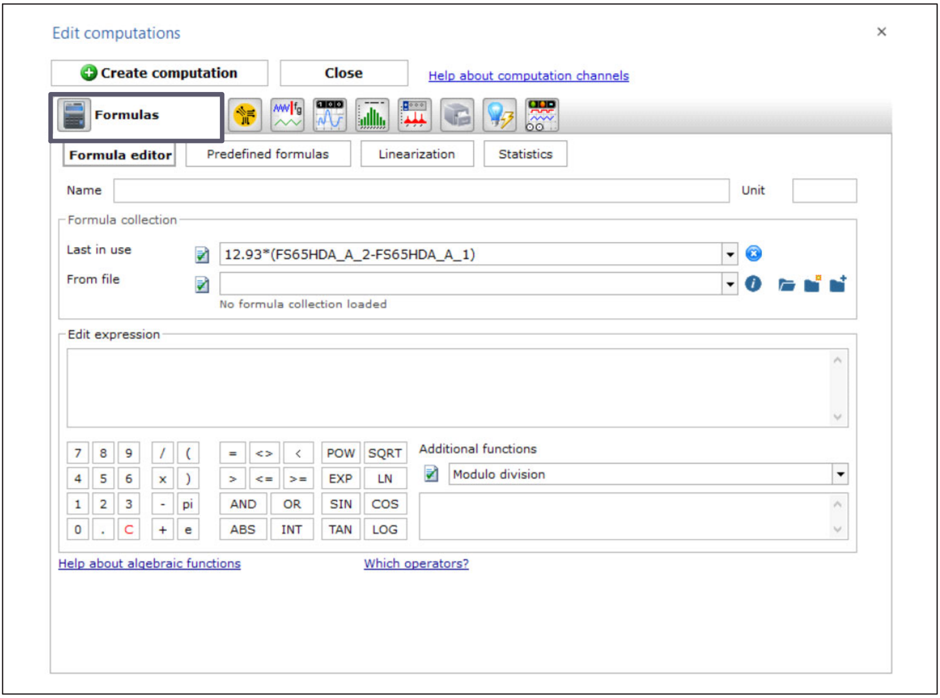


Fig. 4.24 Computational channels Formulas menu

Strain rosettes

Catman also supports relevant stress analysis calculations from rosette measurements on its computational channels. By using this interface, catman will create as many computational channels as selected.

Information

Available optical rosettes are available as 60°/120° type and the three measurement directions are marked as a, b or c, matching catman's menu.

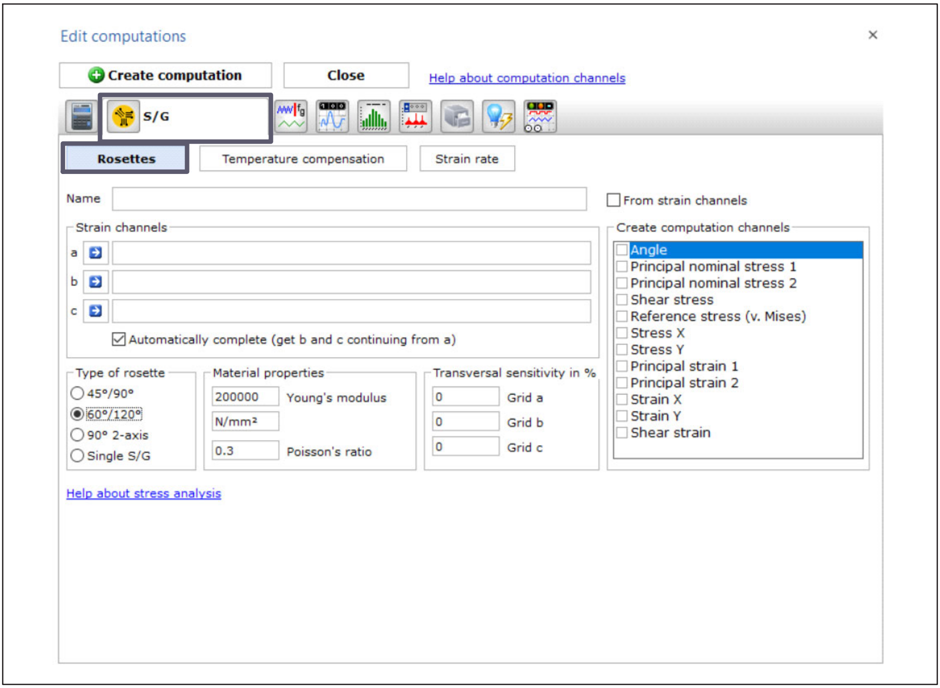


Fig. 4.25 Computational channels Rosettes menu

4.2.5 Zero balance

Catman offers the possibility of zeroing the sensors under its project configuration as an easy way to zero values at the beginning of a measurement, for example.

- To zero one or more sensors, select the desired lines and press the **Zero balance** button on the top ribbon.

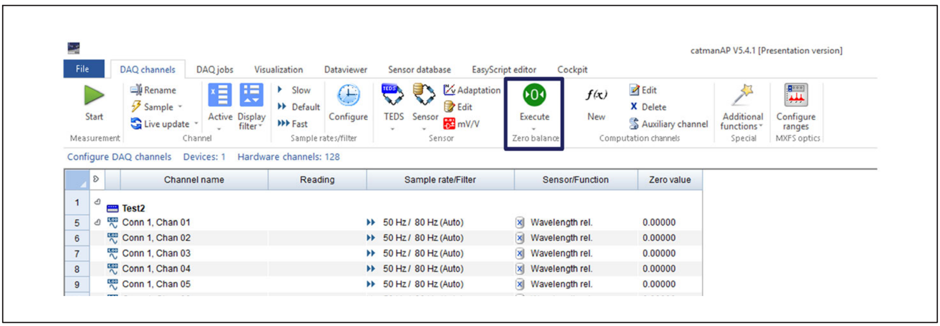


Fig. 4.26 Zero Balance

- Alternatively, right click on the line to zero and select **Zero Balance** option (number **1** in *Fig. 4.27*).

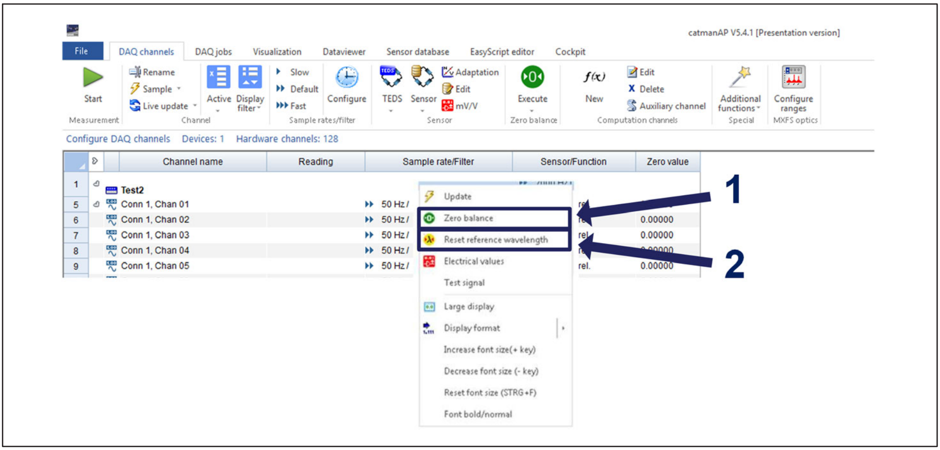


Fig. 4.27 Zero balance and reset reference wavelength

Zeroing optical sensors will create an offset on the measurement equal to its value at the instant of zeroing. This is a very helpful feature for relative measurements, but has to be performed with care in absolute and calibrated measurements as, for example, temperature measurements - especially if temperature values are being used for compensating the effect of temperature on strain measurements.

Important

You can prevent an inadvertent zero of absolute measurement sensors such as temperature by locking the zero action at the channel level. If by chance you select the zeroing of a channel that is locked, it will not be applied.

Important

Zeroing sensors in catman will create an offset on the sensors configuration at the device level. Zero balance will affect measured values delivered by the device.

4.2.6 Reset reference wavelength

In a similar way to the Zero balance, it is also possible to reset the reference wavelength to the value being measured at the moment.

- Right click on the line to reset and select **Reset reference wavelength** option (number **2** in *Fig. 4.27*).

This changes the reference wavelength value against which all wavelength measurements are compared (check subsection “Reference Wavelength” in *chapter 3.7.1.3 “Wavelength”, page 31* for more details) on the device channel configuration.

Important

While resetting reference wavelength might be a very handy tool for relative sensor measurements such as strain or acceleration, it will compromise absolute and calibrated measurements such as temperature that rely on the reference wavelength as stated on the calibration sheet for an accurate measurement. Always take extra care upon resetting reference wavelength values.

4.3 Reset the device

The MXFS interrogator can be reset to its factory settings via catman software.

▶ Right click over the device name and select **Device Reset**.

Fig. 4.28 Device reset

▶ Select reset options.

Fig. 4.29 Device reset options

1 Factory settings for all channels. When selected reset will:

- deactivate all channels;
- delete all configured bands;
- change sensor type to "Wavelength Relative";
- delete zero balance value.

2 Reset channel names will:

- change all channel names to its default (<Device Name>_CH_<Connector #>-<Channel #>, e.g. MXFS8_CH_2-13 for channel 13, in connector 2 of the device MXFS8).

3 The option activate TEDS is not applicable to MXFS.

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