

ENGLISH

# User Manual



# FS22DI

## Industrial BraggMETER DI

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Subject to modifications.  
All product descriptions are for general information  
only. They are not to be understood as a guarantee of  
quality or durability.

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# 1 TECHNICAL DETAILS

## 1.1 General Information

The Industrial BraggMETER DI is a continuous swept laser scanning interrogator for fiber Bragg grating (FBG) sensors. 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.

Multiple sensors can be connected in series in each optical fiber, which in combination with the eight optical connectors with parallel acquisition for the FS22 - Industrial BraggMETER DI, makes it particularly suitable for large scale sensing networks, acquiring a large number of sensors simultaneously, providing 1000 S/s acquisition rates with sub picometer resolution.

The BraggMETER is available either in Standard and Rack-mountable formats. This Manual applies to the following equipment:

- K-FS22 (1000 S/s option)
- 1-FS22DI-ST/4CH
- 1-FS22DI-ST/8CH

## 1.2 System Components

The Industrial BraggMETER DI set includes:

Standard format	Rack-mountable format
<ul style="list-style-type: none"><li>- Interrogator</li><li>- AC-DC power supply unit 24V</li><li>- Ethernet cable (L ~2 m)</li><li>- Mounting blocks with M6 screws</li><li>- Connector protection caps</li><li>- Mounting hole protection caps</li><li>- Quick start guide</li><li>- Digital support material</li><li>- Calibration certificate</li></ul>	<ul style="list-style-type: none"><li>- Interrogator</li><li>- Power cord</li><li>- Ethernet cable (L ~2 m)</li><li>- Connector protection caps</li><li>- Quick start guide</li><li>- Digital support material</li><li>- Calibration certificate</li></ul>

## 1.3 Software

FS22DI Interrogators are delivered with BraggMONITOR DI software that enables easy device configuration, data viewing, saving and management, and can operate as a simple interface for command communication.

These interrogators can be integrated into any system through SCPI like commands (ASCII strings). LabView Drivers are also available for third party integration. Relevant software packages are available for download on our website (<https://www.hbkworld.com/en/services-support/support/support-hbm/downloads/downloads-software/software-firmware-downloads-for-optical-interrogator>).

The dynamic industrial BraggMETER is compatible with the powerful professional catman Easy/AP software. Catman is available for purchase and download on our website (<https://www.hbkworld.com/en/services-support/support/support-hbm/downloads/downloads-software/support-downloads-catman>)

## **1.4 Synchronization**

FS22 follows the NTP synchronization via Ethernet method, using an external NTP server.

## 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.

#### 2.1.2 Packaging Disposal

The packaging of this equipment is designed to protect it from damage during transportation and storage. It is also made of materials that can be recycled or reused, in accordance with the European Union's waste management regulations to minimize its environmental impact.

If you plan to move your equipment to different locations it is advisable that you keep the original package for reuse. This will not only grant proper protection for transportation, but also ensure the reduction of waste creation.

Packing boxes include a label with information on the materials used on that specific package.



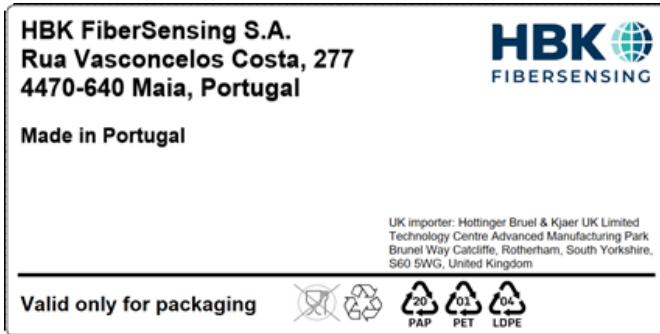


Fig. 2.1 Packing label example

Please follow the instructions below to dispose of the packaging properly and responsibly and contribute to the preservation of our planet. Thank you!

To dispose of packaging, you should:

- Remove any labels, adhesives, nails, staplers or caps that are not part of the same material.
- Rinse the packaging with water to remove any residues or dirt.
- Flatten or fold the packaging to reduce its volume and save space (except for glass that should not be crushed).
- Separate the packaging by material and place it in the appropriate recycling bin or bag.

Most of our packing are made of paper and plastic and aimed to be reused or recycled, but they are not appropriate for food containing. Please consult the chapter “Packing Symbols” for more detailed information about the packing materials used by HBK FiberSensing, marked in the packing label of each product delivered to customers.

### Packaging Symbols

Packaging materials are marked with the correspondent symbol for guidance.



Not appropriate for food



Recyclable

The recycling symbols for the different materials include numbers and letters that identify the material type. For example, PET (polyethylene terephthalate) is marked also with the number 1, and PE-HD (high-density polyethylene) is marked with the number 2. For paper (PAP) 20 corresponds to corrugated cardboard and 22 to paper as seen in newspapers, books,...

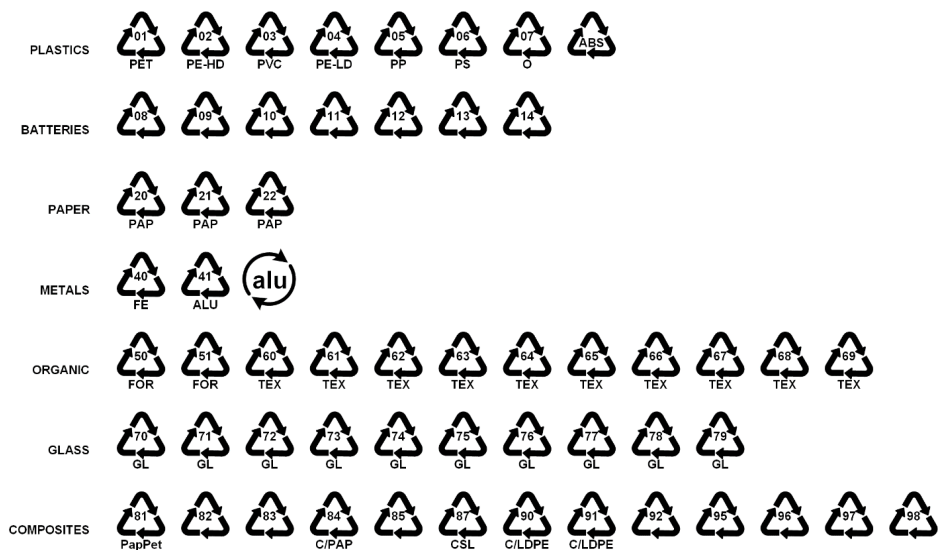


Fig. 2.2 Recycling symbols

### Plastics

Plastic packaging materials are commonly bags, films, trays, blisters or containers.

### Batteries

Batteries are not part of the packaging, but they may be included in the equipment or its accessories. *Please refer to section 2.1.1 “Disposal of your Old Appliance” for more information.*

### Paper

Paper packaging materials are commonly boxes, cartons, envelopes, or labels.

### Metals

Metal packaging materials are commonly cans, foils, caps, or wires.

### Organic

Organic packaging materials could be wood, cork, or cotton and are made of natural or biodegradable materials that can be composted or reused.

### Glass

Glass packaging materials are bottles, jars, or vials.

## Composites

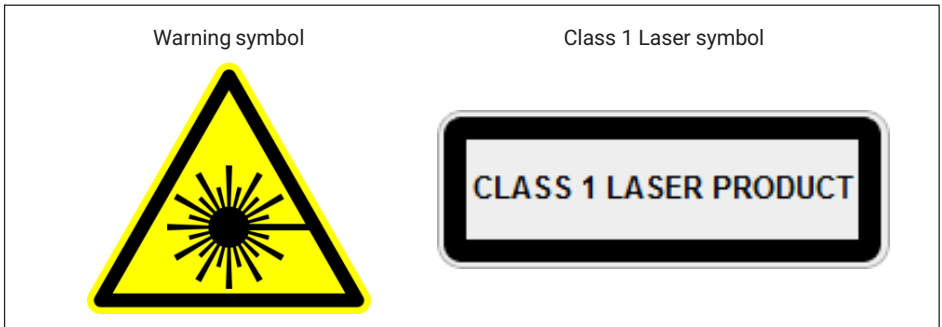
Composite packaging materials are made of layers of different materials, such as paper, plastic, and aluminum. They are marked with a recycling symbol and a letter that indicates the composition of the packaging. For example, PAP is for paper and plastic, and ALU is for aluminum.

## 2.2 Laser Safety

The FS22 - Industrial BraggMETER DI 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



### 2.2.2 Class 1 Laser

The FS22 - Industrial BraggMETER DI 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. This product contains a laser within an enclosure that prevents exposure to the radiation and that cannot be opened without shutting down the laser.

Laser Safety	
Laser Type	Fiber Laser
Laser Class (IEC 60825-1)	1

Laser Safety	
Typical Output Power per connector	≈ 0.3 mW (-5 dBm)
Max Output Power per connector	≈ 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 connector is not in use (no optical cable 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 4.3.1 for maintenance procedure.*

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

It is in compliance with the EN61326/EN55011 Emission Radiated Test Class A, under the Electromagnetic Compatibility Standard.

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:

- EMC: Electromagnetic Compatibility Regulation 2016, No. 1091
- Safety: Electrical Equipment Regulations 2016, No. 1101

The corresponding Declaration of Conformity is available upon request.

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



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





### 2.3.4 Degree of protection



In compliance with the IEC/EN 60529 Degrees of protection provided by enclosures is:

- For the Standard format: IP40 certification (protection against the ingress of solids larger than 1 mm in diameter).
- For the Rack-mountable format: IP20 certification (protection against the ingress of solids larger than 12.5 mm in diameter).

## 2.4 The 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
 <b>CAUTION</b>	This marking warns of a <i>potentially</i> dangerous situation in which failure to comply with safety requirements <i>can</i> result in slight or moderate physical injury.
 <b>Notice</b>	This marking draws your attention to a situation in which failure to comply with safety requirements <i>can</i> lead to damage to property.
 <b>Important</b>	This marking draws your attention to <i>important</i> information about the product or about handling the product.
 <b>Tip</b>	This marking indicates application tips or other information that is useful to you.

Symbol	Significance
 <b>Information</b>	This marking draws your attention to information about the product or about handling the product.
<i>Emphasis</i> <i>See ...</i>	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

#### 3.1.1 Standard

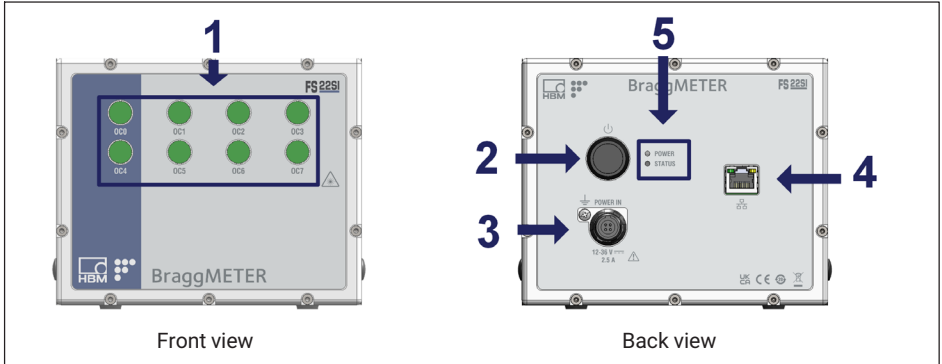


Fig. 3.1 Front and back view of FS22DI Standard

The connectors and buttons in Fig. 3.1 are:

- 1 Optical Output Connectors (FC/APC)
- 2 ON/OFF Button
- 3 Power Connector
- 4 Ethernet Connector
- 5 POWER and STATUS LEDs

### 3.1.2 Rack-Mountable

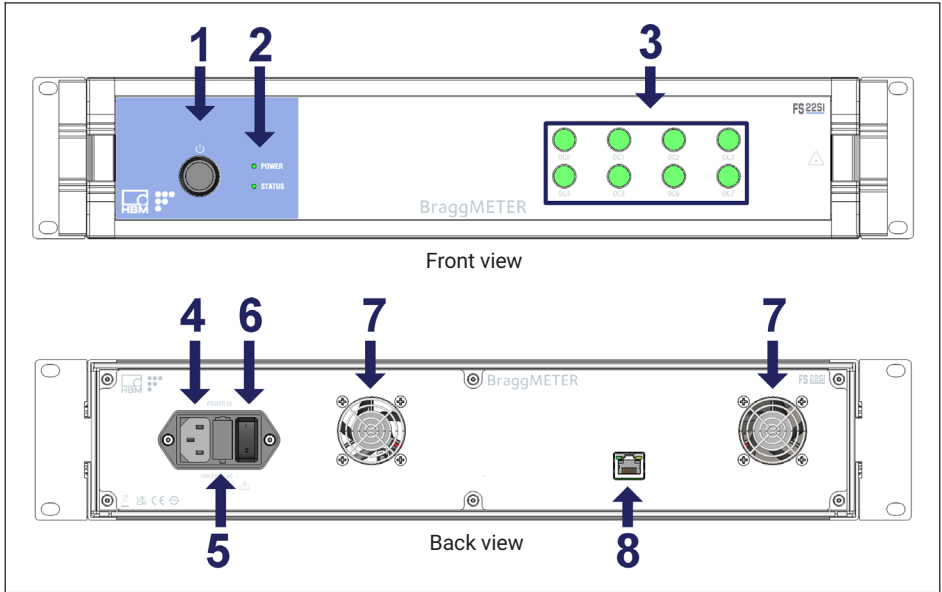


Fig. 3.2 Front and back view of FS22DI Rack-Mountable

The connectors and buttons in Fig. 3.2 are:

- 1 ON/OFF Button
- 2 POWER and STATUS LEDs
- 3 Optical Output Connectors
- 4 Power Connector
- 5 Electric Fuse
- 6 Safety Power Button
- 7 Fans
- 8 Ethernet Connector

## 3.2 Setting Up

### 3.2.1 Power Supply

To start the FS22 - Industrial BraggMETER DI interrogator connect the power cable to the interrogator Power Connector (number 3 in Fig. 3.1 or number 4 in Fig. 3.2). To acknowledge proper power supply, the POWER LED will turn green during 2 seconds after connecting the power supply.



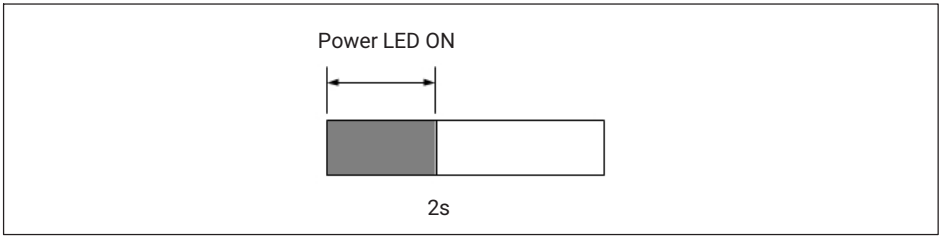


Fig. 3.3

**i** **Information**

For the Standard version of the interrogator the power supply must have a minimum of 30 W, with an output voltage between 12-36 v and must withstand a peak of 4 A for at least 4 ms. For the Rack-Mountable version of the interrogator the power must be 100-240 V AC, 50-60 Hz, 1A.

**Notice**

Powering above the specified limits will damage the equipment. For the Rack-mountable version there is a fuse protection that can be replaced. Please see section 4.3.5 Fuse Failure.

**i** **Information**

The interrogator must be powered using a power supply source not shared with other equipment's. A replacement AC-DC power supply unit 24 V (1-NTX001) for the Standard version or Power Cable (1-KAB274) available with different plug formats can be ordered directly from HBK.

**3.2.2 Optical Connectors**

The Industrial BraggMETER DI can be purchased either with FC/APC, or SC/APC optical connectors. Number **1** in Fig. 3.1 and number **3** in Fig. 3.2 exemplifies FC/APC connectors.

Attention should be paid to the cleaning of the optical connectors. A dirty connector can compromise the measurement and will degrade the performance of the interrogator. It is advisable to frequently clean the connectors using appropriate tools.

FS22 - Industrial BraggMETER DI can have one, four or eight optical connectors in parallel.

### 3.2.3 Ethernet Connection

Connect the Ethernet RJ45 connector directly to a PC using a Ethernet cross-over cable, or to a network connector using a direct Ethernet cable (in this case, the Industrial BraggMETER DI must be in the same subnet as your Local Network).



#### Important

*The interrogator default network configuration is "10.0.0.150:255.0.0.0:0.0.0.0".*

### 3.2.4 Positioning

When installing the FS22 interrogator, please exercise caution regarding its placement.

The FS22 interrogator can be positioned in any orientation without impacting its functionality, providing that the remaining environmental conditions as specified on the data sheet are observed. However, it is essential to handle the fiber optic cables connected to the optical connectors with care to avoid strain or damage. Pay careful attention to rack doors or cabinet lids that may force, twist or pinch the cables (optical or electrical) compromising measured signals.

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

## 3.3 Maintenance

### 3.3.1 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.

### 3.3.2 Ventilation

The FS22DI is an electronic equipment with active ventilation, meaning that it uses fans for thermal control of the device. Fine dust particles over time can reduce the life time of optical and electronic components leading to a general degradation of the equipment, so it is important to prevent dust from entering the device. For that reason the interrogators should be kept on a controlled environment, far or protected from major dust areas.

### 3.3.3 Optical connectors

Optical connectors of the interrogator are subject to degradation and can actually break upon misuse (see section 4.3.2. *Broken Connector*). If this happens, the interrogator must be sent back to HBK FiberSensing for repair.

### 3.3.4 Calibration

BraggMETER interrogators have a built-in traceable wavelength reference 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 and can be requested to HBK FiberSensing.

## 3.4 Switching On

Pressing the "ON/OFF" button (number 2 in Fig. 3.1 or number 1 in Fig. 3.2) will start the interrogator. The STATUS LED (number 5 in Fig. 3.1 or number 2 in Fig. 3.2) will start blinking at 2 Hz. After approximately 10 seconds it will start blinking at 1 Hz. This means that the interrogator is already on and responsive, but the optoelectronic module is still warming up. After less than 90 seconds it should stay on permanently. This means that the interrogator is able to measure.

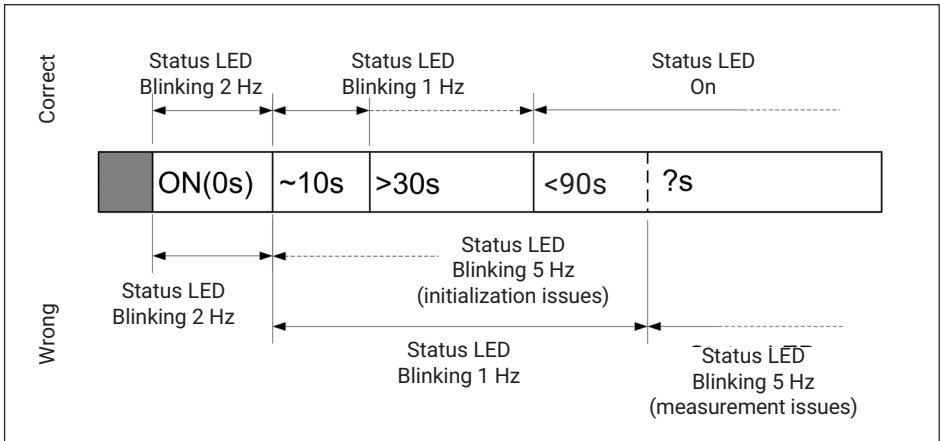


Fig. 3.4 Power ON/OFF button and status LED behavior

### Information

If the interrogator does not start correctly, the STATUS LED will blink faster. If this happens, please contact HBK FiberSensing technical support.

### 3.5 Switching Off

To avoid accidental shut-down of the interrogator, press the "ON/OFF" button (number 2 in Fig. 3.1 or number 1 in Fig. 3.2) between 2 and 6 seconds (Fig. 3.5).

If for some reason the 6 seconds are exceeded and the button is released before 10 seconds are over, the interrogator will remain ON (Fig. 3.6).

#### Notice

If the "ON/OFF" button is pressed more than 10 seconds, changes on the interrogator configuration are performed and connection might be lost. See section 3.6.2, under *Resetting IP to Default*, for further details.

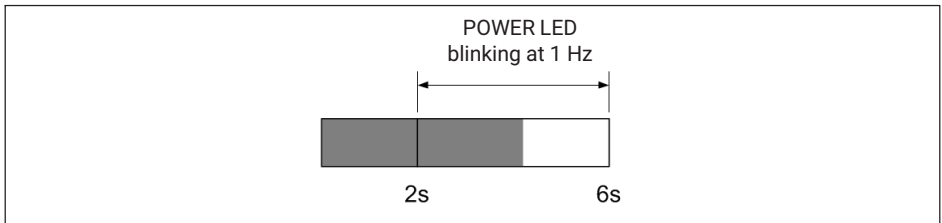


Fig. 3.5 Power led while pressing Switching Off between 2 s and 6 s

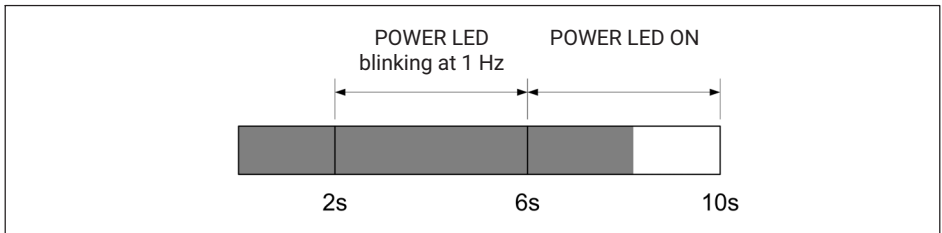


Fig. 3.6 Power led while pressing Switching Off between 6 s and 10 s

### 3.6 Operating the Interrogator

#### 3.6.1 Network Properties

To operate the FS22 - Industrial BraggMETER DI from a personal computer, the PC network properties should be set so that both elements are configured in the same subnet.

To configure your personal computer so that it is on the same subnet as the default for the interrogator, proceed as follows:

- ▶ On the control panel choose **Network Connections**

- ▶ Select the LAN connection. The window displayed in Fig. 3.7 will appear. Click on **Properties**.

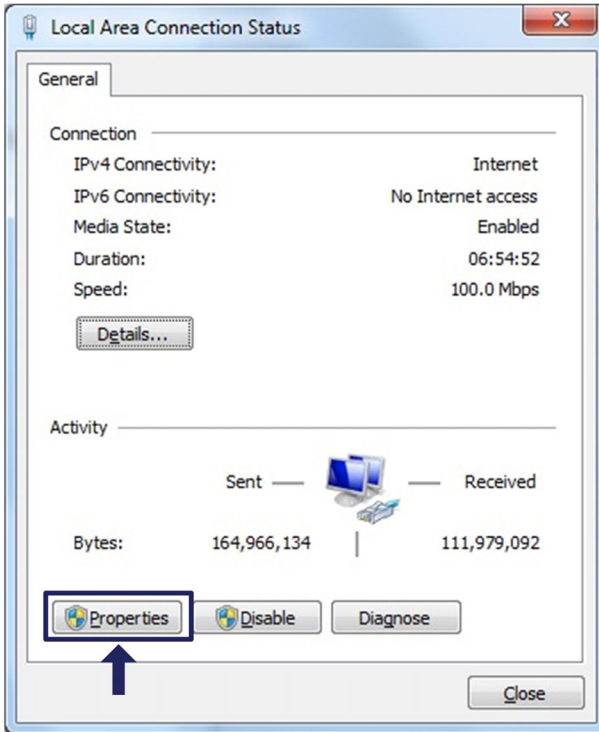


Fig. 3.7 Local Area connection Status

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

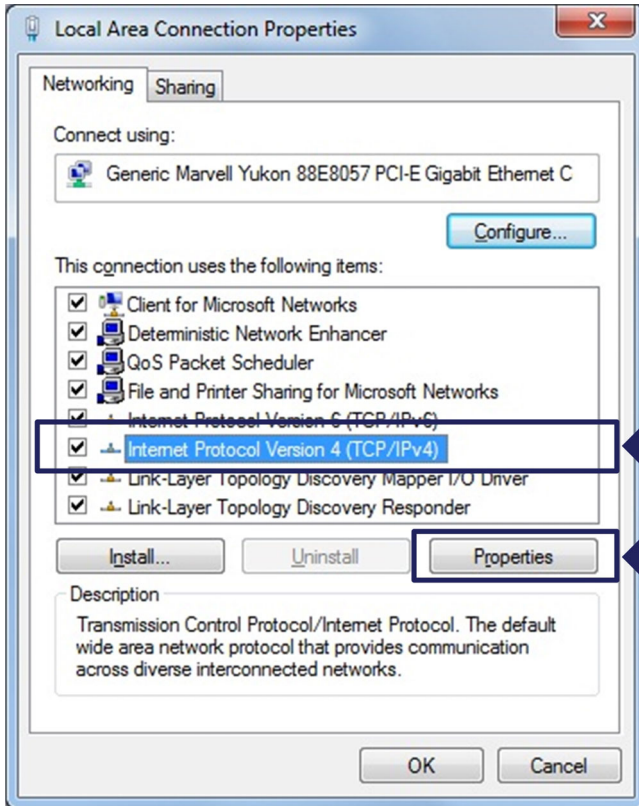


Fig. 3.8 Local Area connection properties

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

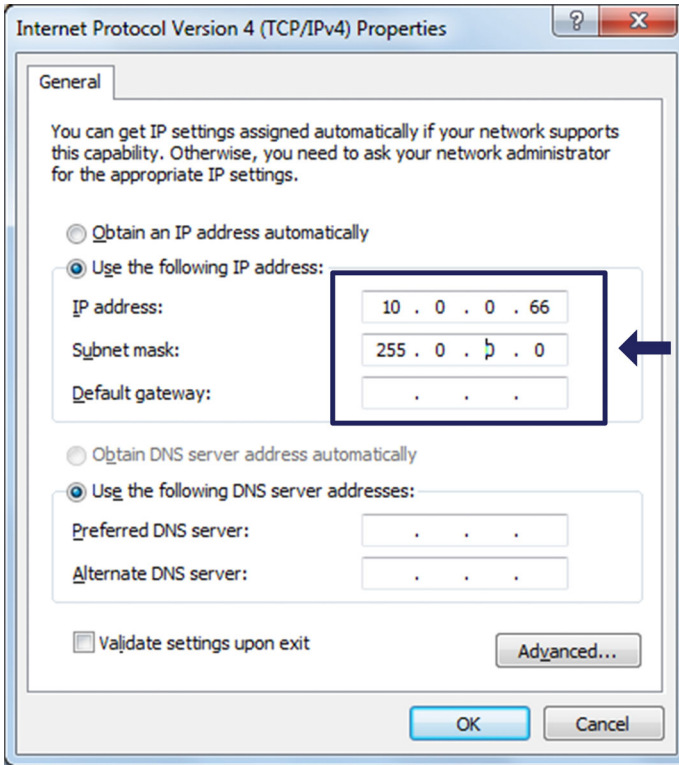


Fig. 3.9 Internet Protocol Version 4 Properties

- ▶ Press **OK**.

### 3.6.2 Resetting the IP address of the interrogator

If for any chance there is the need to physically change the IP address of the interrogator, there is a reset procedure that consists on pressing the ON/OFF button for more than 10 seconds.

When the button is being pressed for 10 seconds the POWER LED blinks 3 times and goes OFF. At this moment the ON/OFF button can be released and the reset of IP address will happen.

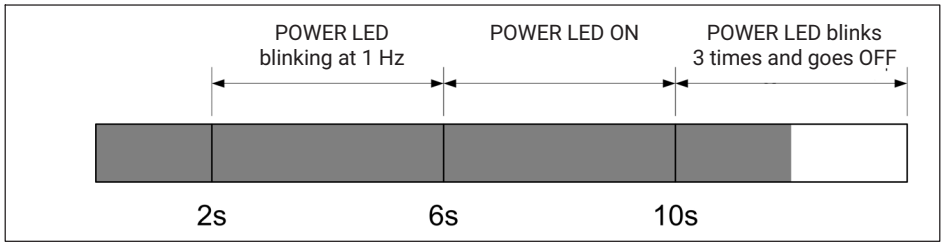


Fig. 3.10 Power LED while pressing Switching Off for more than 10 s

This procedure resets the interrogator changing its IP address to the default and its measuring settings to the last ones stored.



### Information

The interrogator default network properties are "10.0.0.150:255.0.0.0:0.0.0.0".

### 3.6.3 Synchronization

In order to achieve synchronous measurements between different devices the NTP (Network Time Protocol) synchronization via Ethernet must be used.

Each optical Interrogator can synchronize its internal clock with an NTP server. It is possible to achieve accuracies of 1ms or higher, depending on whether or not a dedicated NTP server is being used.

Further information about NTP can be found at <http://www.ntp.org>

### Measuring systems typology

A measurement system can be as simple as a single interrogator or a bit more complex with combined interrogators with the same or different sampling rates, and interrogators combined with other equipment.

#### Single interrogator

For the usage of a single interrogator no special synchronization is needed.

BraggMONITOR DI software can only operate one interrogator at a time. If an NTP server is running on the same PC as the BraggMONITOR DI, the interrogator internal clock – hence BraggMONITOR DI – will sync.

#### Multiple interrogators

If more than one interrogator is used, synchronization becomes important and if an NTP server is running the equipment will start syncing as soon as a first communication from the server is received.



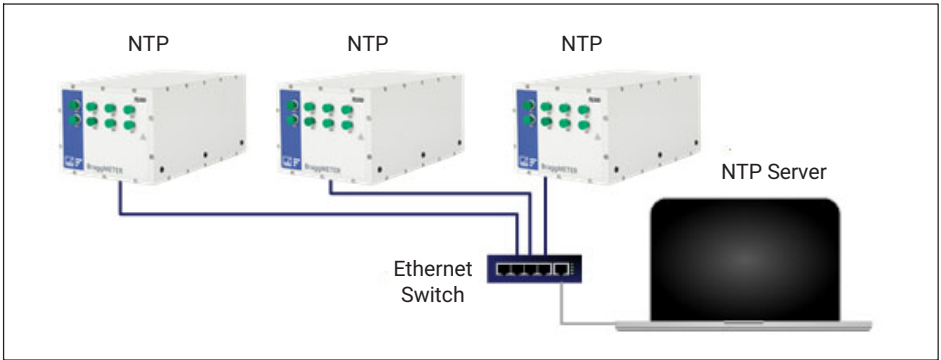


Fig. 3.11 Synchronizing multiple interrogators

**Hybrid**

A hybrid measurement system is a system composed by different equipment types and technologies that can be operated with different sampling rates. Taking the example of HBK families a hybrid system could be a combination of Interrogators with QuantumX.



**Important**

*The combination of FS22 interrogators and MXFS QuantumX Optical Interrogators is not possible in catman.*

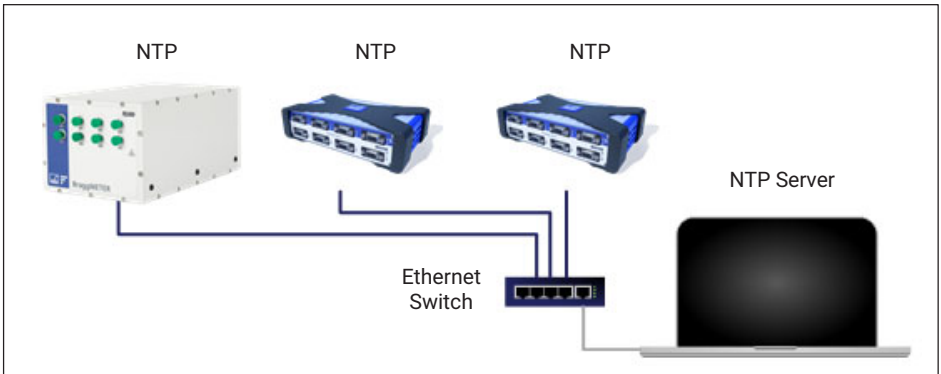


Fig. 3.12 Synchronizing interrogators with conventional technology

Synchronization is again of extreme importance in such systems. When an NTP server is running the Interrogator will start synching as soon as a first communication from the server is received.

For details on the other equipment please refer to their respective user manuals.

### Synchronization process

Each interrogator synchronizes its internal clock with the NTP server. Upon starting, all devices and the NTP server need some settling time to achieve the best synchronism possible.

The following features for NTP synchronization are available:

<b>Number of devices to be synchronized</b>	Unlimited
<b>Synchronization accuracy</b>	100 $\mu$ s to 10 ms
<b>Synchronization settling time</b>	Up to 30 min during first start, up to 2 min during restart
<b>Synchronization master</b>	External SyncMaster, e.g. PC

For a good synchronization, the dedicated NTP server should run continuously. The accuracy is described by the two values:

- Offset: average deviation from time server
- Jitter: typical variation range of the offset value

The clock synchronization is classified using the following offset intervals:

- <500  $\mu$ s: excellent
- <1 ms: very good
- <2 ms: good
- <5 ms: acceptable
- <10ms: poor
- >10ms: not acceptable

A successful NTP Sync is achieved if the offset between the internal clock of the device and the NTP server is below 5ms.

The quality of the NTP synchronization can be queried using the SCPI commands (*please refer to section 3.6.3 Synchronization on page 24 for further details*).

#### 3.6.4 Operation

The FS22 - Industrial BraggMETER DI interrogator can be fully controlled using standard SCPI syntax commands (for a complete command list, *please refer to section 5.1 "Communication Protocol Syntax" on page 40*).

## Using the available Drivers

LabVIEW™ drivers can be downloaded from our webpage for operating with the FS22DI: Software & Firmware Downloads for Optical Interrogators - HBK ([hbkworld.com](http://hbkworld.com)).

These drivers are to be used within the LabVIEW™ environment. To develop custom applications using this language, copy the drivers' library. A set of ready to use examples to run on LabVIEW™ is also provided.



### Important

*Before using the provided LabVIEW™ examples on a PC, make sure the Regional and Language options (in standards and formats) are defined as dot for decimal symbol, comma for digit grouping symbol and dash for date separation.*

## Operational States

The FS22 - Industrial BraggMETER DI interrogator has five operational states:

- |                                 |   |
|---------------------------------|---|
| <b>0 Error</b>                  | The error state corresponds to a malfunction of the optoelectronic module of the FS22 - Industrial BraggMETER DI interrogator. The system can recover from this state by resetting.   |
| <b>1 Ready</b>                  | In the ready state, the FS22 - Industrial BraggMETER DI interrogator is ready to start acquisition.   |
| <b>2 Free acquisition</b>       | The free acquisition state enables the FS22 - Industrial BraggMETER DI interrogator to perform single measurements on a specified optical connector. The interrogator can be configured in terms of gain, threshold and sampling rate. The corresponding configuration can be stored for future reference.                      |
| <b>3 Continuous acquisition</b> | The continuous acquisition state allows continuous wavelength acquisition over all optical connectors at 50, 100, 200, 500 or 1000 S/s. The FS22 - Industrial BraggMETER DI interrogator can also display continuous OSA trace acquisition every second. For that the sampling rate of the interrogator shall be set to 50 S/s. |
| <b>5 Warming-up</b>             | The FS22 - Industrial BraggMETER DI interrogator starts on the warming-up state that enables the settling of the operation parameters and recall of the acquisition configuration.  |



### Information

*The interrogator will only answer when the STATUS LED is already blinking at 1 Hz (see section 3.4 "Switching On" on page 19).*

Change status commands	Change status actions	STATUS	Available commands
:ACQU:OSAT:CONT:STAR:CHAN:X * :ACQU:WAVE:CONT:STAR:CHAN:X :ACQU:WAVE:CONT:NTPS:STAR:CHAN:X :ACQU:STAR :ACQU:STOP	Reset →	<b>0</b> Error	:IDEN? :STAT? :SYST:TIME? :SYST:TIME:HH:MM:SS :SYST:DATE? :SYST:DATE:YYY:MM:DD :SYST:NTPS? :SYST:NTPS:ENAB :SYST:NTPS:DISA :SYST:NTPI? :SYST:NTPI:N.N.N.N :SYST:IPAD? :SYST:IPAD:N.N.N.N:N.N.N.N:N.N.N.N
:ACQU:STOP		<b>1</b> Ready	:IDEN? :STAT? :STOR :RECA :SYST:NTPS? :ACQU:CONF:RATER :ACQU:CONF:RATE? :ACQU:CONF:THRE:CHAN:X?
:ACQU:STOP		<b>2</b> Free acquisition	:IDEN? :STAT? :STOR :RECA :SYST:NTPS? :ACQU:CONF:RATER :ACQU:CONF:RATE? :ACQU:CONF:THRE:CHAN:X? :ACQU:CONF:THRE:CHAN:X:T :ACQU:CONF:GAIN:CHAN:X? :ACQU:CONF:GAIN:CHAN:X:G :ACQU:WAVE:CHAN:X? :ACQU:WAVE:CHAN:X? * :ACQU:OSAT:CHAN:X? *
:ACQU:STOP		<b>3</b> Continuous acquisition	:IDEN? :STAT?
	Wait	<b>5</b> Warning-up	:IDEN? :STAT?

Fig. 3.13 Operational States and main commands

## **Power Shortage**

In case of power shortage when the FS22 - Industrial BraggMETER DI interrogator is running in the ready, free acquisition or continuous acquisition states, the operational state is maintained once the power supply is reestablished with the stored acquisition settings.

## **Default Network Properties**

The default network properties are "10.0.0.150:255.0. 0.0:0.0.0.0". Whenever there is the need, the interrogator can be reset to this default address (see section 3.6.2 "Resetting the IP Address of the Interrogator" on page 16). The default address cannot be changed.

## 4 MEASURING EXAMPLES

### 4.1 Typical Configuration

Typically, a fiber Bragg grating Sensing Network is divided into branches of several sensors connected in series. Fig. 4.1 shows a scheme of a possible fiber Bragg grating sensing branch.

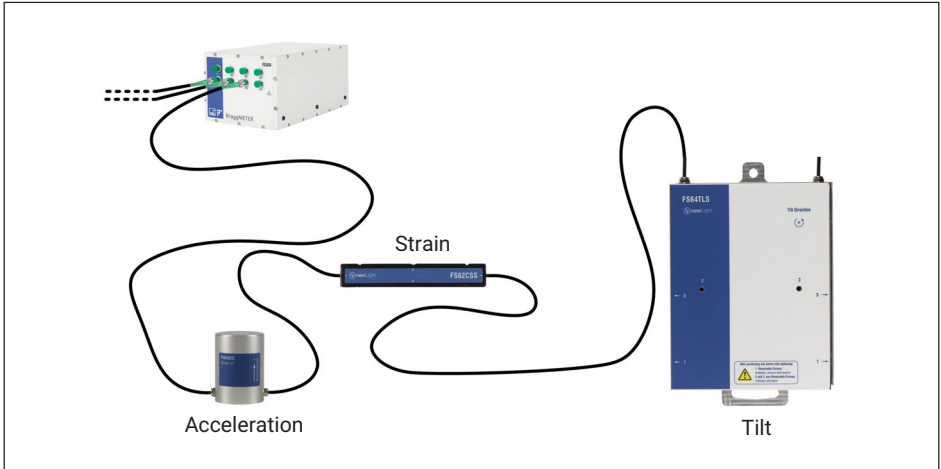


Fig. 4.1 Typical network configuration

A branch can accommodate sensors with wavelengths corresponding to all standard HBK FS wavelengths. The number of sensors in a connector can vary if there is previous knowledge about the spectral range the sensors will cover. The major concern is the overlap of adjacent sensors. The available optical connectors have simultaneous acquisition, meaning that the sensing network can have a large number of fiber Bragg grating sensors interrogated at the same time.

The employed technology allows multi-functionality meaning that on the same branch it is possible to measure Strain, Temperature, Displacement, Pressure, Acceleration, etc...

The sensing network can be placed up to 10 km from the interrogator without significant losses on transmission over the optical fiber, operating under EM/RF interferences.

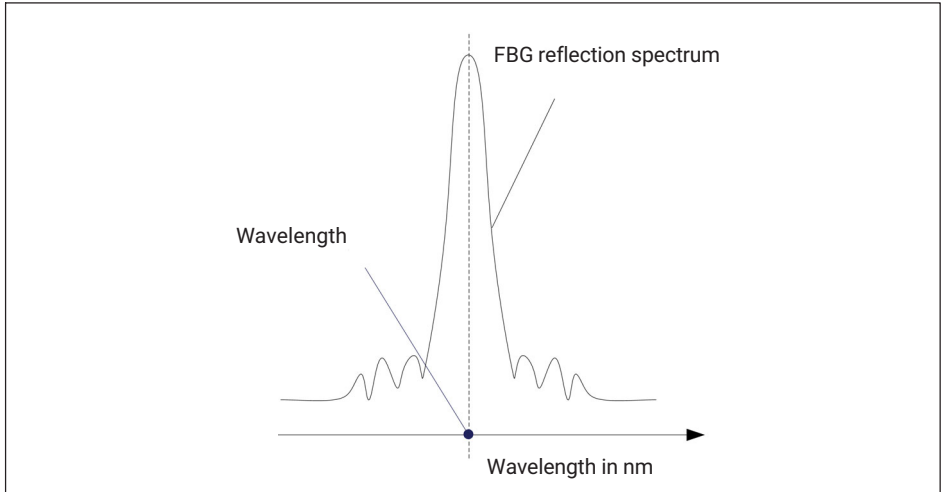
Each fiber Bragg grating sensor has a characteristic central wavelength ( $\lambda_0$ ) that depends only on the measurand. This means that with this technology there is no need for recalibrations every time the system is shut down. The Industrial BraggMETER DI is a ruggedized interrogator designed for 24/7 operation.

## 4.2 Definitions

The following definitions are applicable to this equipment only.

### 4.2.1 Wavelength

The Wavelength value corresponds to the wavelength at the peak of the fiber Bragg grating reflection spectrum, commonly referred as Bragg wavelength (*Fig. 4.2*).



*Fig. 4.2* Wavelength

### 4.2.2 Power

The Power value corresponds to the optical power reflected by the fiber Bragg grating at the peak wavelength (Fig. 4.3). It is a relative value from 0 to 4095.

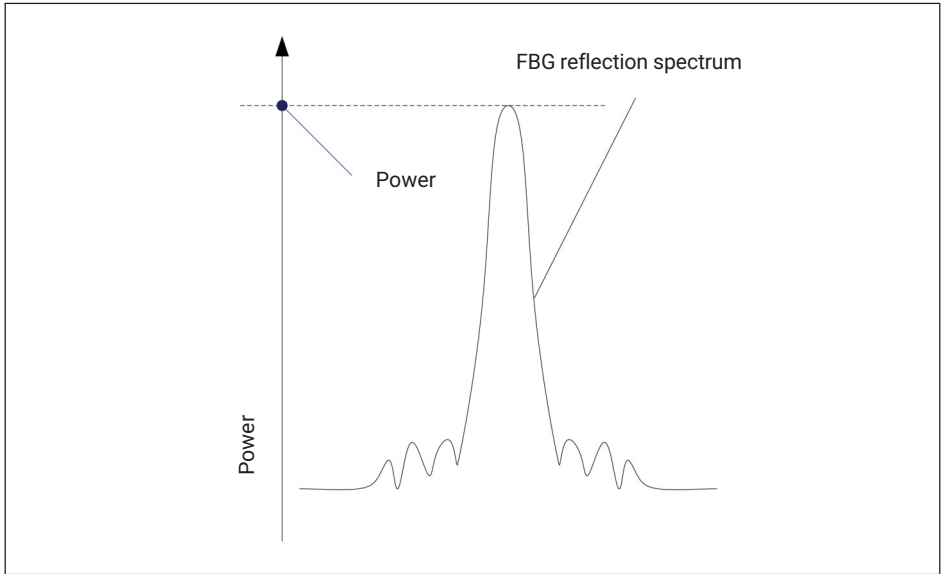


Fig. 4.3 Power



### 4.2.3 Gain

The gain is an amplification value applied to the received reflected signal in order to optimize the measured power. It is a value from 0 to 255.

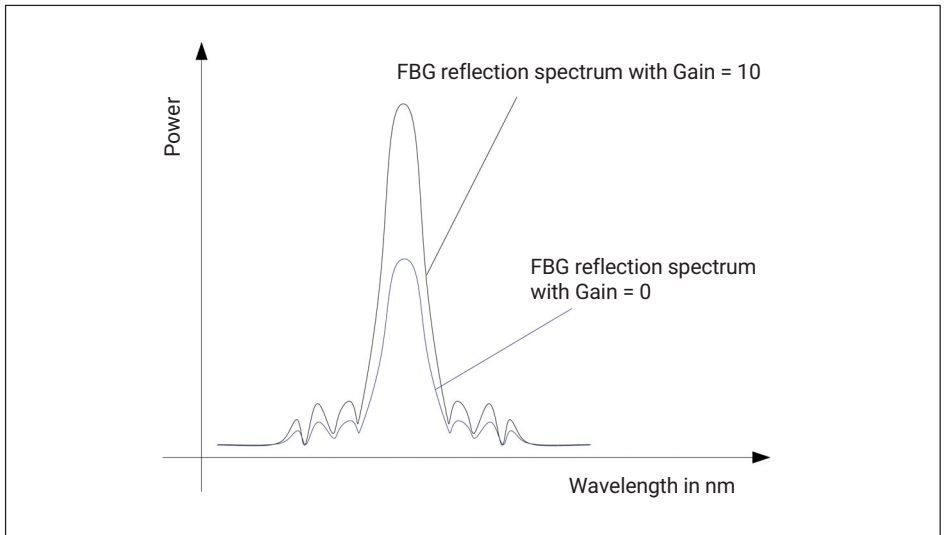


Fig. 4.4 Gain

#### 4.2.4 Threshold

The threshold value corresponds to the considered power level for the FBG peak computation and can be used to disregard side lobes and ground noise. It is a value from 200 to 3200 definable for each optical connector individually. It is measured bottom-up from the 0 (zero) power value.

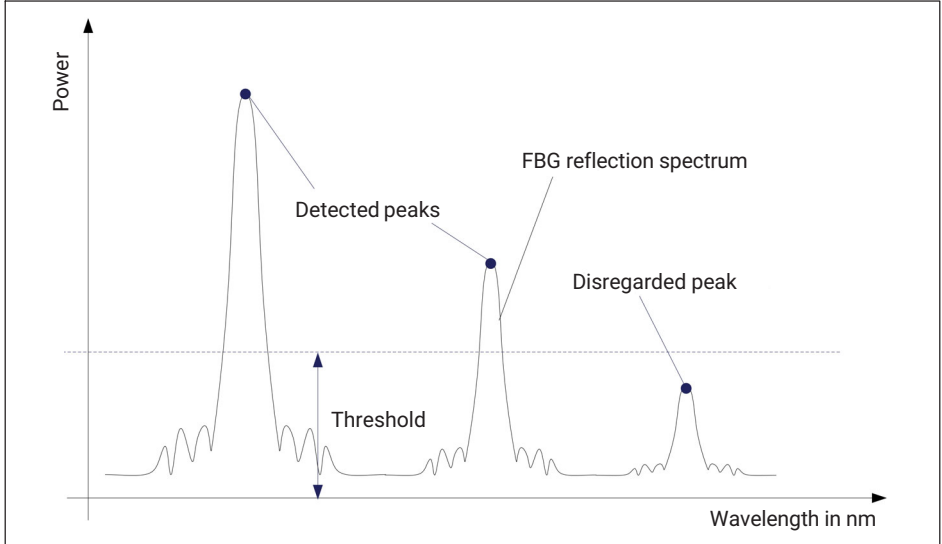


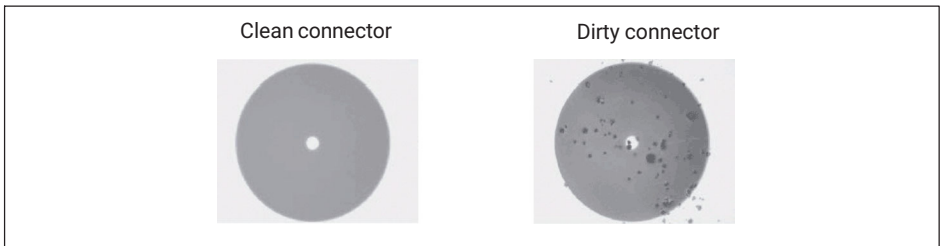
Fig. 4.5 Threshold

### 4.3 Common Measuring Difficulties

There may be the possibility of having measuring malfunctions due to problems in the sensing network or optical connections. A list of some of the usual problems is described below with the explanation for their occurrence and correction.

#### 4.3.1 Dirty Connector

It is very important that the connectors are cleaned prior to any connection. Otherwise, dust and moisture can be deposited in the interrogator's optical adaptors, which will compromise measurements. In *Fig. 4.6* 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. 4.6 Magnified Clean vs 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.

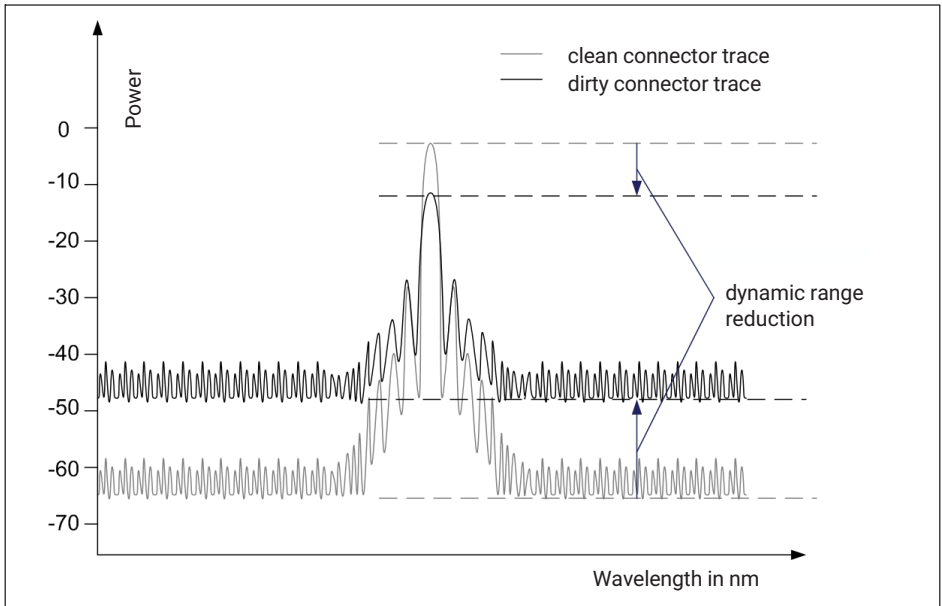


Fig. 4.7 Dirt impact on sensor signal

To clean an optical interrogator adapter, use an appropriate cleaner (1-FSCLEANER from HBK or similar). Insert it in the optical adapter, number **1** in Fig. 4.8, and press it against the inside of the connector to clean.

Alternatively, use an appropriate cotton swab (there are several cleaning swabs in the market frequently used for telecom) embedded in isopropyl alcohol. Insert it in the optical adapter, number **2** in Fig. 4.8, and rotate the swab always on the same direction.



Fig. 4.8 Cleaning connectors

### 4.3.2 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. 4.9.

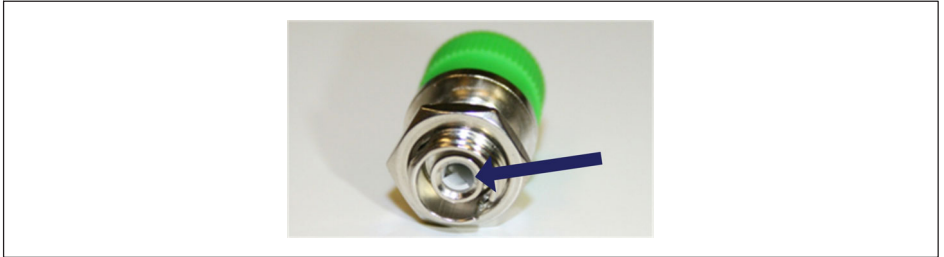


Fig. 4.9 Broken connectors

To solve this problem you should contact HBK FiberSensing.

### 4.3.3 Reflective Fiber Ending

Even when all connections have been performed correctly, it may occur that the interrogator does not find any sensor on an array. One of the reasons may be the excess of reflected light saturating the detectors.

When a fiber is perfectly cut (Fig. 4.10 on the left) a large amount of light is reflected right back into the core of the fiber in such an angle that it gets guided back heading to the interrogator detectors. When this occurs, an index matching gel or an angled termination must be used. If these are unavailable, the tip of the fiber can be smashed with a metallic tool. This will destroy the perfect geometry (Fig. 4.10 on the right) and the light that is reflected at the surface will take random directions ending up outside the core.

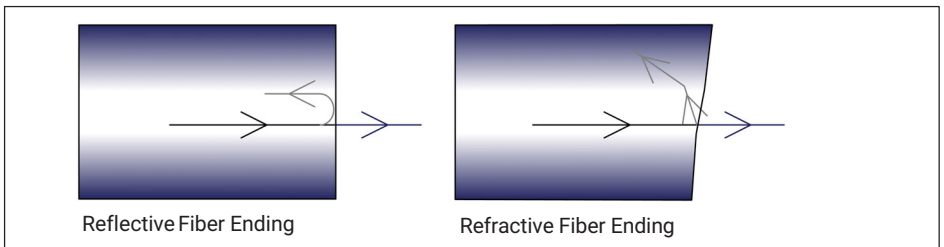


Fig. 4.10 Refraction and reflection at fiber end

### 4.3.4 Cut Fiber

When the fiber, for any reason, is broken between two sensors in series, the sensors that are after the fault may disappear from the optical spectrum and may not be detected.

There may also be the case that the fiber is cut, but not completely spread apart (e.g. the fiber is damaged in an area covered with glue). This will cause a Fabry-Pérot effect – the light will suffer multiple reflections inside the cavity creating sinusoidal background reflection.

Fig. 4.11 shows a schematic representation of the reflected spectrum for the three presented cases.

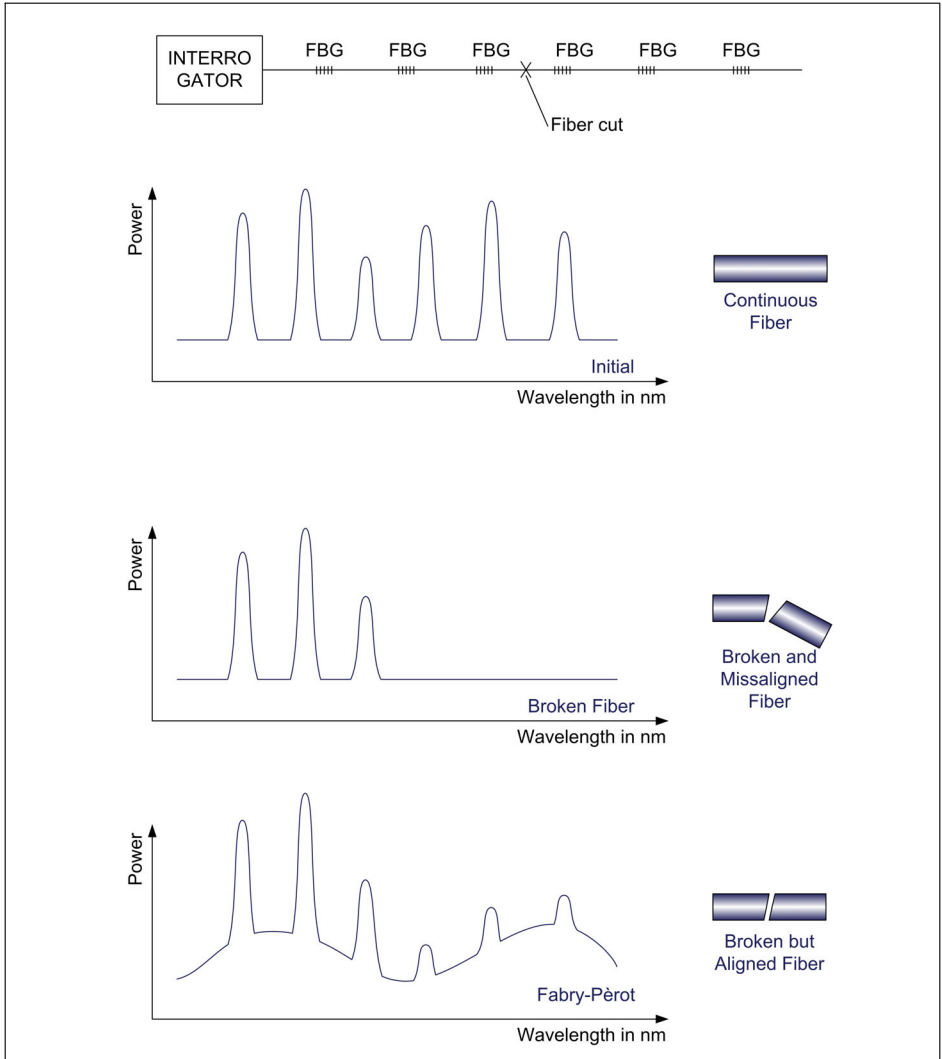


Fig. 4.11 Cut fiber effect

### 4.3.5 Fuse Failure

Electrical shorts on the power supply may cause problems to the interrogators. The Industrial BraggMETER DI on its Rack-Mountable format is directly connected to the 100-240 V power line meaning that it has no external protection. Replaceable fuses are available on the interrogator's back-side next to the power connector (number **5** in Fig. 3.2). To replace the fuses, release the top and bottom springs of the fuses' support (Fig. 4.12) and then remove the piece (Fig. 4.13).

Fuse characteristics:

- Rated voltage: 250 Volt AC
- Interrupting rate: 1 Ampere
- Number of fuses: 2



Fig. 4.12 Removing the fuse



Fig. 4.13 Fuse holder

The Standard format of the interrogator is powered at 11-36 VDC, which means that the electrical protection should be granted by the power source or the adapter. If, by any chance, the power supply is overcome, the interrogator might be damaged and needs repair at HBK FiberSensing.

### 4.3.6 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
$\Delta\lambda = \frac{d \cdot 2 \cdot n \cdot RepRate \cdot FullRange}{SweepDirection \cdot DutyCycle \cdot c}$
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 is the selected acquisition rate, in S/s); $FullRange$ is the length of the range of measured wavelengths (102 nm for BraggMETER interrogators); $SweepDirection$ is the signal of the sweeping direction: 1 for sweeping from the lowest to highest wavelengths and -1 for sweeping from the highest to lowest wavelengths (-1 for FS22DI); $DutyCycle$ is a constant for the acquisition period (0.9 for FS22DI interrogators); $c$ is the speed of light ( $3 \cdot 10^8$ m/s).

This means that for FS22DI, 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

$$\Delta\lambda = \frac{2 \cdot 1.446 \cdot 102}{-1 \cdot 0.9 \cdot 3 \cdot 10^8} \cdot d \cdot RepRate = -1.0925 \cdot 10^{-6} \cdot d \cdot RepRate$$

Next table 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 sampling rates.

Distance (m)	Acquisition rate (S/s)			
	50	100	200	1000
10	-0.5	-1.1	-2.2	-10.9
50	-2.7	-5.5	-10.9	-54.6
100	-5.5	-10.9	-21.9	-109.3
150	-8.2	-16.4	-32.8	-163.9
200	-10.9	-21.9	-43.7	-218.5
500	-27.3	-54.6	-109.3	-546.3
1000	-54.6	-109.3	-218.5	-1092.5
1500	-81.9	-163.9	-327.8	-1638.8
2000	-109.3	-218.5	-437.0	-2185.1
5000	-273.1	-546.3	-1092.5	-5462.7

Tab. 4.1 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 than the interrogator's "accuracy";
- The measurement is based on an absolute wavelength measurement, which is true for the temperature, for example. Sensors to which measurements are based either on a variation of wavelength to a reference value or on two FBG that are very close to each other do not require the compensation of the wavelength measurement error as it gets canceled by the differential calculation.

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

$$d = \frac{\lambda_{\text{RepRate1}} - \lambda_{\text{RepRate2}}}{\text{RepRate1} - \text{RepRate2}} \cdot \frac{\text{SweepDirection} \cdot \text{DutyCycle} \cdot c}{2 \cdot n \cdot \text{FullRange}}$$

Where:

$d$  is the distance (in m) between the sensor and the measurement unit;

$\lambda_{\text{RepRate1}}$  is the sensor wavelength (in mm) measured with an acquisition rate RepRate1 (in Hz);

$\lambda_{\text{RepRate2}}$  is the sensor wavelength (in mm) measured with an acquisition rate RepRate2 (in Hz);

*SweepDirection* is the signal of the sweeping direction: 1 for sweeping from the lowest to highest wavelengths and -1 for sweeping from the highest to lowest wavelengths (-1 for FS22DI);

*DutyCycle* is a constant for the acquisition period (0.9 for FS22DI Interrogators);

$c$  is the speed of light ( $3 \times 10^8$  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 FS22DI distance computation can be done by using the two different acquisition rates. On the example below, we'll be using the interrogator operating at 50 S/s and 1000 S/s.

### Distance calculation using the two speed modes

$$d = \frac{\lambda_{1000 \text{ S/s}} - \lambda_{50 \text{ S/s}}}{1000 - 50} \cdot \frac{\text{SweepSpeed} \cdot \text{DutyCycle} \cdot c}{2 \cdot n \cdot \text{FullRange}}$$

$$= \frac{\lambda_{1000 \text{ S/s}} - \lambda_{50 \text{ S/s}}}{1000 - 50} \cdot \frac{-1 \times 0.9 \times 3 \times 10^8}{2 \times 1.446 \times 102} = (\lambda_{1000 \text{ S/s}} - \lambda_{50 \text{ S/s}}) \times -963.48$$

Where:

$d$  is the distance (in m) between the sensor and the measurement unit;

$\lambda_{50 \text{ S/s}}$  is the sensor wavelength measured at low acquisition speed (50 S/s);

$\lambda_{1000 \text{ S/s}}$  is the sensor wavelength measured at high acquisition speed (1000 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.

## 5 REMOTE COMMUNICATIONS

### 5.1 Communication Protocol Syntax

The interrogator is controlled using standard SCPI syntax commands.

#### 5.1.1 Command Syntax

Each command is an ASCII string with arguments separated by ":" and terminated with the "Line Feed" and "Carriage Return" characters ("End of Line").

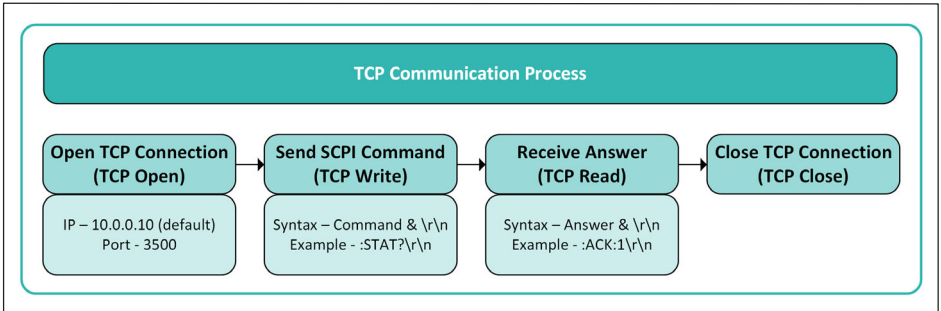


Fig. 5.1 TCP Communication Process

Commands for the Industrial BraggMETER DI are sent by port 3500. All commands, except for Continuous Acquisition (see section 5.1.2 "Common Commands" on page 44), are received via the same port. Continuous Acquisition answers are retrieved via port 3365.

The commands for the FS22 - Industrial BraggMETER DI have the following correspondence:

X	Optical Connector	String. Integer: FS22 Single: 0. FS22 Quad: 0 to 3. FS22 Octo: 0 to 7. Character: A for all connectors
S	Sensor	Integer.
T	Threshold	Integer. From 200 to 3200.
G	Gain	Integer. From 0 to 255.

R	Sampling Rate	Integer. Valid Sampling Rates: 1000, 500, 200, 100, 50 (S/s).
N	Number	Integer.
HH:MM:SS	Time	Integer. HH – hour MM – minutes SS – seconds
YYYY:MM:DD	Date	Integer. YYYY – year MM – month DD – day
Q	NTP Quality	Integer. 0 for “Not acceptable” 1 for “Acceptable”.

There are several possible answers with error messages:

:NACK:INVALID COMMAND

The command does not exist. Check if the spelling is correct.

:NACK:COMMAND NOT ACCEPTED AT CURRENT STATUS

It is not possible to execute the command sent at the current status. Ask the current status of the interrogator (:STAT?) and confer with scheme from Fig. 3.12 to see how to change it.

:NACK: '?' MUST BE THE LAST CHARACTER

The sent command should have a '?' at the end of the command string.

:NACK:ARGUMENT OUT OF RANGE

The defined value for the parameter that is being configured with the command is outside the possible interval.

### 5.1.2 Common Commands

#### :IDENtification?

Queries the interrogator type and firmware revision. The return string is a list separated by "." consisting of Manufacturer, Unit Name and Revision, Number of connectors, Serial Number and Date.

*Example:*

**Command** :IDEN?

**Answer** :ACK:HBK FiberSensing:FS22DI v3.0:08:046 840 200  
626:20240318

## :STORe

Stores the current interrogator acquisition settings to the internal configuration file. The gain and threshold values of each connector are stored.

*Example:*

**Command** :STOR

**Answer** :ACK

## :RECAII

Recalls previously saved interrogator settings from the internal configuration file. The command restores the gain and threshold values of each connector of the interrogator to the values previously stored in the configuration file.

*Example:*

**Command** :RECA

**Answer** :ACK

## :STATUs?

Queries the operation condition status of the interrogator. Returns the current status of the instrument:

0 error;

1 ready;

2 free acquisition;

3 continuous acquisition;

5 warming up.

*Example:*

**Command** :STAT?

**Answer** :ACK:2

### 5.1.3 System Commands

## :SYSTem:TIME?

Queries the interrogator time.

The interrogator returns hours, minutes and seconds separated by ":".

*Example:*

**Command** :SYST:TIME?

**Answer** :ACK:15:33:56

### **:SYSTem:TIME:HH:MM:SS**

Sets the interrogator time. Sent format must be hours, minutes and seconds separated by ":".

*Example:*

**Command** :SYST:TIME:14:26:10

**Answer** :ACK

### **:SYSTem:DATE?**

Queries the interrogator date.

The interrogator returns the year, month and day separated by ":".

*Example:*

**Command** :SYST:DATE?

**Answer** :ACK:2011:09:23

### **:SYSTem:DATE:YYYY:MM:DD**

Sets the interrogator date. Sent format must be year, month and day separated by ":".

*Example:*

**Command** :SYST:DATE:2011:09:23

**Answer** :ACK

### **:SYSTem:IPADress:N.N.N.N:N.N.N.N:N.N.N.N**

Changes interrogator IP address, subnet mask and gateway. Address description must have three characters to define each number. After this command is successfully executed the FS22 will restart automatically. The gateway content of this command (the last set of N.N.N.N) is optional.

*Example:*

**Command** :SYST:IPAD:010.000.000.134:255.000.000.000:000.000.000.000

### **:SYSTem:NTPSynchronization:ENABLE**

Enables NTP synchronization on the interrogator.

*Example:*

**Command** :SYST:NTPS:ENAB

**Answer** :ACK

### **:SYSTem:NTPSynchronization:DISable**

Disables NTP synchronization on the interrogator.

*Example:*

**Command** :SYST:NTPS:DISA

**Answer** :ACK

### **:SYSTem:NTPIpaddress?**

Queries for NTP server IP address, NTP maximum offset and the NTP state. Retrieves the NTP server IP address, maximum offset (default 10000µs) and status ( 1 = On, 0 = Off) separated by ":".

*Example:*

**Command** :SYST:NTPI?

**Answer** :ACK:10.0.0.1:10000:1

### **:SYSTem:NTPIpaddress:N.N.N.N:N**

Sets the NTP synchronization server IP address and admissible offset threshold for good NTP synchronization. Address description must have three characters to define each number and must be separated by "." from the offset threshold (default value is 10000 µs).

*Example:*

**Command** :SYST:NTPI:010.000.000.001:10000

**Answer** :ACK

### **:SYSTem:NTPSynchronization?**

Queries for the NTP synchronization status. Retrieves information on three parameters separated by ":"

Q: NTP Quality:

0 = not acceptable if offset >= 10 ms;

1 = acceptable if offset < 10 ms.

Offset: time difference in milliseconds between the server clock and host clock.

Jitter: time difference in milliseconds between 2 samples.

*Example:*

**Command** :SYST:NTPS?

**Answer** :ACK:1:0.489:0.345

## 5.1.4 Acquisition Commands

### **:ACQUsition:START**

Starts the acquisition of the fiber Bragg grating sensors in all connectors of the interrogator. This command can only be executed in the ready state (see section 3.6.4, subsection *Operational States*, for state description).

*Example:*

<b>Command</b>	:ACQU:STAR
<b>Answer</b>	:ACK

### **:ACQUsition:STOP**

Stops all types of acquisition of the fiber Bragg grating sensors in all connectors of the interrogator, returning to the ready state.

*Example:*

<b>Command</b>	:ACQU:STOP
<b>Answer</b>	:ACK

### **:ACQUsition:CONFigure:GAIN:CHANnel:X:G**

Sets the detection gain in the X connector of the interrogator. The gain is a value from 0 to 255.

*Example:*

<b>Command</b>	:ACQU:CONF:GAIN:CHAN:0:3
<b>Answer</b>	:ACK

### **:ACQUsition:CONFigure:GAIN:CHANnel:X?**

Queries the detection gain in the X connector of the interrogator. The returned gain value can range from 0 to 255.

*Example:*

<b>Command</b>	:ACQU:CONF:GAIN:CHAN:0?
<b>Answer</b>	:ACK:3

### **:ACQUsition:CONFigure:THREShold:CHANnel:X:T**

Sets the threshold value for the peak detection algorithm in the X connector of the interrogator. The threshold is a value from 200 to 3200.

*Example:*

<b>Command</b>	:ACQU:CONF:THRE:CHAN:0:1000
<b>Answer</b>	:ACK



### **:ACQUisition:CONFigure:THREshold:CHANnel:X?**

Queries the threshold value for the peak detection algorithm in the X connector of the interrogator. The threshold is a value from 200 to 3200.

*Example:*

**Command** :ACQU:CONF:THRE:CHAN:0?

**Answer** :ACK:1000

### **:ACQUisition:CONFigure:RATE:R**

Sets the sampling rate value R of the interrogator for all connectors. The sampling rate can assume the following values: 1000, 500, 200, 100, 50 (S/s).

This parameter is automatically stored in the interrogator.

*Example:*

**Command** :ACQU:CONF:RATE:500

**Answer** :ACK

### **:ACQUisition:CONFigure:RATE:R?**

Queries the sampling rate value of the interrogator. The sampling rate can assume the following values: 1000, 500, 200, 100, 50 (S/s).

*Example:*

**Command** :ACQU:CONF:RATE?

**Answer** :ACK:200

### **:ACQUisition:WAVElength:CHANnel:X?**

Returns the peak wavelengths of the fiber Bragg grating sensors in connector X of the interrogator according to the threshold settings. The central wavelength values for different fiber Bragg sensors are separated by a comma ",", the row of values ends with carriage return "\r" and line feed "\n". The number of connectors can be "A" to retrieve the wavelength of all sensors in all connectors simultaneously. Wavelengths are presented in ascending values.

*Example:*

**Command** :ACQU:WAVE:CHAN:0?

**Answer** :ACK:1560.0732,1554.9894,1547.8012,1540.0954

### :ACQUisition:POWER:CHANnel:X?

Queries the optical peak power of the fiber Bragg gratings in connector X. Returns a value between 0 and 4095 for each sensor on the connector. If the optical connector is saturated, a value of 4095 will be returned. The peak power values for different fiber Bragg sensors are separated by a comma ",", the row of values ends with carriage return "\r" and line feed "\n". The FS22 - Industrial BraggMETER DI does not reply, if no sensor is detected. The number of connectors can be "A" to retrieve the power of all the sensors in all the connectors simultaneously.

*Example:*

```
Command :ACQU:POWE:CHAN:0?
:ACK:3875,3622,3161,3240
```



### Information

The following commands on the OSA trace are only available when the acquisition rate is set as 50 S/s.

### :ACQUisition:OSATrace:CHANnel:X?

Acquires the optical spectrum trace in the connecto X of the interrogator. This command is only available when the acquisition rate is set at 50 S/s. The acknowledged and data reply to this command is sent through port 3500. The optical spectrum trace reply is a list of power values and a list of wavelength values separated by ":". There is a direct correspondence between each power value and each wavelength value. The wavelength data is sorted in descending order. Each power value in arbitrary units is represented by a set of three hexadecimal digits. For example, the value D13 represented with hexadecimal digits corresponds to a power value of 3347 in decimal notation. The wavelength values are separated by "," and written in decimal notation (with 4 decimal digits and "." for decimal separation). The reply string is terminated with the carriage return "\r" and line feed "\n" characters. This command can only be executed in the ready state with the acquisition rate set to 50 S/s (see [section 3.6.4, subsection Operational States](#) for state description).

*Example:*

```
Command :ACQU:OSAT:CHAN:1?
Answer  Port 3500:
:ACK:...D13D03FA0B98.....1563.1333,1563.1194,1563.1054,15
63.0915...\r\n
```

## **:ACQUisition:OSATrace:CONTInuous:STARt:CHANnel:X**

Continuously acquires the optical spectrum trace in the connector X of the interrogator. This command is only available when the acquisition rate is set at 50 S/s. The acknowledged reply to this command is sent through port 3500 while data is sent through port 3365. The optical spectrum trace reply is a list of power values and a list of wavelength values separated by ":". There is a direct correspondence between each power value and each wavelength value. The wavelength data is sorted in ascending order. Each power value in arbitrary units is represented by a set of three hexadecimal digits. For example, the value D13 represented with hexadecimal digits corresponds to a power value of 3347 in decimal notation. The wavelength values are separated by "," and written in decimal notation (with 4 decimal digits and "." for decimal separation). The power and wavelength values are updated every second. The consecutive data reply strings are terminated with the carriage return "\r" and line feed "\n" characters. This command can only be executed in the ready state with the acquisition rate set to 50 S/s (see section 3.6.4, subsection [Operational States](#) for state description).

*Example:*

<b>Command</b>	:ACQU:OSAT:CONT:STAR:CHAN:1
<b>Answer</b>	Port 3500: :ACK Port 3365: :...D13D03FA0B98.....1563.1333,1563.1194,1563.1054,1563.09 15...\r\n

### **:ACQUisition:WAVElength:CONTInuous:STARt**

Continuous acquisition of the peak wavelengths of the fiber Bragg grating sensors in all connectors of the interrogator. Wavelength data is sent continuously with updated time data at every second.

On each second one data packet with time stamp information is sent, followed by the  $n$  data packets corresponding to each sample within that second.

Each time stamp data packet starts with ":" followed by the date and time with the format «YYYY.MM.DD:HH.MM.SS».

Sample data packets also start with ":" and the central wavelength values for different fiber Bragg sensors are separated by a comma ",", being the information corresponding to different connectors separated by ".". The row of values is terminated by carriage return "\r" and line feed "\n". This command can only be executed in the ready state (see section 3.6.4, subsection *Operational States* for state description).

*Example:*

---

<b>Command</b>	:ACQU:WAVE:CONT:STAR
<b>Answer</b>	Port 3500: :ACK Port 3365: :1554.9891,1560.0732:1547.8027:: :TS:2017:02.20:11.13.25 :1554.9897,1560.0741:1547.8030:: :1554.9894,1560.0727:1547.8029:: :1554.9893,1560.0732:1547.8027:: 

---

## **:ACQUisition:WAVElength:CONTInuous:NTPSynchronization:START**

Continuous acquisition of wavelengths of all the connectors of the interrogator. This command is sent via port 3500 and corresponding data is received through port 3365. The received data is in binary format and contains information on Timestamp, Wavelength values of all sensors from all optical connectors with the following structure:

- 1) Fixed Header (30 bytes) [always sent independently of the payload content (even without sensors)]:
  - a) 2 bytes (sync "#0")
  - b) 4 bytes (remaining header length 24 bytes + payload length)
  - c) 8 bytes (timestamp):
    - LWORD1: seconds since 1.1.1970
    - LWORD2: fraction of current second mapped to an integer range of 32 bit (i.e. 0.5 s would correspond to  $\frac{1}{2} * 2^{32}$ )
  - d) 2 bytes #sensors CH0 + 2 bytes #sensors CH1 + 2 bytes #sensors CH2 + 2 bytes #sensors CH3 + 2 bytes #sensors CH4 + 2 bytes #sensors CH5 + 2 bytes #sensors CH6 + 2 bytes #sensors CH7
- 2) Payload:
  - a) Payload on interrogator with 1 optical connector:  
4 bytes CH0/wvl0 + 4 bytes CH0/wvl1 + (...)
  - b) Payload on interrogator with 4 optical connectors:  
4 bytes CH0/wvl0 + 4 bytes CH0/wvl1 + (...) + CH3/wvl0 + CH3/wvl1 + (...)
  - c) Payload on interrogator with 8 optical connectors:  
4 bytes CH0/wvl0 + 4 bytes CH0/wvl1 + (...) + CH7/wvl0 + CH7/wvl1 + (...)with wavelengths in ascending order [wvl0 < wvl1 < (...)].

Example:

**Command** :ACQU:WAVE:CONT:NTPS:STAR

**Answer** Port 3500 » :ACK  
Port 3365 »

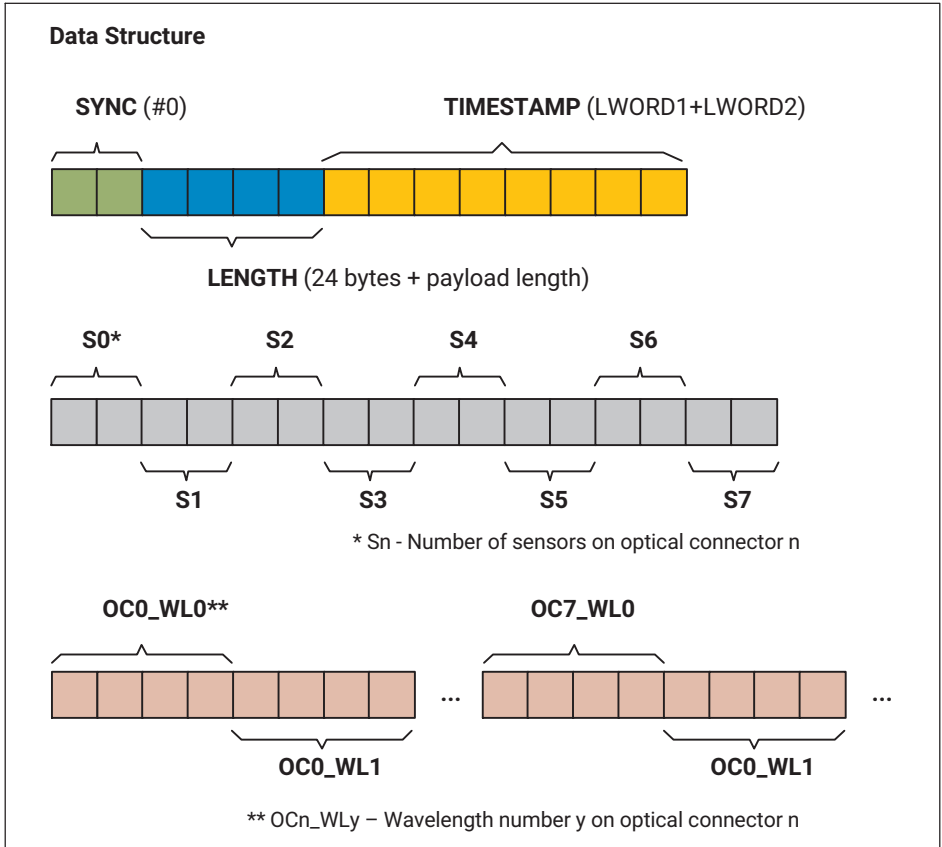


Fig. 5.2 NTP answer scheme

## 6 BRAGGMONITOR DI SOFTWARE DETAILS

---

### 6.1 Software Version

This document refers to BraggMONITOR DI Software version 1.8.

### 6.2 Install and Uninstall Software

#### 6.2.1 System Requirements

To operate the current version of BraggMONITOR, your PC must have the following requirements:

- Intel Pentium or equivalent processor upwards from 1 GHz
- Windows XP or later (32-bit and 64-bit versions)
- Main memory (RAM):
  - at least 512 Mbyte for Windows® XP
  - at least 1,024 Mbyte for Windows Vista®
  - at least 2,048 Mbyte for Windows®7 or higher
- Graphics card (and screen) with a resolution of 1,024 x 768 pixel or higher
- Approx. 1 GByte of free storage capacity for the program installation; at least a further 1 GByte is needed for the temporary storage of data; however you can also use a different drive for this.
- Ethernet interface (100/1000 MBit)

The above requirements are sufficient if you use low sample rates and some sensors. You must use a more powerful PC if you wish to use a large number of sensors with high sample rates.



#### Information

*Using windows display settings with the size of text not set to 100% might compromise the correct visualization of BraggMONITOR DI software.*

#### 6.2.2 Software Installation

To install HBK FiberSensing BraggMONITOR DI Software on a PC, please follow the described steps:

- ▶ Download BraggMONITOR DI from our website and store it on the PC;
- ▶ Run Setup.exe;



## Information

When the operating system is Windows Vista or higher, open *setup.exe* as an Administrator with a right-click (see Fig. 6.1).

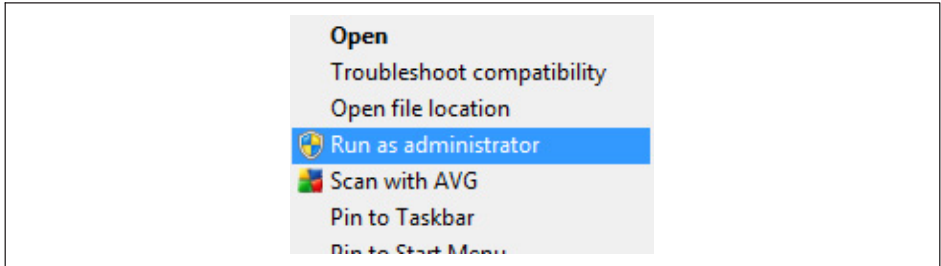


Fig. 6.1 Run as administrator (once)

► Follow the described steps and press finish.

The installation is now completed. You will need to restart the computer before using the application.

### 6.2.3 Software Uninstall

To uninstall the application use the Add and Remove programs tool in Windows

- Go to the **Control Panel**
- Select **Programs and Features**
- Select **BraggMONITOR DI Software**
- Click **Uninstall/Change** Option and follow the steps.

## 6.3 Running the Software

### 6.3.1 Network Properties

To operate the interrogator, the PC network properties should be set so that both elements are configured in the same subnet.

To configure your personal computer so that it is on the same subnet as the default for the interrogator, proceed as described on section 3.6.1 "Network Properties" on page 20.

### 6.3.2 Run as Administrator

The BraggMONITOR DI Software should run with full administrator privileges. To have these privileges when the operating system is Windows Vista or higher, right-click the BraggMONITOR DI Software icon and then select the "Run as administrator" option (see Fig. 6.2).



To configure the application to always open with Administrator privileges, right-click on the software icon and select "Properties > Compatibility". Check the box "Run this program as administrator" (see Fig. 6.2).

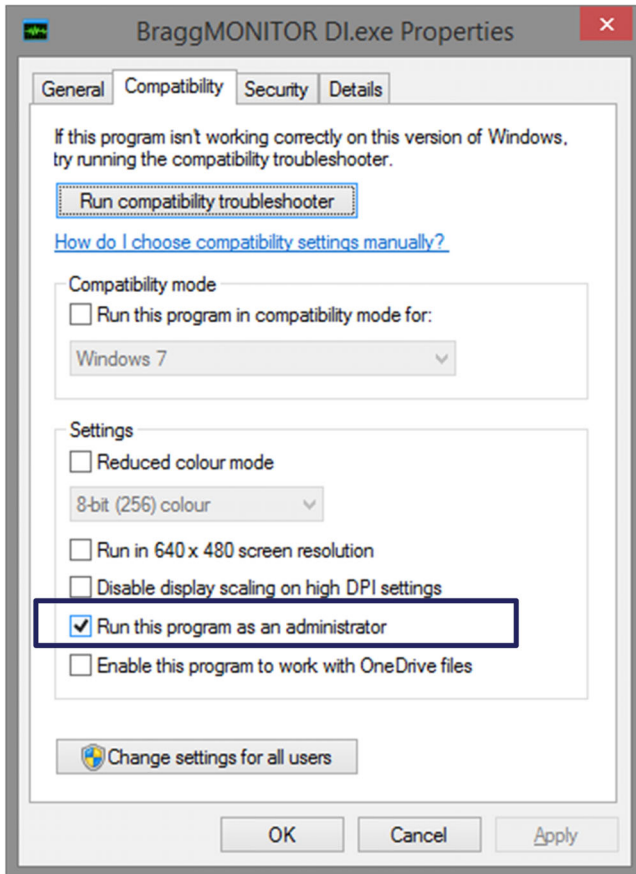


Fig. 6.2 Set Run as administrator automatically

## 7 BRAGGMONITOR DI USER INTERFACE

The BraggMONITOR DI Software graphical interface is divided in two different areas (Fig. 7.1):

- 1 Graphical Bar
- 2 General Bar

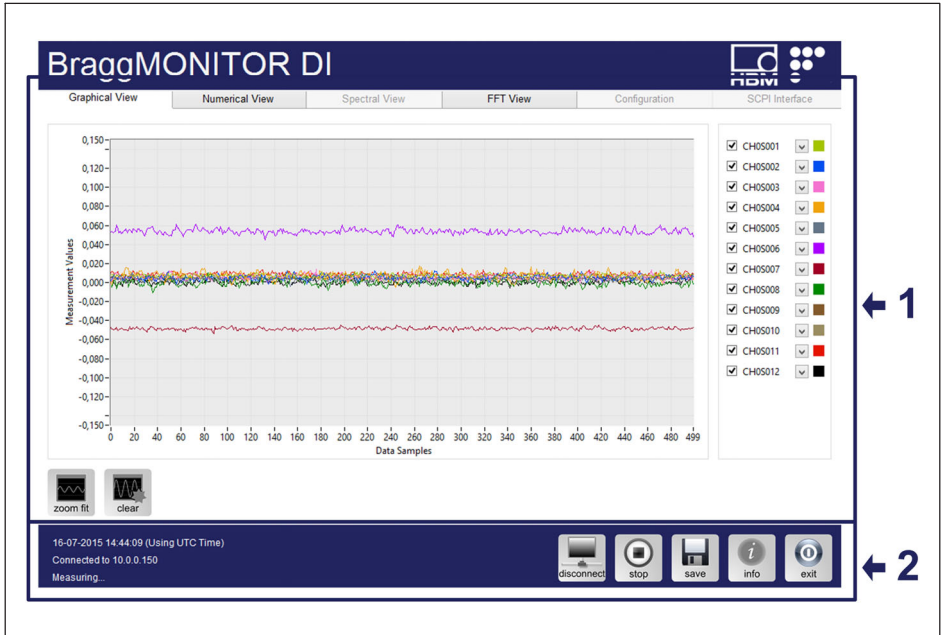


Fig. 7.1 BraggMONITOR DI User interface

### 7.1 General Bar

The General Bar, which is always active, is where the main acquisition actions can be performed.

The current date and time are shown on the left (number 1 in Fig. 7.2).

Before starting acquisition, it is necessary to establish connection between the interrogator and the software. For that, press the "connect" button (number 2 in Fig. 7.2). If the software finds the device, the "connect" button changes to "disconnect", as shown in Fig. 7.3, and the "start" button (number 3 in Fig. 7.2) becomes active.



Fig. 7.2 General Bar



Fig. 7.3 Connect to Interrogator

If an interrogator is not found in the previously used IP Address, a window will pop up (Fig. 7.4) and a new IP Address has to be defined (number 1 in Fig. 7.4) and confirmed (number 2 in Fig. 7.4) by the user.

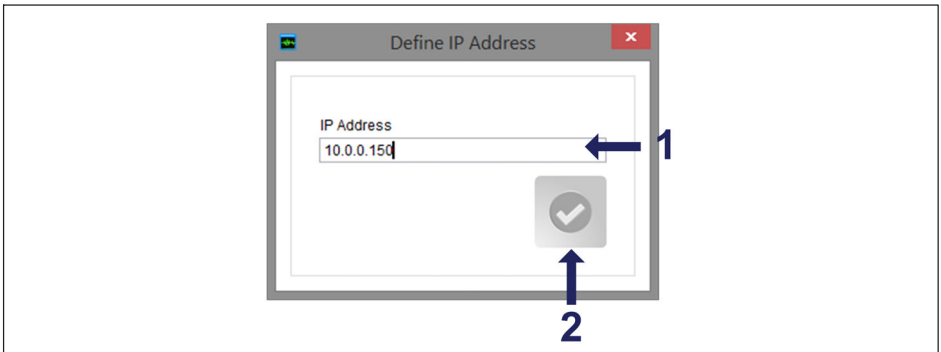


Fig. 7.4 Define IP Address

**i** Information

The FS22 – Industrial BraggMETER DI interrogators default IP is 10.0.0.150 which is the IP Address used in the first connection with the BraggMONITOR DI Software.

## 7.1.1 Acquisition

### Start Acquisition

Press the “start” button (number **3** in Fig. 7.2) to start acquisition. This will start the acquisition and representation of the measured values for all optical connectors. The button will change from start to stop status (Fig. 7.5).

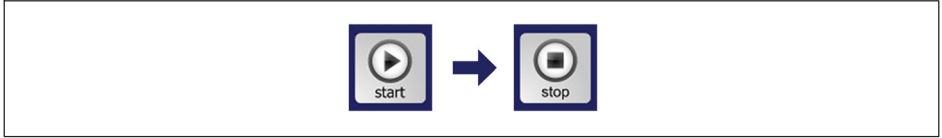


Fig. 7.5 Start Acquisition



### Information

Before starting acquisition make sure that the network configuration on «Configuration» tab is up to date. For more details refer to section 7.2.5, page 69.

### Save Data

To start saving data, select the file path to define the folder where data is to be stored (see section 7.2.3, page 66).

The naming of the file is automatic and corresponds to the timestamp of the last measurement recorded (ex. BraggMONITOR DI Data [2015.07.16.14.48.40; 2015.07.16.14.49.06].txt).

Saved data file collects the data between the instant the save button is pressed and the instant it is pressed back. Data files are divided in accordance to a predefined maximum size. To define the maximum size of the data files, see section 7.2.5, page 69.

The first row of data files indicates the acquisition rate and the second row indicates the columns meaning. The data file is organized in columns as follows, see Fig. 7.6.

- 1 1<sup>st</sup> column – UTC Date: «DD-MM-YYYY»
- 2 2<sup>nd</sup> column – UTC Time: «HH:MM:SS.SSS»
- 3 3<sup>rd</sup> column – Sample: Sample number
- 4 Following columns – Sensor Name (Formula): measured values (formula computed) ordered by optical connector, then by wavelength.

16-07-2015	14:48:40,000	000001	0,0104	0,0111	0,0075
16-07-2015	14:48:40,002	000002	0,0078	0,0123	0,0099
16-07-2015	14:48:40,004	000003	0,0101	0,0120	0,0101
16-07-2015	14:48:40,006	000004	0,0104	0,0079	0,0063
16-07-2015	14:48:40,008	000005	0,0090	0,0061	0,0036
16-07-2015	14:48:40,010	000006	0,0095	0,0090	0,0084
16-07-2015	14:48:40,012	000007	0,0097	0,0086	0,0070
16-07-2015	14:48:40,014	000008	0,0097	0,0062	0,0080
16-07-2015	14:48:40,016	000009	0,0105	0,0084	0,0097
16-07-2015	14:48:40,018	000010	0,0106	0,0054	0,0099

↑  
**1**
↑  
**3**

Fig. 7.6 Data file example

### Open Data in Microsoft Excel

To import the data file to a Microsoft Office Excel Workbook proceed as follows:

Once Microsoft Excel is opened, press button "From Text" from menu Data>Get External Data (see Fig. 7.7) and select the file data file.

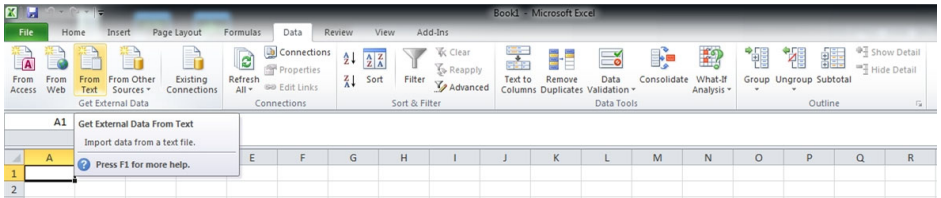


Fig. 7.7 Import data from text file in Excel

Then it is necessary to complete text import wizard. All options must be set as shown in Fig. 7.8, Fig. 7.9, Fig. 7.10, Fig. 7.11 and Fig. 7.12.

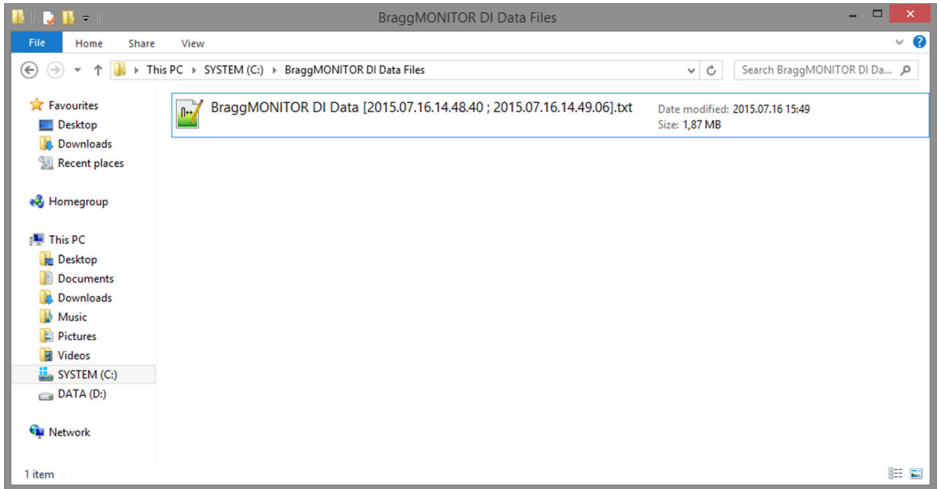


Fig. 7.8 BraggMONITOR DI Data files

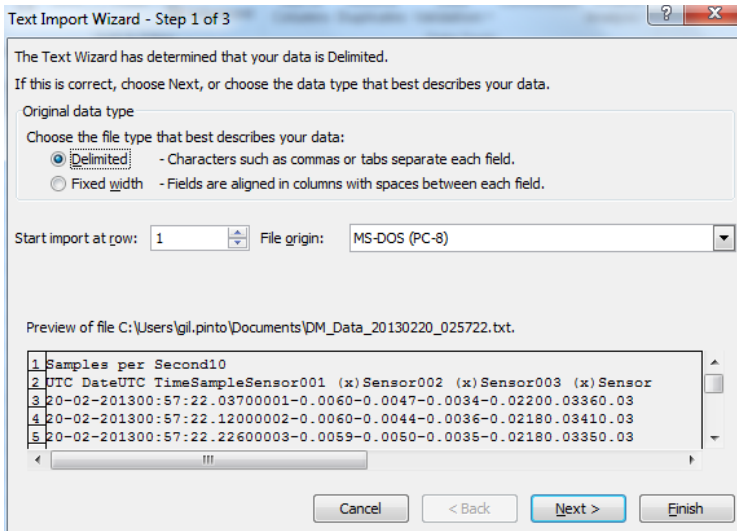


Fig. 7.9 Excel text Import Wizard Step 1

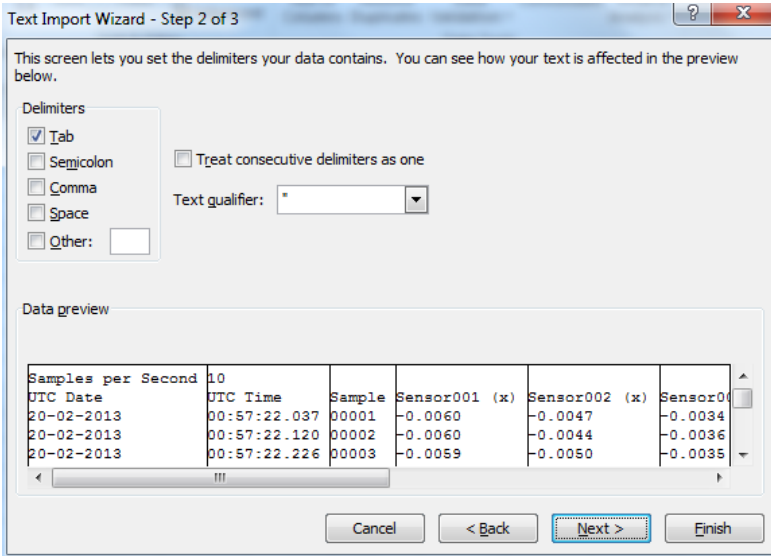


Fig. 7.10 Excel text Import Wizard Step 2

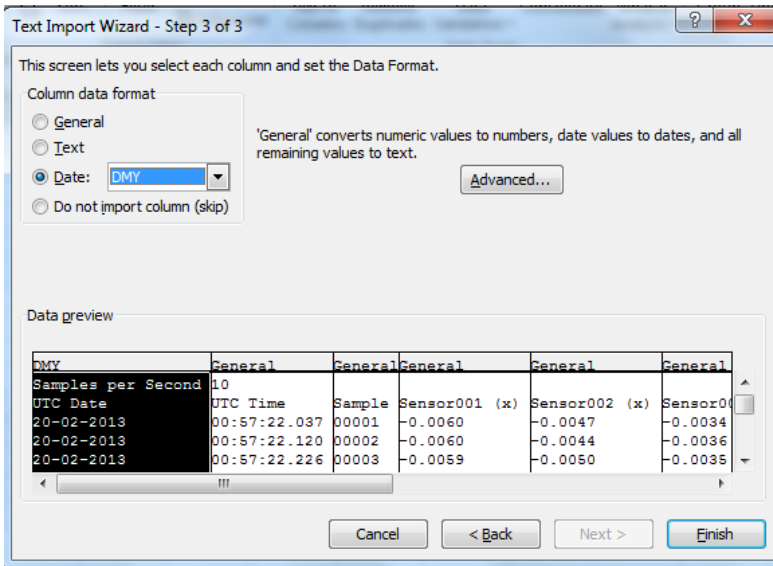


Fig. 7.11 Excel text Import Wizard Step 3

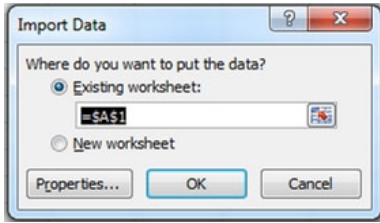


Fig. 7.12 Data location selection

## Stop Acquisition

To stop acquisition, press the “stop” button (number **3** in Fig. 7.2).

### 7.1.2 Software and Interrogator Information

General information about the software and the interrogator can be displayed by pressing the “info” button (number **5** in Fig. 7.2).

### 7.1.3 Exit Application

To exit BraggMONITOR DI Software application, press the “exit” button (number **6** in Fig. 7.2).

## 7.2 Graphical Area

The graphical area is divided into six tabs:

- Graphical View
- Numerical View
- Spectral View
- FFT View
- Configuration
- SCPI Interface



## 7.2.1 Graphical View

On the Graphical View, graphical representation of 1000 measured values can be found every second (number **1** in Fig. 7.13).

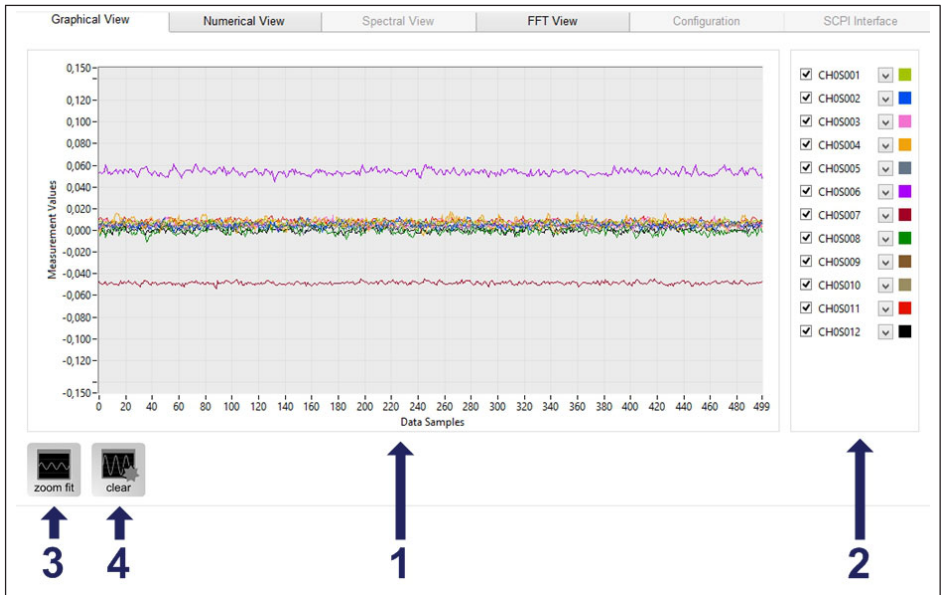


Fig. 7.13 Graphical View

Select the sensors to be displayed using the drop-down arrow next to the legend (number **2** in Fig. 7.13). Tick the connector box to enable or disable their representation.

### Zoom In and Zoom Fit

To adjust the graphical representation, use the zoom in and zoom fit functions. Zoom in by selecting an area on the displayed graph and zoom fit by pressing number **3** in Fig. 7.13. Alternatively, scale numbers can be edited.

### Clear Graph

All displayed data can be deleted from the graph by pressing the “clear” button (number **4** in Fig. 7.13).

## 7.2.2 Numerical View

The Numeric View shows the acquired values (in accordance to the configuration formula - see table Tab. 7.1 on page 74) for each optical connector, organized in columns as in Fig. 7.14.

Graphical View		Numerical View		Spectral View		FFT View		Configuration		SCPI Interface					
CH0 (15 Sensors)		CH1 (0 Sensors)		CH2 (1 Sensor)		CH3 (0 Sensors)		CH4 (0 Sensors)		CH5 (0 Sensors)		CH6 (0 Sensors)		CH7 (0 Sensors)	
Name	Value	Name	Value	Name	Value	Name	Value	Name	Value	Name	Value	Name	Value	Name	Value
CH0S001	0,0101			CH2S001	-0,0002										
CH0S002	0,0077														
CH0S003	0,0080														
CH0S004	0,0110														
CH0S005	0,0065														
CH0S006	0,0541														
CH0S007	-0,0460														
CH0S008	0,0032														
CH0S009	0,0089														
CH0S010	0,0063														
CH0S011	0,0139														
CH0S012	0,0047														
CH0S013	0,0101														
CH0S014	0,0087														
CH0S015	0,0078														

Fig. 7.14 Numerical View

### 7.2.3 Spectral View

The Spectral View tab is only accessible when data acquisition is stopped.

This tab represents the spectral response of the sensors connected to the interrogator. The full spectrum contains approx. 7020 data points corresponding to the reflected optical power in dBm from 1500 nm to 1600 nm with an approx. 15 pm sampling resolution (number **1** in Fig. 7.15). For each detected FBG peak the pair of wavelength and power values are represented in a table format (number **11** in Fig. 7.15)

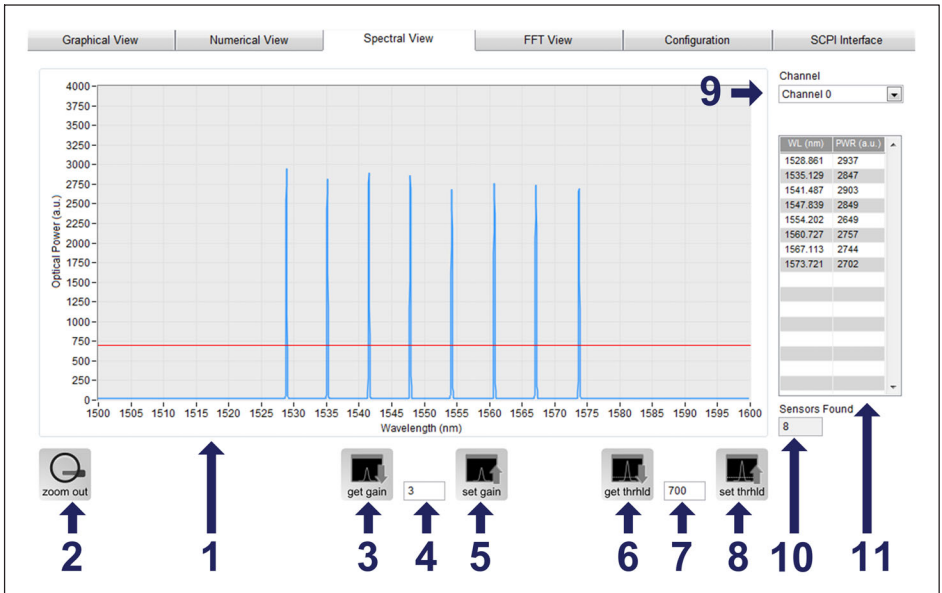


Fig. 7.15 Spectral View

The Spectral View can only represent one connector at a time. Connector selection can be performed on number **9** in Fig. 7.15.



### Important

Whenever the spectral view is active, the sampling rate of the interrogator is set to 50 S/s, reverting back to the previously operating sampling rate when another tab is selected.

The number of FBGs identified in the selected connector is represented in number **10** in Fig. 7.15.



### Information

The number of detected peaks per connector is limited in accordance to the sampling rate. In case there are more peaks than the limit, the lower wavelengths will be eliminated from the list. For more detailed information about the maximum number of sensors per optical connector at a specified sampling rate please refer to the product Datasheet.

### Measurement Configuration

Measurement settings can influence sensor readings. Gain and Threshold values should be defined according to the FBG sensing network status, so that peak amplitude is

around 3000 and no FBG side lobes are detected as peaks. These settings can be configured independently for each optical connector.

### Gain

Gain is directly related to the optical power used on the measurement of the optical connector. The gain value should be raised to overcome losses on the network. Gain is an integer value between 0 and 255. The current gain value can be found using the get gain button (number **3** in Fig. 7.15). The gain value is updated every time the Spectral View tab is selected or a new connector is defined. To define a new gain value, write it on the gain box (number **4** in Fig. 7.15) and press “set gain” button (number **5** in Fig. 7.15).



### Important

*Upon setting the gain attention must be paid to the fact that the optimum gain value will depend on the selected sampling rate for the acquisition. For the same gain value signal power will decrease with the increase of the sampling rate. Because the spectrum is represented with the interrogator operating at 50 S/s, consider a slight saturation of the signals when defining the gain for an acquisition at higher speeds than 50 S/s.*

### Threshold

Threshold defines the line between usable signals and noise. It is an integer value between 200 and 3200. Operations for getting and defining threshold values can be performed on a similar way to the gain, but using the threshold buttons (number **6**, **7** and **8** in Fig. 7.15). The threshold value is updated every time the Spectral View tab or a new connector are selected. This value is also represented graphically as a horizontal line on the power bar graph.

## 7.2.4 FFT View

FFT View tab shows the Fast Fourier Transform (FFT) graph of the acquired measurements. This computation is based on a predefined FFT function, considering the measured values exponential weighted (with no averaging), being the latest signals more significant for the calculations.

Once the “start” button is pressed, all previous measurements are erased from the FFT temporary memory. FFT is shown for the active sensors on the sensors list (number **1** in Fig. 7.16) as defined on the Graphical View tab. This list of sensors cannot be edited on the FFT View tab. To enable/disable any sensor, tick the sensor tick box.



### Information

*To choose sensors that are not present in the sensors list, edit the list on the Graphical View tab.*

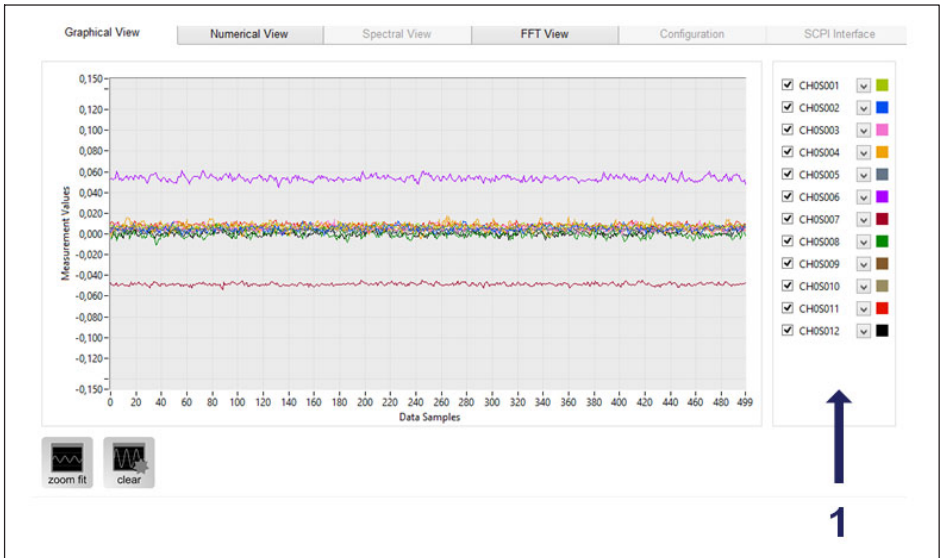


Fig. 7.16 FFT View

## 7.2.5 Configuration

Acquisition configuration allows sensors' configuration for the acquisition of engineering values to be performed. To accomplish this step correctly, the sensors' calibration sheets might be needed.

The BraggMONITOR DI allows editing, saving and opening sensor configurations. The configuration corresponds to the identification and the definition of the calibration formula that converts measured wavelengths into engineering values of the sensors.

The easiest way to start measuring and creating a configuration is to perform an auto-scan (refer to section «AutoScan» on page 70).

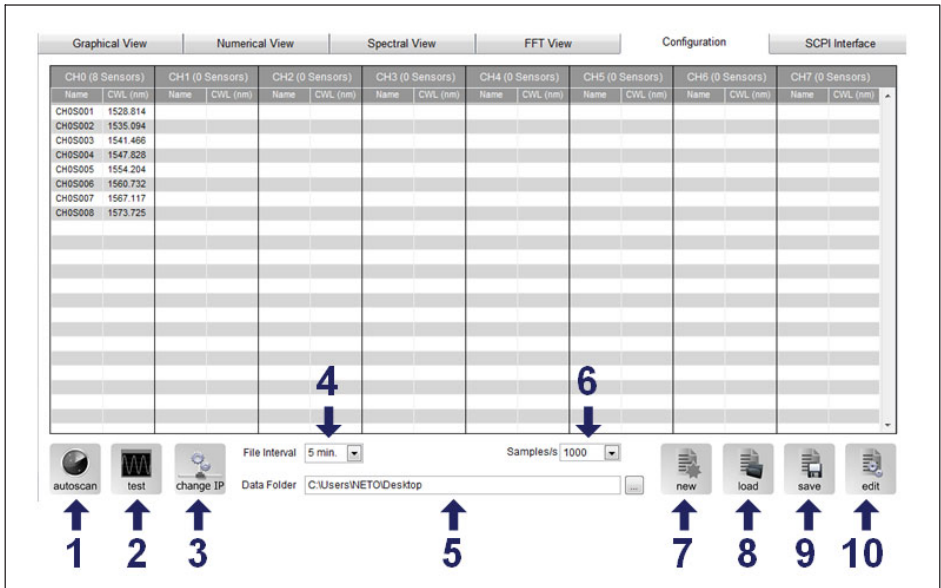


Fig. 7.17 Configuration

### Clear Configuration

If an old configuration is set, it is possible to clear it and start a new configuration by pressing the “new” button (number 7 in Fig. 7.17). Be aware this operation will discard all previous unsaved configurations of all connectors.

### AutoScan

When autoscan (number 1 in Fig. 7.17) is performed for the first time, the interrogator executes a measuring sweep and the BraggMONITOR DI defines a new configuration with all the found sensors. This configuration sets the current measured wavelength as central wavelength ( $\lambda_0$ ) with a default range of 2.5 nm that can be edited to a minimum of 0.5 nm.



### Important

Confirm that gain and threshold values are correctly defined so that no sensor is left out and that no noise is configured as a sensor (see section «Measurement Configuration»). If the interrogator sample rate is defined to 1 kHz (1000 S/s), the defined gain value should be higher to compensate for a loss in optical power.

Sensor Names are set by default as CHxSzzz, where x is the optical connector and zzz is the number of the sensor on that optical connector ordered by wavelength.

Example: CH0S001 corresponds to the 1<sup>st</sup> sensor of optical connector 0.

## Test Configuration

Test configuration (number **3** on Fig. 7.17) allows the user to check the current values from each sensor according to their configuration.

### Information

Error code will be displayed as -998 when no sensor is found within the defined range.

## Change IP

The interrogator's IP address can be changed easily by using the BraggMONITOR DI software. By pressing the "change IP" button (number **3** on Fig. 7.17) a pop up will appear (Fig. 7.18).

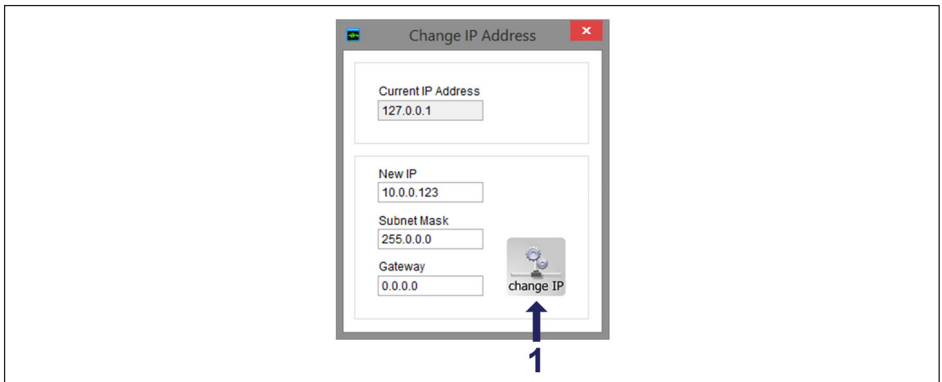


Fig. 7.18 Change IP address

Fill in the new IP address, subnet mask and gateway. By pressing the "change IP" button (number **1** on Fig. 7.18) The interrogator will restart and BraggMONITOR DI will try to connect to the newly defined IP address of the interrogator.

### Important

Connection to the interrogator with the updated IP will only be effective if it was kept under the same range as the defined on the PC. Otherwise the network properties of the PC should be changed and BraggMONITOR DI restarted.

## File Options

File Interval (number **4** in Fig. 7.17) - Each saved file has a limited length defined by time. The maximum time interval for each data file can be defined on this drop down list. When this interval is over, the data file is created and named with the timestamp of the last recorded measurement.

Data Folder (number **5** in Fig. 7.17) - Saved data files are named automatically (refer to section "Save Data" in 7.1.1). Measured data is recorded in the directory defined. To define it, write on the box or press the folder button next to the box, choose the desired directory and then press the "current folder" button.

Sampling Rate (number **6** in Fig. 7.17) - The sampling rate can be defined in samples/second. The available options are 50, 100, 200, 500, and 1000 S/s.



### Important

*If the interrogator sampling rate is defined to 1kHz (1000 S/s), the gain value should be higher to compensate for a loss in optical power (refer to section «Measurement Configuration» on page 79).*

## Add and Edit Configuration

In order to add new sensors to an existing configuration, repeat the autoscan and tick the checkbox "Update only the new or deleted sensors on the network" as shown in Fig. 7.19. If this option is not selected, all sensors configurations (including formulas) will be lost and new autoscan configurations will be created.

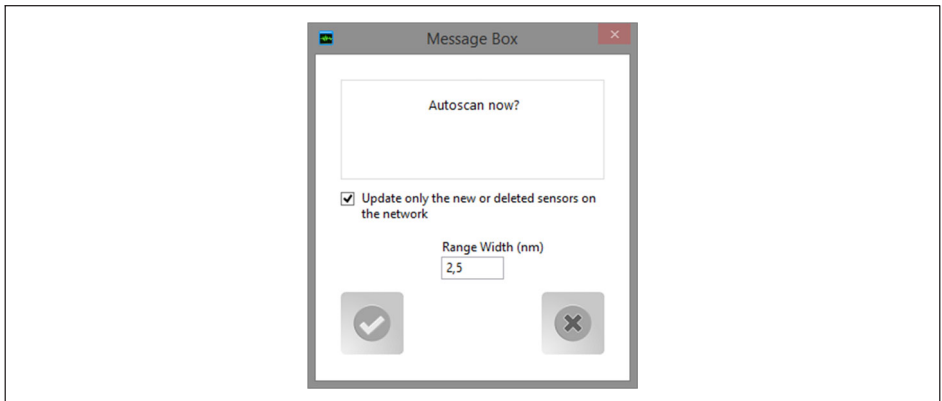


Fig. 7.19 Autoscan range width selection

To configure a sensor individually, select its cell and click on the "edit" button (number **11** in Fig. 7.17). A dialog box will pop up (Fig. 7.20). Additional info about this dialogue box might be found at Tab. 7.1.



**Sensor Name**

**Sensor CWL (nm)**

**Sensor Range (nm)**

**Range Limits (nm)**

**Sensor Formula**

✓

✕

Fig. 7.20 Sensor Settings

<b>Sensor Name</b>	Sensor's identification field. It is not possible to have two sensors with the same name.
<b>Central Wavelength (CWL)</b>	Reference wavelength from which wavelength shift ( $\Delta\lambda=x$ ) is calculated.
<b>Range</b>	Safety bands defined to avoid crosstalk between sensors. Each sensor has its own operation range. For instance, if we have a central wavelength of 1522.659 nm and a range spanning 3 nm, only wavelength values between 1525.659 and 1519.659 are accepted. Wavelength values out of the defined bands are returned as -998.

<b>Formula</b>	Function defining the correlation between the wavelength shift ( $\Delta\lambda=x$ ) and the engineering values.	
	x corresponds to the difference between the measured wavelength ( $\lambda$ ) at each instant and the defined central wavelength ( $\lambda_0$ ).	
	Here it is possible to set a formula manually, although it is also possible to copy and paste from other locations. If the desired output is wavelength shift, insert x on formula textbox.	
	Do	Do Not
	-11.3*x	-11.3x
	-11.3*x^2+105.4*x+30	=-11.3*x^2+105.4*x+30
Note: For decimal separation, use comma or dot according to the regional settings of the computer.		

Tab. 7.1

### Save and Load configuration

Acquisition configuration can be saved in .txt extension file by pressing the “save” button (number 9 in Fig. 7.17) and choosing a save path as shown in Fig. 7.21.

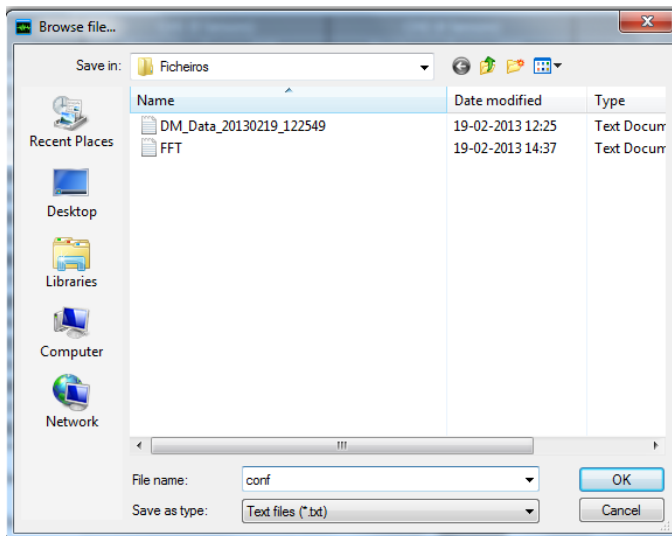


Fig. 7.21 Save configuration

In the configuration file the information is divided by optical connector identified between brackets (number **1** in Fig. 7.22). For each sensor there are four columns, namely: Sensor's Name, Central wavelength (nm), Range (nm) and Formula separated by semicolons (as in numbers **2, 3, 4** and **5** in Fig. 7.22).

```

[CH0] ← 1
CH0S001 ; 1506.446 ; 1.0 ; x
CH0S002 ; 1514.175 ; 1.0 ; x
CH0S003 ; 1522.265 ; 1.0 ; x
CH0S004 ; 1530.089 ; 1.0 ; x
CH0S005 ; 1538.113 ; 1.0 ; x
CH0S006 ; 1546.158 ; 1.0 ; x
CH0S007 ; 1554.211 ; 1.0 ; x
CH0S008 ; 1561.963 ; 1.0 ; x
CH0S009 ; 1570.311 ; 1.0 ; x
CH0S010 ; 1578.074 ; 1.0 ; x
CH0S011 ; 1586.300 ; 1.0 ; x
CH0S012 ; 1594.214 ; 1.0 ; x
[CH2]
[CH2]
CH2S001 ; 1534.559 ; 1.0 ; x
CH2S002 ; 1541.325 ; 1.0 ; x
CH2S003 ; 1545.164 ; 1.0 ; x
CH2S004 ; 1549.143 ; 1.0 ; x
CH2S005 ; 1554.045 ; 1.0 ; x

```

Fig. 7.22 Configuration file

This file might be edited in Notepad or Excel (see «*Opening Data in Microsoft Excel*» section on page 61) and saved as .txt extension file after editing.

Configuration file can always be loaded by pressing the "load" button (number **8** in Fig. 7.17) and picking the configuration file (see Fig. 7.23).

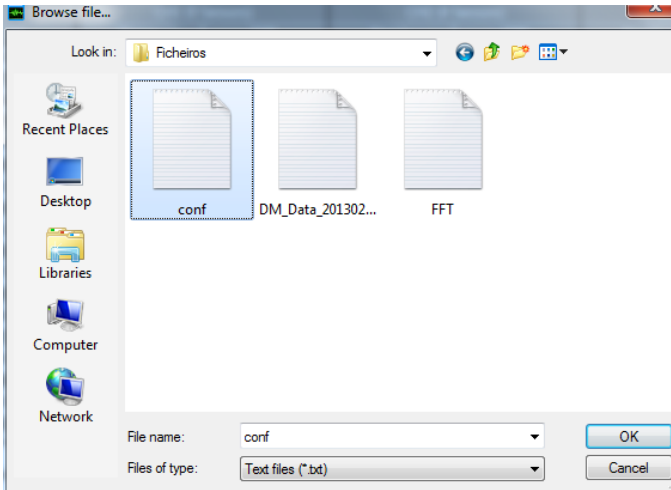


Fig. 7.23 Load configuration

### 7.2.6 SCPI Interface

This tab allows the user to send Standard Commands for Programmable Instruments (SCPI) to the equipment. Please refer to *section 5 "Remote Communications" on page 43* for a list of the commands available to communicate with the interrogator.

Commands are inserted on the command line (number **3** in Fig. 7.24) and sent by pressing Enter or the "send cmd" button (number **2** in Fig. 7.24). The interrogator's answers appear on the command board (number **1** in Fig. 7.24).

Each time new answers are displayed, older ones are pushed down. To delete the previous answers, press the "clear" button (number **4** in Fig. 7.24).

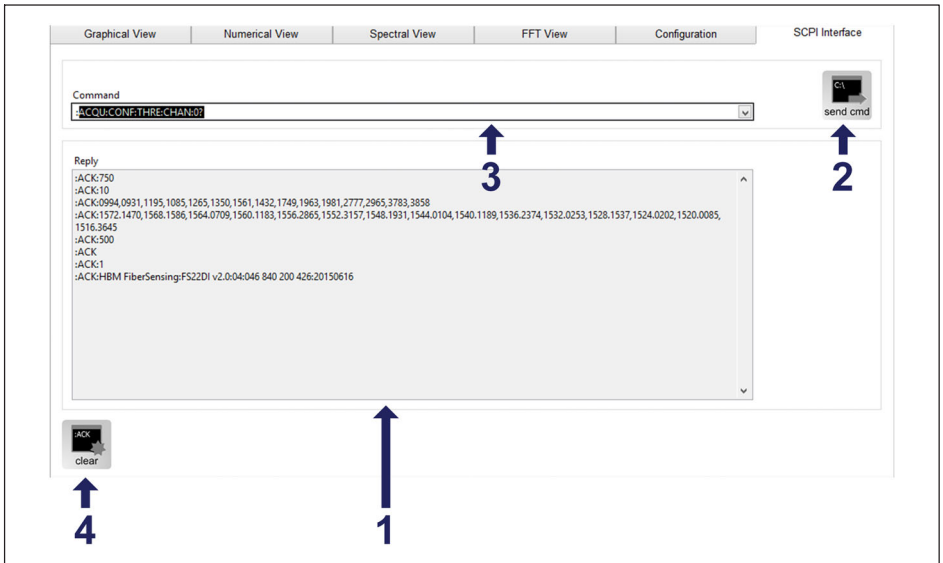


Fig. 7.24 SCPI Interface

Each time a new command is sent, a shortcut at the scroll down box is created, as shown in Fig. 7.25.

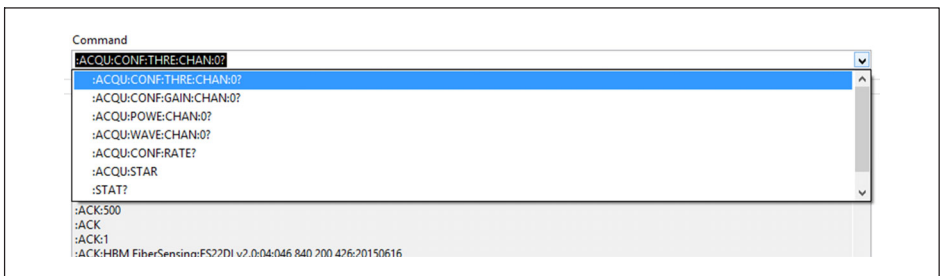


Fig. 7.25 Previously sent comments selection

**!** **Important**

When the user leaves the SCPI Interface tab, the interrogator status is changed and scheduled acquisitions are disabled.

## 8 CATMAN® SOFTWARE

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The FS22DI interrogator is compatible with the powerful catman Easy and catman AP software (from version 4.2 with limitations and from version 5.2 with all specs) allowing the simple combination of optical and electrical signals on the same interface.

Version	Limitations
catman v4.2	Maximum compatible sampling rate of 500 S/s NTP synchronization with TSUA (time stamp upon arrival)
catman v5.0	NTP synchronization with TSUA (time stamp upon arrival)
catman v5.2	None

The following chapter aims to describe in a simplified manner the most common steps to configure and use the FS22DI interrogator with catman.



### Information

*Catman software has to be purchased separately. Please refer to our website ([www.hbkworld.com](http://www.hbkworld.com)) for further information and detailed documentation.*



### Important

*The combination of FS22 and MXFS optical interrogators is not available in catman.*

### Connect to the device

Ensure that the system is correctly setup and the device is turned on and in communication with the PC.

- ▶ Open catman
- ▶ On the start menu, click to select the device types
- ▶ Select FS22 and search via Ethernet
- ▶ Fill in IP or IP range to scan

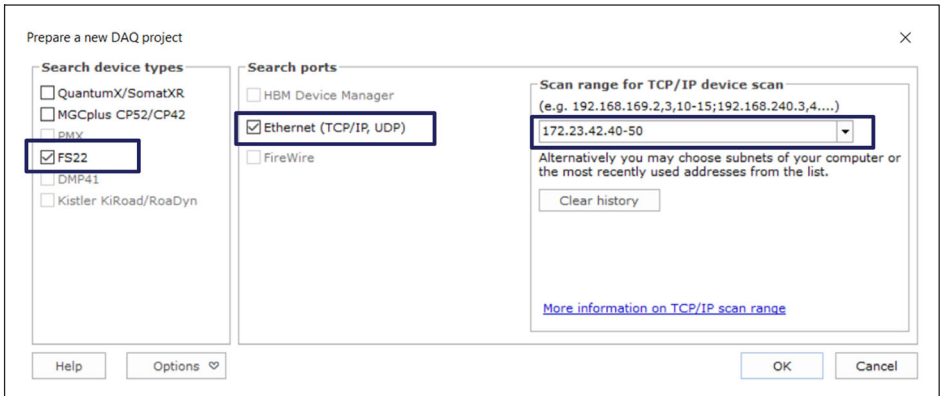


Fig. 8.1 Preparing a new DAQ project within catman

## Device configuration

- ▶ Start a new measurement.

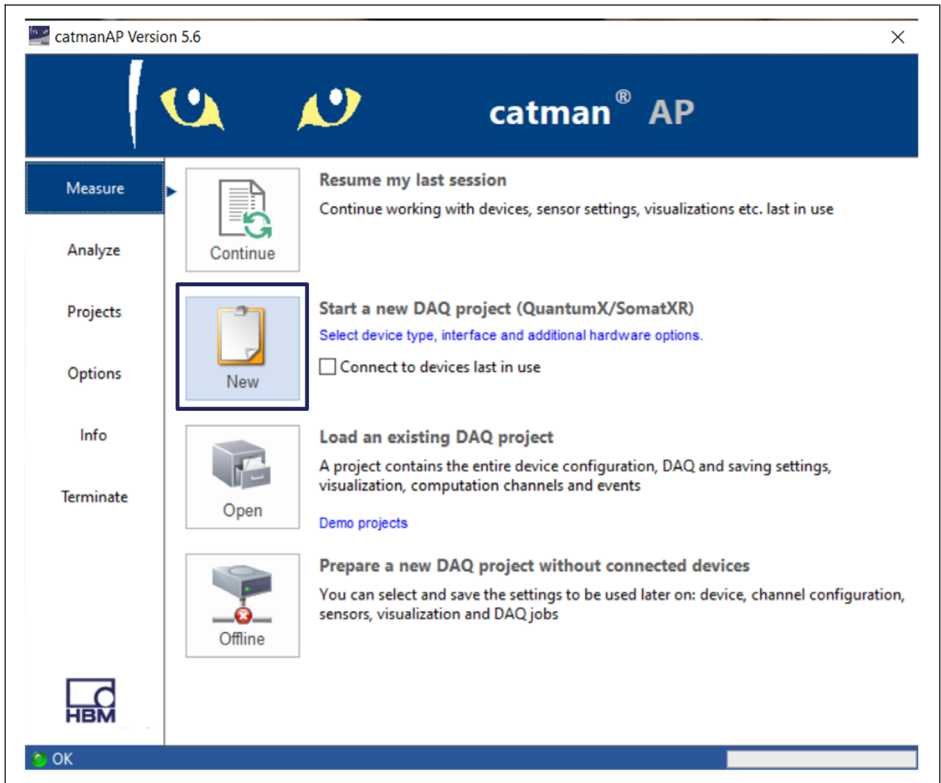


Fig. 8.2 Fig. 8.1 Starting a new DAQ measurement project in catman

The channel list will be populated with the previously set definition for each device. A pop-up warning that spectrum should be checked and adapted appears. This verification is important as the previously set definitions might not be true for the current network setup.



### Tip

Always check the optical spectrum signals of each connector through the “Optical functions” interface.

- ▶ Click “Yes” to open the optical functions. Alternatively, while on the channel list, open “Optical functions” tab to correctly configure the sensors (channels) on each optical connector.



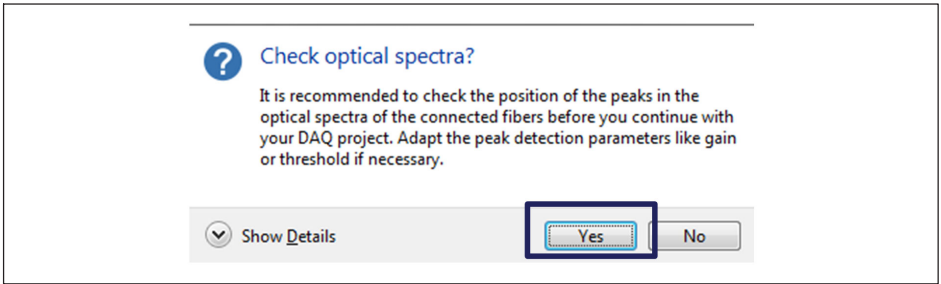


Fig. 8.3 Pop-up for Optical Spectrum visualization and optical channels definition

► Press Configure device.

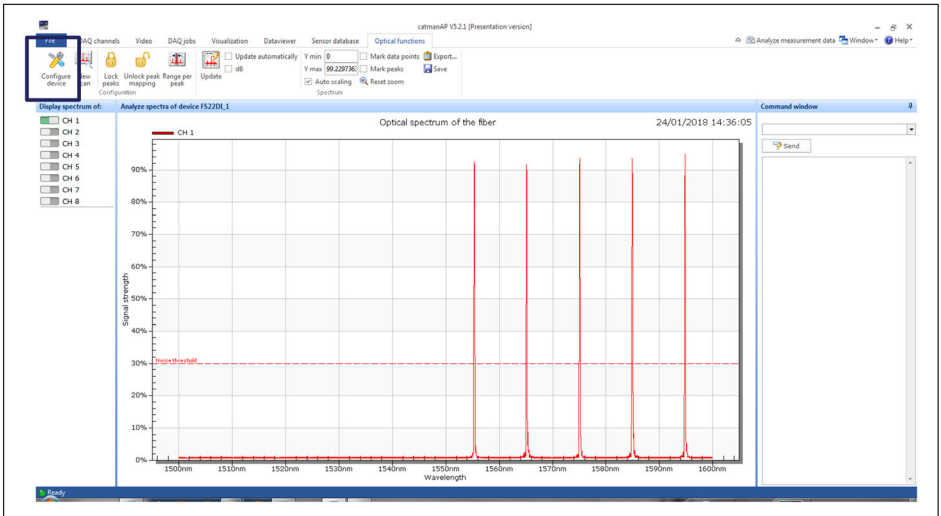


Fig. 8.4 Configure device button

► Adjust Gain levels.



**Tip**

For a well-defined gain value, the highest peak should be close to the maximum power without saturating. Saturation of the signal can be identified by the shape of the spectrum that appears cut at the top. Refer to section "4.2 Definitions" on page 31 for further support.

► Adjust Threshold values.

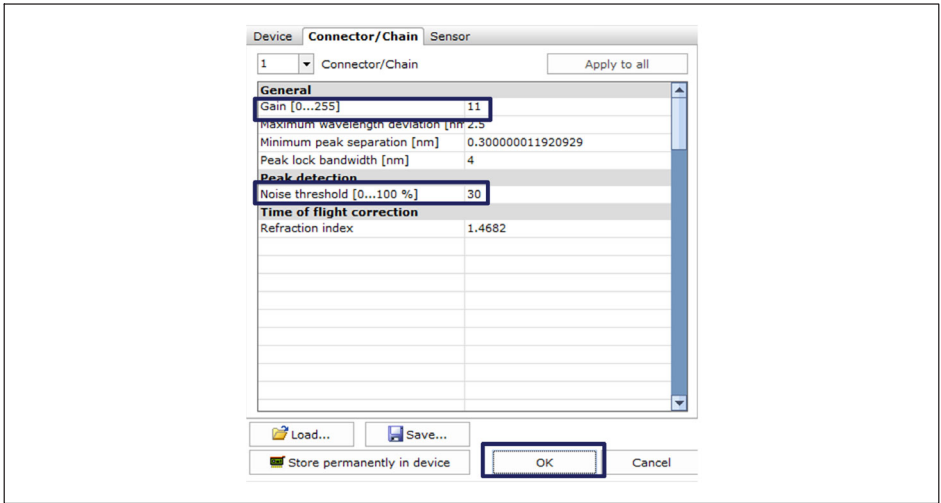


Fig. 8.5 Configuring each connector's gain and threshold



### Tip

A good Threshold value disregards all sidelobes and peak imperfections while granting a large area of the FBG peak above (the number of points on the trace interferers with the peak detection algorithm performance). Refer to section "4.2 Definitions" on page 31 for further support.

- ▶ Adjust the Peak locking bandwidth that will define each sensor's original position. The defined bands in catman® will be moving with the peak which means that their width does not have to cover the full measurement range of the sensor. Peak locking bandwidth is defined in [nm] and corresponds to the full width of the defined band. Band limits will be the FBG central wavelength  $\pm$  half peak locking bandwidth.
- ▶ Lock peaks.
- ▶ Perform a new scan.

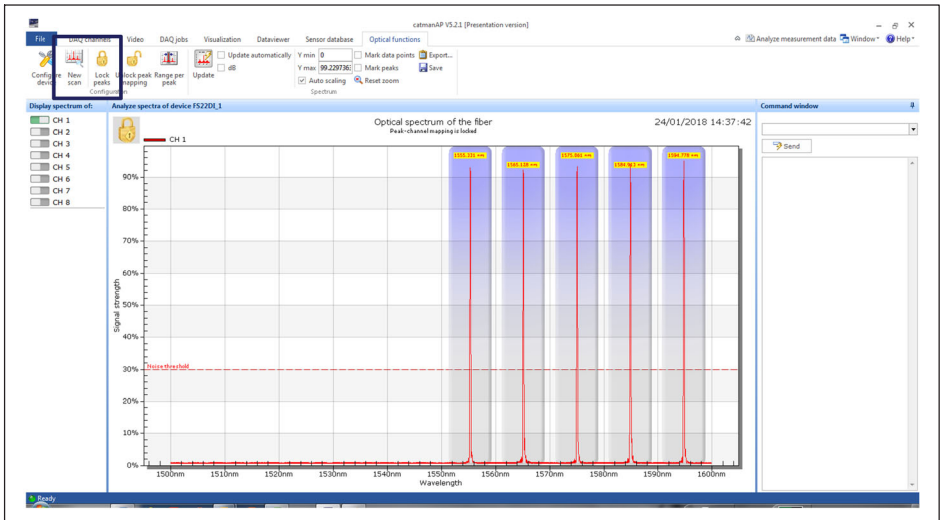


Fig. 8.6 Locking peaks and performing a new scan

## Measurement configuration

On the channel list, configure sensors in accordance with the needs.

- ▶ Rename sensors.
- ▶ Assign sensors from the database.

## Information

*HBK Optical Sensors Database is divided into interrogator categories as the sensor configuration communication with the device defers from model to model. For FS22DI open the optical sensors for FS22 section of the database.*

- ▶ Adapt sensors.
- ▶ Create computation channels.
- ▶ Etc.

## Important

*For further details please refer to catman® software documentation available online and on the help interface of the software.*

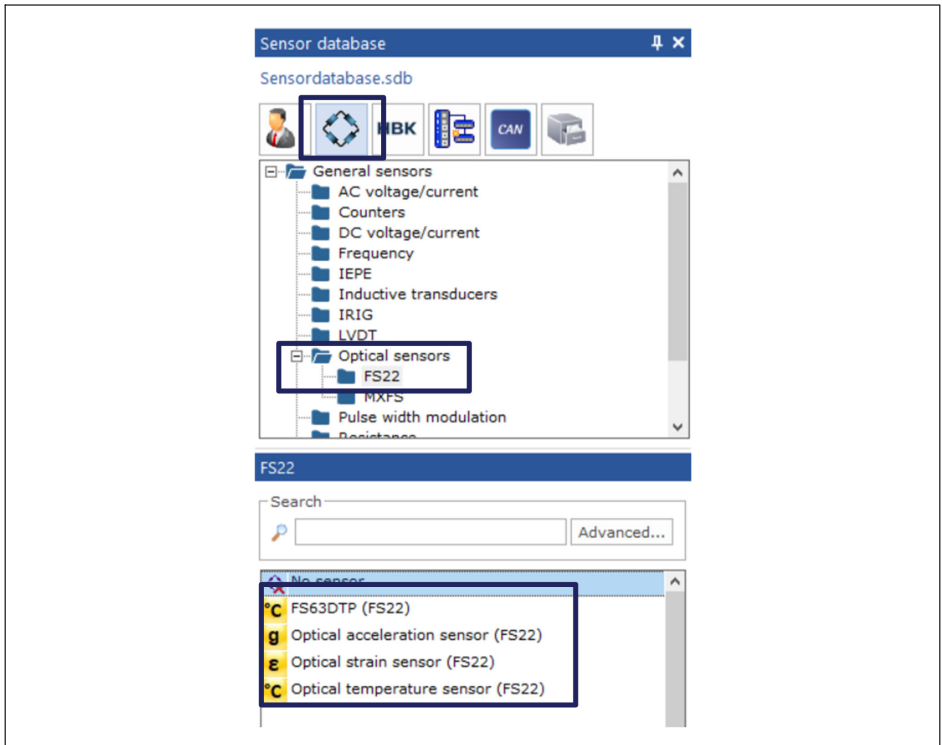


Fig. 8.7 Optical sensors on the database

### Acquisition and visualization

With the prepared channel list, you are ready to start an acquisition job. Remember that some sensors might require zeroing (for example strain sensors) and others must not be zeroed if an absolute measurement value is needed (for example temperature sensors).

Setting up visualization panels for real time data display is also very simple.



### Important

*For further details please refer to catman software documentation available online and on the help interface of the software.*







