imc

fos4Test dyn

Fibre optic measurement device for dynamic measurements

Product highlights

fos4Test dyn expert:

- 4 fiber Bragg grating sensor channels
- Inherent galvanic isolation
- Sample rate 50 kHz
- Optical half-bridge capability
- Temperature compensation of strain gauges sensors via imc STUDIO
- Easy device cascading
- Supply voltage 12 to 24 V
- True Anti-Aliasing
- PTP-capability
  Precision Time Protocol (IEEE1588)

Setting a new standard for strain measurement

Advantages of fiber optic measurement technology include extreme sensor durability without EMI, ESD or isolation problems. Repeatable measurements of very high strain levels are feasible as well as the use of such sensors within harsh environments like high voltage transformer, microwave ovens or explosive settings.

In the field of strain measurement the characteristics of conventional resistive strain gauges such as synchronous sampling, signal band limitation or halfbridges for temperature compensation are now available with the fos4Test instrument series.

The fos4Test dyn instruments combine the specific advantages of optical sensors and the established handling of conventional electrical resistive strain gauges.

Software support

By means of the Ethernet-interface, the device can be integrated into the measurement and test engineering software imc STUDIO. This comprises:

- configuring the device,
- temperature compensation and zero-balancing,
- transfer and storage of measured data,
- live visualization of the measured data,
- comprehensive options for data processing and analysis, applied to live data streams of current measurements as well as in post processing,
- synchronized operation in conjunction with multiple imc measurement systems.

One particular capability of relevance to this context is complete temperature compensation of fiber-optic strain gauges on the basis of independent temperature sensors/channels, which can be provided either by the fos4x device or other independent sources via imc devices. Thus, it is also possible to utilize conventional analog sensors (thermocouples, PT100, etc.) or such sources as the CAN-Bus for the compensation.

Errors and changes excepted   **1**
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Vibration measurement with band limitation

fos4Test dyn is the first fiber Bragg grating measurement device that is suited for vibration measurement.

The fos4Test dyn series features synchronous sampling of up to 50 kHz for each channel while providing anti-alias filtering. The sensor signal bandwidth is up to 10 kHz.

Unlike other FBG measurement devices, aliasing effects [1] are thus prevented. This is an essential requirement for vibration measurements according to DIN 45662.

Ease of use

The instruments and the user interface have been designed with focus on ease of use. This makes optical measurement accessible without deep knowledge of the underlying technology.

Applications

The fos4Test dyn instruments have proven their performance amongst other applications in wind turbine blade monitoring installations. Installed in the rotating hub of several multi megawatt wind turbines, the system is being exposed to harsh environment conditions such as vibration, temperature cycles and moisture.

Working principle

A fos4Test nSens instrument consists of four independent measurement channels. Each channel transmits light at a wavelength of 1550 nm into the sensing fiber.

At one point within the fiber a Bragg grating sensor reflects a certain wavelength of the incoming light, depending on the value of the measurand.

The wavelength of the light reflected from the fiber Bragg grating sensor λ is proportional to the physical quantity being measured (strain, temperature, acceleration etc.).
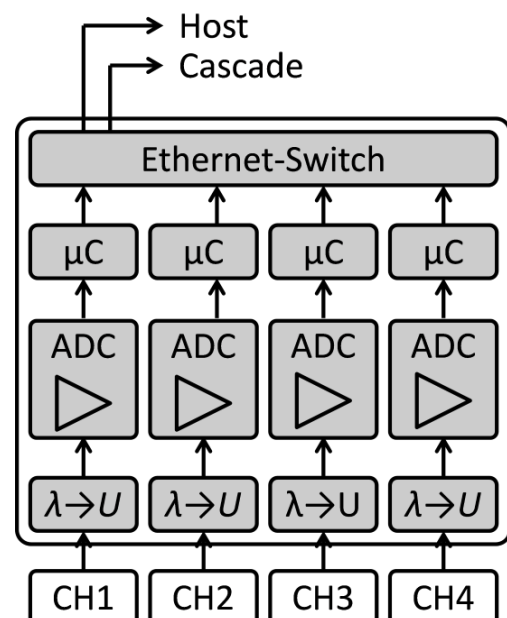
Signal processing

The incoming light is converted into an analogue voltage signal, which is proportional to the sensor wavelength λ.

Each analogue signal is then low pass filtered and converted to a digital value by an analogue to digital converter. Depending on the type of sensor the corresponding measurand is calculated from this. Each measurement channel's sampling frequency can be adjusted individually. Each measurement channel has its own microcontroller where the current sensor wavelength is calculated. All sensor data is then transferred to the host PC via Ethernet.

System connectivity

The fos4Test dyn instruments connect easily with your measurement environment.

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[1]   i.e. compliance with Nyquist-Shannon's sampling theorem

Scalability

Several fos4Test dyn instruments may be cascaded in chain mode, without additional equipment required. Each fos4Test dyn features two Ethernet communication channels with RJ45 LAN / Ethernet connectors.
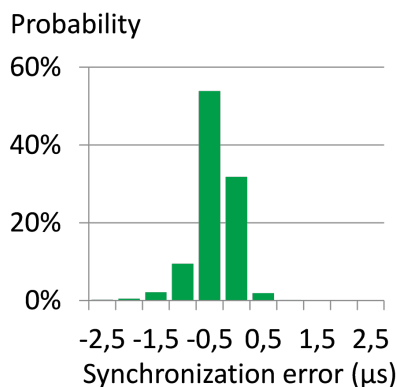
Synchrony and synchronization

Internal hardware synchronisation allows a sampling synchrony of 20 ns between individual channels of a device.

Several fos4Test devices and other devices in the measurement environment that support the IEEE 1588 protocol can be synchronized with a typical synchronization accuracy of below 4 µs.

The synchronization uncertainty is typically below 400 ns.

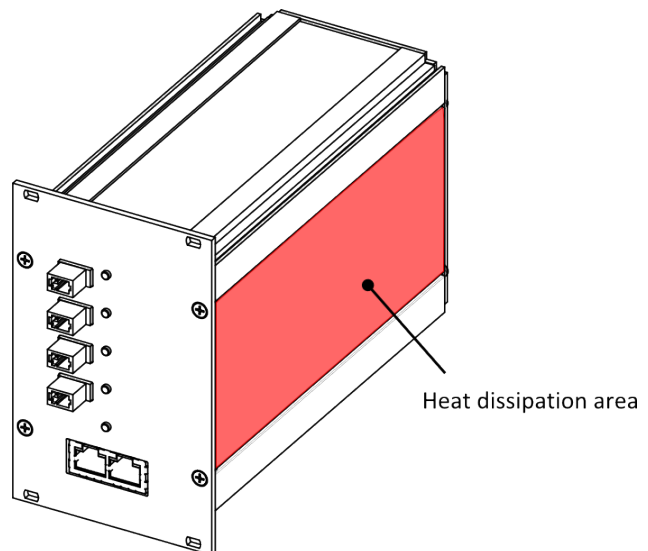### Typical synchrony [2]

Passive conductive cooling

The fos4Test dyn instruments are designed for conductive cooling with low thermal resistance. No fans or active mechanical cooling are required. This allows dense integration into housings with a high protection rating (e.g. IP65).

Heat dissipation area

Mounting options

See table on next page for device dimensions.
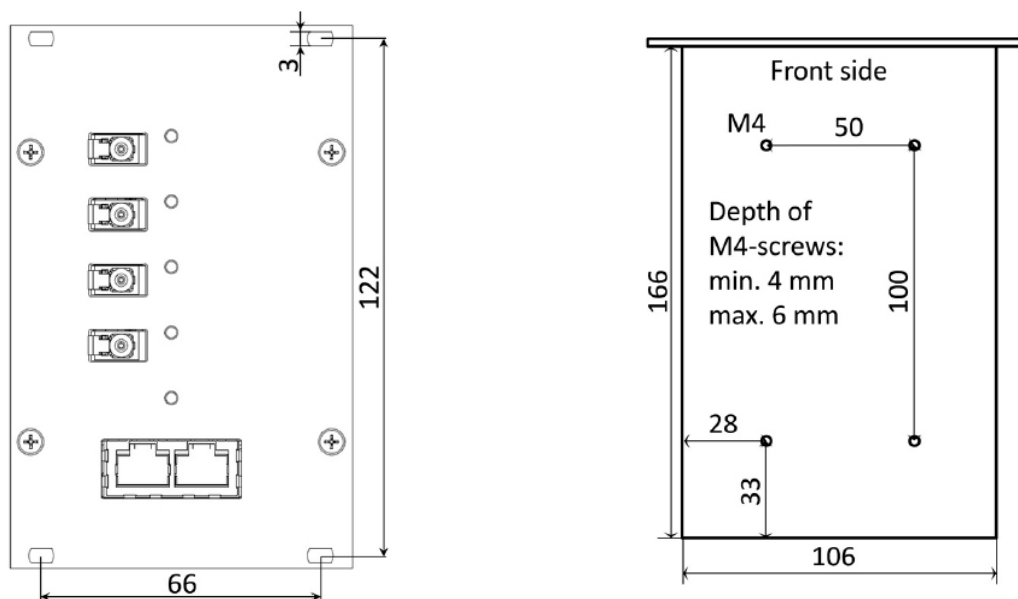
The measurement device is designed for:

- **19'' rack**
  fos4Test dyn devices can be mounted in standard 19'' racks with four M3 screws
- **Side mounting**
  The heat dissipation area may be mounted to other heat conducting structures with four M4 screws.

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[2]   Measurement results over 12 hours operation for displayed channel: $\mu=-0.63$ µs, $\sigma=0.37$ µs

Mechanical drawings [3]

Included accessories

- Power supply 110 V / 230 V, 15 W
- Ethernet interface cable
- fos4Test C compliant driver
- User manual
- Data sheet

Additional equipment and software

- imc STUDIO
- MATLAB and Python driver
- Cleaning kit for fiber optic connectors
- Fiber optic sensors and cables
- Fiber optic extensions

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[3]   Drawing is not to scale

Technical Specs - fos4Test dyn

General		
Parameter	**Unit**	**fos4Test dyn**
Optical channels		4
FBG-sensor sampling rate (fos4Test dyn expert)	Hz (kHz)	500 (50)
FBG-sensor sampling rate via CANopen	Hz	100
3 dB cut-off frequency (fos4Test dyn expert)	Hz (kHz)	10 (10)
Internal sample synchrony	ns	<20
External sampling synchrony [4, 5]	µs	<4
Measurement range (@ 1550 nm)	nm	±4
MTBF	h	>100.000

Measurement accuracy		
Parameter	**Unit**	**fos4Test dyn**
Wavelength reproducability [6]	pm	10
Absolute accuracy	pm	30
Temperature drift (wavelength stability) across the entire operating temperature range	pm	20
Temperature drift (wavelength stability) @ 25°C ±3°C	pm	10
Noise [7]	pm	<1
Resolution	pm	0.024

FBG parameter	Unit	fos4Test dyn
Sensor type		Faser Bragg Gitter
FWHM	pm	100 ... 1500
Reflectivity	%	50 ±10
Full width half maximum	pm	400 ... 600
Side mode suppression	dB	15

Available sensors	Unit	fos4Test dyn
Strain measurement		fos4Strain, fos4Strain expert
Temperature measurement		fos4Temp
Vibration measurement		fos4Acc (1D, 2D, 3D)

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[4]   Measurement results over 12 hours operation for displayed channel: µ=-0.63 µs, σ=0.37 µs
[5]   Precision Time Protocol (PTP)
[6]   measured connections to the front during 100 cycles
[7]   Standard deviation with a sampling rate of 5 Hz

CAN interface	Unit	fos4Test dyn
Connector		RJ45
Connector pin-out		CiA®-303-1
Data rate	kbps	10 - 1000
Protocol		CANopen

Ethernet interface	Unit	fos4Test dyn
Connector		RJ45
Data rate		10/100 Mbps
Protocol		IPv6

Optical interface	Unit	fos4Test dyn
Laser class		1
Optical output power per channel	mW	<10 (typisch 2)
Optical output wave length	nm	1550
Optical connector type		LC/APC or F3000
Fiber type		SMF28 compatible

Power interface		
Parameter	**Unit**	**fos4Test dyn**
Connector		MC 1,5/2 - GF-3,81
Supply voltage	V	12-24 DC
Power consumption	W	<15

Temperature characteristics		
Parameter	**Unit**	**fos4Test dyn**
Storage temperature	°C	-20 ... +65
Operating temperature	°C	+5 ... +40
Warm up time	min	45

Dimension		
Parameter	**Unit**	**fos4Test dyn**
Housing		19" rack
Dimension (Height/Width/Depth)	mm	128.4 (3U) / 81 (16HP) / 170.5
Weight	kg	1.5