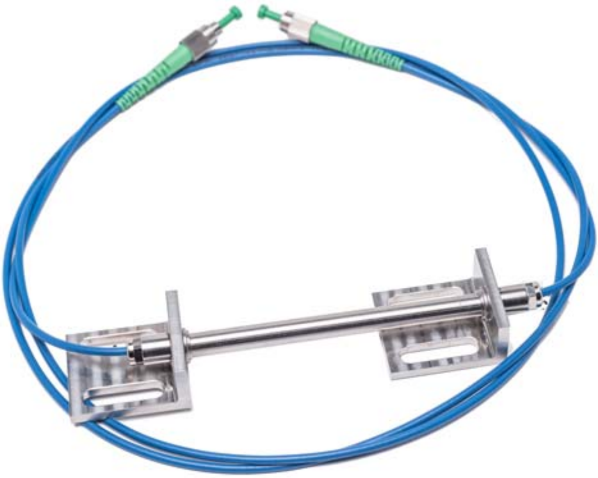
Installation Guide

English



FS62

Surface Mountable Strain Sensor

Hottinger Baldwin Messtechnik GmbH
Im Tiefen See 45
D-64239 Darmstadt
Tel. +49 6151 803-0
Fax +49 6151 803-9100
info@hbm.com
www.hbm.com

HBM FiberSensing, S.A.
Optical Business
Rua Vasconcelos Costa, 277
4470-640 Maia
Portugal
Tel. +351 229 613 010
Fax +351 229 613 020
fibersensing@hbm.com
www.hbm.com/fs

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Sensor Design Version: v1.0

1 Technical Details

1.1 General Information

This installation guide applies to the following products:

Part Number	Description
K-FS62-30-11-302	FS62 - Surface Mountable Strain Sensor • Outdoor • FC/APC
K-FS62-30-13-302	FS62 - Surface Mountable Strain Sensor • Outdoor • SC/APC
K-FS62-30-10-302	FS62 - Surface Mountable Strain Sensor • Outdoor • NC

1.1.1 Overview

The FS62 - Surface Mountable Strain Sensors are fiber Bragg grating (FBG) sensors designed to be bolted connected to concrete, steel, masonry or other materials.

1.1.2 Characteristics

: Robustness

Long-term reliability ensured by innovative sensor design, careful selection of materials and ruggedized packaging.

: Completely passive

Inherent immunity to all electromagnetic effects (EMI, RFI, sparks, etc.) and safe operation in hazardous environments.

: High multiplexing capability

Connection of a large number of sensors to a single optical fiber, reducing network and installation complexity.

: Remote sensing

Large distance between sensors and interrogator (several kilometers).

: Compatible with most interrogators

Provided with calibration sheet, allowing easy and accurate configuration.

: Self-referenced

Based on the measurement of an absolute parameter - the Bragg wavelength - independent of power fluctuations.

1.1.3 Applications

HBM FiberSensing strain sensors can be used in several strain measuring applications. They are particularly suited for structural health monitoring in large structures (SHM).

: Civil Engineering
: Transportation
: Energy
: Aeronautics
: R&D

1.1.4 Quality

All HBM FiberSensing's processes are strictly controlled from development to production. Each product is subjected to high standard performance and endurance tests, individually calibrated and checked before shipping.

HBM FiberSensing, S.A. concentrates all optical sensing activity of HBM and is an ISO 9001:2008 certified company.

1.1.5 Accessories

The implementation of complex sensing networks in large structures is made simpler with HBM FiberSensing accessories. These include cables especially designed to resist harsh environments as in civil engineering, not only during construction, but also during the lifetime of the structure (humidity, corrosion, etc.).

1.2 General Specifications

Sensor	
Sensitivity[1)]	1.5 pm/µε
Measurement range	±2500 µε
Gauge length	108 + 20 mm[2)]
Resolution[3)]	1 µε
Optical	
Central wavelengths	1500 to 1600 nm
Spectral width (FWHM)	< 0.2 nm/FBG
Reflectivity	> 65%
Side lobe suppression	> 10 dB
Inputs / Outputs	
Cable type	Ø 3 mm outdoor (armor)
Cable length	2 m each side (±5 cm)
Connectors	FC/APC SC/APC NC (No Connectors)
Environmental	
Operation temperature	-20 to 80 ºC
Protection class	IP68
Mechanical	
Materials	Stainless steel
Dimensions	163 x 35 x 20 mm
Weight	122 g

1) Typical value
2) Exact value defined by distance between fixation screws
3) For 1 pm resolution in wavelength measurement

2 Sensor Installation

2.1 List of Materials

2.1.1 Surface Mountable Strain Sensor Package

Included Material

Surface Mountable Strain Sensor
Calibration Sheet

2.1.2 Needed Tools

List of Equipment

Drilling Machine
Interrogator (or equivalent)

List of Material

Hammer	1
Drill bit diameter	6 mm
Spanner wrench	10 mm
Metal anchors	Hilti: HSA-R M6X50/-/5 (suggested)

2.1.3 Preparing the Surface

The surface where the sensor is to be installed should be regular.

Make sure of that there are no major irregularities that could interfere with the sensor's fixation to the structure.

Fig. 2.1

Afterwards mark two points distanced by 110 mm and perfectly aligned along the measuring direction (*Fig. 2.2*). Repeat the process with an offset of 22 mm, according to *Fig. 2.2*.

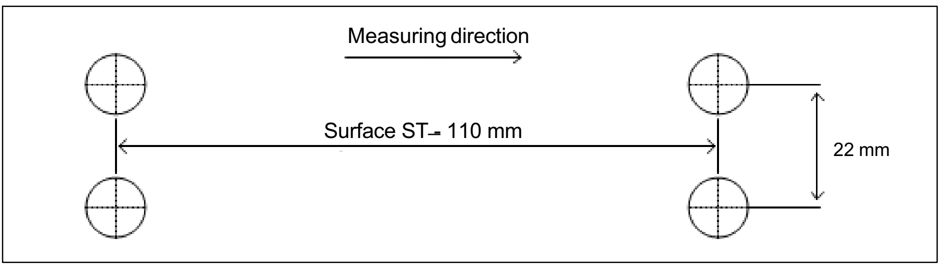


Fig. 2.2

2.1.4 Installing the Sensor

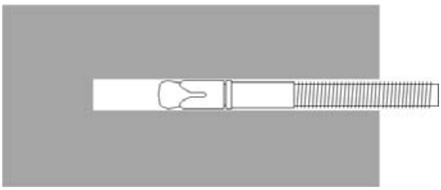
The following procedure refers to the installation on a (cracked/non-cracked) concrete surface. For others base materials, procedure adaptations might be necessary.

1. Drill the holes according to the chosen anchors. (suggested hole depth: 55 mm)
2. Clean the holes and remove the inside dust.

3. Install the anchors in the holes, leaving 10 mm outside.

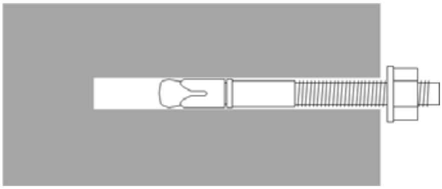
Information

An hammer might be needed for this operation.

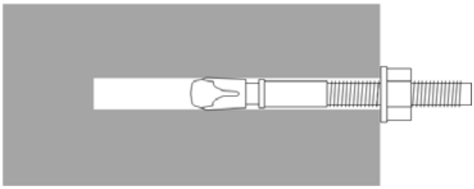


4. Verify the screws position with a measuring tape.

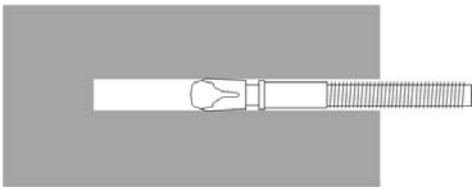
5. Introduce the washes and the nuts.



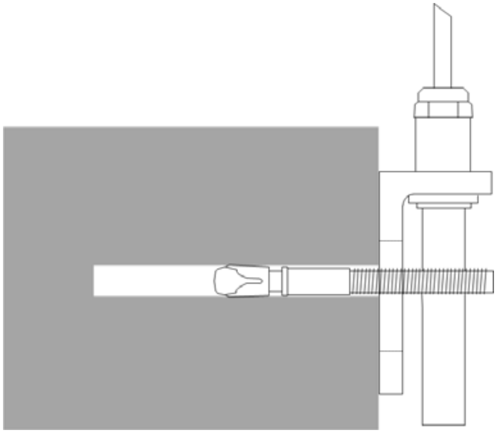
6. Insert the washes and fasten the nuts tightly.
(Recommended tightening torque: 5 Nm)



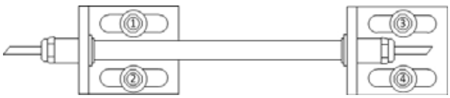
7. Remove the nuts and the washes.



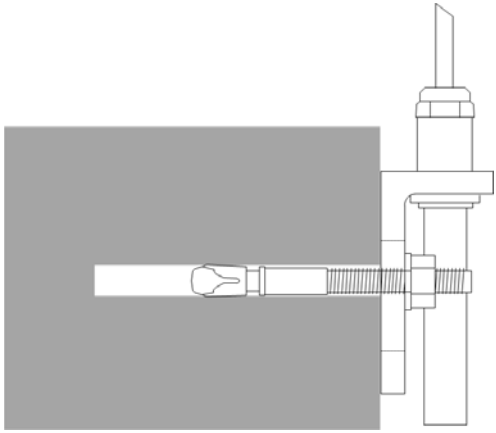
8. Carefully take the sensor out of the transportation box and place it on the supports.



9. Slightly fasten the nuts, 1 and 4, over the washes followed by 3 and 2.



10. Repeat the process, fastening the nuts tightly by the same order. (Recommended tightening torque: 5 Nm)



2.1.5 Custom Installations

For specific applications it is possible to develop customized attachments. See the example in *Fig. 2.3*.

Fig. 2.3

3 Sensor Configuration

Every HBM FiberSensing sensor is provided with a calibration sheet. The layout of this document is the same for all strain sensors.

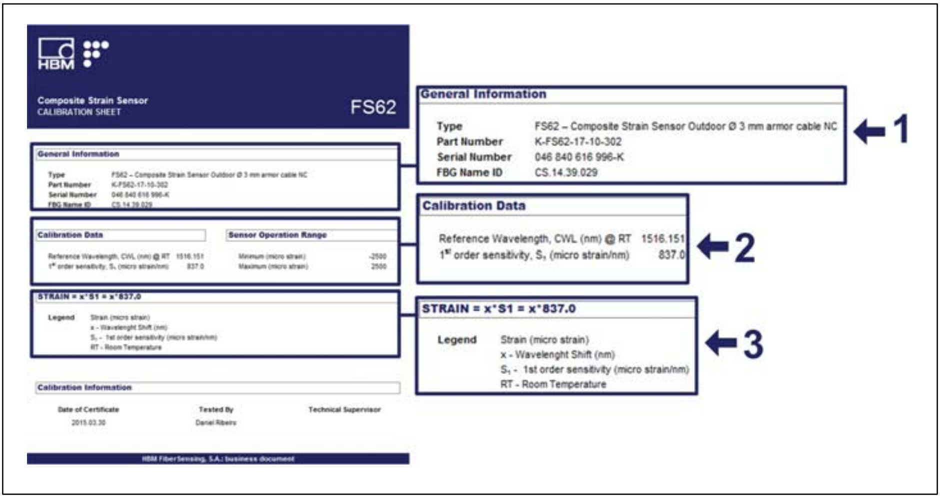


Fig. 3.1

3.1 General Information

Number **1** in *Fig. 3.1* shows the general information on the particular sensor, such as its type, the sensor part number, its serial number and the production tracking number, the FBG ID.

3.1.1 Calibration Data

The most important information related to the strain sensor - central wavelength at room temperature and sensitivity - is shown in the calibration data table (number **2** in *Fig. 3.1*). These values should be used for strain computation.

3.1.2 Strain Computation

Number **3** in *Fig. 3.1* exemplifies the calculations that should be performed for wavelength measurement to strain conversion. The strain variation, under constant temperature, of a Surface Mountable Strain Sensor is given by the product of wavelength shift from the zero moment by the sensor's sensitivity.

$$strain = x * S \leftrightarrow strain = (WL - CWL) * S$$

Fig. 3.2

Where

- x is the wavelength shift in nm
- S is the given sensitivity in $\mu\varepsilon$/nm
- CWL is the central wavelength of the sensor at the zero moment in nm
- WL is the measured wavelength in nm.

3.2 Temperature Effect on the Sensor

The surface mountable strain sensor, as most sensors, is sensitive to temperature changes. The temperature induced wavelength shift can be confused as strain. For its correction, a representative temperature sensor should be used.

3.2.1 Effect of the Temperature on the Sensor

The temperature dependence of the surface mountable strain sensor is:

$$7,32 \times \Delta T$$

Fig. 3.3

Where:

- ΔT is the temperature shift from the zero moment, in ºC, measured with a representative temperature sensor.

This means that in order to compensate for the effect of temperature on the sensor measurement the following computation should made:

$$strain = x * S - 7.32 \times \Delta T \leftrightarrow$$
$$strain = (WL - CWL) * S - 7.32 \times \Delta T$$

Fig. 3.4

Information

Note: this computation only corrects the effect of temperature on FBG and does not take into account the thermal expansion of the base material where the sensor is attached to.

3.2.2 Effect of the Temperature on the Sensor and on the Base Material

To compensate also for the deformation of the structure due to temperature effects, the computation should be made considering the coefficient of thermal expansion (CTE) of the structure.

The total strain variation of a structure is:

$$strain = strain_{Load} + strain_{Temp\ on\ FBG} + strain_{Temp\ on\ Structure} \leftrightarrow$$
$$strain = strain_{Load} + strain_{Temp\ on\ FBG} + CTE_{Structure}\,\Delta T \leftrightarrow$$

Fig. 3.5

Where

- Strain is total strain in $\mu\varepsilon$
- $Strain_{Load}$ is the strain due to loading that we want to measure in $\mu\varepsilon$
- $Strain_{Temp\ on\ FBG}$ is the temperature induced strain measurement, as explained above, in $\mu\varepsilon$
- $Strain_{Temp\ on\ Structure}$ is the temperature induced strain on the structure, in $\mu\varepsilon$
- $CTE_{Structure}$ is the thermal expansion coefficient of the structure material in $°C^{-1}$

Meaning that to compensate the deformation of the structure due to temperature effect, it is necessary to know the CTE value of the material of the structure where the sensor is fixed on.

The strain caused by loading can then be computed as:

$$strain_{Load} = strain - strain_{Temp\ on\ FBG} - CTG_{Structure}\,\Delta T \leftrightarrow$$
$$strain_{Load} = x * S - 7.32 \times \Delta T - CTE_{Structure} \times \Delta T$$

Fig. 3.6

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HBM Test and Measurement
Tel. +49 6151 803-0
Fax +49 6151 803-9100
info@hbm.com

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