ENGLISH

Mounting Instructions

FS65ACC

Accelerometer

HBK FiberSensing, S.A.
Via José Régio, 256
4485-860 Vilar do Pinheiro
Portugal
Tel. +351 229 613 010
support.fs@hbkworld.com
www.hbkworld.com

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TABLE OF CONTENTS

1 GENERAL INFORMATION

The following instructions refer to the installation procedure of FS65ACC Optical Accelerometer

These sensors are delivered individually. Nevertheless, these sensors have two fibers for easy assembly in series for example to be mounted in bi- or tri-axial configurations.

Material Numbers
K-FS65ACC
1-FS65ACC-10/1530
1-FS65ACC-10/1540
1-FS65ACC-10/1550
1-FS65ACC-10/1560
1-FS65ACC-10/1570

1.1 Environment Considerations

1.1.1 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. 1.1 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

Packing 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,...

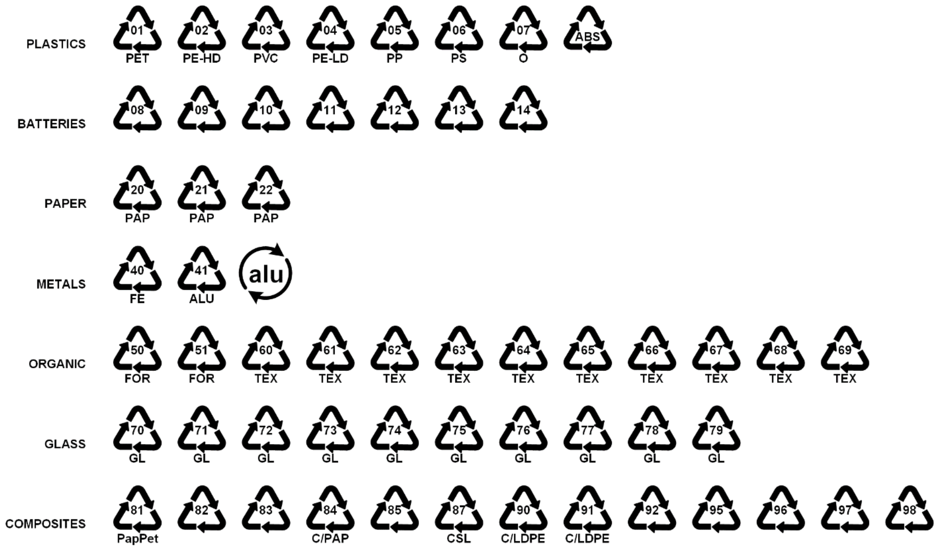

Fig. 1.2 Recycling symbols

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 SENSOR INSTALLATION

2.1 Introductory notes

When mounting FS65ACC sensors, please pay attention to the following:

- Handle with care.
  These are precision sensors and so their achievable accuracy highly depends on correct mounting.
- Do not overload the sensors.
- Avoid lateral forces or torque.
- Handle the cables with care before fixing to avoid damage. Do not hold the sensor by the cables.
- Nuts from the cable exiting from the sensors are part of the sensors' body and must not be unfastened.

Notice

The FS65ACC sensors are precision measuring elements and need to be handled carefully. Dropping or knocking the sensors may cause permanent damage. Make sure that the sensors cannot be overloaded, including while they are being mounted.

2.2 List of materials

Included material
FS65ACC Accelerometer

Needed equipment
Drilling Machine (optional)

Needed material
Anchors (M5 Bolt)
Specifically designed mounting brackets (optional)

The needed tools to install the FS65ACC Optical Accelerometer depend on the structure the sensor is to be installed on. In many cases, mounting parts may need to be designed in order to adapt the sensor to the spot where it is going to be installed.

2.3 Preparation of the mounting area

The installation solution should be carefully designed in order to meet the sensor measuring direction and the structure characteristics.

2.4 Positioning the sensor

The sensor can be placed headed up, headed down or towards the side (Fig. 2.1), in accordance to the desired measuring direction.

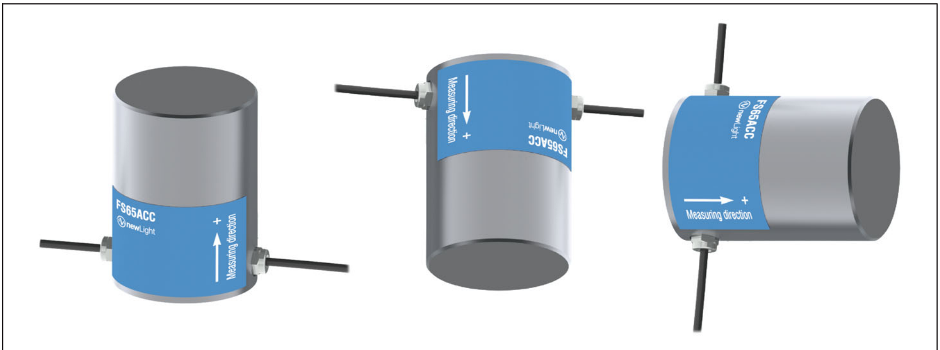

Fig. 2.1 Versatile mounting positions

Information

This will only alter the sensor's DC output. Dynamically, it will still have the same behavior.

2.5 Fixing the sensor

The sensor has an M5 hole at its base. The sensor can be fixed directly on an anchor with a compatible bolt. For some situations a mechanical mounting base should be used for easier onsite installation and sensor orientation.

2.6 Routing and protecting the cables

Sensor cable should be routed without being left hanging. The cable should be fixed by means of plastic clamps, for example (*Fig. 2.2*).

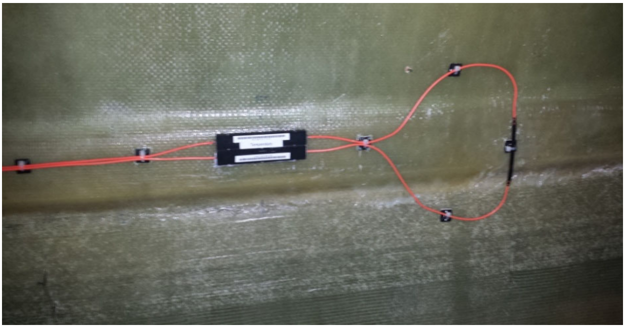

Fig. 2.2 Cable fixed with plastic clamps

Plastic corrugated tubes can also help routing the longer lead cables that will connect to the interrogator (*Fig. 2.3*).

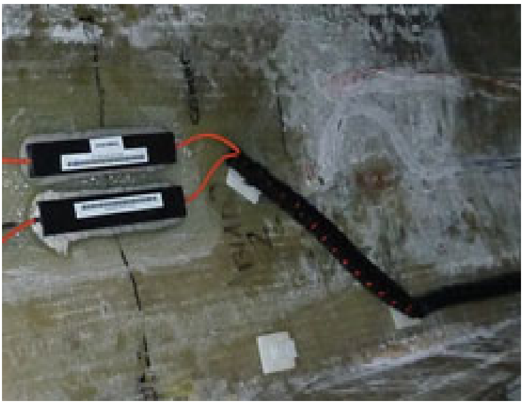

Fig. 2.3 Cable protected with corrugated tubes

Excess cable should be coiled and stored in a suitable IP case, so it can be used in case of network refurbishment (*Fig. 2.4*).

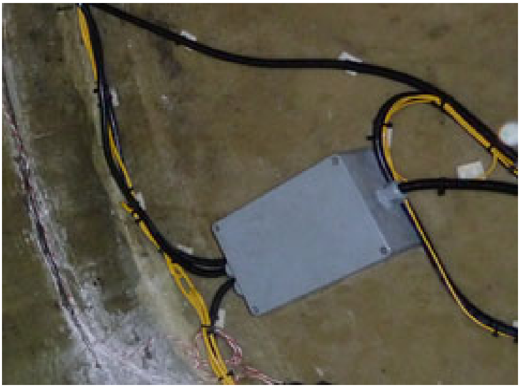

Fig. 2.4 Protection boxes for extra cable and connections

2.7 Protecting the sensor

The FS65ACC Accelerometer is IP65 rated, meaning that additional protection might be needed. It can be protected with a box or other for higher mechanical protection level.

3 SENSOR CONFIGURATION

3.1 Sensors documentation

Calibrated HBK FiberSensing Sensors are delivered with a Calibration Sheet.

Within the sensor's packing this installation instructions document is delivered in a printed version. Installation instructions can also be downloaded from HBK website (www.hbkworld.com).

3.2 Measurement computation

The FS65ACC Accelerometer is a single axis measurement sensor that shows a linear calibration formula.

3.2.1 Acceleration

The calculations that should be performed for converting a wavelength measurement into acceleration are the shown in *Fig. 3.1*.

$$A = S \times (\lambda - \lambda_0)$$

Fig. 3.1 Acceleration computation formula

Where

- A is the measured acceleration in g
- λ is the measured Bragg wavelength of the accelerometer sensor in nm
- λ_0 is the Bragg wavelength of the accelerometer sensor at reference instant in nm
- S is the calibration factor as delivered by the calibrtion sheet in g/nm

3.2.2 Measurement flatness

The calibration of the FS65ACC Accelerometer Sensors is performed at a reference frequency. Nevertheless, calibration dependency on the measurement frequency is kept under strict limits as referred on the sensors calibration sheet.

A typical deviation on the wavelength for a fixed acceleration amplitude is depicted below:

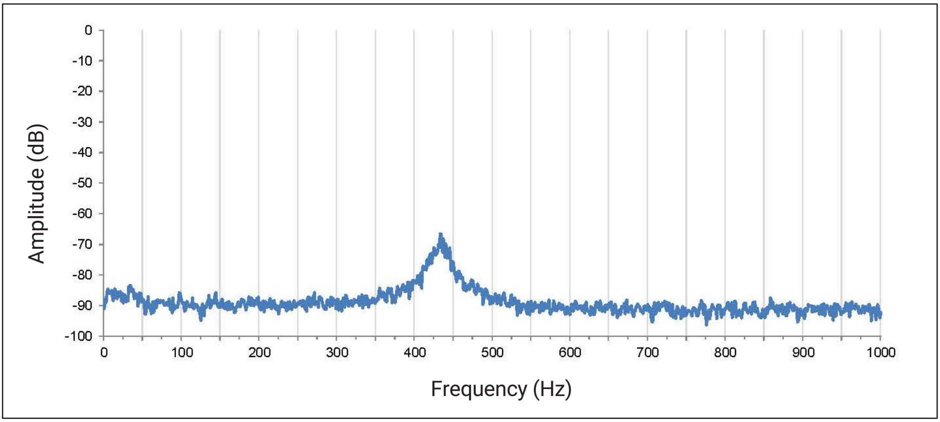

Fig. 3.2 Typical frequesncy dependency curve of the FS65ACC

3.2.3 Signal resolution

The bare fiber Bragg grating measurement resolution is dictated directly by the resolution in the wavelength measurement of the used interrogator system. If we add, on top of the FBG, some kind of transducer the resolution becomes also dependent on the mechanics of the sensor.

Time based measurement

For determining the signal resolution of a fiber Bragg grating based sensor on the time domain there is the need to consider the sensitivity of the transducer combined with the resolution of the interrogator that is used for the measurement

$$\textit{Sensor Resolution} = \frac{\textit{Interrogator Resolution}}{\textit{Sensor Sensitivity}}$$

Fig. 3.3 Time domain resolution determination

When combining a typical FS65ACC sensor sensitivity (59 pm/g) with the typically used FS22DI interrogator (with a resolution of 1pm) we can estimate a sensor resolution of 17mg.

Frequency based measurement

On the particular case of the FS65ACC Accelerometer one can also take advantage of a dynamic measurement and increase the measurement resolution by performing a frequency based measurement.

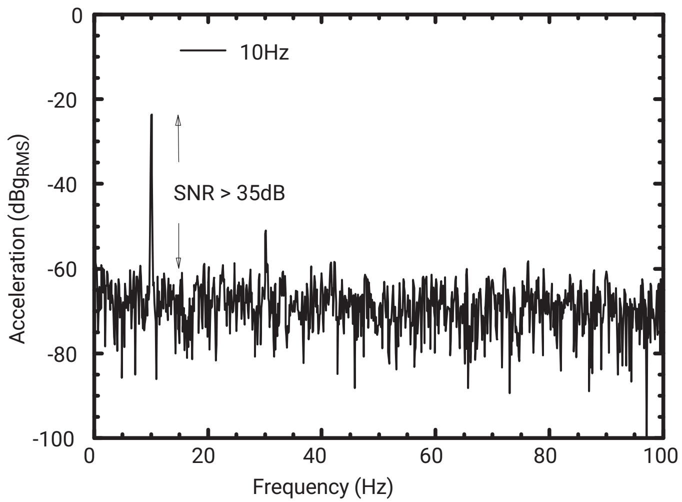

Fig. 3.4 Zoom of the FTT analysis for a signal at 10 Hz

The relation between the time domain peak acceleration value (A) and the FFT peak RMS value (A_{RMS}) is given by

$$A = \sqrt{2} * 10^{\left(\frac{A_{RMS}}{20}\right)}$$

Fig. 3.5 Frequency domain acceleration determination

The FFT trace peak value is -23.3 dBg_{RMS} at 10 Hz that corresponds to a peak acceleration of 0.097 g. Taking into account that the noise level is at -60 dBg_{RMS} the system resolution can be calculated as 1mg (45 µg/√Hz considering the system bandwidth of 500 Hz).

3.2.4 Temperature compensation

The accelerometer output is sensitive to temperature changes.
Temperature changes are commonly slow when compared to the desired measurements. In dynamic applications involving short acquisition periods, the temperature influence on the measurement is not relevant.

On the other hand, for long term measurements the effect of temperature on the accelerometer output cannot be neglected.

The temperature effect can be easily compensated by using one of the following methods:

Signal filtering

When the desired signal has a faster behavior than the temperature change, a high pass filter, such as a Butterworth high pass filter, can be used on the signal eliminating the slow effect of temperature.

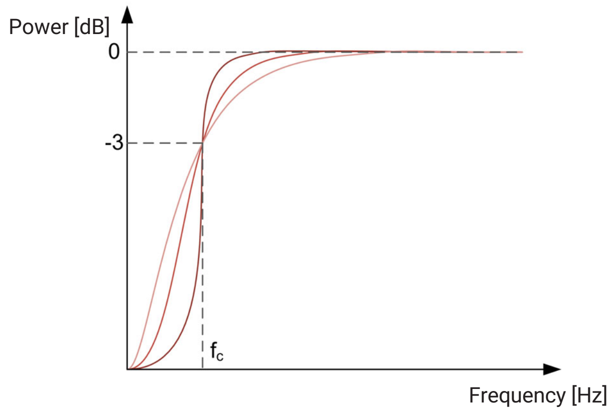

Fig. 3.6 *Butterworth high pass filter*

Measuring temperature

By means of using a temperature sensor (optical or electrical) the temperature variation can be determined and used for signal compensation as in *Fig. 3.7*.

$$A = S \times (\lambda - \lambda_0) - TCS \times (T - T_0)$$

Fig. 3.7 *Acceleration measurement with temperature compensation*

Where

- *A* is the measured acceleration in g
- λ is the measured Bragg wavelength of the accelerometer in nm
- λ_0 is the Bragg wavelength of the accelerometer sensor at the reference instant in nm
- *S* is the calibration factor as delivered by the calibration sheet in g/nm
- *TCS* is the temperature cross sensitivity of the accelerometer sensor in g/ºC
- $T\text{-}T_0$ is the temperature variation since the reference instant to the measurement instant in ºC

Measurement with distance effect correction

When measuring with 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. Distance error becomes important for sensors that base their measurement on absolute wavelength values as it is the case of temperature sensors.

This effect is a constant shift in the wavelength measurement that depends on the actual sampling rate of the optical module and on the distance between the sensor and the interrogator. 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.

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.

HBK - Hottinger Brüel & Kjaer
www.hbkworld.com
info@hbkworld.com

A05090 02 E00 00