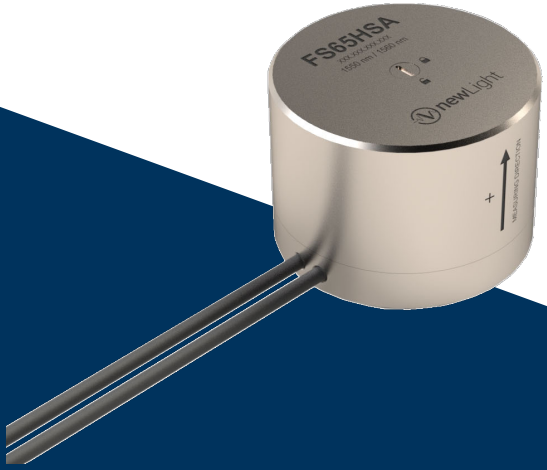
FiberSensing by HBK
HOTTINGER BRÜEL & KJÆR

ENGLISH

Mounting Instructions



FS65HSA

High Sensitivity 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

Mat.:
DVS: A06266 01 E00 00
11.2024

TABLE OF CONTENTS

1 GENERAL INFORMATION

The following instructions refer to the installation procedure of FS65HSA High Sensitivity Accelerometer.

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

Material numbers
K-FS65HSA
1-FS65HSA-02/2510
1-FS65HSA-02/2525
1-FS65HSA-02/2540
1-FS65HSA-02/2555
1-FS65HSA-02/2570
1-FS65HSA-02/2585
1-FS65HSA-05/2510
1-FS65HSA-05/2530
1-FS65HSA-05/2550
1-FS65HSA-05/2570
1-FS84-FS65HSA01

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,...

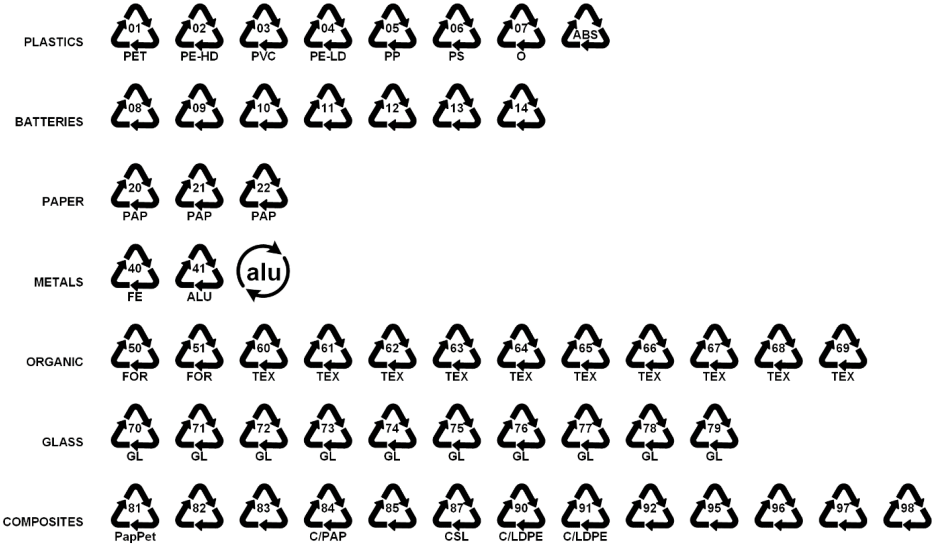


Fig. 1.2 Recycling symbols

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 FS65HSA sensors, please pay attention to the following:

Notice

The FS65HSA sensor is delivered in the locked position, that should be kept for all handling. Unlock the sensor only when readily installed for operation.
Always handle the sensor in the lock position. Check section 2.3 "Locking and unlocking the sensor", page 9 for details.

- 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 FS65HSA sensors are precision measuring elements and need to be handled carefully, even when in the lock position. 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
FS65HSA
Mounting accessory with M5 bolt (optional)

Needed equipment
Drilling Machine (optional)
Deburring Machine (optional)

Needed material
M5 Bolt (when without mounting accessory)
3x M5 Anchors (for using the mounting accessory)
Screwdriver for anchors and bolts
Screwdriver to unlock the sensor (4 mm slotted recommended)

The needed tools to install the FS65HSA Optical Accelerometer depend on the structure the sensor is to be installed on. In many cases, mounting parts may need to be designed in arder to adapt the sensor to the spot where it is going to be installed.

A mounting accessory with three anchoring points is available (**1-FS84-FS65HSA01**) that can be purchased separately or selected as an option for the configurable accelerometer (**K-FS65HSA**).

2.3 Locking and unlocking the sensor

The FS65HSA sensor is highly sensitive. It is therefore very delicate and cannot be subjected to uncontrolled movements and shock as the regularly seen during transportation and installation. The sensor has a locking mechanism to prevent damage upon handling or transportation.

Notice

Always handle the sensor in the locked position. Unlock the sensor only when readily installed for operation.

You must ensure the sensor is in the locked position before starting a mounting or unmounting operation.

- Use a 4 mm slotted screwdriver to rotate the mechanism to the lock position.

Fig. 2.1 Locked position

Fig. 2.2 Unlocked position

2.4 Preparation of the mounting area

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

The surface where the sensor is to be installed should be regular and provide support over the full area of the sensor base.

Make sure that there are no major irregularities that could interfere with the sensors' or mounting accessory's base surface and fixation stability.

- Mechanically remove major bumps or irregularities of the installation surface

It is now time to drill the anchoring points.

- Mark one point if the sensor is to be installed without the mounting accessory, or the three points from the mounting accessory with the following dimensions.

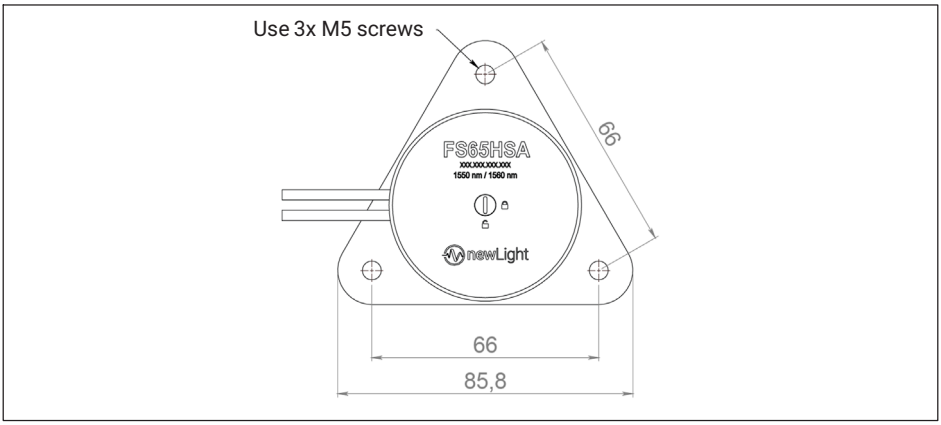


Fig. 2.3 Fixation points of the mounting accessory

▶ Drill the holes in accordance to the used anchor's manufacturer instructions.

Fig. 2.4 Drilling

▶ If needed, remove burrs using an appropriate tool.

2.5 Positioning the sensor

The sensor can be placed headed up, headed down or towards the side (*Fig. 2.5*), in accordance to the desired measuring direction.

Fig. 2.5 Versatile mounting positions

Information

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

2.6 Fixing the sensor

2.6.1 Without the mounting accessory

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 onside installation and sensor orientation.

- Apply the anchor and M5 bolt in accordance with the anchor's manufacturer instructions.
- Ideal thread engagement length is 7-8 mm.
- Fix the sensor by rotating on the preinstalled bolt.

Information

For rotating the FS65HSA during the installation its cables need to be free so that the movement does not tangle the cables. In situations where this is not possible, opt to use the mounting accessory that allows for the direct installation without the need to rotate the sensor.

2.6.2 With the mounting accessory

- Use the provided M5 bolt to securely fix the sensor to the mounting accessory. Recommended torque: 4Nm
- Apply the anchors for the mounting accessory fixation in accordance with the anchor's manufacturer instructions.
- Position the mounting accessory with the sensor over the holes and align.
- Apply the M5 bolts and secure the mounting accessory.

2.7 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. 2.6*).

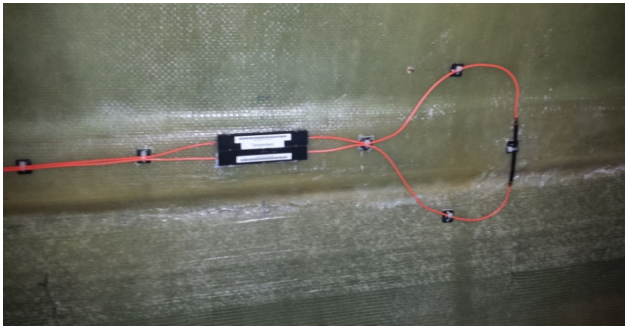


Fig. 2.6 Cable fixed with plastic clamps

Plastic corrugated tubes can also help routing the longer lead cables that will connect to the interrogator (*Fig. 2.7*).

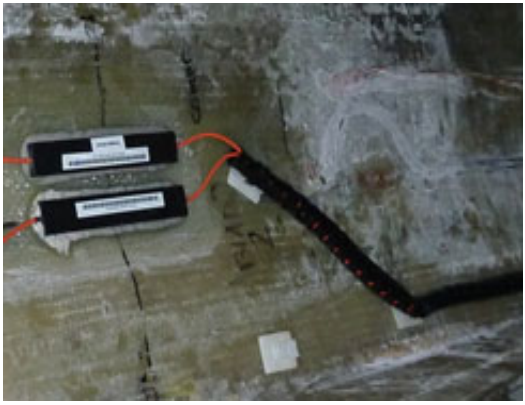


Fig. 2.7 Cable protected with corrugated tubes

Excess cable should be coiled and stored in a suitable IP case, so it can be used in case of network refurbishment (*Fig. 2.8*).

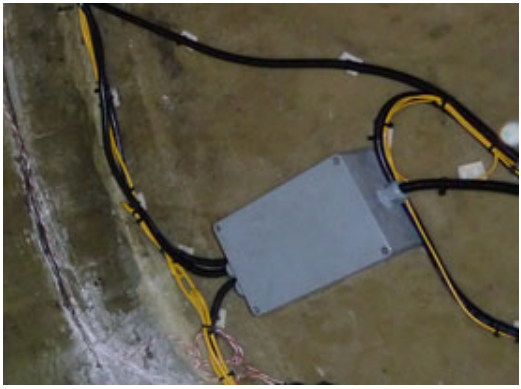


Fig. 2.8 Protection boxes for extra cable and connections

2.8 Protecting the sensor

The FS65HSA Accelerometer is IP68 rated. Nevertheless, in case of need, a cover can applied on top of the sensors for mechanical protection.

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 FS65HSA High Sensitivity Accelerometer is a single axis measurement sensor that uses two fiber Bragg gratings in a push-pull configuration for effective thermal compensation of the measurement.

3.2.1 Acceleration

The calculations that should be performed for converting two wavelength measurements from FBG 1 and FBG2 into acceleration are the shown in *Fig. 3.1*

$$A = S \times [(\lambda - \lambda_0)_{FBG2} - (\lambda - \lambda_0)_{FBG1}]$$

Fig. 3.1 Computation formula

Where

- A is the measured acceleration in g
- λ is the measured Bragg wavelength of the FBG1 and FBG2 sensors in nm
- λ_0 is the Bragg wavelength of the FBG1 and FBG2 sensors at reference instant in nm
- S is the calibration factor as delivered by the calibration sheet in g/nm

3.2.2 Measurement flatness

The calibration of the FS65HSA 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:

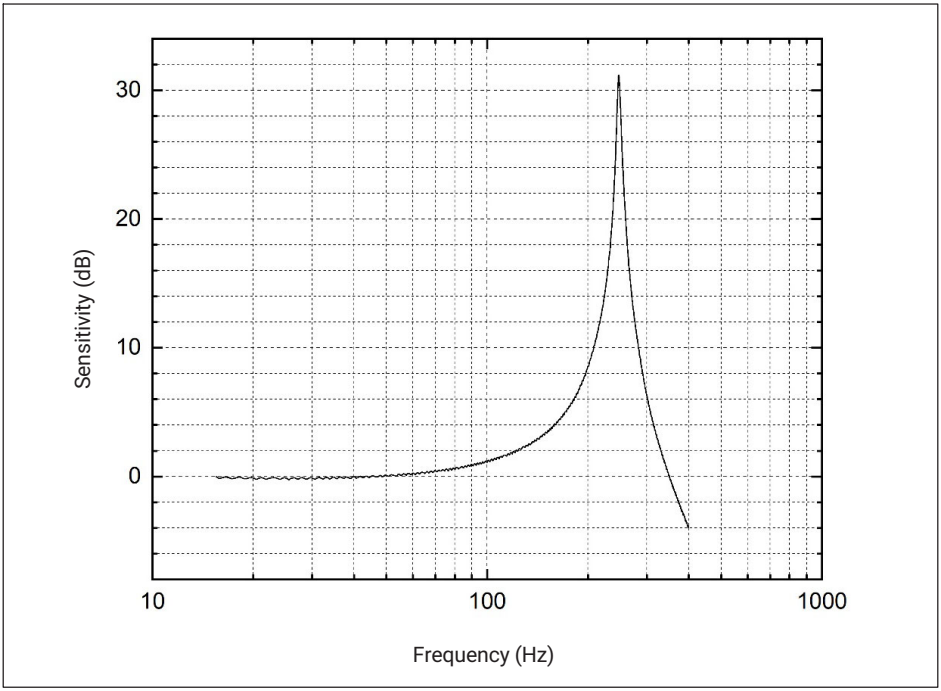


Fig. 3.2 Typical sensitivity frequency dependency curve of the FS65HSA

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

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

Fig. 3.3 Time domain resolution determination

When combining a typical FS65HSA sensor sensitivity (650 pm/g per FBG resulting in 1300 pm/g combined sensitivity) with the typically used MXFS interrogator (with a resolution of 1 pm) we can estimate a sensor resolution of less than 1 mg.

Frequency based measurement

On the particular case of the FS65HSA Accelerometer one can also take advantage of a dynamic measurement and increase the measurement resolution by performing a frequency based measurement.

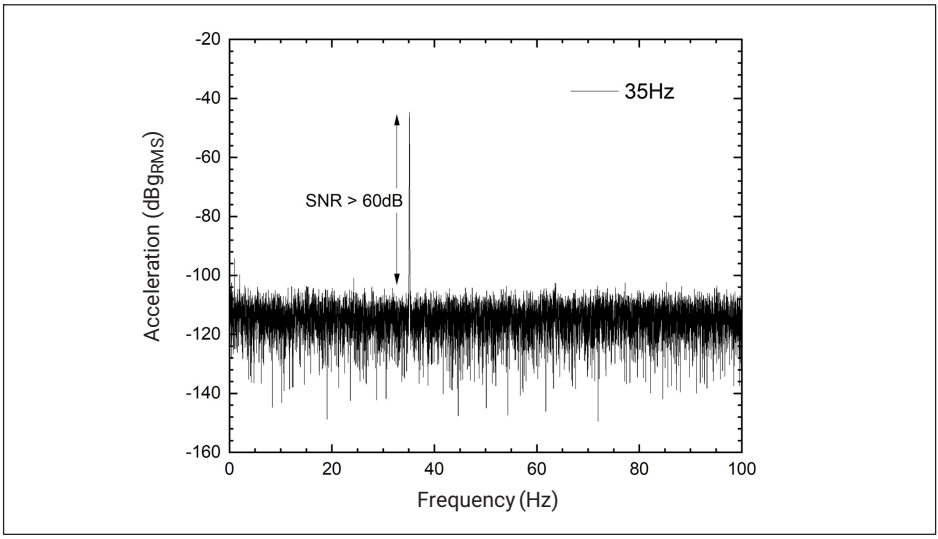


Fig. 3.4 Zoom of the FTT analysis for a signal at 35 Hz

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 -44.6 dBg$_{RMS}$ at 35 Hz that corresponds to a peak acceleration of 0.0083 g. Taking into account that the noise level is at -105 dBg$_{RMS}$ the system resolution can be calculated as 8 µg (0.25 µg/√Hz considering the system bandwidth of 1000 Hz).

Tip

This resolution is dependent not only on the accelerometer performance, but also on the noise floor of the measurement unit being employed. The presented results correspond to the FS65HSA connected to an MXFS DI (v2) Interrogator.

3.2.4 Temperature compensation

The FS65HSA High Sensitivity Accelerometer uses two FBG in a push pull configuration to compensate for thermal changes. Typically, the effect of temperature over the full frequency operating range is limited to 4 mg/ºC.

Temperature has no visible effect on the sensor's sensitivity.

3.2.5 Multi axis configuration

FS65HSA sensors can be combined in series on the same line. It is, therefore, possible to assemble the sensors in their different positions to create a multi axis measurement.

The standard wavelength definition for the FS65HSA sensors dictate how many FS65HSA sensors can be inserted in series on the same optical connector.

Important

Pay attention to the selection of the sensors' central wavelengths as signal overlapping can occur.

4 SENSOR MAINTENANCE

The FS65HSA is designed to withstand harsh environments. It is not expected that it requires maintenance. However, the installation robustness can degrade over time and repairs might be needed.

Notice

Before acting on the sensor do not forget to lock it to prevent complete damage. Please refer to section 2.3 “Locking and unlocking the sensor”, page 9 for details.

4.1 Sensor

If the sensor requires repair or maintenance, it should be performed by HBK FiberSensing at their facilities. Please contact HBK for support. Note that repairs performed by HBK FiberSensing may be subject to a fee.

4.2 Cables

If a cable is damaged during installation or use, a local repair might be possible. However, the feasibility of the repair depends on the damage's location. If the damage is too close to the sensor, there may not be enough cable length available to use the splicing tools, making the repair unfeasible.

When a repair is feasible and there is sufficient cable length, you can cut the cable to remove the damaged section and perform a splice on the fiber cable. If there isn't enough cable length, you will need to insert an extension and perform two splices.

Please contact HBK FiberSensing for support on the splicing procedures.

4.3 Connectors

If a connector is damaged, it can be replaced either by performing a local splice or by returning the sensor for reconnection. Note that repairs performed by HBK FiberSensing may be subject to a fee.

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

A06266 01 E00 00