

MS-03 Installation procedure

Introduction

This document aims to describe the installation procedures of the MS-03 strain sensor on a surface of a monitored object.

Mounting of the brackets depends on the installation conditions and surface material type. For achieving the most stable and long-term bond between the monitored structure and the MS-03 sensor's brackets, the following selection of the installation method is recommended:

Welding → Screwing → Gluing.

MS-03 is also a concrete embeddable sensor – after being correctly mounted it is possible to grout or spray or cover the whole sensor with concrete.

This installation manual serves only as a guide and presents the most used installation approach.

Please, adapt the installation to your current conditions and possibilities.

Installation requirements

Instruments & Tools

- Pair of MS-03 mounting brackets
- Two spanner keys, size 10
- High Strength Thread-Locking Adhesive Loctite 2701
- Hole Template, Tape measure, Permanent Marker, Spirit Level
- FBG interrogator with matching bandwidth and necessary accessories for connecting sensor and measure value (Installation Water/Shock/Dustproof CASE: Sylex: S-line Battery + Scan 800 + Microsoft Surface)
- Charged Batteries or Electric Extension Cord
- Health and Safety Protective Equipment
- **For Screwing Installation method into Solid Building Materials:**
 - o Drilling equipment (drill machine, drill)
 - o Hole cleaning equipment (Vacuum cleaner, Hole Brush)
 - o Metal anchor (as an example we use Fischer Brass dowel MS 4 x 15)
- **For Steel Strand Installation method**
 - o Optional LOCTITE 648 high strength retaining compound for increase adhesion between brackets and steel strand.

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- **For Welding Installation method into Steel Surfaces:**
 - Welding equipment (Direct method MMA/MIG/MAG/TIG/LASER or Indirect method CD Stud Welding)
 - By used technology, additional equipment and tools may be required
 - (Pegasar 500 ACCU + Stud Gun C06-3 + M6 SS Studs)
 - Surface cleaning accessories:
 - Sandpaper (80) or Grinder
 - Cleaning tissues
 - Cleaner: Loctite 7061 / 7063 / Isopropanol IPA
 - Surface recovery:
 - Gap Filling Epoxy Adhesive System:
 - Spabond 345 with Slow hardener + mixer + latex gloves
 - Cold Chisel and Hammer for removing test pins

Installation time

Typical installation time for MS-03 sensor: **between 5-10min** (surface preparation is not considered).

Installation sequence

This sequence is described in the next chapters in more detail. Time indicates estimated time efforts.

- (1) Anchoring distance [<1 minute]
- (2) Surface preparation [5 minutes] ¹⁾
- (3) Mounting of brackets [2 minutes]
 - I. Welding
 - II. Mechanical (Screwing)
 - III. Chemical (Gluing)
- (4) Mounting of MS-03 into brackets [2 minutes]
- (5) Setting up pre-strain [2 minutes] ²⁾

¹⁾ Time for completing highly depends on the surface of the monitored object.

²⁾ Requires sensor to be connected to the interrogator.

(1) Anchoring distance and gauge length

MS-03 is a short gauge strain sensor with a fixed gauge length. The gauge length is equal to the anchoring distance, Figure 1. Positions of the sensor's mounting brackets on the measured object are defined by the anchoring distance. An ideal anchoring distance of 110mm is however nearly impossible to achieve during real word deployment and therefore the sensors feature an adjustable fixation range of 38mm.

For example:

- Bracket MBM-03 Steel Strand width = 15mm.
- Anchor distance tolerance: minimum 92,45mm (77,45+15) and maximum 111,25mm (126,25-15)



Figure 1. MS-03 anchoring length

(2) Surface preparation

Regardless of the installation method, it is recommended to properly treat the surface to which the brackets should be applied. This process includes mechanical cleaning of the surface using abrasive materials and removing any paint, rust, debris, or similar imperfection from the surface. It's only necessary to clean areas where the mounting brackets will be installed.

Chemical treatment of the surface is recommended to happen no longer than 20min before the installation to avoid the creation of oxide layers on the treated surface.

Recommended cleaning solvents (not included inside the packaging):

- ▲ Loctite 7061
- ▲ Loctite 7063

(3) Installation of the mounting brackets

The MBM-03 brackets series are made from stainless steel 304 grade and therefore it's possible to weld them down to a steel object. Or, the brackets can be mechanically mounted (screwed) or even bonded to a surface using appropriated adhesive. Welding is of course recommended installation method from the long-term stability point of view.

No matter what method is chosen, several critical conditions must be fulfilled to have the mounting brackets reliable installed on the surface:

- (1) The anchoring distance is the center-to-center distance of a pair of MBM-03 mounting brackets used for the installation (see Figure 1).
- (2) The mounting brackets have to be installed and aligned in one axis to each other and perpendicular to the measured surface.
- (3) Both brackets have to be in the same height level to prevent the possible geometrical error from the measurement.

Indirect and Direct welding method

Indirect welding using stud welding technology allowing the attachment of thread pin is sometimes the only one possible option of bracket installation. The approach is fast, with minimal surface intrusion to the measured construction and with the possibility to deploy the brackets without the necessity of limiting the operation of the subjected construction.

However, direct welding of the mounting brackets is the recommended and preferred method to achieve long term stable bond between the brackets and the monitored surface.

For both approaches, it is mandatory to follow up the anchoring distance to adjust the pre-strain of the sensor. A mismatch in the anchoring distance could result in possible issues and not meeting the required measurement range.

Figure.2 shows the surface preparation for both welding method. The green color represents a protective layer that presents the structure that has to be removed before the installation. The areas in the axis of the sensor area used for the actual welding of the brackets - 30x30mm with a

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distance between each other of 110mm. The additional cleaned area 3 is for attaching the ground cable for the welding machine.

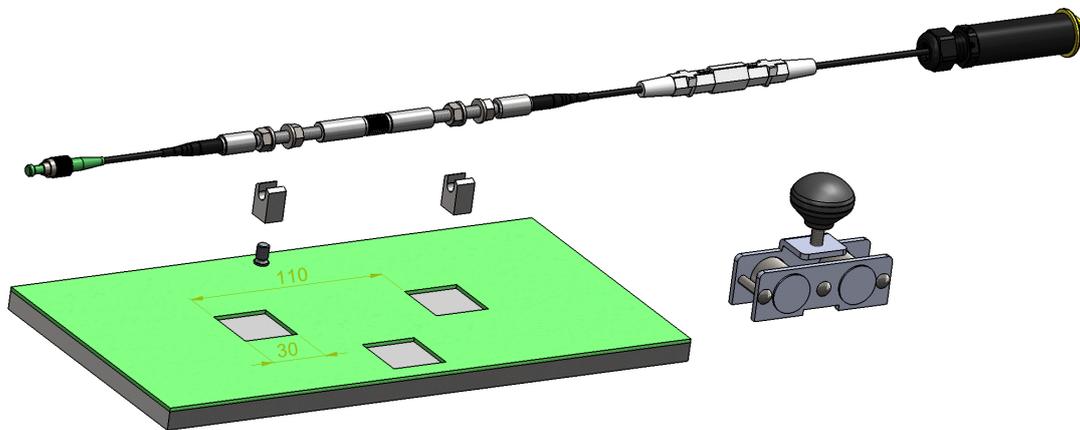


Figure 2. Installation of the mounting brackets MBM-03 M6 version using Indirect and direct welding method

In the following collage (Figure. 3) are shown some examples of the application of the indirect welding approach. The collage shows; battery-powered grinder with flap disc grit 80; prepared area for welding; stud welding process; recovered surface, supportive threaded rod to maintain axial symmetry, and final anchor.

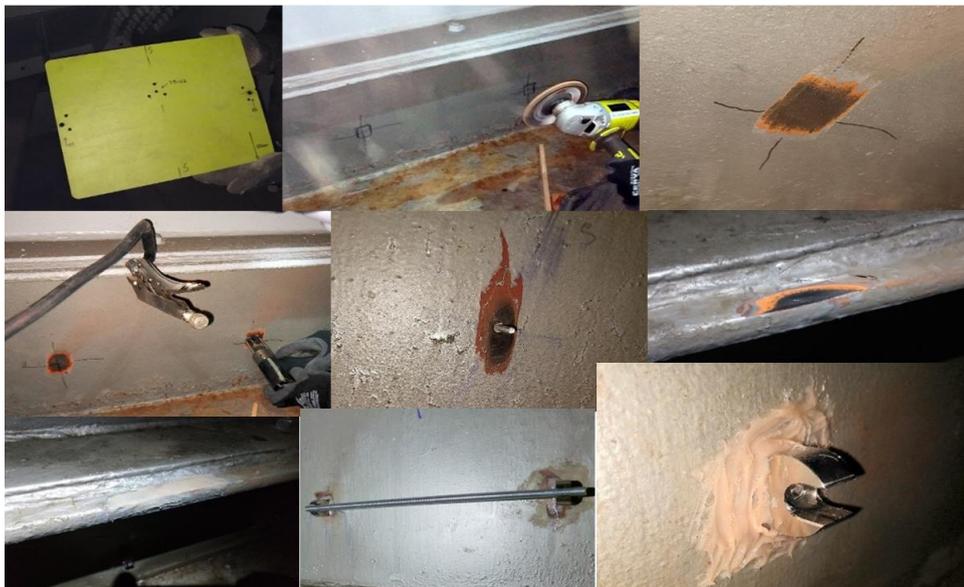


Figure 3. Application example of indirect welding method (Installation conditions were 0°C, water droplets, and uneven surfaces, confined space).

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Screwing installation method on the surface

Mechanical installation is based on using four standard M4 metric screws (two for each bracket). These screws are supplied with the brackets MBM-03 XY version¹. This method applies to the concrete, walls, or even metal structures if welding is not allowed. It is mandatory to follow the anchoring distance during drilling the holes.

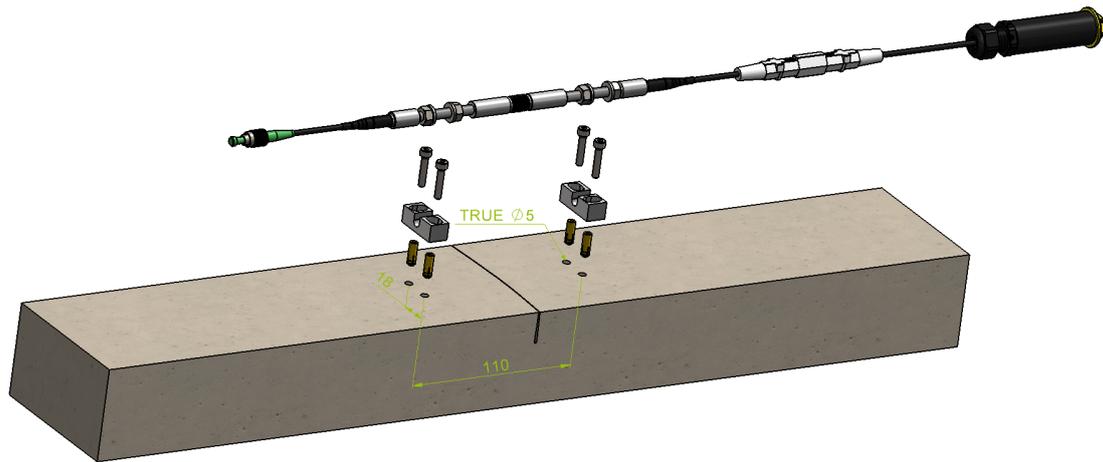


Figure 4. Mechanical installation for concrete crack monitoring

The XY version bracket features position adjustment in the X and Y axis within 3mm to compensate for a possible mismatch during the drilling.

Screwing installation method on steel strand

Mechanical installation is based on using four standard M4 metric screws (two for each bracket). These screws are supplied with the brackets MBM-03 Steel strand version².

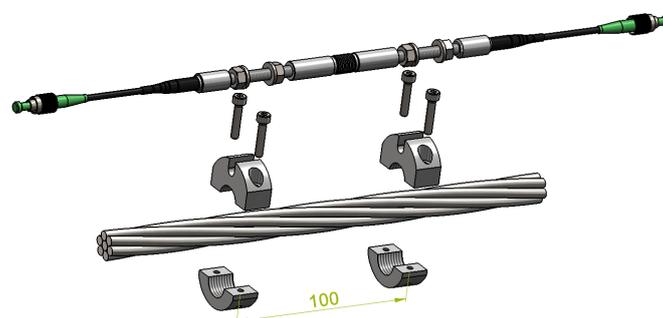


Figure 5. Mechanical installation on steel strand

¹ Suitable thread adhesive (Loctite 2701) or secure washers can always improve the stability of this installation method.

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Chemical installation (glue bonding)

Chemical installation is based on using an adhesive that bonds the sensor with the measured surface. The glue is not supplied with the sensor. The selection of the right glue highly depends on the material of the surface³ and environmental conditions. Special curing procedures such as elevated temperature, pressure, or air humidity can be required by using such adhesives.

All types of MBM-03 brackets are compatible with this method.

(4) Mounting of MS-03 into brackets

Before inserting the MS-03 into the already installed brackets (Figure 6) move the washers and nuts to the sides in a way that after placing the sensor into the brackets there will be always one nut and a washer at each side of a bracket.

Tip: Mount the sensor into brackets in a way where on side of the bracket is close to the end of the threaded part, around 1cm from the edge (Figure 6, second step). This will make the pre-straining process more convenient. Afterward, secure this position by using two spanner keys size 10.

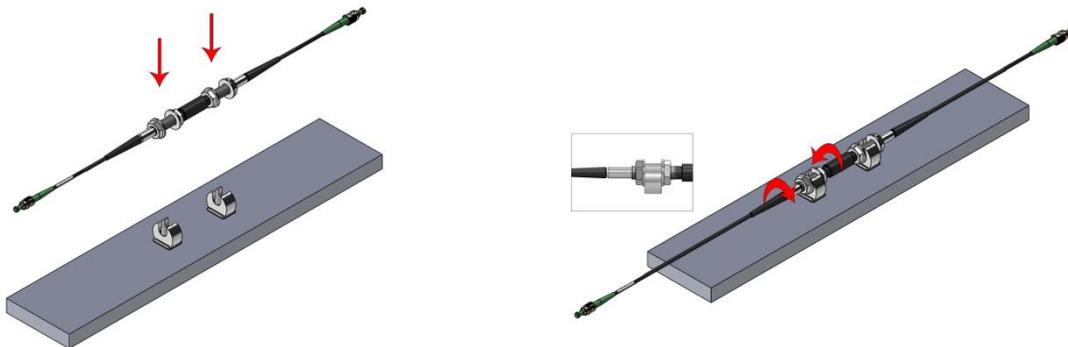


Figure 6: Mounting of MS-03 into brackets.

³ As an example, for steel surface a so-called liquid metal can be used, Loctite 3450. For concrete surfaces, EPO-TEK® 730 is possible to use.

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(4) Setting up pre-strain

MS-03 doesn't have an in-built pre-strain and therefore it is necessary to pre-strain this sensor during installation. This is done with the sensor inside the mounting brackets and hence, it's necessary to install the mounting brackets before the pre-strain process.

For example, if the measuring range of the MS-03 should be $\pm 2000\mu\epsilon$, it is necessary to pre-strain the sensor for no less than 4800pm (4,8nm). The necessary wavelength shift can be calculated using equation (1).

$$\lambda_{shift} = \epsilon_{max} \times 1,2 \quad (1)$$

where, λ_{shift} is the calculated wavelength shift after applying pre-strain and ϵ_{max} is the maximum assumed strain.

After securing one side of the MS-03, the pre-straining of the sensor can be done (Figure 7). Use a spanner key size 10 and by rotating the inner nut in the clockwise direction adjust the pre-strain to the desired level. Afterward, secure this position by using two spanner keys size 10.

It is recommended to use a thread securing adhesive after the sensor is fixed in brackets and pre-strained. For example, Loctite 2701 can be used.

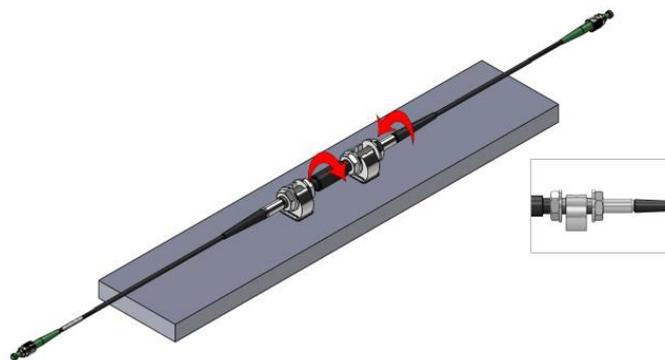


Figure 7: Pre-straining the sensor.

For more information contact our sales team at sales@sylex.sk

* Specifications are subject to change without notice