



## FlexiMeasure™

### Application Focus: Structural Monitoring

#### Structural Monitoring Challenges

The use of movement sensors deployed in a vertical or horizontal string can deliver significant benefits in many structural applications. Precise, reliable, automated monitoring instruments can warn stakeholders of problems and inform long term decision-making, helping to protect assets and people. Instruments such as inclinometers have been used to measure structural deflection for at least 30 years. Widely available inclinometer options share a number of limitations however: they tend to be heavy and hard to handle, power-hungry and not very flexible. This limits their value in many engineering or mining applications where sites tend to be remote from mains power supply and hard to access due to factors such as time pressure, rough ground or restricted space.

#### Solution: FLEXIMEASURE™

FlexiMeasure™ from Senceive provides an alternative that is easy to transport and use, highly adaptable and built around the company's well-proven, precise, triaxial wireless tilt sensors.



Used in structural monitoring applications, a string of FlexiMeasure™ segments can be embedded in, or attached directly to, a building or structure to measure change in verticality. Example applications include:

- bridges, retaining walls, shafts and other civil engineering structures
- diaphragm walls and secant piles
- buildings.

Because it is quick to install and easy to re-deploy it is ideal for use on structures that are under construction, or on third party assets nearby. And with virtually no maintenance requirements, it is also well-suited for longer term structural health monitoring.

The carbon fibre segments can be connected in seconds and are available in four lengths, ranging from 0.5 metre to 3 metres. Up to 32 segments can be used per string. Segment lengths can be mixed.

With a single one metre segment weighing just 250 grammes it is often possible for one person to carry a full system to site and install it in less than an hour.



FlexiMeasure™ self-configures on site, with data transmitted via a smart gateway immediately it is installed, cutting the need for a detailed installation report. The robust IP67 Gateway provides a 4G communication uplink to WebMonitor – Senceive's cloud based visualisation software. Internal memory provides back-up data storage. It is engineered for low power operation and to supply the system with uninterrupted power and communications due to its on-board battery and optional solar PV panel or DC supply.

**FlexiMeasure™ simplifies complex structural monitoring challenges, providing a precise, robust way to monitor structural movement.**



## FlexiMeasure™

FlexiMeasure is a lightweight inclinometer designed for structural monitoring applications. Multiple segments can be connected in series to form a chain of flexibly coupled sensors. Because FlexiMeasure uses triaxial sensors it can be installed in any orientation.

### Suitable for many monitoring applications including:

- Tunnel distortion and convergence
- Tunnel heave/settlement
- Structural movement
- Consolidation and compaction
- Shape/stability - Profile monitoring

### Key features

- Light weight carbon fibre construction
- Operates in any orientation
- Ultra-low power consumption – can operate indefinitely with a small solar panel
- Quick-connect segments – length of overall chain can be determined on site and adjusted to suit requirements
- Joints are flexible so a string of segments can be fitted to bridge or tunnel arches
- Auto segment sequence detection
- Extremely low noise performance
- Low profile and discreet
- Resolution of  $0.0001^\circ$  ( $0.0018 \text{ mm/m}$ ) and repeatability of  $\pm 0.0005^\circ$  ( $\pm 0.009 \text{ mm/m}$ )
- Integrated temperature sensor
- Versatile mounting options
- Waterproof to 200 m depth
- Compliant with EMC standards for railway trackside equipment
- Available in different lengths to suit specific requirement
- Segments can be re-used in other applications and configurations

# FlexiMeasure™



## Physical Specifications

| Parameter                                 | Value                                           |
|-------------------------------------------|-------------------------------------------------|
| Length                                    | 0.5 m, 1 m, 2 m, 3 m                            |
| Total Mass                                | 250 g for 1 m segment                           |
| Housing Material                          | Carbon fibre and stainless steel 316            |
| Protection (BS EN 60529: 1992 + A2: 2013) | IP68 at 200 m water depth pressure for 24 hours |
| Mounting Options                          | Inclinometer casing and structural              |
| Operating Temperature Range               | -40°C to +85°C                                  |

## Tilt Sensor Specifications

| Parameter     | Value                   |
|---------------|-------------------------|
| Resolution    | 0.0001° (0.00175 mm/m)  |
| Repeatability | ±0.0005° (±0.0087 mm/m) |
| Range         | ±90°                    |

## Power and Communication

| Parameter            | Value                            |
|----------------------|----------------------------------|
| Power                | 3.6V DC from EdgeHub             |
| Readout Device       | Senceive EdgeHub with LTE        |
| Typical Battery Life | Indefinitely on 30 W solar panel |
| Maximum Chain Length | 32 segments or 96 m              |

# FlexiMeasure™



## Certifications

System including EdgeHub:

- Tested to conformity with the essential requirements of the Radio Equipment Directive (RED) 2014/53/EU and the RoHS Directive 2011/65/EU
- Tested to comply with Part 15 of CFR 47 of the FCC Rules
- Passed testing to EN 50121-4 Railway EMC: "Emission and immunity of the signalling and telecommunications apparatus" for equipment within 3 metres of the track

## Ordering Information and Accessories

| Model           | Description                                                     |
|-----------------|-----------------------------------------------------------------|
| FS-FXM-0500     | FlexiMeasure segment 0.5 m                                      |
| FS-FXM-1000     | FlexiMeasure segment 1 m                                        |
| FS-FXM-2000     | FlexiMeasure segment 2 m                                        |
| FS-FXM-3000     | FlexiMeasure segment 3 m                                        |
| FS-EC-BB59-FX10 | FlexiMeasure IPI Borehole Cable Assembly (59 mm ID, 10 m cable) |
| FS-EC-BB59-FX2  | FlexiMeasure IPI Borehole Cable Assembly (59 mm ID, 2 m cable)  |
| FS-EC-BB49-FX10 | FlexiMeasure IPI Borehole Cable Assembly (49 mm ID, 10 m cable) |
| FS-EC-BB49-FX2  | FlexiMeasure IPI Borehole Cable Assembly (49 mm ID, 2 m cable)  |
| FF-FXW-59       | FlexiMeasure IPI Wheel Guide Kit (59ID)                         |
| FF-FXW-49       | FlexiMeasure IPI Wheel Guide Kit (49ID)                         |
| FT-FXM          | FlexiMeasure Installation Kit                                   |
| FS-FXMT         | FlexiMeasure Chain Terminator                                   |
| FF-FXM-SF       | FlexiMeasure Structural Mounting Bracket                        |
| FS-EC-FX2       | FlexiMeasure to EdgeHub connection cable (2 m)                  |
| FS-EC-FX10      | FlexiMeasure to EdgeHub connection cable (10 m)                 |
| FM3H-LTE-S      | Senceive EdgeHub with LTE (without FlatMesh)                    |



## FlexiMeasure™

Application Focus: Tunnel Monitoring



### Tunnel Monitoring Challenges

Construction of every tunnel presents unique challenges and can be unpredictable. Monitoring is necessary to alert stakeholders to subtle changes in subterranean conditions to protect the integrity of the structure, third party assets and the safety of people. Monitoring tools such as inclinometers have been used to measure deformation for at least 30 years. Widely available inclinometer options share a number of limitations however: they tend to be heavy and hard to handle, power-hungry and not very flexible. This limits their value in tunnelling applications.

Other survey based options are also widely used, such as automated total stations and laser scanners but their value is often limited by factors such as lack of mains power and satellite/cellular coverage, restricted access opportunities, no line of sight, aggressive environmental conditions (including extreme temperatures, moisture, vibration, dust, acidity/alkalinity and combustible gases), and lack of space, particularly near the tunnelling face where most movement occurs.

### Solution: FLEXIMEASURE™

FlexiMeasure™ from Senceive provides an alternative that is easy to install, lightweight, wireless and robust, provides reliable and accurate data in the most difficult environments and is ideal for use during construction, or for long-term structural health monitoring.

Due to its highly flexible joints, simple masonry fixings and short carbon fibre segment lengths, a FlexiMeasure™ string can be installed around a tunnel arch with minimal effect on clearance. Applications can range from the biggest road tunnels to much smaller utility tunnels with a diameter of as little as two metres, FlexiMeasure can be fitted quickly and simply to monitor convergence or divergence for many years.

The carbon fibre segments can be connected in seconds and are available in four lengths, ranging from 0.5 metre to 3 metres. Up to 32 segments can be used per string. Segment lengths can be mixed to fit the structure. With a single one metre segment weighing just 250 grammes it is often possible for one person to carry a full system to site and install it in less than an hour.

Because it is quick to install and easy to re-deploy it is ideal for use on structures that are under construction, FlexiMeasure™ self-configures on site, with data transmitted via a smart gateway immediately after it is installed, cutting the need for a detailed installation report. The robust IP67 gateway has internal memory and provides a 4G communication uplink to WebMonitor – Senceive's cloud based visualisation software. It is engineered for low power operation and to supply the system with uninterrupted communications and power from its on-board battery or optional solar PV panel or DC supply.

**FlexiMeasure™ simplifies complex monitoring applications, providing a precise, robust way to monitor movement. If you are responsible for the long-term integrity of underground structures whether in transport, utilities or mining you should consider FlexiMeasure™ for your next project.**