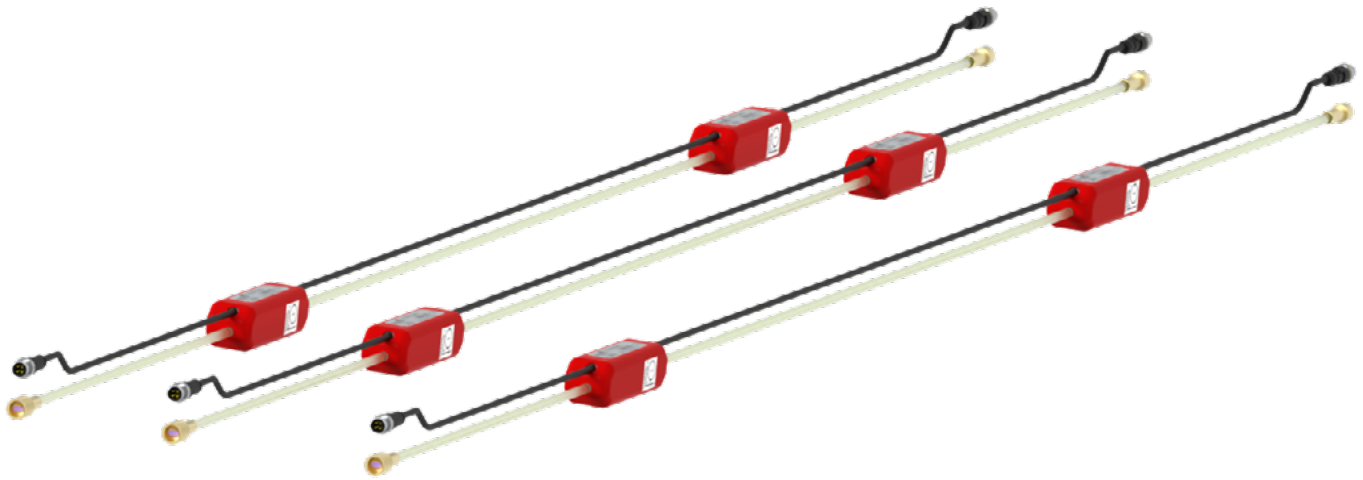


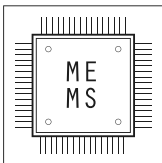
LTIN

# — LT-INCLIBUS 360

INCLINOMETERS  
& PENDULUMS



## LT-INCLIBUS 360



The LT-Inclibus monitors local tilting along a line while maintaining the alignment, spacing and measuring-axis orientation between the gauges. The standard segment consists of a 2 m fibreglass rod with two waterproof gauges spaced at 1 m intervals.

Versions with one or four gauges on the 2 m rod are also available on request.

The LT-Inclibus chain can be installed inside a borehole, laid in a trench, embedded in concrete, or mounted on the surface of a structure.

The rods are connected by mechanical joints, while the gauges are connected in an RS485 chain.

The innovative 360° technology allows each gauge to be calibrated over the full 360° range on three axes. This allows the LT-Inclibus to be installed in any spatial orientation without affecting measurement quality, thus simplifying installation.

Customers can use any electronic device compatible with RS485 and Modbus RTU protocol as a data logger. The LT-Inclibus provides a complete and transparent set of data directly in engineering units.

### MAIN APPLICATIONS

- Embankments
- Unstable slopes
- Settlements
- LNG tanks
- Deep excavations
- Tunneling
- Dam slope stability
- Bridge deck deformation

### FEATURES

- Lightweight and flexible array
- Simple and quick to install
- Customizable number of measuring points
- Each measuring point is individually calibrated according to high-level metrological procedures over the full 360° range

## WORKING PRINCIPLE

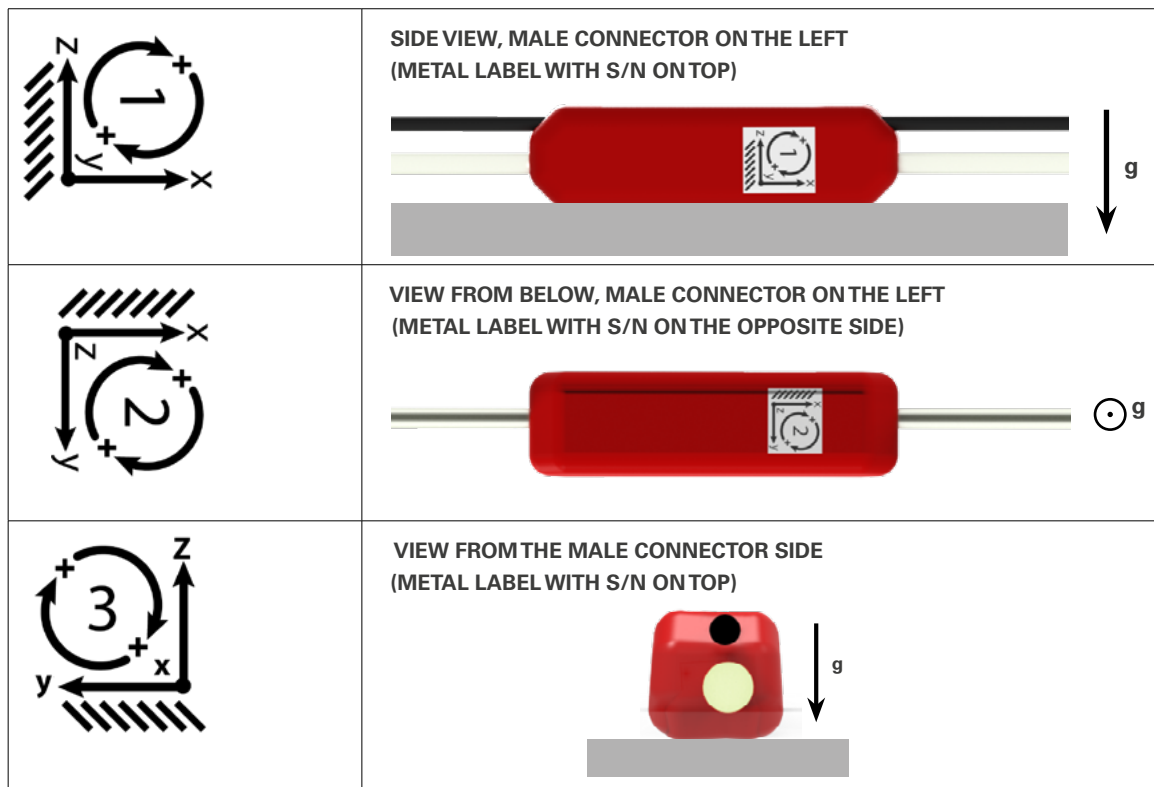
The sensor used in the 360° LT-Inclibus is a triaxial MEMS accelerometer. The three axes x, y and z of the MEMS sensor define three planes ZY, XZ and YX, generated by the pairs of axes zy, xz and yx.

MEMS sensors are capable of measuring inclinations with respect to the acceleration of gravity "g."

In the three pictures below, the LT-Inclibus is installed on a **horizontal surface** so that the z axis is vertical and parallel to g. In this position, the MEMS sensor will be able to measure the rotations of the XZ and ZY planes, while it will NOT be able to measure the rotation of the YX plane (perpendicular to the acceleration of gravity "g").

The rotations of the three planes XZ, YX and ZY are defined by the numbers 1, 2 and 3 corresponding to channels 1, 2 and 3 of the instrument output (refer to the labels on the gauges, the label "3" is not applied due to clearance limitations).

So, with LT-Inclibus installed on a horizontal surface like in the pictures below, channels 1 and 3 of the gauge will give the rotation of the XZ and ZY planes, while channel 2 will return no data (channel automatically disabled). Channel 2 will remain disabled if the inclination of the YX plane relative to the horizontal is less than 40° or greater than 140°. This ensure the stated accuracy performance can be guaranteed.



If the gauge is installed e.g. in a **vertical borehole** such that the x-axis is vertical and parallel to g, the data returned by the gauge will be on channel 1 (XZ plane rotation) and channel 2 (YX plane rotation), while channel 3 will return no data (channel automatically disabled as described before for the horizontal application).

With this configuration, by simply reading channels 1 and 3, or 1 and 2, an LT-Inclibus string can cover most of the required installation types (vertical or sub-vertical borehole, and horizontal or sub-horizontal surfaces). In addition, due to calibration over the entire 360° range on all axes, there is no need for careful positioning of the instrument.

The 360° LT-Inclibus, in parallel to the rotations of the main planes on channels 1, 2 and 3, also outputs the inclinations of the XZ, YX and ZY planes with respect to gravity acceleration g on channels 4, 5 and 6. These data can be used in the case of complex monitoring, such as for checking gauge alignment on a circumferential arc. For more information, please refer to the instrument's user manual.

The 360° LT-Inclibus also provides the values of internal temperature and voltage supply on channels 13 and 15, and the calibrated components of gravity acceleration  $g_x$ ,  $g_y$  and  $g_z$  on channels 7, 8 and 9. This is in keeping with Sisgeo's view of complete data transparency.

## TECHNICAL SPECIFICATIONS

| PRODUCT CODES                                  | 0LTIB103602 (2m fibreglass rod, one gauge)<br>0LTIB203602 (2m fibreglass rod, two gauges)<br>0LTIB403602 (2m fibreglass rod, four gauges) |
|--|---|
| Measurement principle                          | Triaxial MEMS accelerometer   |
| Measuring range                                | <b>360° (±180°) on all three axes</b> (see Working Principle)   |
| Repeatability                                  | <± 0.001°   |
| Resolution                                     | 0.0001°   |
| Sensor mechanical bandwidth                    | Hz  |
| Stability @ 24 hours                           | <± 0.004°   |
| Sensitivity <sup>(1)</sup>                     | see individual Calibration Report   |
| MPE Accuracy <sup>(2)</sup>                    | <±0.02° (<±0.0055% FSR at 360°)   |
| Offset temperature dependency                  | ±0.002° / °C  |
| Power supply                                   | 8 to 28 Vdc   |
| Signal output and protocol                     | RS485, Modbus RTU protocol <sup>(3)</sup>   |
| Average consumption                            | 3.7 mA @ 24 Vdc, 7.0 mA @ 12 Vdc  |
| Temperature operating range                    | -30°C to +70°C  |
| Internal temperature sensor                    | Embedded on electronic board (output channel 13)  |
| - measuring range                              | -40°C to +125°C   |
| - accuracy (resolution)                        | ±1°C over the temperature range -10°C to +85°C (resoluton 0.01 °C)  |
| On-board supply voltage monitor <sup>(4)</sup> | Embedded on electronic board (output channel 15)  |
| - measuring range                              | 0 to 36 V   |
| - accuracy (resolution)                        | ±5% FS (res. 0.01 V)  |
| IP Protection class                            | IP68 up to 1.0 MPa (2.0 MPa on request)   |
| Materials                                      | polycarbonate (gauge enclosure), fibreglass (rod), stainless steel joint ends   |
| Weight   | 0.2 kg per gauge, 0.2 kg (2m FG rod and joints)   |
| Max. cable length to logger                    | 1000 m (for more information, see <a href="#">FAQ #077</a> ) <sup>(7)</sup>   |

(1) Sensitivity is a specific parameter and is different for each gauge. Sensitivity is determined during the gauge calibration test and reported in the Calibration Report.

(2) MPE is the Maximum Permitted Error over the full scale range (FSR). In the Calibration Report, the accuracies of the gauge are calculated using the linear regression; the error reported is the maximum residual error on the FSR on the three axis

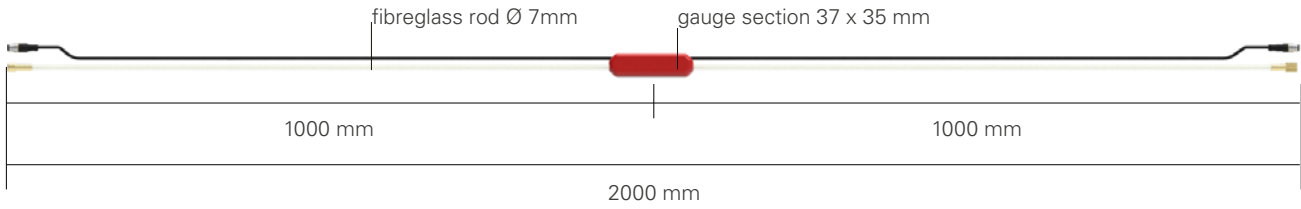
(3) RS485 not-opto-isolated Modbus communication with RTU protocol. Default output unit is degree. Other units available are mm/m or inch/foot (to be specified at order). The Sisgeo Modbus protocol manual is available for download from the Sisgeo web site.

(4) These sensors are installed on the internal electronic board to provide diagnostic information in the event of gauge malfunction.

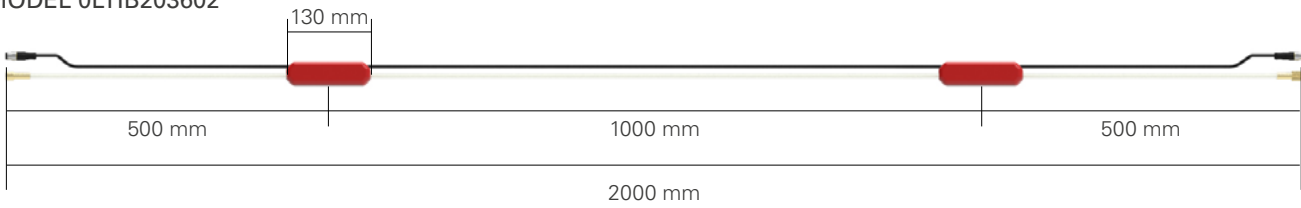
(7) Refer to FAQ section on Sisgeo website: [www.sisgeo.com/faq](http://www.sisgeo.com/faq)

## PHYSICAL FEATURES

MODEL 0LTIB103602



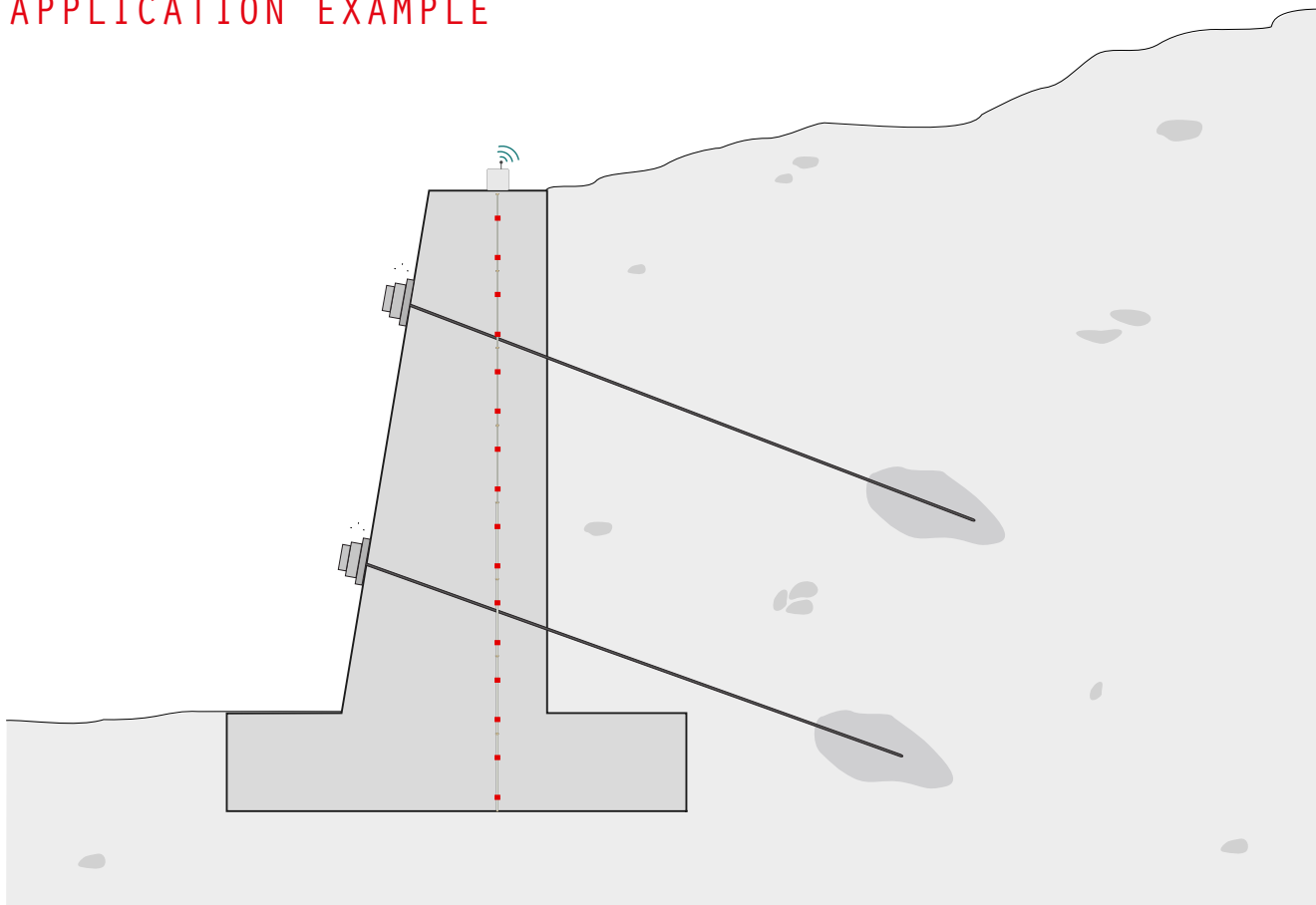
MODEL 0LTIB203602



MODEL 0LTIB403602



## APPLICATION EXAMPLE



## ACCESSORIES AND SPARE PARTS

### CABLE WITH CONNECTOR OS400HD00MT

Available in different lengths (2 m, 5 m, 10 m, 15 m), it consists of a signal cable with IP68 connector to connect the nearest gauge to a local logger, wireless node or junction box.

### TERMINATION RESISTANCE OETERMRESIO

Resistance ending device with connector, required to terminate every digital IPI chain. The value of resistor depends on the layout of the system. For more details, please see the [FAQ#076](#).

### 2M FG ELONGATION ROD OLTIBROD020

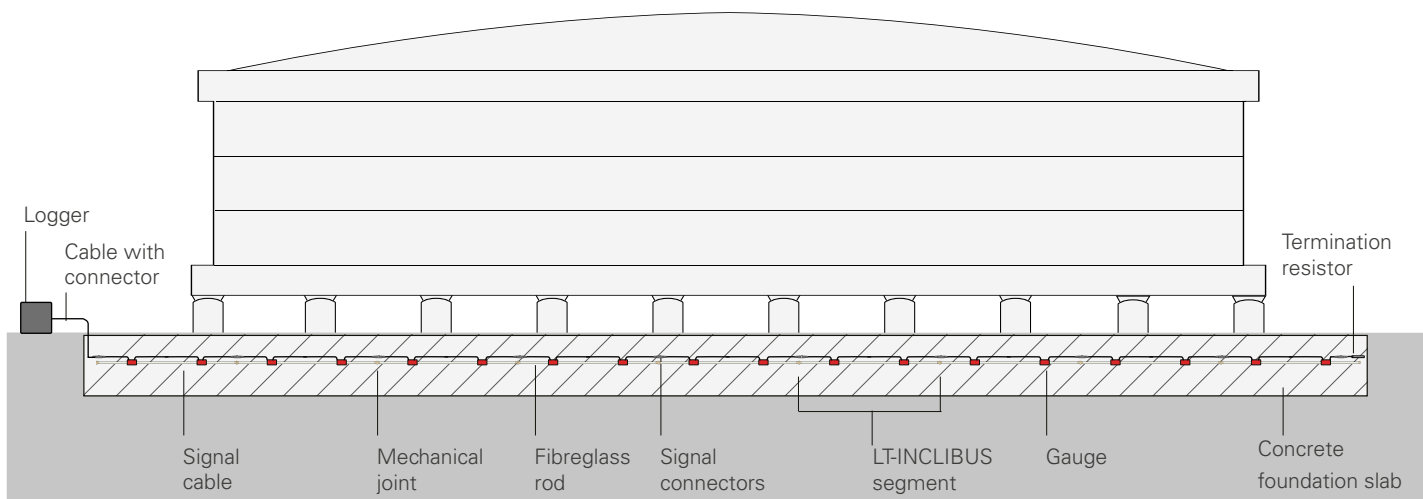
Fibreglass rod for chain extension, 2m length, including mechanical joints and signal cable with connectors assembled at factory.

### DIGITAL CABLE OWE606IPDZH

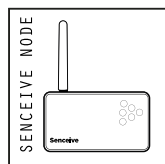
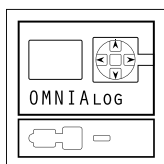
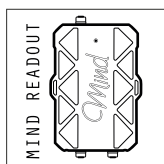
LSZH cable for connecting digital gauge chains to the OMNIAlog datalogger.

### RESISTANCES KIT (SPARE) OERESIKIT00

Kit composed of one 120 Ohm, two 240 Ohm, three 360 Ohm and four 480 Ohm resistance ending devices. Each resistor has an M12 5-pin connector for linking to SISGEO digital gauges. Check the compatibility with old digital gauges, consulting your Sales Representative.



## READABLE BY



For further information, refer to the relevant readout datasheets.

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### TECHNICAL ASSISTANCE

SISGEO offers e-mail technical support to ensure correct installation and use and to maximize system performance. For full installation and maintenance procedures, refer to the Installation & User Manual. For further information, contact: [assistance@sisseo.com](mailto:assistance@sisseo.com)