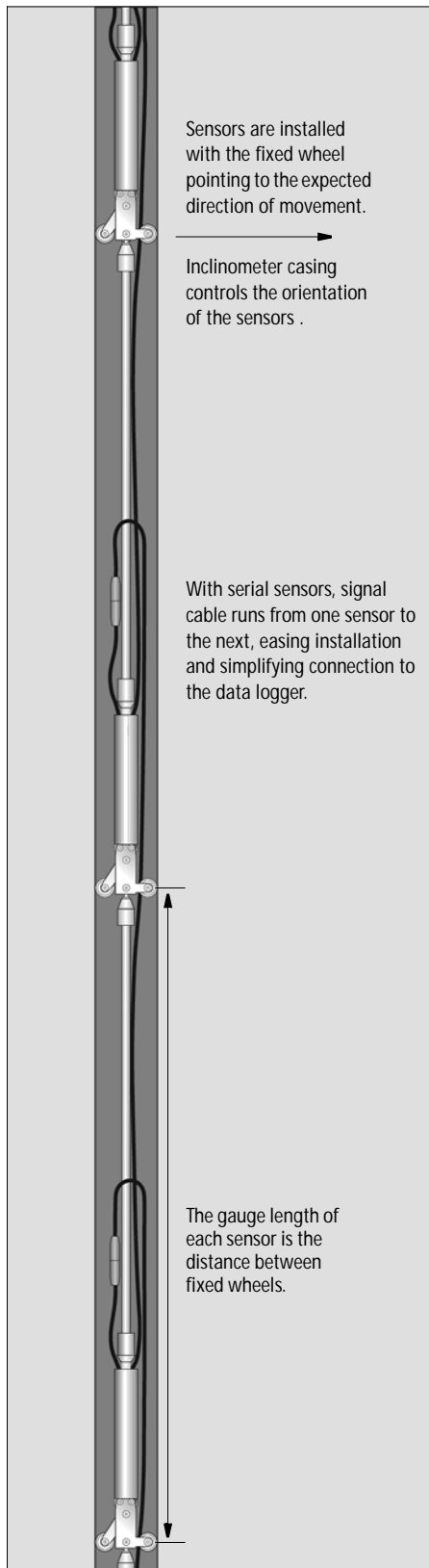


In-Place Inclinometer Sensors



Applications

In-place inclinometer sensors are ideal for data logging and real-time monitoring. Typical applications include:

- Monitoring deformation of the diaphragm walls that support deep excavations.
- Monitoring ground movements induced by tunnel construction.
- Monitoring deformations of embankments and retaining walls.
- Monitoring landslide areas above dams, highways, and railroads to provide early warning of slope failure.

Operation

The system consists of a number of in-place inclinometer sensors that are installed in inclinometer casing.

The casing provides access for subsurface measurements. Grooves inside the casing control the orientation of the sensors.

The casing is typically installed in a vertical borehole that passes through a suspected zone of movement into stable ground below. One set of grooves is aligned with the expected direction of movement, down hill or towards an excavation, for example.

The sensors are positioned inside the casing to span the zone of movement. When the ground moves, the casing moves with it, changing the inclination of the sensors inside.

Inclination measurements from the sensors are processed to provide graphs of the casing profile and changes in the profile. Changes indicate displacement (movement).

In most applications, sensors are connected to a data acquisition system, and readings are transmitted to processing software that can trigger alarms based on displacements or rates of change.



Advantages

Real Time Monitoring: The in-place inclinometer is ideal for continuous, unattended monitoring and can deliver readings in near-real time.

Single Cable Installation: Serial sensors are supplied with cable to connect to the sensor above, effectively reducing the number of signal cables to one. This eases installation and simplifies connection to the data logger.

Configurable Gauge Lengths: The use of varied gauge lengths can provide better measurements while reducing the total number of sensors needed for complete coverage.

Durable and Reusable: Sensors are equipped with durable wheels that make it practical to move the sensors to other casings as needed and also to periodically remove the sensors for verification readings with a traversing probe.

Complete Solutions: DGSi offers complete monitoring solutions that include data loggers and Atlas web-based monitoring software. Atlas can check for alarm conditions in near-real time and can present plotted data immediately after the readings are obtained.

SERIAL SYSTEM CONFIGURATION

A serial IPI system requires inclinometer casing, serial sensors with wheels and gauge tubes, a suspension kit, and a jumper cable. Data reduction software is also required.

Inclinometer Casing: Choose 70 mm or 85 mm (2.75 or 3.34 in) diameter inclinometer casing.

Uniaxial or Biaxial Sensors: Uniaxial sensors measure tilt in the plane of the wheels. Biaxial sensors include a second sensor that measures tilt in the plane perpendicular to that of the wheels.

Wheels: Choose wheels to fit 70 mm or 85 mm casing. Order sensor wheels for each sensor, and one top wheel for each chain of sensors.

Tubing for Gauge Lengths: Order gauge tubing for each sensor. Tubing is sized to make exact gauge lengths of 1, 2, or 3 m. Custom gauge lengths can be special-ordered.

Signal Cable: Serial sensors include signal cable that can accommodate gauge lengths up to 3m. Cable of deepest sensor must be terminated with a bottom plug. Cable from top sensor is connected to the data logger via a jumper cable. Jumper cable consists of a jumper cable connector and standard signal cable.

Top Suspension Kit: Order one top suspension kit for each installation. The kit includes hand ring, chain, hook, cable thimbles, and clamps. Requires stainless steel cable, not included.

In-Line Suspension Kit: The in-line suspension kit is used to suspend an independent chain of sensors from the chain above. This allows monitoring of two more widely separated zones of interest in the borehole. The kit includes cable thimbles and clamps. Requires stainless steel cable, not included.

Data Logger: The Slope Indicator M-Logger is specifically designed to read MEMS sensors. It can operate 10 serial sensors when placed within 50 m of the sensors. The M-Logger can also be used to verify proper operation of the sensors before they are installed downhole.

The Campbell Scientific CR1000 data logger allows direct connection of up to 5 chains of serial sensors. Each chain of sensors can contain up to 10 sensors when the logger is placed within 50 m. LoggerNet software is required to retrieve data from the logger.

Data Reduction Software: Readings retrieved from the logger can be processed manually by spreadsheet or automatically by the Atlas web-based data management system.

SERIAL IPI SENSORS

Serial IPI Sensor, Uniaxial	57804621
Serial IPI Sensor, Biaxial	57804622
Sensor Wheels for 70 mm Casing .	57805122
Top Wheels for 70 mm Casing . . .	57805024
Sensor Wheels for 85 mm Casing .	57805132
Top Wheels for 85 mm Casing . . .	57805034
Tubing for 1 m Gauge Length	57805221
Tubing for 2 m Gauge Length	57805222
Tubing for 3 m Gauge Length	57805223
Tubing for Custom Gauge Length.	97805240
Bottom Plug for Deepest Sensor .	57804511
Jumper Cable Connector	56804510
Signal Cable for Jumper	50613527

SUSPENSION KITS

Top Suspension Kit	57804310
In-Line Suspension Kit	57804320
3.2mm Stainless Steel Cable	50402310

IPI SENSOR SPECIFICATIONS

Sensor Type: MEMS (Micro Electro-Mechanical Systems) tilt sensor for inclination readings. Thermistor for temperature readings.

Requirements: Accepts power input between 8 to 15 Vdc. Outputs ± 2.5 volt differential signal. Biaxial version contains two tilt sensors.

Calibrated Range: ± 10 degrees.

Resolution: 9 arc seconds or 0.04 mm/m using the CR1000 data logger.

Repeatability: ± 22 arc seconds or ± 0.1 mm/m.

Calibration: 11 angles at temperatures from 4 to 20°C. Other temperature ranges available.

Required Casing: Fits 70 or 85mm (2.75 or 3.34") diameter casing.

Housing: Stainless steel, 38 mm (1.25") diameter, waterproof.

Weight: Average weight of sensor with 2m gauge length is 1.6 kg.

Signal Cable: Each serial sensor is supplied with cable sufficient for 3 meter gauge lengths.



Each serial sensor has cable for a 3m gauge length. A jumper cable runs from the top sensor to the logger.

STANDARD IPI SENSORS

Standard IPI Sensor, Uniaxial	57804221
Standard IPI Sensor, Biaxial	57804222
Signal Cable	50613527

A standard IPI system requires inclinometer casing, standard sensors with wheels, gauge tubes, and signal cable for each sensor, and a suspension kit. Specify the cable length for each sensor: the distance between the sensor and the data logger. Wheels, tubing, and suspension kits are the same as those used with serial sensors.

