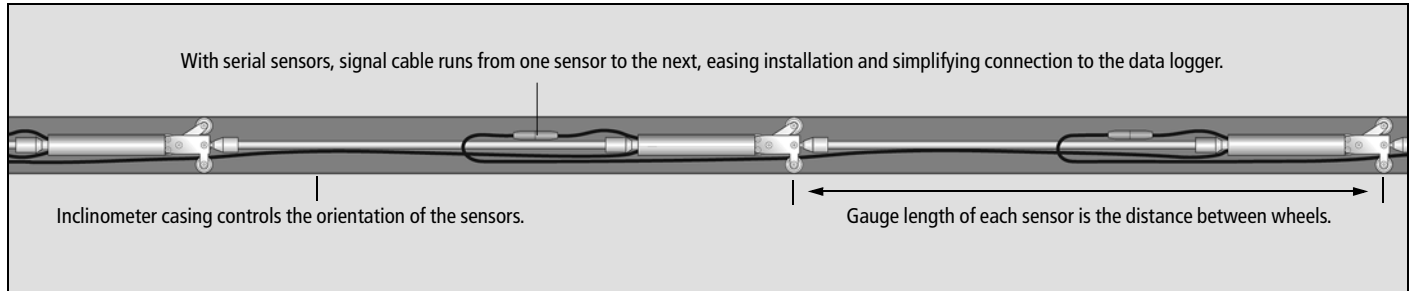


Horizontal In-Place Inclinometer Sensors



Applications

The horizontal in-place inclinometer is ideal for data logging and real-time monitoring. Typical applications include:

- Monitoring ground movements induced by tunnel construction and excavation.
- Monitoring stabilization measures such as compensation grouting and underpinning.
- Monitoring settlement under tanks and landfills and in embankments and dams.



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.

Casing is typically installed in a trench that crosses the area to be monitored. One set of grooves must be aligned to vertical, since the instrument is expected to monitor vertical movements (settlement or heave).

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 the casing profile, the displacement in mm for the gauge length of each sensor, and the cumulative displacement in mm for the entire string of sensors.

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: Each sensor connects to the next in line, effectively reducing the number of signal cables to one. This eases installation and simplifies connections to the data logger.

Flexible Configurations: Because sensors are connectorized rather than hard-wired, it is easy to extend or shorten sensor chains. In addition, sensor gauge lengths are easily changed to optimize coverage of important zones, yet minimize the total number of sensors in the chain.

Durable Components: Sensors, cables, connectors, and wheels are exceptionally durable, making it practical to remove the sensors at the end of the project and redeploy them on other projects.

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 includes inclinometer casing, serial sensors with wheels and gauge tubes, placement accessories, and jumper cable.

Inclinometer Casing: Choose 70 or 85 mm (2.75 or 3.34") inclinometer casing. The 85 mm size is preferred.

Serial Sensor: Horizontal IPI sensors have a uniaxial sensor that is oriented to measure tilt in the plane of the wheels.

Wheels: Choose wheels to fit 70 or 85 mm inclinometer casing. Order sensor wheels for each sensor. Order one horizontal top wheel for each chain of sensors. Top wheel can be omitted if gauge tube of top sensor is held directly by a tubing clamp at the top of the casing.

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.

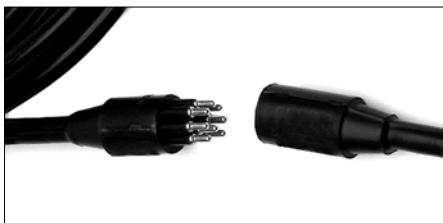
Signal Cable: Serial sensors include signal cable sufficient for gauge lengths up to 3m. Cables have connectors that allow them to be joined into a bus. A bottom plug is required for the bottom of the bus. A jumper cable connects the top of the bus to a data logger.

Placement Accessories: Order one tubing clamp for each installation. Tubing clamp replaced top wheel if it holds gauge tube of top sensor directly. If top sensor is deeper into the casing, then order a placement tube and a top wheel. Placement tube is supplied in 3m lengths. Order a coupling to create longer lengths.

Data Logger: The Slope Indicator M-Logger is specifically designed to read MEMS sensors. It can operate a single chain of up to 16 sensors. The M-Logger can also be used to verify operation of the sensors at installation time.

The Campbell Scientific CR1000 data logger can operate 6 chains of serial sensors, and the CR800 logger can operate 3 chains of serial sensors.

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 incorporate heavy-duty waterproof connectors good for multiple connects/disconnects.

SERIAL IPI SENSORS

Horizontal Serial IPI Sensor. 57804723

Sensor Wheels for 85 mm Casing. 57805343

Sensor Wheels for 70 mm Casing. 57805342

Tubing for 1 m Gauge Length. 57805321

Tubing for 2 m Gauge Length. 57805322

Tubing for 3 m Gauge Length. 57805323

Tubing for Custom Length. 57805340

Horizontal Top Wheel, 85 mm 57805338

Horizontal Top Wheel, 70 mm 57805328

Bottom Plug. 57804510

Jumper Cable, 25m. 56804525

PLACEMENT ACCESSORIES

Tubing Clamp, 85 mm Casing 57805355

Tubing Clamp, 70 mm Casing 57805352

Placement Tube, 3 m Length 57804340

Coupling for Placement Tube 57804345

STANDARD IPI SENSORS

Horizontal IPI Sensor 57804123

Signal Cable 50613527

Standard (non-serial) sensors are not connectorized, so each sensor requires its own, full-length signal cable. Wheels, tubing, placement accessories, and performance are the same as those of serial sensors.

Specify signal cable length for each sensor: the distance between the sensor and the data logger. Signal cable has seven 22-gauge conductors, shield, and polyurethane jacket.

IPI SENSOR SPECIFICATIONS

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

Requirements: Power input between 7.5 to 15 Vdc. Outputs ±2.5 volt differential signal.

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-point calibration obtained at three temperatures from 4 to 20 °C.

Max Gauge Length: 3 meters.

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

Housing: Stainless steel, 32 mm (1.25") diameter, waterproof to 2 MPa (300 psi).

Signal Cable: Cable for 3m gauge lengths supplied with serial sensors. Waterproof connectors rated to 70 MPa (10,000 psi).

Sensors per Chain: The table below shows nominal limits for chains of serial sensors.

Jumper Length	Number of Sensors
40 m	50
75 m	43
115 m	37
150 m	32
190 m	27
225 m	23
265 m	19
300 m	16
340 m	13
375 m	10