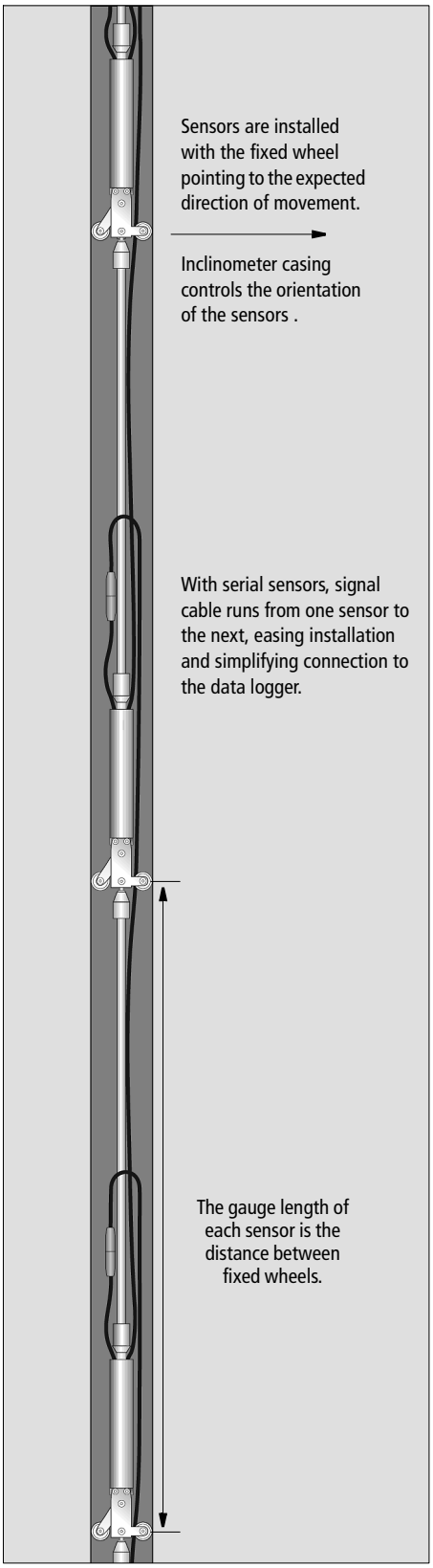
In-Place Inclinometer Sensors



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 sub-surface 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 rate 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 sensor above, effectively reducing the number of signal cables to one. This eases installation and simplifies connection 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 requires inclinometer casing, serial sensors with wheels and gauge tubes, a suspension kit, and a jumper cable.

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. Top wheels can be provided for suspension by cable or tubing.

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 (3 m max).

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 the data logger.

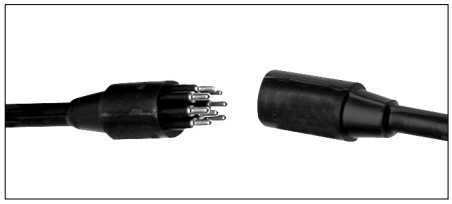
Top Suspension Kit: Order one top suspension kit for each installation. Suspension kits can be provided for tubing or cable suspension.

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 or more widely separated zones. 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 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 monitoring system.



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

SERIAL HD IPI SENSORS

Serial HD IPI Sensor, Uniaxial 57804721
Serial HD IPI Sensor, Biaxial 57804722

Sensor Wheels for 70 mm Casing. 57805342
Sensor Wheels for 85 mm Casing. 57805343

Tubing for 1 m Gauge Length. . . . 57805321
Tubing for 2 m Gauge Length. . . . 57805322
Tubing for 3 m Gauge Length. . . . 57805333

Tubing for 3 ft Gauge Length 57805331
Tubing for 5 ft Gauge Length 57805332
Tubing for 10 ft Gauge Length . . . 57805333

Bottom Plug 57804510
Jumper Cable, 25 m 57804525

IPI SENSOR SPECIFICATIONS

Sensor Type: MEMS (Micro Electro-Mechanical Systems) tilt sensor for inclination readings. Biaxial model has two sensors. 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: 70 or 85mm (2.75 or 3.34") diameter casing.

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

Weight: 4.01 kg with 2m gauge length.

Signal Cable: Cable for 3m gauge length supplied with each sensor. Connectors are rated to 70 MPa (10,000 psi).

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

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

DISCRETE HD IPI SENSORS

Discrete HD IPI Sensor, Uniaxial . .57804711
Discrete HD IPI Sensor, Biaxial . . .57804712
Signal Cable 50613527

A standard (non-serial) IPI system requires inclinometer casing, standard sensors with wheels and gauge tubes, a signal cable for each sensor, and a suspension kit. Specify cable length for each sensor (from depth of sensor to data logger). Wheels, tubing, and suspension kits are the same as those used with serial sensors.

SUSPENSION KITS

2.75" Casing, Tubing Suspension Top Wheel Kit 57805328
3.34" Casing, Tubing Suspension Top Wheel Kit 57805338
2.75" Casing, Tubing Suspension Top Cap 57805352
3.34" Casing, Tubing Suspension Top Cap 57805355

2.75"/70mm IPI Cable Suspension Kit 57804452
HD IPI 70mm Top Wheel (for Cable Suspension) 57805324
3.34"/85mm IPI Cable Suspension Kit 57804453
HD IPI 85mm Top Wheel (for Cable Suspension) 57805334

3mm Stainless Steel Cable 50402310M
1/8" Stainless Steel Cable. 50402310F
1/8" SS Cable In-Line Suspension Kit. 57804320

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