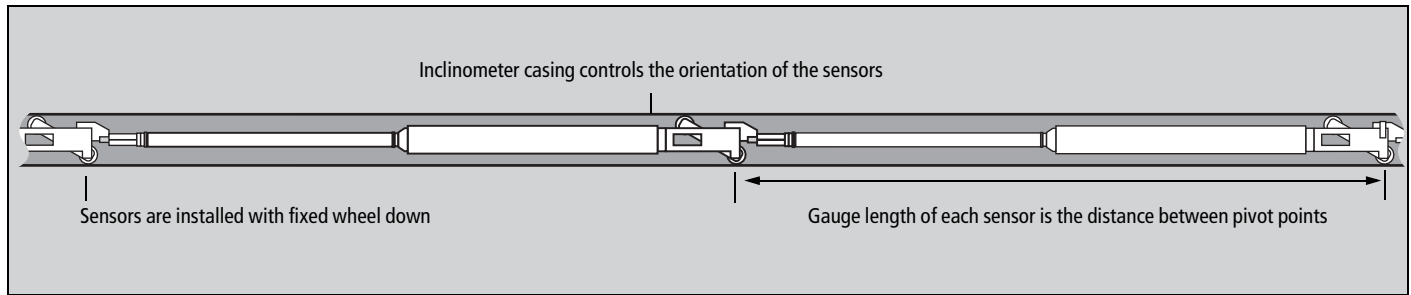


# Horizontal EL In-Place Inclinometer



## 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. 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 data processing is completed by a computer program such as Argus, which can trigger alarms based on a rate of change or other criteria.

## Advantages

**Real Time Monitoring:** Ideal for monitoring and control applications such as compensation grouting, in-place inclinometers can deliver readings in near real-time.

**One-Cable Installation:** The multiplexed version of the IPI is easy to install, since all sensors in the string share a single cable.

**Removable:** Wheeled sensors can be removed to allow verification checks with a traversing probe.

**Rigid Gauge Tubing:** Accurate displacement calculations require straight-line sensor gauge lengths. Rigid gauge tubing satisfies this requirement. Rigid gauge tubing also provides reliable performance in soft ground.

**Complete Solution:** Slope Indicator's IPI is part of a complete monitoring solution that includes data logging systems and Argus web-based monitoring software, which can process and present inclinometer data in profile plots or trend plots just minutes after readings are obtained.

## SYSTEM CONFIGURATION

A complete IPI system includes inclinometer casing, IPI sensors, signal cable, placement kit, data logger, and software.

**Inclinometer Casing:** Choose 85 mm or 70 mm (3.34" or 2.75) diameter casing.

**Standard or Multiplexed Sensors:** Standard sensors are less expensive, but cable handling and connections are more complex. Each sensor requires its own signal cable, and an external multiplexer is required if more than three sensors are connected to the data logger.

Multiplexed sensors are more expensive, but easier to install and connect to the data logger. Signal cable is included with these sensors and they do not require an external multiplexer.

**Tubing for Gauge Lengths:** Tubing makes exact gauge lengths of 1, 2, or 3 meters. Three meters is the maximum recommended length.

**Wheels:** Order wheels for each sensor. Choose wheels to fit 85 or 70 mm casing. The wheels required to complete the gauge length of the top (nearest) sensor are included in the placement kit.

**Signal Cable:** Standard sensors require signal cables. Specify a cable length for each sensor. Cable runs from the location of the sensor to the location of the data logger or multiplexer.

Multiplexed sensors are supplied with signal cable, but you must order a jumper cable to run from the top (nearest) sensor to the data logger. The jumper cable consists of a jumper cable connector plus signal cable ordered to length.

**Placement Kit:** One placement kit is required for each string of sensors. Placement kit includes wheel assembly to complete gauge length of top (nearest) sensor and tubing clamp. A tubing clamp retainer, which prevents movement of the tubing clamp, is a recommended accessory.

Placement tubing with coupling is supplied in 10 foot lengths. Order number of lengths required to position sensor string.

**Data Loggers:** Slope Indicator supplies Campbell Scientific CR10X data loggers. See separate data sheet. Other data loggers can be used. Full electrical specifications can be found in tech-notes section at [www.slopeindicator.com](http://www.slopeindicator.com).

**Software:** Communication software is required to retrieve data from the data logger. Data reduction software is required to process and plot the data. Slope Indicator supplies Argus web-based monitoring software for processing and distributing the data. Datasheet and specifications are available at [www.slopeindicator.com](http://www.slopeindicator.com).

## IPI SENSORS

Horizontal IPI Sensor . . . . . 56804123

Wheels for 85mm Casing . . . . . 56805032

Wheels for 70 mm Casing . . . . . 56805022

Tubing for 1 m gauge length . . . . 16804221

Tubing for 2 m gauge length . . . . 16804222

Tubing for 3 m gauge length . . . . 16804223

Signal Cable . . . . . 50613527

Order wheels and tubing for each sensor. Wheels are sized for 85 or 70 mm casing. Tubing is sized to make 1, 2, or 3 meter gauge length.

Order signal cable for each sensor. Specify length in feet or meters from sensor to readout station. Signal cable has seven 22-gauge tinned-copper conductors, shield, and polyurethane jacket.

## MULTIPLEXED IPI SENSORS

Horizontal IPI Sensor with Mux . . 56804523

Wheels for 85mm Casing . . . . . 56805032

Wheels for 70 mm Casing . . . . . 56805022

Tubing for 1 m gauge length . . . . 16804221

Tubing for 2 m gauge length . . . . 16804222

Tubing for 3 m gauge length . . . . 16804223

Jumper Cable Connector . . . . . 56804510

Signal Cable . . . . . 50613527

Sealing Kit . . . . . 56804505

Order tubing and wheels for each sensor. Wheels are sized for 85 or 70 mm casing. Tubing is sized to make 1, 2, or 3 meter gauge length.

Order jumper cable connector and signal cable to run from top (nearest) sensor to data logger. Specify length in feet or meters.

Optional sealing kit strengthens waterproof connectors and may be useful for high pressures or long-term applications. Order one sealing kit for each sensor

## PLACEMENT KIT

Placement Kit, 85 mm Casing . . . 56804112

Placement Kit, 70 mm Casing . . . 56804110

10' Tubing with Coupling . . . . . 56805200

In-Line Wheel for 85mm Casing . . 56804170

In-Line Wheel for 70 mm Casing . 56804160

Tubing Clamp Retainer . . . . . 56805257

Order one placement kit for each sensor string. Placement kit includes a tubing clamp and an in-line wheel. Does not include tubing.

Stainless Steel tubing measures 10' x 0.75" (3 m x 19 mm) and includes expansion coupling. Tubing is required to push and then hold sensor string at required location in the casing. Not required if top sensor is held directly by tubing clamp.

In-line wheel provides articulation when several lengths of placement tube are required.

## TUBING CLAMP ONLY

Tubing Clamp, 85 mm Casing . . . .56805255

Tubing Clamp, 70 mm Casing . . . .56805252

Tubing Clamp Retainer . . . . . 56805257

If top of sensor string can be held directly, order tubing clamp instead of placement kit and the tubing clamp retainer.

## READOUTS

EL Data Recorder . . . . . 56813500

This readout can be used to check IPI sensors at installation time. It displays and stores tilt readings in volts and temperature readings in degrees C. See separate data sheet for details.

## DATA LOGGERS

### Campbell Scientific CR10X System

See CR10 data sheet for part numbers and overview of system. Standard sensors and multiplexed sensors are connected differently.

**Standard IPI Sensors:** Connect up to 16 sensors to an AM16/32 multiplexer or connect up to three sensors directly to the CR10.

**Multiplexed IPI Sensors:** Connect up to six complete strings of IPI sensors directly to CR10. Each string may contain 20 or more sensors.

## SPECIFICATIONS

**Sensor Type:** Uniaxial electrolytic tilt sensor for tilt measurements, thermistor for temperature measurements. Built-in signal conditioner accepts power input of 5.5 to 15 Vdc. Outputs  $\pm 2.5$  volt differential signal.

**Calibrated Range:**  $\pm 10$  degrees.

**Resolution:** 9 arc seconds or 0.04 mm/m using 13 bit readout device such as the CR10 data logger.

**Repeatability:**  $\pm 22$  arc seconds or  $\pm 0.1$  mm/m.

**Calibration:** 11 point calibration taken at three temperatures. Standard calibration temperatures are 4 to 20 °C. Optional extended calibration temperatures are -15 to +40 °C.

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

**Max Gauge Length:** 3 meters.

**Housing:** Stainless steel. 38mm (1.5") diameter.