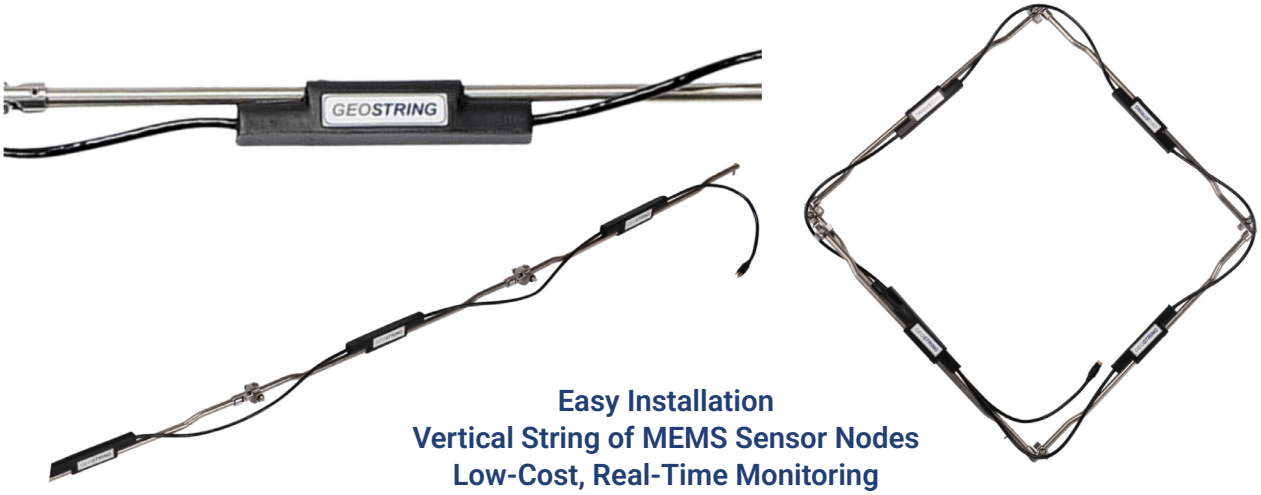
GEOSTRING - In Place MEMS Inclinometer

Inclinometer



Easy Installation
Vertical String of MEMS Sensor Nodes
Low-Cost, Real-Time Monitoring

The GEOSTRING inclinometer system is an array of closely spaced MEMS sensors used with a data-logger. It is ideal for real time continuous and unattended monitoring of lateral displacement of soil, rock, and structures.

Description

The GEOSTRING array consists of a number of sensor nodes installed vertically in either 70mm (2.75 inch) or in 85mm (3.34) diameter inclinometer casing.

The casing or pipe provides access for subsurface measurements. The joints between nodes are strong and stable, allowing the array to maintain consistent orientation of all the nodes, regardless of installation type.

The pipe or casing is typically installed in a vertical borehole that passes through a suspected zone of movement. The nodes are spaced at 0.61 m (2 ft) intervals and provide a reading resolution similar to a traversing probe. The array spans the zone of movement. If movement occurs, the casing/pipe moves, changing the inclination of the nodes inside.

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

The GEOSTRING system is an array connected to a SENSLOG data acquisition system. Readings are transmitted to processing software that can trigger alarms based on displacements or rates of change.

Nodes, cables, connectors and gauge rods are exceptionally robust, allowing easy removal of an array at the end of the project and deployment on other projects.

GEOSTRING segments have joints capable of bending to 90°, allowing for compact shipping.

Key Features

- Easy installation
- Real-time monitoring
- Single cable installation
- Interconnected nodes
- Pre-loaded calibration factor in each node
- Sensorless (dummy) nodes available
- Ultra-robust components
- Long-term reliability
- Cost effective
- Retrievable, reusable

Applications

- Slope stability, early warning of slope failure.
- Performance of dams and embankments
- Ground movements due to tunneling
- Deflection of laterally loaded piles
- Deformations of retaining walls.
- Monitoring landslide areas

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GOESTRING System Configuration

A typical system requires casings, GEOSTRING segments, a suspension kit, a bottom plug, a jumper cable, and a datalogger.

Casing

Select either the 70 mm (2.75 in) or 85mm (3.34 in) diameter inclinometer casing. When ordering your GEOSTRING System, it is very important to indicate the type of installation in order that proper centralizers will be included on the array.

GEOSTRING Standard Segment 3.048 m (10 ft), 5 nodes

A Standard GEOSTRING array consists of 3.048 m (10 ft) segments. Segments can be installed in any sequence, since the calibration of each node is embedded in the sensor and read by the data logger.

Each segment has a male connector at the upper end and a female connector at the lower end. The lower end can be recognized by the presence of a centralizer and a universal joint, as seen in the picture on the right.

GEOSTRING Custom Segments, 1 to 4 nodes

GEOSTRING custom segments can be manufactured in shorter lengths of 0.608 m (2 ft), 1,219 m (4 ft),1.828 m (6 ft) and 2.438 m (8ft) length (with 1, 2, 3 or 4 nodes, respectively). Custom segments allow the flexibility to adjust the array to the depth of your boreholes.

GEOSTRING Sensorless Dummy Segments

GEOSTRING sensorless (dummy) segments are available in 0.609 m (2 ft) and 1.524 m (5ft) for installation at any place within the array, allowing designers to optimize their system by only monitoring the zone of interest. A custom patchcord is required if the dummy portion occurs between monitored sections of the array. Seperate jumper cables are another option for the monitored sections.

Male cable connector

GEOSTRING Standard Segment
10 feet / 5 nodes

Female cable connector

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GEOSTRING Signal Cable

To install the signal cable, attach the bottom plug to the female connector on the first segment of the array to be placed in the casing. Insert the bottom end of the first segment, plug first, into the casing.

GEOSTRING Bottom Plug

One bottom plug is required for the end of each array. The bottom plug has a male connector on one end and is used to protect the last node from water ingress via the connector.

GEOSTRING Jumper Cable

A jumper cable connects the top of each array to the data logger. The jumper cable has a female connector on one end and exposed, inner inner-conductor wires on the other for connection to the data logger.

GEOSTRING Suspension Kit

One suspension kit is required for each array. The kit includes the suspension gate and hardware for securing the array to the casing or pipe.

Data Logger

The GEOSTRING system is connected to a Senslog data acquisition system and readings are transmitted to a processing software that can trigger alarms based on displacement or rate of change.

A variety of Campbell Scientific data loggers can be integrated in a Roctest Senslog for GEOSTRING systems. Two GEOSTRING arrays can be connected to each CR6 or CR1000X. Incorporating an MD485 per GEOSTRING array, the CR1000x can read five arrays, the CR800 three arrays and the CR300 one array.

Compatible with CR6, CR300, CR800, CR1000 & CR1000X. MD485 RS RS-485 Interface required for CR300, CR800 & CR1000.

Data Retreiver

The GEOSTRING array outputs the displacement as engineering units, requiring less computing power and a lighter load on your data acquisition system. The nodes are preloaded with the calibration information, allowing the segments to be installed in any order.

Readings retrieved from the logger can be processed manually by spreadsheet or automatically by third third-party, web web-based monitoring programs.

Nominal Jumper Cable Limits for an Array of Nodes

Number of Nodes	Max Jumper Length, m (12V Supply)	Max Jumper Length, m (24V Supply)
10	320	-
25	122	-
50	52	215
75	24	139
100	5	97
125	-	69
150	-	47
175	-	28
200	-	12

Easy Shipping

GEOSTRING segments have joints capable of bending to 90°, allowing for compact packaging.

Five segments, each 3.048 m (10 ft) long can be shipped in a box measuring approximately 64 x 64 x 64 cm (26 x 26 x 26 in) which weigths less than 22 kilograms (50 pounds).

The arrays can be shipped via standard overnight service due to their compact size.

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Specifications

Sensor type	MEMS (Micro Electro-Mechanical Systems) tilt sensors for inclination readings Thermistor for temperature readings
Calibrated Range	±30 degrees from vertical over a temperature range of -10°C to +40°C
Resolution with SENSLOG	9 arc seconds or 0.04 mm/m using the CR1000 data logger
Repeatability	±82 arc seconds or ±0.4 mm/m
Power requirements	Minimum supply voltage of 10 Vdc. Maximum supply voltage of 30 Vdc. Digital RS485 signal requires Campbell Scientific data logger
Housing	Stainless steel, 32 mm diameter, waterproof to 2 MPa
Weight	0.54 kg per 0.6m (1.2 lb per 2 feet) gauge length
Waterproof	Waterproof to 2 MPa (300 psi)
Signal Cable	Jumper Cable for connecting the system to the datalogger. Connectors are rated to 70 MPa (10,000 psi)
Casing	70 mm (2.75 in) diameter casing 85 mm (3.34 in) diameter casing
Data Logger	Compatible with CR6, CR300, CR800, CR1000 & CR1000X Data Loggers MD485 RS-485 Interface required for CR300, CR800 & CR1000 Data Loggers as well as WorldseNsing and Ackcio digital nodes

Roctest Ltd
680 Birch Street •St-Lambert, Quebec J4P 2N3
Phone +1 450.465.1113
Fax +1 450.465.1938
Email: info@roctest.com
Web: www.roctest.com

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