



EASY INSTALLATION
VERTICAL STRING OF MEMS SENSOR NODES
LOW COST REAL TIME MONITORING

The GEOSTRING inclinometer is a string of closely spaced MEMS sensors, ideal for real time continuous and unattended monitoring of lateral displacement of soil, rock and structures.

Description

The GEOSTRING system consists of a number of sensor nodes in a vertical string installed in either 70mm (2.75 inch) diameter inclinometer casing or in 38mm (1.5-inch) diameter Schedule 40 PVC pipe.

The pipe or casing provides access for subsurface measurements. The joints between each sensor are robust, allowing the system to maintain a consistent orientation of all the nodes, regardless of whether it is installed in ABS inclinometer casing or PVC pipe.

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 system spans the zone of movement occurs, the pipe/casing moves as well, 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 connected to a SENSLOG data acquisition system, and readings are transmitted to processing software that can trigger alarms based on displacements or rate of change.

Nodes, cables, connectors and gage rods are exceptionally robust, making it practical to remove the systems at the end of the project and redeploy them on other projects.

GEOSTRING systems have joints capable of bending to 90°, allowing for a compact shipping option.

Key Features

- Easy installation
- Real time monitoring
- Single cable installation
- Each sensor connected to the sensor above.
- Pre-loaded calibration factor in each node
- Sensorless nodes available
- Ultra robust components
- Long term reliability
- Cost effective
- 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

GEOSTRING System Configuration

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

Casing

Select either the 70 mm (2.75 in) diameter inclinometer casing or the 38 mm (1.5 in) diameter Schedule 40 PVC pipe. When ordering your GEOSTRING System it is very important to indicate the type of casing being used so that the proper centralizers will be installed on the string.



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

A Standard GEOSTRING system is made up of a string of 3.048 m (10 ft) segments. Segments can be installed in any order, the calibration of each sensor is embedded the node and read by the data logger.

Each segments 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 an universal joint, as seen in the picture on the right.

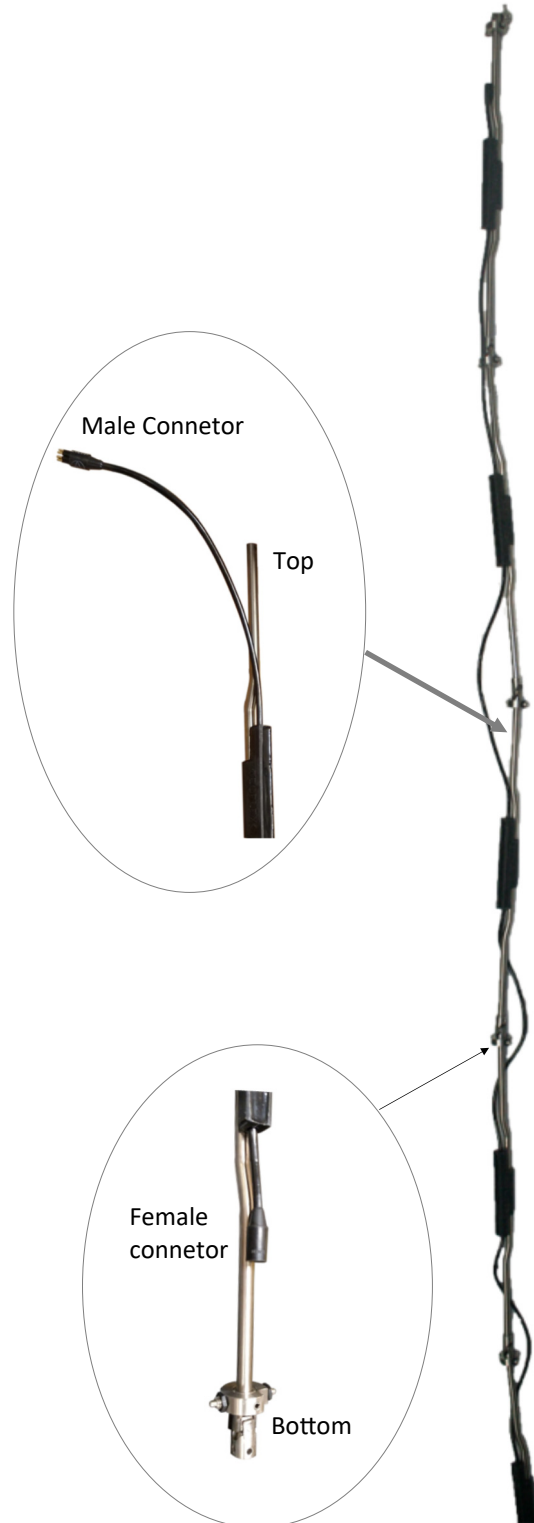


1 to 4 Nodes GEOSTRING Custom Segments

GEOSTRING custom segments can also 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). Shorter GEOSTRING custom segments length can be ordered to adjust the string 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 the top of the system, allowing designers to optimize their system by only monitoring the zone of interest and bypassing the upper layers.



GEOSTRING - In Place MEMS Inclinometer

Inclinometer

GEOSTRING Signal Cable

Installation

Attach the Bottom Plug to the female connector on the first segment to be placed in the casing.
Insert the bottom end of the first segment into the casing.



GEOSTRING Bottom Plug

A bottom plug is required for the bottom end of each string. 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 string to the data logger. The jumper cable has a female connector on one end and exposed inner conductor wires on the other for connection to the data logger.

GEOSTRING Suspension Kit

One suspension kit is required for each borehole. The kit includes the suspension gate and hardware for securing the system.



Data Logger



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

A number of Campbell Scientific data loggers can be integrated in a RocTest Senslog for GEOSTRING systems. Two GEOSTRING systems can be connected to each CR6 or CR1000X. With an MD485 module per GEOSTRING system, the CR1000 can read five systems, the CR800 three systems and the CR300 one system.

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

Data Retriever

The GEOSTRING system 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 party webbased monitoring system.

Nominal Limits for String 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 systems have joints capable of bending to 90°, allowing for a compact shipping option.

Five segments, each 3.048 meters (10 feet) long, can be shipped in a carton measuring approximately 64 x 64 x 64 cm (26 x 26 x 26 in) and which weighs less than 22 kilograms (50 pounds).

Because of its compact size, the system can be shipped via standard overnight service.



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 38 mm (1.5 in) Schedule 40 PVC Pipe
Data Logger	Compatible with CR6, CR300, CR800, CR1000 & CR1000X Data Loggers MD485 RS-485 Interface required for CR300, CR800 & CR1000 Data Loggers

Ordering Information

Description	Length (m)	Length (ft)	Inclinometer Casing System 70 mm (2.75 in)	Schedule 40 PVC Pipe System 38 mm (1.5 in)
GEOSTRING Standard Segment				
5 Sensor GEOSTRING Segment (Standard)	3.048	10	FR-0387050100	FR-0387050200
GEOSTRING Custom Segments				
4 Sensor GEOSTRING Custom Segment	2.438	8	FR-0387050108	FR-0387050208
3 Sensor GEOSTRING Custom Segment	1.828	6	FR-0387050106	FR-0387050206
2 Sensor GEOSTRING Custom Segment	1.219	4	FR-0387050104	FR-0387050204
1 Sensor GEOSTRING Custom Segment	0.609	2	FR-0387050102	FR-0387050202
GEOSTRING Dummy Segments				
Dummy GEOSTRING Segment	1.524	5	40-0387040105	40-0387040205
Dummy GEOSTRING Segment	0.609	2	40-0387040102	40-0387040202
GEOSTRING Required Accessories				
Suspension Kit, GEOSTRING			40-0387040410	40-0387040420
Jumper Cable, GEOSTRING to Logger	50	164	40-0387040350	40-0387040350
Jumper Cable, GEOSTRING to Logger	25	82	40-0387040325	40-0387040325
Bottom Plug, GEOSTRING, 6 Pin Seacon			40-0387040500	40-0387040500
GEOSTRING Replacement Accessories				
Replacement Centralizer			40-0387040610	40-0387040620
GEOSTRING Clevis Pin with Head			40-0387040700	40-0387040700