

A portable system to monitor either heave or settlement in soil and rock. Installation may be either as a single purpose device to monitor settlement/heave only, or in conjunction with RST flush-coupled inclinometer casing to obtain both vertical and horizontal deformation data from a single installation. The system is simple, accurate, and has proven long term reliability at low cost.

Installations are typically vertical, however, horizontal applications may be accommodated utilizing installation rods to insert the probe.



FEATURES

Simple, yet accurate principle of operation.

Low cost.

High performance ceramic magnets.

Flush OD, O-ring sealed telescopic sections for access tube or inclinometer casing.

High accuracy, non-stretch tape.

Simple, mechanically released spider magnets without the necessity for pneumatic cutters.

Compatible with RST inclinometer casing.

Integral electrical cable and survey chain.

FUNCTIONS

Monitor settlement or heave associated with construction, mining, and tunneling.

When used around inclinometer casing, deformation in the third axis can be monitored.

Subsidence monitoring.

Displacement of retaining walls, piers, and abutments.

Bottom heave of excavations.

Relaxations of rock around tunnel openings.

Foundation settlement monitoring.

Embankments and fills.



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MAGNETIC SETTLEMENT SYSTEM

rst
INSTRUMENTS

RST Instruments Ltd.
200 - 2050 Hartley Ave., Coquitlam, BC Canada V3K 6W5
Telephone: +1-604-540-1100 • Facsimile: +1-604-540-1005
Toll Free (USA & Canada): 1-800-665-5599
Email: info@rstinstruments.com
www.rstinstruments.com

The RST Instruments
Management System
is certified to
ISO 9001:2000



PRINCIPLE OF OPERATION

Magnetic targets are anchored to the ground around either a PVC pipe, Standpipe Piezometer, or Inclinator Casing. The anchors are not coupled to the access pipe, and are free to move with the soil. Magnets are available for attachment to inclinometer casing to monitor closure of casing telescopic sections

The probe is a normally open, simple reed switch that closes upon entering the magnetic field of the target anchor. Operation is analogous to a water level meter in that when the switch closes, the electrical circuit is completed, causing a buzzer/light in the readout to operate. A two-conductor tape serves to both lower the probe and connect the probe to the circuit board. The switch closes upon entering magnetic field, the signal amplified, and fed to the light/buzzer. Anchor elevation is then read directly from the tape. An optional micrometer head is available for utmost accuracy.

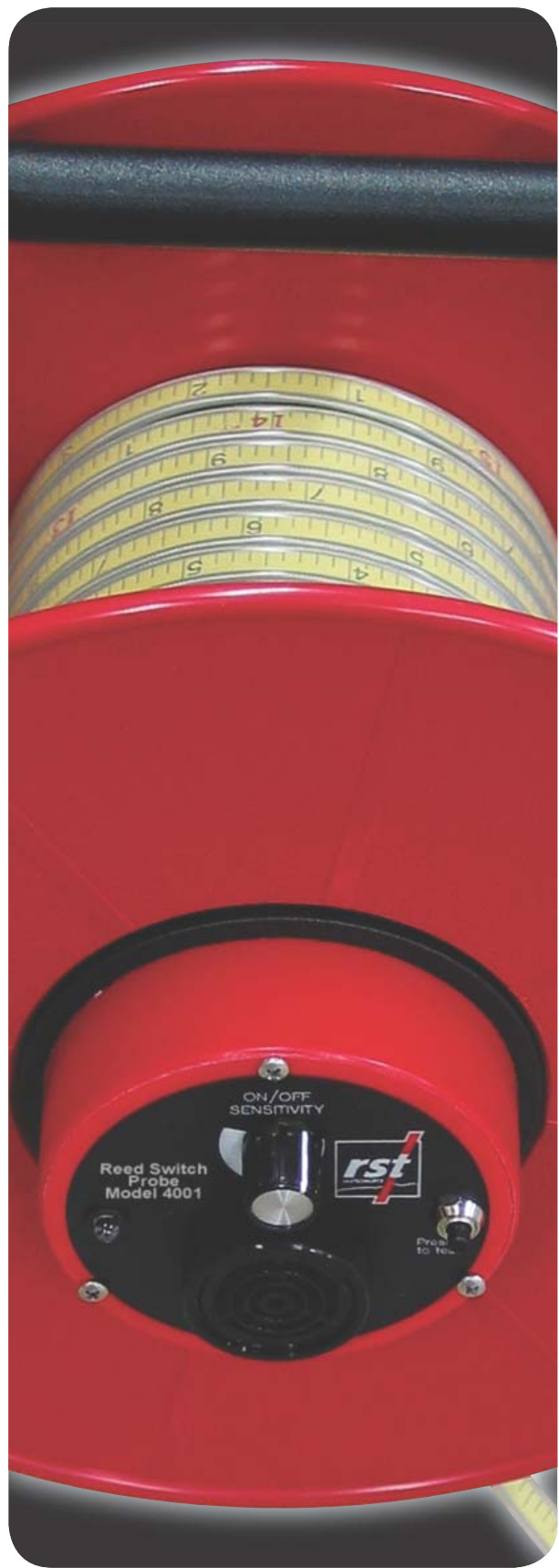
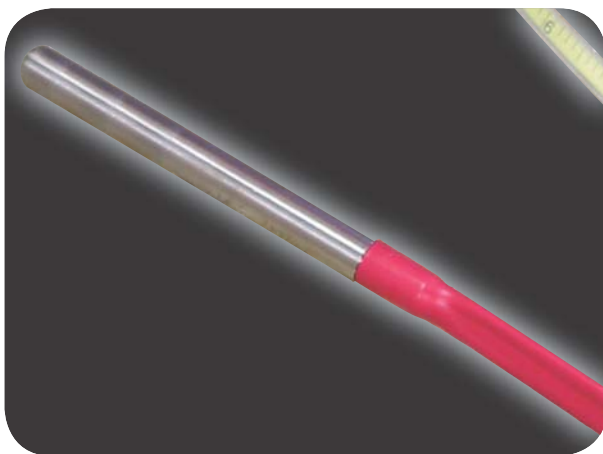
The probe incorporates two reed switches to avoid difficulty in manufacturing a ring magnet with uniform polarity, preclude false closure when passing through the three magnetic fields of the magnet, and negate the end effects on the magnetic field when spring steel spider magnets are employed.

Magnets are arranged within the anchor to yield a uniform, axial magnetic field with a well-defined null zone. Ceramic magnets, rather than ferrous magnets, are used because of their consistent magnetic properties:

- There is no significant change in field strength with time.
- The magnets are unaffected by most groundwater regimes.
- There is no appreciable difference in field strength with temperature.
- Field strength is unaffected by impact.

Like an inclinometer installation, Reed Switch Settlement Systems utilize the bottom of the borehole as a reference datum. Typically, the borehole is drilled to stable ground and a datum reference magnet installed. If site conditions preclude the use of the bottom of the borehole as a datum, optical survey methods must be used at the borehole collar.

Settlement or heave is determined by comparing subsequent readings to the initial datum readings.



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READOUT

Supplied on a sturdy winding reel, complete with brake and carry handle. A polyethylene or Teflon coated, non-stretch, flat tape with stainless steel conductors serves to lower the twin reed switch probe. Tapes are dual scale in feet and meters, or single scale in either ft/m, as preferred with a 1/100 ft. or 1 mm resolution. The moisture resistant electronics and standard 9V battery are housed in the reel hub for ease of access. Depth to anchor is indicated by both a light and buzzer with sensitivity control as standard.

ACCESS PIPE

Access pipes may be either inclinometer casing to monitor both horizontal and vertical deformation, or PVC pipe for settlement/heave measurement only.

RST Inclinometer Casing is precision manufactured in 70mm (2.75 in.) OD and 85mm (3.34 in.) OD sizes. Two flush coupling methods are available to permit spider anchor installation in cased boreholes. The standard coupling method utilizes ABS cement and pop-rivets, with the RST Snap Seal Coupling System providing an O-ring sealed, self-coupling method.

Telescopic sections are available to accommodate settlement. Please refer to the RST Inclinometer Casing literature for complete specifications. PVC access pipes are flush coupled, threaded joints in either 5ft. (1.5m) or 10ft. (3m) lengths, O-ring sealed telescopic sections are available.

TELESCOPIC SECTIONS

When vertical compression exceeds 1-2%, telescopic sections must be used to allow axial movement of the access pipe/casing while minimizing distortion due to vertical strain. Telescopic sections are O-ring sealed and flush coupled to permit slipping anchors over the pre-installed access tube are tube are available to suit either PVC pipe or Inclinometer Casing.

NOTE: In applications where anticipated settlement exceeds the range of telescopic sections, the convoluted sheath may be employed to accommodate axial compression up to 35%.

READOUT SPECIFICATIONS

LENGTHS (Standard lengths, alternate lengths on request)	MODEL	RS0001	RS0002	RS0003	RS0004	RS0005	RS0006	RS0007	RS0008	RS0009	RS0010
	LENGTH	15 m 50 ft.	30 m 100 ft.	45 m	150 ft.	60 m	200 ft.	75 m	250 ft.	100 m	300 ft.
RESOLUTION	1 mm / 0.01 ft.			REED SWITCH PRECISION	±0.03 to 0.3 mm (±0.001 to 0.01 in.)						
TAPE	Polyethylene coated [Teflon (R) coated optional]. 10mm (0.4 in.) flat style. Stainless steel conductors.			SYSTEM PRECISION	Vertical installations typically ±3 to 5 mm (±0.1 to 0.2 in.). Vertical installations with micrometer head typically ±0.5mm (±0.02 in.).						
PROBE	Two reed switches standard. 16 X 200 mm (5/8 in. OD X 8 in. long)			BATTERY	Standard 9 V						

ANCHOR MAGNETS

Datum magnets are coupled directly to the bottom of the access pipe or casing, and grouted in place, to serve as a non-settling reference datum in stable ground.

Plate magnets are available for use in fill. The magnets are simply slipped over the pipe or casing as the fill progresses. A large surface area serves to couple the anchor to the fill.

Spider magnets are utilized in borehole installations, employing two methods of deployment. The simplest method requires a cased borehole or hollow stem augers, whereby the greased access pipe/casing is installed and the drill casing is pulled to the first anchor elevation. A 3-legged spider anchor is then pushed down over the access pipe/casing, exiting the drill casing, allowing the spring legs of the spider magnet to bite into the soil. The casing is pulled to the next anchor location and the procedure is repeated until all anchors are placed. RST systems incorporate flush telescopic sections to permit this method of installation.

Alternately, a 6-legged spider anchor can be utilized. In an open borehole, the access pipe/casing is inserted with all the spider magnets pre installed on the pipe, but with the spider legs retracted. Lengths of corrugated pipe may be utilized to link the magnets, and prevent the grout from bonding to the access pipe. A pin is pulled, similar to a snap ring extensometer anchor, thereby releasing the spider legs to anchor in the soil.

Inclinometer casing magnets are available for incorporation into inclinometer casing telescopic sections, to measure closure of the telescopic joint. This performs the same function as the USBM crossarm device, or a hook type settlement probe, while retaining the simplicity of the reed switch system.



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DATUM MAGNETS

MODEL	SPECIFICATIONS
RS00D1	To fit 1 in. flush threaded PVC pipe. Max OD 5.95cm (2.4 in.).
RS00D2	To fit RST 70 mm (2.75 in.) standard inclinometer casing.
RS00D3	To fit RST 2.75 in. Snap Seal inclinometer casing. Max OD 7.25 cm (2.85 in.).
RS00D4	To fit RST 85 mm (3.34 in.) standard inclinometer casing.
RS00D5	To fit RST 3.34 in. Snap seal inclinometer casing. Max OD 8.89 cm (3.50 in.).

SPIDER MAGNETS

MODEL	SPECIFICATIONS
RS00S1	To fit 1 in. flush threaded PVC pipe. Max OD 5.95cm (2.4 in.). Borehole size as required i.e. # RS00S1 –xxx
RS00S2	To fit RST 70 mm (2.75 in.) Standard or Snap Seal inclinometer casing. Max OD 9.92cm (4.0 in.). Borehole size as required i.e. # RS00S2 –xxx
RS00S3	To fit RST 85 mm (3.34 in.) Standard or Snap Seal inclinometer casing. Max OD 11.16 cm (4.5 in.). Borehole size as required i.e. # RS00S3 –xxx

ACCESS PIPES SPECIFICATIONS

MODEL	DESCRIPTION
RS00SA1	25 mm (1 in.) PVC X 1.5 m (5 ft.)
RS00A2	25 mm (1 in.) PVC X 1.5 m (5 ft.)
RS00SA3	25 mm (1 in.) PVC telescopic section Extended length 660 mm (26 in.) Compressed length 508 mm (20 in.)
IC0202	2.75 in. Standard coupling casing X 10 ft.
IC0212	70 mm Standard coupling casing X 3 m
IC0203	2.75 in. Standard coupling casing X 5 ft.
IC0213	70 mm Standard coupling casing X 1.5 m
IC0214	70 mm (2.75 in.) Standard telescopic casing section
IC0302	3.34 in. Snap Seal casing X 10 ft.
IC0312	85 mm Snap Seal casing X 3 m
IC0303	3.34 in. Snap Seal casing X 5 ft.
IC0313	85 mm Snap Seal casing 1.5 m
IC0314	85 mm (3.34 in.) Snap Seal telescopic casing section

PLATE MAGNETS

MODEL	SPECIFICATIONS
RS00P1	To fit 1 in. flush threaded PVC pipe. Standard OD 30 cm (12 in.).
RS00P2	To fit RST 70 mm (2.75 in.) Standard or Snap Seal Inclinometer casing. Standard OD 30cm (12 in.).
RS00P3	To fit RST 85 mm (3.34 in.) Standard or Snap Seal Inclinometer casing. Standard OD 30cm (12 in.).

INCLINOMETER CASING TELESCOPIC SECTION MAGNETS

MODEL	SPECIFICATIONS
RSTS01	To fit RST 70 mm (2.75 in.) Standard Inclinometer Casing. Max OD 7.25 cm (2.85 in.)
RSTS02	To fit RST 70 mm (2.75 in.) Snap Seal Inclinometer Casing. Max OD 7.25 cm (2.85 in.)
RSTS03	To fit RST 85 mm (3.34 in.) Standard Inclinometer Casing. Max OD 8.89 cm (3.50 in.)
RSTS04	To fit RST 85 mm (3.34 in.) Snap Seal Inclinometer Casing. Max OD 8.89 cm (3.50 in.)

OPTIONS (Specify when ordering)

Teflon (R) coated readout tape for corrosive environments or environmental applications.

Micrometer readout head.

Insertion rods for horizontal applications. For utmost accuracy in vertical applications, insertion rods may be used in conjunction with the micrometer head above.

Combination Reed Switch/Water Level Meter Instrument



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