S L O P E   I N D I C A T O R

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Inclinometer Casing

Inclinometer Casing

Inclinometer casing is a special purpose, grooved pipe used in inclinometer installations. It is typically installed in boreholes, but can also be embedded in fills, cast into concrete, or attached to structures.

Inclinometer casing provides access for the inclinometer probe, allowing it to obtain subsurface measurements. Grooves inside the casing control the orientation of the probe and provide a surface from which repeatable tilt measurements can be obtained.

Choosing Inclinometer Casing

Although Slope Indicator casing is competitively priced, price should never be the deciding factor in choosing inclinometer casing. The cost of casing is quite small relative to the cost of mobilizing a drill rig, and very small relative to the cost of a failed installation.

This page summarizes the most important factors to consider when choosing casing.

Casing Diameter

The useful life of the casing ends when ground movement pinches or shears the casing, preventing the probe from passing through. Larger diameter casing generally provides longer life.

85mm (3.34") Casing is suitable for landslides and long term monitoring. It is also appropriate for monitoring multiple shear zones or very narrow shear zones, and it is required for the horizontal Digitilt inclinometer probe.

70mm (2.75") Casing is suitable for construction projects. It can also be used for slope stability monitoring when only a moderate degree of deformation is anticipated.

48mm (1.9") Casing is suitable for applications where small deformations are distributed over broad zones. It is generally not installed in soils.

Casing Grooves

Measurement accuracy is directly influenced by the quality of casing grooves. Slope Indicator optimizes casing grooves for the wheels of the Digitilt inclinometer probe, providing a flat surface for the wheels and also the extra width needed when the probe must pass through cross-axis curvature. Groove spiral is also tightly controlled.

Casing Strength

In borehole installations, the annular space around the casing is usually backfilled with grout. The grouting process can generate pressure high enough to cause the casing to collapse. In deep installations, the pressure of grout must be controlled by stage grouting, but in other cases, the casing must be strong enough to withstand the normal pressure of grouting. Slope Indicator uses thick-walled pipe and carefully controls the depth of the grooves.

Sealable Couplings

If casing joints are not adequately sealed, grout can force its way into the casing and later prevent the probe from reaching its intended depth.

Slope Indicator offers several types of couplings and casings, all of which can be sealed easily and consistently. Our newest designs feature O-ring seals, and our older designs feature tight-fitting surfaces that are fused together with solvent cement.

Assembly

Inclinometer casing should be easy to assemble, even with an untrained crew. Slope Indicator's QC casing, which snaps together, is the current leader in quick and easy assembly. Other types of casing are assembled with shear wires or with solvent cement.

Casing Materials

Slope Indicator uses only ABS plastic for its casing for several reasons. ABS plastic retains its shape and flexibility over a wider range of temperatures than PVC plastic. ABS plastic is much easier to handle and seal than fiberglass casing. Finally, ABS plastic is suitable for long term contact with all types of soils, grouts, and ground water, unlike aluminum casing, which is no longer recommended for any application.

Installation Information

Visit the technical support section at www.slopeindicator.com to find recommended grout mixes, ways to counter casing buoyancy, and notes on other installation issues.

QC CASING

QC (Quick Connect) casing features snap-together convenience and strong, flush joints.

Grooves: Grooves are machine broached for excellent control of width, chamfer, depth, straightness, and spiral.

Sealing: O-ring seals prevent entry of grout.

Coupling: Built-in couplings snap together to make a flush joint. Unique locking mechanism engages full inner circumference of casing, providing much stronger joints than other snap-type casings.

Assembly: Press casing sections together until joint snaps closed. The resulting joint is strong, flush, and grout-proof. Solvent cement, rivets, or tape are not required. O-ring lubricant is applied at factory. Extra O-rings and lubricant are supplied with each box of casing.

Best for: General use.

QC Casing 85mm · 3.34"

Casing OD: 85 mm, 3.34 inches.
Casing ID: 73 mm, 2.87 inches.
Collapse Rating: 12.4 bar, 180 psi.
Load Rating: 635 kg, 1400 lb.
Temp rating: -29 to 88 ºC, -20 to 190 ºF.
Spiral: ≤ 0.33º per 3m or 10' section.

QC Casing 70mm · 2.75"

Casing OD: 70 mm, 2.75 inches.
Casing ID: 59 mm, 2.32 inches.
Collapse Rating: 16.5 bar, 240 psi.
Load Rating: 635 kg, 1400 lb.
Temp rating: -29 to 88 ºC, -20 to 190 ºF.
Spiral: ≤ 0.33º per 3m or 10' section.

STANDARD CASING

Slope Indicator's traditional inclinometer casing features high-strength, flush joints and is available in three diameters.

Grooves: Grooves are machine broached for excellent control of width, chamfer, depth, straightness, and spiral.

Sealing: Solvent cement and tape.

Coupling: Precision molded couplings have interference fit for high-strength bonding. Small diameter version has integral couplings.

Assembly: Casing and couplings are glued together with ABS solvent cement, riveted, and wrapped with tape.

Best for: General use. The extra-strong joints are helpful in very deep boreholes and oversize boreholes in which casing is not well supported.

Standard Casing 85mm · 3.34"

Coupling OD: 89 mm, 3.51 inches.
Casing OD: 85 mm, 3.34 inches.
Casing ID: 73 mm, 2.87 inches.
Collapse Rating: 10.6 bar, 155 psi.
Load Rating: 320 kg, 700 lb.
Temp rating: -29 to 88 ºC, -20 to 190 ºF.
Spiral: ≤ 0.33º per 3m or 10' section.

Standard Casing 70mm · 2.75"

Coupling OD: 70 mm, 2.75 inches.
Casing OD: 70 mm, 2.75 inches.
Casing ID: 59 mm, 2.32 inches.
Collapse Rating: 15 bar, 220 psi.
Load Rating: 320 kg, 700 lb.
Temp rating: -29 to 88 ºC, -20 to 190 ºF.
Spiral: ≤ 0.33º per 3 m or 10' section.

Standard Casing 48mm · 1.9"

Casing OD: 48 mm, 1.9 inches.
Casing ID: 38 mm, 1.5 inches.
Collapse Rating: 24 bar, 350 psi.
Load Rating: 320 kg, 700 lb.
Temp rating: -29 to 88 ºC, -20 to 190 ºF.
Spiral: ≤ 0.33º per 3 m or 10' section.

EPIC CASING

EPIC casing is an economical casing that can be cut and coupled at any point along its length.

Grooves: Grooves are formed during extrusion and are less precise than broached grooves.

Sealing: Solvent cement, mastic, and tape.

Coupling: Oversize couplings make very strong joints.

Assembly: Casing and couplings are glued together with ABS solvent cement. The joint must then be sealed with mastic and tape.

Best for: General use. Some care must be taken to seal the coupling.

EPIC Casing 70mm · 2.75" Only

Coupling OD: 78 mm, 3.07 inches.
Casing OD: 70 mm, 2.75 inches.
Casing ID: 60 mm, 2.32 inches.
Collapse Rating: 15 bar, 220 psi.
Load Rating: 320 kg, 700 lb.
Temp rating: -29 to 88 ºC, -20 to 190 ºF.
Spiral: ≤ 0.5º per 3m or 10' section.

85mm (3.34") casing accomodates the most movement and provides the longest installation life. It is useful for landslides and long-term monitoring projects. 70mm (2.75") casing is suitable for medium to short-term construction projects. 48 mm (1.9") casing is used in rock or concrete where deformations will be small.

CPI CASING

CPI casing features quick assembly and disassembly and is available in 3 diameters.

Grooves: Grooves are machine broached for excellent control of width, chamfer, depth, straightness, and spiral.

Sealing: O-ring seals prevent entry of grout.

Coupling: Oversize couplings and shear wires make high strength joint.

Assembly: Apply grease to O-rings, press coupling onto casing, and insert shear wire.

Best for: Cold weather assembly or temporary installations that involve repeated disassembly.

CPI Casing 85mm · 3.34"

Coupling OD: 94 mm, 3.7 inches.
Casing OD: 85 mm, 3.34 inches.
Casing ID: 73 mm, 2.87 inches.
Collapse Rating: 11 bar, 155 psi.
Load Rating: 635 kg, 1400 lb.
Temp rating: -29 to 88 ºC, -20 to 190 ºF.
Spiral: ≤ 0.33º per 3m or 10' section.

CPI Casing 70mm · 2.75"

Coupling OD: 76 mm, 3 inches.
Casing OD: 70 mm, 2.75 inches.
Casing ID: 59 mm, 2.32 inches.
Collapse Rating: 15 bar, 220 psi.
Load Rating: 400 kg, 900 lb.
Temp rating: -29 to 88 ºC, -20 to 190 ºF.
Spiral: ≤ 0.33º per 3m or 10' section.

CPI Casing, 48mm · 1.9"

Coupling OD: 54 mm, 2.12 inches.
Casing OD: 48 mm, 1.9 inches.
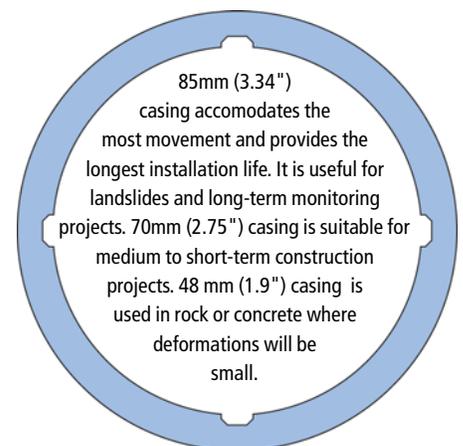Casing ID: 38 mm, 1.5 inches.
Collapse Rating: 24 bar, 350 psi.
Load Rating: 320 kg, 900 lb.
Temp rating: -29 to 88 ºC, -20 to 190 ºF.
Spiral: ≤ 0.33º per 3 m or 10' section.

SHEAR-WIRE CASING

Shear-Wire casing features flush joints that can be assembled easily in cold weather.

Grooves: Grooves are machine broached for excellent control of width, chamfer, depth, straightness, and spiral.

Sealing: O-ring seals prevent entry of grout.

Coupling: Built-in couplings lock together with removable nylon shear wire to make flush joint.

Assembly: Press casing sections together, then insert shear wire. The result is a flush, grout-proof joint. Solvent cement, rivets, and tape are not required. O-ring lubricant is applied at the factory. Extra O-rings, lubricant, and shear wires are supplied with each box of casing.

Best for: Easy assembly in weather that is too cold for solvent cement or snap-together joints. Generally used in water-filled boreholes.

Shear Wire Casing 85mm · 3.34"

Casing OD: 85 mm, 3.34 inches.
Casing ID: 73 mm, 2.87 inches.
Collapse Rating: 12.4 bar, 180 psi.
Load Rating: 225 kg, 500 lb.
Temp rating: -29 to 88 ºC, -20 to 190 ºF.
Spiral: ≤ 0.33º per 3m or 10' section.

Shear Wire Casing 70mm · 2.75"

Casing OD: 70 mm, 2.75 inches.
Casing ID: 59 mm, 2.32 inches.
Collapse Rating: 16.5 bar, 240 psi.
Load Rating: 225 kg, 500 lb.
Temp rating: -29 to 88 ºC, -20 to 190 ºF.
Spiral: ≤ 0.33º per 3m or 10' section.

GROUT VALVES

Grout valves allow placement of grout backfill in boreholes that cannot accommodate an external grout pipe. The one-way valve is installed in the bottom section of casing. A grout pipe is lowered through the casing to mate with the grout valve and deliver the grout.

TELESCOPING SECTIONS

Optional telescoping sections accommodate 150 mm (6 inches) of compression or extension. Fully extended, each telescoping section adds 0.76 m (2.5 feet) of length to the casing

CASING ANCHORS

In its fluid state, grout exerts an uplift force that can push even water-filled casing out of the borehole. Holding the casing down from the top has unfortunate side-effects: the casing goes into compression and snakes from side to side in the borehole. Thus casing curvature is present from the start, and slight variations in the positioning of the probe are more likely to produce reading errors..

The casing anchor, installed in place of the bottom cap, provides a convenient way to counter casing buoyancy and reduces casing curvature, since the casing self-centers in the borehole. The anchor has spring loaded arms that are activated when a pin is pulled. Anchors are available for 70 mm and 85 mm casing.

QC CASING 85MM · 3.34"
Casing Section, 10' (3.05 m) 51150310
Casing Section, 5' (1.52 m) 51150311
Section, Telescoping. 51150320
Cap, Bottom. 51150330
Cap, Bottom, Heavy Duty 51100520
Grout Valve, Gasket Type 51100830
Cap, Top. 51100500
Cap, Locking 51100550
Splice Kit, Male 51150350
Splice Kit, Female. 51150351

QC CASING 70mm · 2.75"
Casing Section,10' (3.05 m) 51150210
Casing Section, 5' (1.52 m) 51150211
Section, Telescoping. 51150220
Cap, Bottom. 51150230
Cap, Bottom, Heavy Duty 51101520
Grout Valve, Gasket Type 51100820
Cap, Top. 51101500
Cap, Locking 51101550
Splice Kit, Male 51150250
Splice Kit, Female. 51150251

STANDARD CASING 85mm · 3.34"
Casing Section, 10' (3.05 m) 51100100
Casing Section, 5' (1.52 m) 51100105
Telescoping Section 51106400
Coupling 51100200
Cap, Bottom, Heavy Duty 51100520
Grout Valve, Gasket Type 51100830
Cap 51100500
Cap, Locking 51100550
Pop Rivet AD44H 51103301

STANDARD CASING 70mm · 2.75"
Casing Section, 10' (3.05 m) 51101100
Casing Section, 5' (1.52 m) 51101105
Telescoping Section 51107400
Coupling 51101200
Cap, Bottom, Heavy Duty 51101520
Grout Valve, Gasket Type 51100820
Cap 51101500
Locking Cap with Padlock 51101550
Pop Rivet AD42H 51003303

STANDARD CASING 48mm · 1.9"
Casing Section, 5' (1.52 m) 51102305
Cap 51102500
Locking Cap with Padlock 51102550
Grout Valve, Gasket Type 51104000

EPIC CASING 70mm · 2.75"
Casing Section, 10' (3.05 m) 51111100
Coupling. 51111200
Telescoping Coupling 51111400
Cap, Bottom, Heavy Duty 51101520
Grout Valve, Gasket Type 51100820
Cap. 51111500
Locking Cap with Padlock. 51101550
Pop Rivet AD46H 51003310
Lubricant for Telescoping Coupling. . . 57504000

CPI CASING 85mm · 3.34"
Casing Section, 10' (3.05 m). 57500100
Casing Section, 5' (1.52 m) 57500105
Telescoping Section 57506400
Coupling with 2 Shear Wires. 57500200
Cap with Shear Wire. 57500500
Cap, Bottom, Heavy Duty 51100520
Grout Valve, Gasket Type 51100830
Cap, Top 51100500
Spare Nylon Shear Wire 57500700
O-Ring Lubricant. 57504000

CPI CASING 70mm · 2.75"
Casing Section, 10' (3.05 m) 57501100
Casing Section, 5' (1.52 m) 57501105
Telescoping Section 57507400
Coupling with 2 Shear Wires. 57501200
Cap with Shear Wire. 57501500
Cap, Bottom, Heavy Duty 51101520
Grout Valve, Gasket Type 51100820
Cap, Top 51101500
Spare Nylon Shear Wire 57501700
O-Ring Lubricant. 57504000

CPI CASING 48mm · 1.9"
Casing Section, 5' (1.52 m) 57502105
Coupling with 2 Shear Wires. 57502200
Cap with Shear Wire. 57502500
Grout Valve, Gasket Type 57503700
Cap, Top 51102500
Spare Nylon Shear Wire 57502700
O-Ring Lubricant. 57504000

SHEAR WIRE CASING 85mm · 3.34"
10' (3.05 m) Casing Section. 51160310
5' (1.52 m) Casing Section. 51160311
Section, Telescoping 51160320
Cap, Bottom .51160330
Cap, Bottom, Heavy Duty 51100520
Grout Valve, Gasket Type 51100830
Cap, Top 51100500
Cap, Locking .51100550

SHEAR WIRE CASING 70mm · 2.75"
Casing Section, 10' (3.05 m) 51160210
Casing Section, 5' (1.52 m) 51160211
Section, Telescoping 51160220
Cap, Bottom .51160230
Cap, Bottom, Heavy Duty 51101520
Grout Valve, Gasket Type 51100820
Cap, Top 51101500
Cap, Locking .51101550

CASING ANCHORS
Casing Anchor, 85 mm (3.34") 51104385
Casing Anchor, 70 mm (2.75") 51104370
Anchor + Grout Valve, 85mm(3.34") .51104485
Anchor + Grout Valve, 70mm(2.75") .51104470

INSTALLATION ACCESSORIES
Mastic Sealing Tape 51003800
Vinyl Tape 51003900
Duct Tape 51004000
ABS Solvent Cement, 1/2 pint 51103401
ABS Solvent Cement, 1 pint. 51103402
Pop Rivet Gun 50100202
Casing Clamp 50100200

Digitilt Classic Inclinometer System

Advantages

Proven Performance: The classic system features the time-tested Digitilt analog probe designed and manufactured by Slope Indicator.

Repeatable Tracking: The Digitilt probe is equipped with robust wheel carriages, sealed wheel bearings, and specially designed wheels to ensure consistent tracking in all types of casing.

Reliable Control Cable: Digitilt control cable is durable and easy to handle. The cable has excellent dimensional stability, and its rubber depth marks are vulcanized to the cable jacket and cannot slip.

Ergonomic Operation: Surveys require just one person, since the cable and hand switch can be gripped at the same time. The pulley also takes the weight of the cable while the reading stabilizes.

Versatile: The Digitilt Classic system includes a horizontal probe, a spiral probe, a portable tiltmeter, slip-ring reels, and other accessories.

DigiPro2 Software: DigiPro2 makes short work of data management and plotting. Its advanced mode provides routines for identifying and correcting errors, reusable reports and many other features.

Digitilt Classic System

Slope Indicator's classic inclinometer system has a world-wide reputation for durability, high precision, and rapid response.

The classic system includes the Digitilt probe, heavy-duty control cable, the DataMate II readout, and DigiPro2 software.

Applications

Inclinometers are used to monitor subsurface movements in landslides, embankments, dams, and deep excavations.

Inclinometer casing is installed in a vertical borehole that passes through suspected zones of movement into stable ground.

The Digitilt Classic system is used to survey the casing. The first survey establishes the initial profile of the casing. Changes in the profile, revealed by comparing subsequent surveys to the initial, indicate that ground movement has occurred.

Plots of inclinometer data show the magnitude, direction, and rate of ground movement.

Operation

To start a survey, the operator selects an inclinometer from a list stored in the DataMate. The DataMate displays a starting depth for the survey.

The operator positions the probe and watches the DataMate for a "ready" signal that indicates that the reading is stable. To record the reading, the operator clicks the hand switch. The DataMate confirms with a beep and displays the next depth.

The operator repositions the probe, watches for the ready signal, and records the reading, repeating these steops until the survey is complete.

If display depth and probe depth get out of sync, the operator can scroll to the required depth, reposition the probe, and continue the survey from that point.

When all readings have been taken, the operator can display checksum statistics to validate the survey.

On return to the office, the operator transfers surveys from the DataMate to the PC using DigiPro2 software. Afterwards, DigiPro2 can process and plot the surveys.
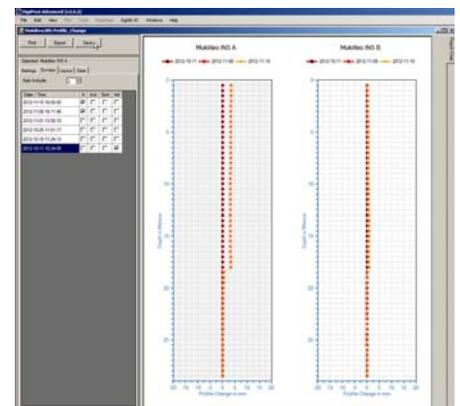
DIGITILT INCLINOMETER PROBE

Metric-Unit Probe 50302510
English-Unit Probe 50302500

Probe includes stainless steel carrying case. Control cable, reel, pulley, and DataMate are ordered by separate part numbers.

	Metric	English
Sensor Type	Analog force-balanced servo-accelerometers x 2	
Wheel Base	500 mm	24 inch
Cal Range*	±30°	±30°
Sys Resolution*	0.01 mm	0.0006"
Sys Accuracy*	±6 mm / 25m	±0.3"/ 100'
Precision	±0.01% FS	
Temp	-20 to +50 °C	-4 to +122 °F
Material	Stainless Steel	

Calibrated Range: Metric and English unit probes are calibrated to ±30° and have an over-range to ±53° and ±42° respectively.

System Resolution: The resolution derived from a two-pass survey converted to mm and inches per standard interval.

System Accuracy: Specifications were derived empirically from the analysis of a large number of surveys and include errors introduced by casing, probe, cable, readout, and operator. Casing was installed within 3 degrees of vertical. Operators followed recommended survey practices. After correcting for systematic errors, the best accuracy obtainable is ±1.4 mm per 50 readings with metric systems and ±0.05 inch per 50 readings with English systems.

CONTROL CABLE

30m Control Cable 50601030
50m Control Cable 50601050
100m Control Cable 50601100

100 ft Control Cable 50601002
150 ft Control Cable 50601003
300 ft Control Cable 50601004

Depth Marks: Metric cable has 0.5m depth marks English cable has 2 foot marks. Marks are molded onto the cable jacket and cannot slip.

Construction: Cable is supplied with no splices or surface defects. Kevlar core provides tensile strength. Dacron torsion braid counters twist and provides dimensional stability. Polyurethane jacket resists chemicals and abrasions and stays flexible in cold temperatures.

Custom Length Cables: Lengths up to 300m (1000 ft) are available on special order. Extension cables are also available.

DIGITILT DATAMATE READOUT

Digitilt DataMate II 50310900
Readout includes hand switch, battery charger with international plugs, and USB cable for PC.

Compatibility: Digitilt probes, both vertical and horizontal, Digitilt tiltmeters, and spiral sensors.

Survey Types: 2-pass surveys for inclinometer probes; 4-pass surveys for spiral sensors.

Minimum Reading Interval: 0.5 m for metric systems and 12 inches for English systems.

Display: Two line backlit LCD shows readings in traditional sine units: 25000 sine (angle) for metric systems and 20000 sine (angle) for English.

Memory Capacity: 160 installations and 32000 A & B axis readings.

Battery: 6 volt, 6 Ah, lead-acid gell cell powers readout and probe up to 16 hours per charge.

Temp Rating: -20 to 50°C (-4 to 122°F).

Case: Aluminum case is splash proof. Connectors are waterproof when capped or in use.

Size & Weight: 127 x 178 x 178 mm at 3 kg. (5 x 7 x 7" at 6.5 lb).

DIGIPR02 SOFTWARE

DigiPro2 Software . . . . Download
DigiPro2 License Key 50310101

DigiPro2 software is an essential component of the classic system. It has two modes, basic and advanced.

DigiPro2 Basic is free to use and provides all the functions necessary to retrieve surveys from the DataMate and make simple plots.

DigiPro2 Advanced provides correction routines, reports, and many other features that enabled by purchase of a license key. Features are described in a separate datasheet and on the website.

DUMMY PROBE

Metric Wheel Base 50304810
English Wheel Base 50304800
Reel & Line for Dummy Probe . . . 50304900

Dummy probe for testing continuity of casing and grooves and for detecting obstructions or severe distortions of casing that could hinder retrieval of Digitilt probe and control cable.

Dummy probe is stainless steel and has dimensions and wheels identical to those of Digitilt probe. Reel with 60 m (200') of nylon line is used to lower and retrieve dummy probe.

PULLEY ASSEMBLY

Small Pulley. 51104604
Large Pulley 51104606

Pulley assembly fits clamps onto top of casing. Cable hold serves as reference for depth marks. Wheel removes for easy insertion of probe. Order small pulley for 48 or 70 mm casing. Order large pulley for 70 or 85mm casing.

CABLE STORAGE REEL

30m (100') capacity. 50502030
70 m (230') capacity 50502050
100 m (360') capacity 50502110

Sturdy storage reels with large diameter hubs keep cable neat when not in use.

SLIP-RING REEL

200 m (650') capacity 50503100
300 m (1150') capacity 50503300

Slip-ring cable reel allows the readout to remain connected while the reel is operated. Includes jumper cable to connect reel to readout.

Digitilt AT Inclinometer System

Advantages

Classic Performance: Survey times match or better start-to-finish times of the classic Digitilt system.

Lightweight Cable: Easy to carry and easy to handle, the lightweight AT control cable is also easy to read, with large labels at every other graduation.

Excellent Tracking: Its short length and top quality wheels allow the AT probe to track casing grooves through tight curves.

Compact Cable Gate: The unique cable gate aligns cable graduations precisely at the top of the casing, eliminating the potential for depth errors if the cable gate is forgotten.

Hands-Free: Simply pull the cable to record a reading.

Digitilt AT System

Slope Indicator's Digitilt AT system provides a modern alternative to the classic Digitilt inclinometer system.

The system includes a digital probe, lightweight control cable, Bluetooth reel, cable gate, Digitilt Reader app, and DigiPro2 software for the PC.

Application

Inclinometers are used to monitor subsurface deformations of the ground in landslides, embankments, and dams and around deep excavations and tunnels.

Inclinometer casing is installed in a vertical borehole that passes through suspected zones of movement into stable ground.

The Digitilt AT system is used to survey the casing. The first survey establishes the initial profile of the casing. Changes in the profile, revealed by comparing subsequent surveys to the initial, indicate that ground movement has occurred.

Plots of inclinometer data show the magnitude, direction, and rate of ground movement.

Survey Operations

The Digitilt AT system leverages advances in sensor technology and mobile computing to bring simplicity to survey operations.

To start a survey, tap an inclinometer from the list displayed by the Reader, or scan a QR code.

At each survey depth, the Reader prompts when the reading is stable and ready to record. To record the reading, just pull the cable upwards to the next depth. The reading is stored in non-volatile memory.

If the survey is interrupted for any reason, simply tap to resume at the same depth, with no loss of data.

Validate the completed survey by plotting checksums, profiles, or changes on the high-resolution display.

Afterwards, send surveys to the office via the internet, using email with automatic file attachments or Dropbox for full synchronization. If the internet is not available, use a USB cable for data transfers.

Digitilt Reader App: The Reader app is central to the simplicity and power of the AT system. Running on a certified Android tablet, the Reader app supports high resolution displays, touch interfaces, and full internet connectivity.

DigiPro2: DigiPro2 software creates inclinometer databases, manages inclinometer data, generates plots and reports, and provides advanced routines for identifying and correcting errors.

AT PROBE

	Metric	English
Tilt Sensors	MEMS x 2	MEMS x 2
Wheel Base	500 mm	24"
Range	±30°	±30°
Resolution	0.005 mm	0.0002"
Repeatability	±0.003°	±0.003°
Temp Rating	-20 to +70°C	-4 to +158°F
Material	Stainless	Stainless

CONTROL CABLE

Metric cables have 0.5m graduations with numeric depth labels every meter. English cables have 2 foot graduations with depth labels every 4 feet. Graduations are measured from top wheels of probe. The four-conductor cable has a Kevlar strain member, and polyurethane jacket.

BLUETOOTH REEL

Bluetooth reel provides 40 hours of operation on one charge. Charge time is 5 hours. Controls include on/off switch and LEDs for power, charge state, and Bluetooth connection.

CABLE GATE

Cable gate aligns graduations with top of casing. Fits 48, 70, and 85mm (1.9, 2.75, 3.34" casing. Outside diameter is 102mm (4").

AT SYSTEM PART NUMBERS

with 30m cable	. . . . 50330303 RK/SK
with 50m cable	. . . . 50330305 RK/SK
with 75m cable	. . . . 50330307 RK/SK
with 100m cable	. . . . 50330310 RK/SK
with 100' cable	. . . . 50330100 RK/SK
with 150' cable	. . . . 50330150 RK/SK
with 200' cable	. . . . 50330200 RK/SK
with 300' cable	. . . . 50330300 RK/SK

The 8-digit part numbers above specify an AT probe, control cable, Bluetooth reel with international AC adaptor, cable gate, and Digipro2 software.

Add RK or SK suffix to the number to include a certified tablet. RK specifies a rugged, waterproof tablet that suitable for all outdoor environments. SK specifies a standard tablet, supplied with weatherproof case, that is suitable for moderate environments.

For example, 50330303 specifies an AT system with a 30m cable. 50330303RK adds a rugged tablet to the same system. 50330303SK adds a standard tablet to the same system.

Longer cables are available on special order. Please contact the factory.
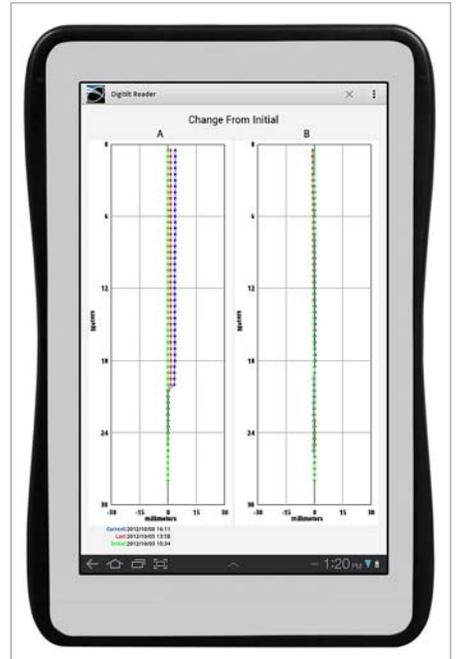
DIGITILT READER APP

Digitilt Reader App . . . . Download
Using the Android device, visit play.google.com and search for "Digitilt Reader."

Requirements: Certified Android device, as listed on the Slope Indicator website.

Capacity: Number of inclinometers and surveys is limited only by device memory. Maximum depth 300m or 1000 ft. Depth intervals are multiples of 0.5m or 2 ft.

Scan: Scans a QR code to start survey. Use DigiPro2 to generate the QR code then fix the code to a convenient surface, such as the casing, cap, or a page in a logbook.
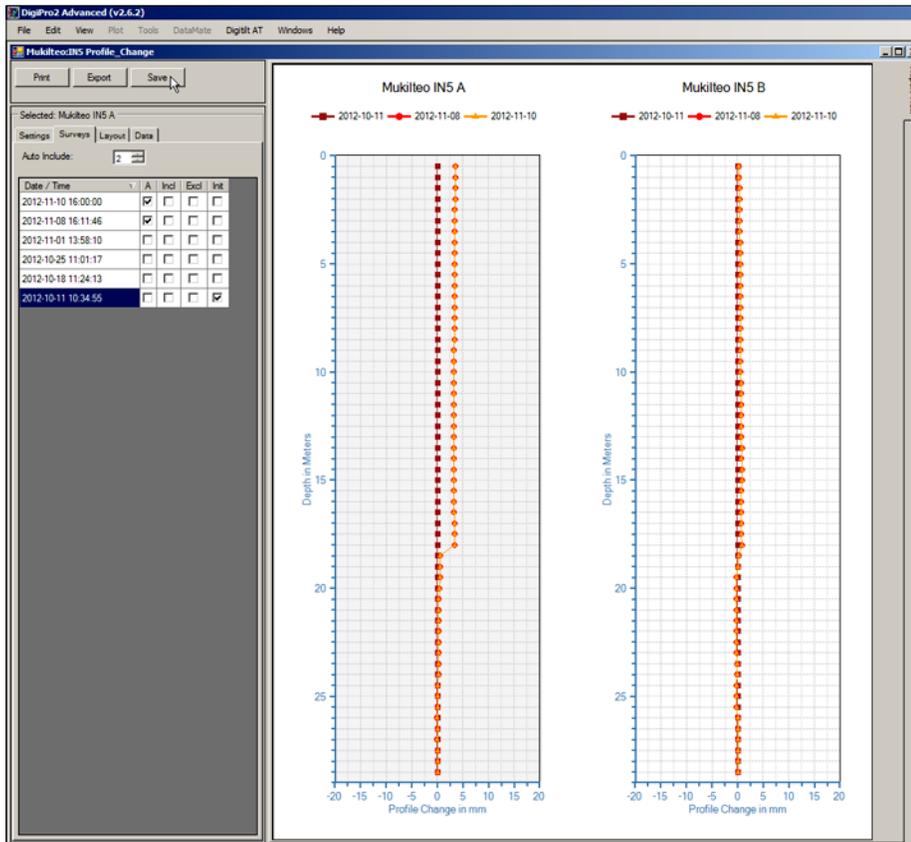
Survey: Displays list of inclinometers. Tap to start a survey. Tap and hold to edit inclinometer parameters.

Survey Screen: Large, readable characters. Shows active depth, depth last recorded, A and B readings in mm, inches, or sine units, checksums, and progress bar. Record button prompts user to wait, tap, or pull. Other features include easy depth changes and automatic bookmarks.

Plots & Data: Plots checksums, profiles, change-from-initial, and change-from-last in high resolution. Displays data table for inspection and survey-time corrections.

Send: Sends inclinometer data to PC as email attachments or syncs via Dropbox. If internet is not available, data files are transferred via USB cable and Windows file manager.

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DigiPro2 Inclinometer Software

Technical Features

Readout Support: DigiPro2 works directly with the Digitilt DataMate. It also provides special support for the Digitilt AT system.

Database Manager: DigiPro2 stores surveys in a database for easy access later. It can import and export various formats and provides easy ways to inspect, edit, copy, and move surveys and inclinometers.

Plot Types: DigiPro2 provides a full range of plot types for both vertical and horizontal inclinometers. Plots can be printed or exported as images.

Advanced Corrections: DigiPro2 provides advanced corrections that can improve the presentation and understanding of data.

Correction routines for individual surveys include bias-shift, rotation, sensitivity, settlement, and XY translation. Correction routines for casing include orientation and spiral.

Compatibility: DigiPro2 runs on XP, Win7, and later versions of Windows. It can import surveys from the mdb databases created by DMM for easy migration to the new database.

Application

DigiPro2 software for Windows creates inclinometer databases, manages inclinometer data, and generates plots and reports. It also provides routines for diagnosing and correcting systematic error in data.

DigiPro2 works with both the Digitilt DataMate and the Digitilt AT Reader. It replaces the original DigiPro for Windows and DMM, the software previously used with the DataMate.

DigiPro2 provides a limited feature basic mode, which is free to use, and a full featured advanced mode, which requires purchase of a license key.

Visit the Slope Indicator website to download the software and view a comparison of basic and advanced features.

Productivity Features

Complete Solution: DigiPro2 does the work previously done by DMM and DigiPro. It is no longer necessary to use one program for retrieving and another program for plotting.

Easy Plotting: DigiPro2 generates plots with just a few clicks, and automatically includes the most recent surveys.

Reusable Plots: DigiPro2 stores plot settings for reuse, saving time and ensuring consistency.

Interactive Corrections: DigiPro2 applies correction values instantly, so it is easy to interate values to find the appropriate ones.

Easy Viewing: DigiPro2 optimizes plots to fit your display. It eliminates extraneous white space to display the largest plots possible.

DigiPro2 supports the Digitilt DataMate and the Digitilt AT Reader.

DATABASE MANAGEMENT

Readout Support: DigiPro2 communicates directly with the Digitilt DataMate and provides complete support for the Digitilt AT Reader.

Import Formats: DigiPro2 can import DMM databases and file formats including DUX, GTL, RPP, PCSLIN, RST, and M-Logger and CSV files.

Export Formats: DigiPro2 can export survey data as CSV, DUX, and GTL files; plotted data in TXT, CSV, Atlas formats; and plots as JPG, PNG, GIF, and BMP image files.

Databases: Create any number of databases, and then inspect, copy, and move surveys and inclinometers between them.

PLOTTING

Plot Types: DigiPro2 provides full support for both vertical and horizontal inclinometers. Supported types include tilt change & profile change (incremental & cumulative displacement), tilt & profile (incremental & cumulative deviation), time-displacement, checksums & difference checksums, spiral, and magnitude & direction plots.

Survey Selection: Surveys can be selected automatically or manually. Specify a number of recent surveys to include and explicitly include or exclude other surveys.

Data Units: Readings in the database are shown in sine units, mm, or inches. Plotted readings are shown in mm or inches.

Depth Units: Depths can be shown as depths or elevations in feet or meters and referenced to ground level via an offset adjustment. Another adjustment ensures that data are plotted at the top or bottom of an interval.

Boring Log: DigiPro2 can represent boring log information in the background of a plot, as a narrow column or as the full width of the plot.

Field Accuracy: The limits of field accuracy can be shown on a plot .

CORRECTION ROUTINES

Advanced Corrections: These routines can improve the presentation and understanding of data.

Routines affecting single surveys are bias-shift, rotation, and sensitivity corrections, which are related to the inclinometer probe, and translation corrections, which are related to the casing.

Routines that affect all surveys are orientation correction and spiral correction. Orientation correction can help when casing grooves are not aligned with the real direction of movement. Spiral correction can help when casing was twisted during installation.

PAGE LAYOUT

Page Layout: Paper size, paper orientation, margins, plot size and placement have default settings that can be modified for individual reports. One, two, or more plots can appear on the page, so long as they belong to the same inclinometer. Title blocks can be placed at the bottom or top of the page.

Graph Labels: Default labels can be replaced by custom labels. Font face and size can be changed. Legends can show date-only or date-and-time and can be placed automatically or manually.

Title Block & Logo: The title block provides one or more columns of data with font control for each column. DigiPro2 accepts PNG or JPG logo images and autosizes the height to the title block while maintaining the aspect ratio of the image.

COMPATIBILITY

DigiPro2 runs on XP, Win7, and later versions of Windows. It uses the Microsoft SQL Express engine. Databases have a new DPW extension.

DigiPro2 can import surveys from mdb databases created by DMM, so there is no loss of data when migrating from DigiPro1 and DMM to DigiPro2. However, plots and reports must be recreated because DigiPro2 uses a new graphics library with support for many more features.

DIGIPRO LICENSE KEYS

DigiPro2 Software. . . . . Download
3 License Keys 50310103
6 License Keys 50310106
12 License Keys 50310112

DigiPro2 software must be downloaded from the Slope Indicator website. It is not available on CD.

DigiPro2 runs in advanced mode for 45 days and then reverts to basic mode if no key is purchased. It continues to work, but all advanced features are disabled. A comparison of advanced and basic features is available at the Slope Indicator website.

To retain the advanced features, a license key must be purchased. The purchaser receives the license key by email and enters it into DigiPro2's license dialog. The program performs a one-time validation of the key via the internet and then permanently enables the advanced features.
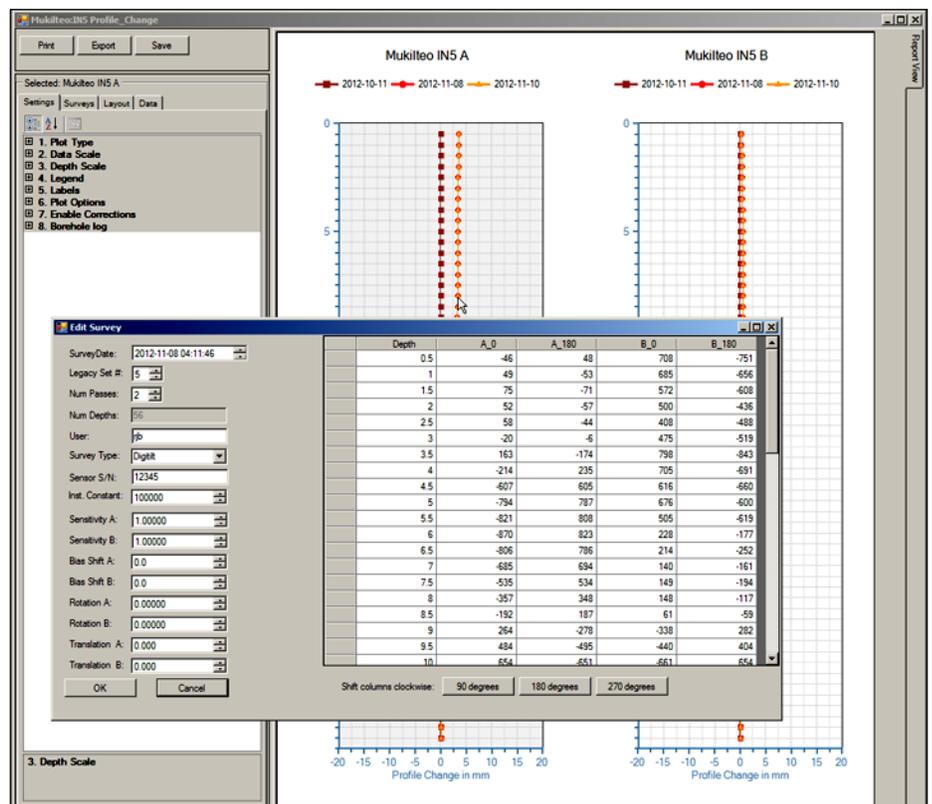
Mouse over a data point to see the plotted value. Click on data point to call up the actual readings.

Horizontal Digitilt Inclinometer Probe

Applications

Horizontal inclinometers are used to obtain profiles of settlement or heave. Typical applications include monitoring settlement and heave under storage tanks, embankments, dams, and landfills.

Operation

The horizontal system consists of inclinometer casing, a horizontal probe, control cable, pull cable, and a readout unit.

Casing is installed in a horizontal trench or borehole with one set of grooves aligned to vertical. If the far end of the casing is not accessible, a dead-end pulley and cable-return pipe are installed with the casing.

The probe, control cable, pull-cable, and readout are used to survey the casing. The initial survey establishes the profile of the casing. Subsequent surveys reveal changes in the profile if ground movement occurs.

The Digitilt probe employs a force-balanced servo-accelerometer to measure tilt in the plane of the probe wheels. During a survey, tilt measurements are obtained at half-meter or 2-foot intervals as the probe is drawn from one end of the casing to the other.

The probe is then reversed end-for-end and drawn through the casing a second time. Tilt measurements from the reversed probe are used to eliminate any error due to sensor bias and to generate checksums for validating the survey.

Settlement and heave are calculated as L(sine q1 - sine q0), where L is the measurement interval, q1 is the current tilt, and q0 is the initial tilt.
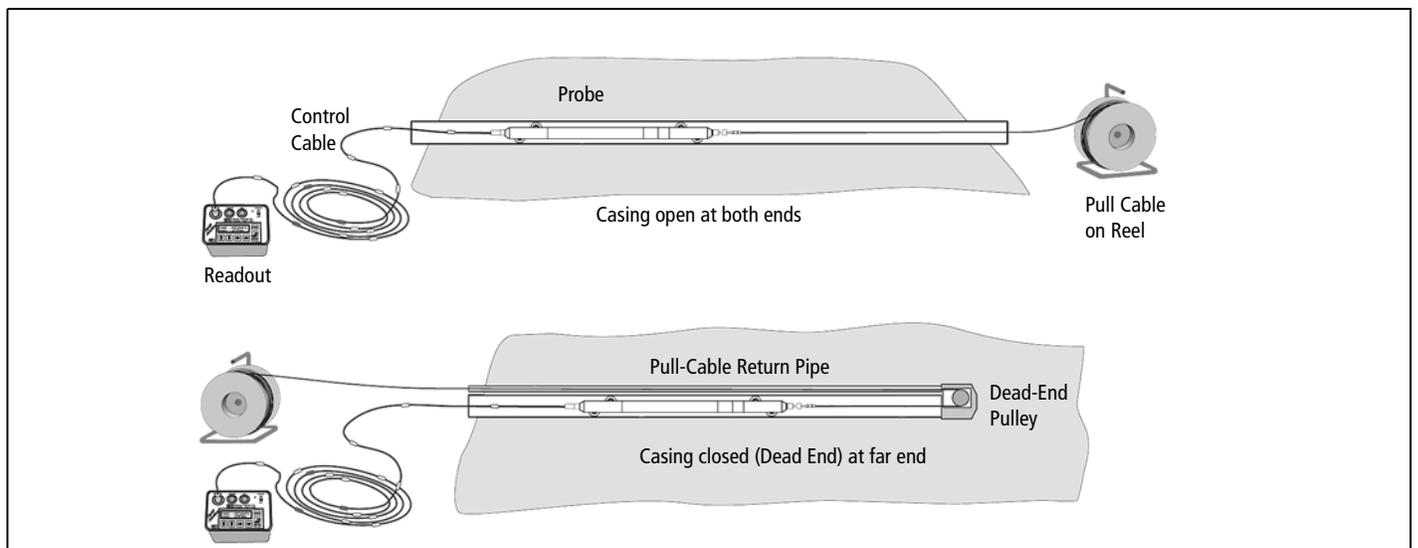
Settlement profiles are generated by summing displacements and plotting them.

Advantages

Differential Settlement: Horizontal inclinometers provide full profiles of differential settlement.

Simple Operation: Horizontal inclinometer surveys are simple and relatively quick. Unlike other profilers, there are no reservoirs or pressure sources to adjust and maintain.

Proven Reliability: The Digitilt inclinometer probe has earned a world-wide reputation for high precision and durability.

Control Cable — Probe — Casing open at both ends — Pull Cable on Reel — Readout

Pull-Cable Return Pipe — Dead-End Pulley — Casing closed (Dead End) at far end

HORIZONTAL DIGITILT PROBE

Horizontal Probe, Metric-Units . . .50303510
Horizontal Probe, English-Units . .50303500

Digitilt inclinometer probe includes a carrying case, accessories and an instruction manual. Control cable and readout are not included.

	Metric	English
Sensor Type	Analog force-balanced servo-accelerometers x 2	
Wheel Base	500 mm	24 inch
Cal Range*	±30°	±30°
Sys Resolution*	0.01 mm	0.0006"
Sys Accuracy*	±6 mm / 25m	±0.3"/ 100'
Precision	±0.01% FS	
Temp	-20 to +50 °C	-4 to +122 °F
Size	38x650 mm	1.5 x 39"
Weight	4.6 kg	10.6 lb
Material	Stainless Ste	
Casing Req	70 or 85mm	

Calibrated Range: Metric and English unit probes are calibrated to ±30° and have an over-range to ±53° and ±42° respectively.

System Resolution: The resolution derived from a two-pass survey converted to mm and inches per standard interval.

System Accuracy: Specifications were derived empirically from the analysis of a large number of surveys and include errors introduced by casing, probe, cable, readout, and operator. Casing was installed within 3 degrees of vertical. Operators followed recommended survey practices. After correcting for systematic errors, the best accuracy obtainable is ±1.4 mm per 50 readings with metric systems and ±0.05 inch per 50 readings with English systems.

CONTROL CABLE

50m Control Cable, Complete 50601050
100m Control Cable, Complete . . .50601100

150 ft Control Cable, Complete . .50601003
300 ft Control Cable, Complete . .50601004

Depth Marks: Metric cable has 0.5m depth marks English cable has 2 foot marks. Marks are molded onto the cable jacket and cannot slip.

Construction: Cable is supplied with no splices or surface defects. Kevlar core provides tensile strength. Dacron torsion braid counters twist and provides dimensional stability. Polyurethane jacket resists chemicals and abrasions and stays flexible in cold temperatures.

Custom Length Cables: Lengths up to 300m (1000 ft) are available on special order. Extension cables are also available.

DIGITILT DATAMATE READOUT

Digitilt DataMate II 50310900

Readout includes hand switch, battery charger with international plugs, and USB cable for PC.

Compatibility: Digitilt probes, both vertical and horizontal, Digitilt tiltmeters, and spiral sensors.

Survey Types: 2-pass surveys for inclinometer probes; 4-pass surveys for spiral sensors.

Minimum Reading Interval: 0.5 m for metric systems and 12 inches for English systems.

Display: Two line backlit LCD shows readings in traditional sine units: 25000 sine (angle) for metric systems and 20000 sine (angle) for English.

Memory Capacity: 160 installations and 32000 A & B axis readings.

Battery: 6 volt, 6 Ah, lead-acid gell cell powers readout and probe up to 16 hours per charge.

Temp Rating: -20 to 50°C (-4 to 122°F).

Case: Aluminum case is splash proof. Connectors are waterproof when capped or in use.

Size & Weight: 127 x 178 x 178 mm at 3 kg. (5 x 7 x 7" at 6.5 lb).

DIGIPR02 SOFTWARE

DigiPro2 Software . . . . Download
DigiPro2 License Key 50310101

DigiPro2 software is an essential component of the classic system. It has two modes, basic and advanced.

DigiPro2 Basic is free to use and provides all the functions necessary to retrieve surveys from the DataMate and make simple plots.

DigiPro2 Advanced provides correction routines, reports, and many other features that enabled by purchase of a license key. Features are described in a separate datasheet and on the website.

PULL CABLE

Pull Cable 50402310
Extra Carabiner 02750012
Extra Saddle Clamp. 02700067

Pull cable is 1/8" stranded stainless steel cable and is used to draw probe to far end of casing. Order one pull cable for each casing installation. If using a dead-end pulley, length of pull cable should be at least twice the length of the casing.

A carabiner and saddle clamp are included with the probe. These are installed on the pull cable and left in the casing with the pull cable. Additional carabiners, saddle clamps, (and pull cable) should be ordered if there is more than one casing installation to be monitored.

DEAD-END PULLEY

Dead-End Pulley 50302951
Cable-Return Pipe 50711104
Coupling for Pipe 50711604

Dead-end pulley is required when far end of casing is not accessible. Rated for casing up to 60 m (200') long.

Cable-return pipe is used with dead-end pulley. 1/2 " schedule 40 PVC pipe is supplied in 10" (3.05 m) lengths.

Couplings are used to join lengths of pipe. PVC cement is required for assembly.

SLIP-RING REEL

200 m (650') capacity 50503100
300 m (1150') capacity 50503300

Slip-ring cable reel allows the readout to remain connected while the reel is operated. Includes jumper cable to connect reel to readout.

STORAGE REEL

70 m (230') capacity 50502050
100 m (360') capacity 50502110

Sturdy storage reels have large diameter hub keeps cable neat when not in use. 30, 50, and 100 m reels are heavy-duty plastic. 200 m reel is steel.

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Spiral Sensor

Operation

The spiral sensor, connected to an inclinometer control cable and read-out, is lowered to the bottom of the casing. Spiral readings are recorded at 1.5-meter (or 5-foot) intervals as the sensor is drawn to the top of the casing. Readings are displayed in arc minutes. In a full spiral survey, the sensor is drawn through the casing four times, with its orientation changed 90° each time.

After the spiral readings have been recorded, DigiPro2 software is used to process the readings, assigning a spiral value to each depth of the inclinometer survey.

DigiPro2 processes the spiral set along with inclinometer data when it generates a graph.

Advantages

Verifies Installation: The spiral sensor can be used to verify that casing was installed without spiral.

Improves Accuracy: Spiral correction can improve accuracy and ease interpretation of data. In some cases, spiral correction allows use of inclinometer casing that would otherwise be abandoned or replaced.

Works with Digitilt System: The spiral sensor is compatible with Digitilt inclinometer cable and the Digitilt DataMate.
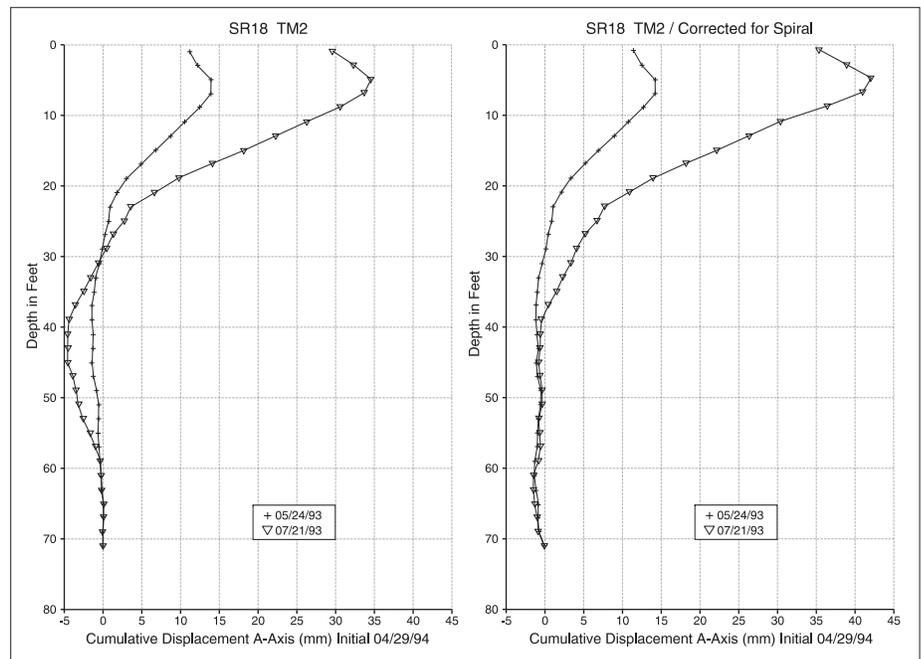
Application

Inclinometer casing controls the orientation of the inclinometer probe. If the casing is twisted during installation, the orientation of the probe will vary, and the resulting data will indicate an incorrect magnitude of movement in the A and B directions.

The spiral sensor tracks grooves in the casing and measures the relative alignment of its top and bottom wheels. These measurements can then be used to correct inclinometer readings.

Spiral surveys are not required for most inclinometer installations, but they are recommended when:

- The installation is very deep.
- Inclinometer readings indicate movement in an unlikely direction.
- Difficulties were experienced during installation of the casing and it is thought that the casing was twisted.

Displacement graphs generated by DigiPro software. Spiral corrections were applied to graph on right.

SPECIFICATIONS

Description: Sensor measures spiral in inclinometer casing. Spiral data is used to calculate corrections for inclinometer data obtained from spiraled casing.

Sensor Type: Rotary potentiometer measures the relative alignment of the upper and lower wheels of the sensor.

Gauge Length: 1.5 m (metric) or 5' (English).

Range: Sensor is calibrated for ± 3° of rotation over its gauge length and has a maximum rotation of ± 4° over its gauge length.

Accuracy: ±10 arc minutes over gauge length of sensor.

Compatible Casing: 85 and 70 mm casing (3.34 and 2.75" casing).

Overall Length: 1.7 m (5.6').

Weight: 3.6 kg (8 lb).

Materials: Stainless steel and aluminum.

Compatible Readouts: Digitilt DataMate.

ORDERING INFORMATION

Metric Spiral Sensor. 50900115
Spiral Sensor with 1.5-meter wheel base. Includes manual, tools and accessories, and carrying case. Does not include control cable, indicator, or data reduction software.
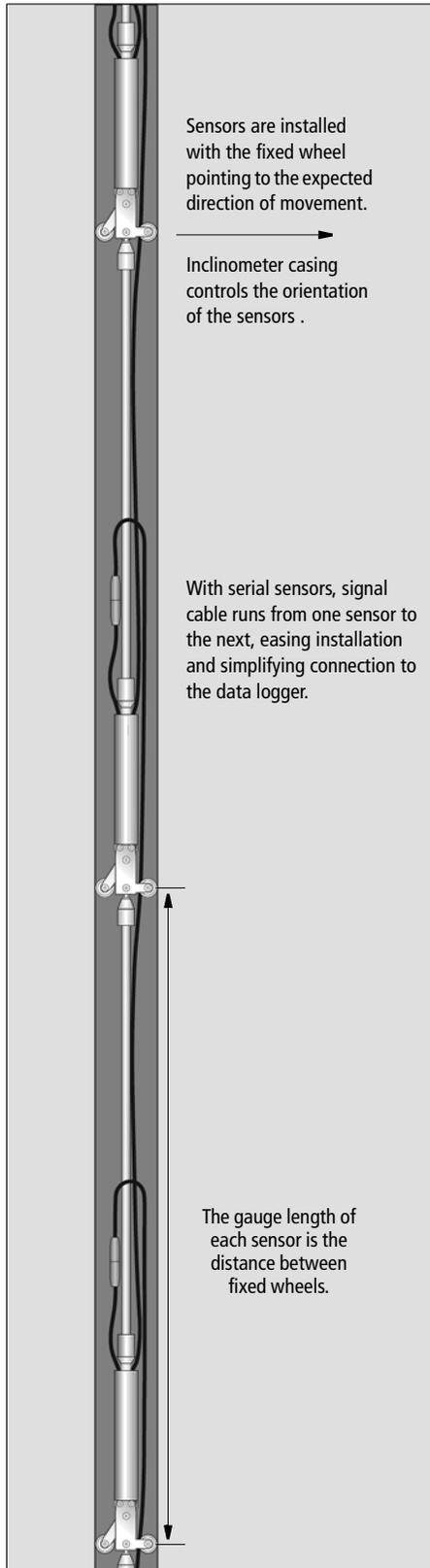
English Spiral Sensor 50900100
Spiral Sensor with 5-foot wheel base. Includes manual, tools and accessories, and carrying case. Does not include control cable, indicator, or data reduction software.

DigiPro2 Software . . . . Download
DigiPro software processes spiral data and applies spiral corrections to inclinometer data sets. A trial version of the software can be downloaded from www.slopeindicator.com. Please refer to DigiPro data sheet for details.

In-Place Inclinometer Sensors

Sensors are installed with the fixed wheel pointing to the expected direction of movement.

Inclinometer casing controls the orientation of the sensors .

With serial sensors, signal cable runs from one sensor to the next, easing installation and simplifying connection to the data logger.

The gauge length of each sensor is the distance between fixed wheels.

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 subsurface 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.

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.

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.
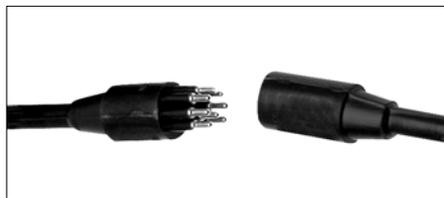
Top Suspension Kit: Order one top suspension kit for each installation. The kit includes hand ring, chain, hook, cable thimbles, and clamps. Requires stainless steel cable, not included.

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 IPI SENSORS

Serial IPI Sensor, Uniaxial. 57804621L
Serial IPI Sensor, Biaxial. 57804622L

Sensor Wheels for 70 mm Casing. 57805122
Sensor Wheels for 85 mm Casing. 57805132

Tubing for 1 m Gauge Length. . . . 57805221
Tubing for 2 m Gauge Length. . . . 57805222
Tubing for 3 m Gauge Length. . . . 57805223

Tubing for 10 ft Gauge Length. . . 57805233
Tubing for Custom Length 97805240

Top Wheels for 70 mm Casing . . . 57805024
Top Wheels for 85 mm Casing . . . 57805034

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: 1.6 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

STANDARD IPI SENSORS

Standard IPI Sensor, Uniaxial 57804221
Standard IPI Sensor, Biaxial 57804222
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.
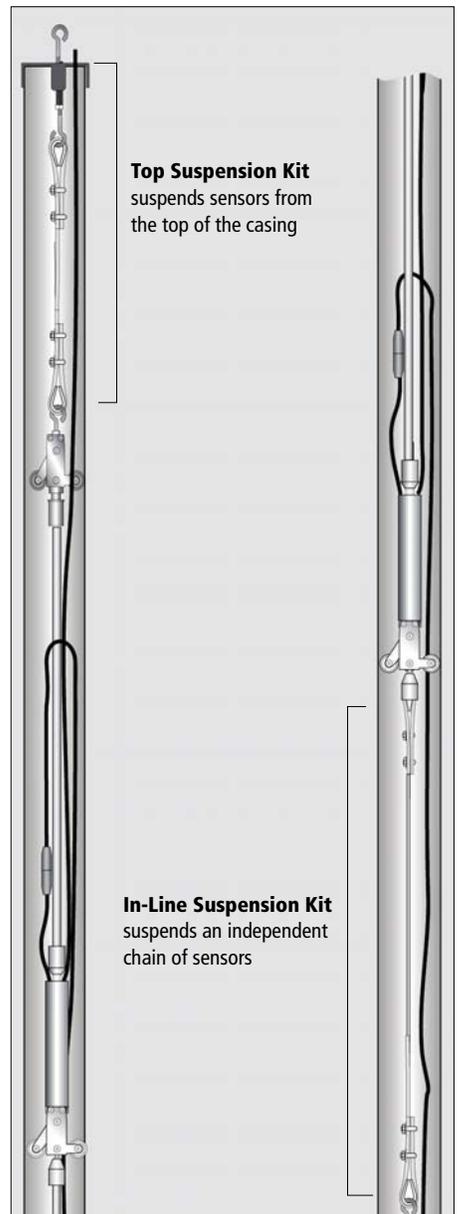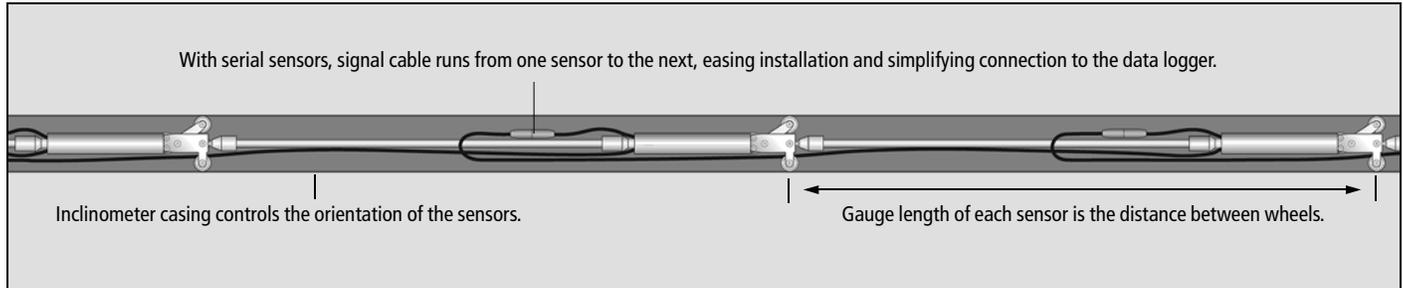
SUSPENSION KITS

Top Suspension Kit (70 mm) 57804452
Top Suspension Kit (85 mm) 57804453
In-Line Suspension Kit. 57804320
Stainless Steel Cable. 50402310

Top Suspension Kit suspends sensors from the top of the casing

In-Line Suspension Kit suspends an independent chain of sensors

Horizontal In-Place Inclinometer Sensors

With serial sensors, signal cable runs from one sensor to the next, easing installation and simplifying connection to the data logger.

Inclinometer casing controls the orientation of the sensors.

Gauge length of each sensor is the distance between wheels.

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 sub-surface 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 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 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 readings are transmitted to processing software that can trigger alarms based on displacements or rates 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 next in line, effectively reducing the number of signal cables to one. This eases installation and simplifies connections 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 includes inclinometer casing, serial sensors with wheels and gauge tubes, placement accessories, and jumper cable.

Inclinometer Casing: Choose 70 or 85 mm (2.75 or 3.34") inclinometer casing. The 85 mm size is preferred.

Serial Sensor: Horizontal IPI sensors have a uniaxial sensor that is oriented to measure tilt in the plane of the wheels.

Wheels: Choose wheels to fit 70 or 85 mm inclinometer casing. Order sensor wheels for each sensor. Order one horizontal top wheel for each chain of sensors. Top wheel can be omitted if gauge tube of top sensor is held directly by a tubing clamp at the top of the casing.

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.

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 a data logger.

Placement Accessories: Order one tubing clamp for each installation. Tubing clamp replaced top wheel if it holds gauge tube of top sensor directly. If top sensor is deeper into the casing, then order a placement tube and a top wheel. Placement tube is supplied in 3m lengths. Order a coupling to create longer lengths.

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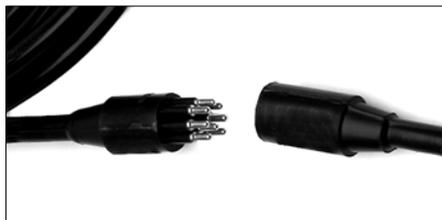
Serial IPI sensors incorporate heavy-duty waterproof connectors good for multiple connects/disconnects.

SERIAL IPI SENSORS

Horizontal Serial IPI Sensor 57804623L

Sensor Wheels for 85 mm Casing. 57805132
Sensor Wheels for 70 mm Casing. 57805122

Tubing for 1 m Gauge Length. . . . 57805221
Tubing for 2 m Gauge Length. . . . 57805222
Tubing for 3 m Gauge Length. . . . 57805223
Tubing for Custom Length 57805240

Horizontal Top Wheel, 85 mm . . . 57805031
Horizontal Top Wheel, 70 mm . . . 57805021

Bottom Plug 57804510
Jumper Cable, 25m. 56804525

PLACEMENT ACCESSORIES

Tubing Clamp, 85 mm Casing 57805255
Tubing Clamp, 70 mm Casing 57805252
Placement Tube, 3 m Length 57804240
Coupling for Placement Tube 57804245

STANDARD IPI SENSORS

Horizontal IPI Sensor 57804123
Signal Cable 50613527

Standard (non-serial) sensors are not connectorized, so each sensor requires its own, full-length signal cable. Wheels, tubing, placement accessories, and performance are the same as those of serial sensors.

Specify signal cable length for each sensor: the distance between the sensor and the data logger. Signal cable has seven 22-gauge conductors, shield, and polyurethane jacket.

IPI SENSOR SPECIFICATIONS

Sensor Type: MEMS (Micro Electro-Mechanical Systems) uniaxial tilt sensor. Thermistor for temperature readings.

Requirements: Power input between 7.5 to 15 Vdc. Outputs ±2.5 volt differential signal.

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-point calibration obtained at three temperatures from 4 to 20 °C.

Max Gauge Length: 3 meters.

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

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

Signal Cable: Cable for 3m gauge lengths supplied with serial sensors. Waterproof connectors rated to 70 MPa (10,000 psi).

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

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

Vibrating Wire Piezometers

Applications

VW piezometers are used to monitor pore-water pressure. They can also be used to monitor water levels. Typical applications include:

- Monitoring pore water pressures to determine safe rates of fill or excavation.
- Monitoring pore water pressures to determine slope stability.
- Monitoring the effects of dewatering systems used for excavations.
- Monitoring the effects of ground improvement systems such as vertical drains and sand drains.
- Monitoring pore pressures to check the performance of earth fill dams and embankments.
- Monitoring pore pressures to check containment systems at land fills and tailings dams.
- Monitoring water levels in stilling basins and weirs.

Operation

The VW piezometer converts water pressure to a frequency signal via a diaphragm, a tensioned steel wire, and an electromagnetic coil.

The piezometer is designed so that a change in pressure on the diaphragm causes a change in tension of the wire. An electro-magnetic coil is used to excite the wire, which then vibrates at its natural frequency. The vibration of the wire in the proximity of the coil generates a frequency signal that is transmitted to the readout device.

The readout or data logger stores the reading in Hz. Calibration factors are then applied to the reading to arrive at a pressure in engineering units.

VW Piezometers: Standard, Heavy Duty, and Push-In (bottom)

Types of VW Piezometers

Standard: The standard piezometer is suitable for most applications. It operates equally well in fully-grouted boreholes or sand-filter zones.

Heavy-Duty: The heavy-duty model has a strong, double-wall housing and is supplied with armored cable.

Push-In: The push-in piezometer can be pushed a short distance into soft soils using a EW drill rod.

Multi-Level: The multi-level piezometer system system provides an easy way to install multiple sensors in a borehole. See separate datasheet.

Low-Pressure: The low-pressure piezometer can monitor very small changes in pore-water pressure.

Vented: The vented piezometer is used to monitor water levels in open standpipes and wells.

Corrosion Resistant: Heat-bonded PTFE coating protects this piezometer from corrosive environments.

Advantages

Groutable: VW piezometers can be installed in fully-grouted boreholes and do not require sand filter zones. This greatly simplifies the installation of multiple sensors in the same borehole. It also makes it possible to install piezometers with inclinometer casing within the same borehole.

High Resolution: VW piezometers provide a resolution of 0.025% FS.

High Accuracy: Slope Indicator's automated, precision calibration system ensures that these sensors meet or exceed specifications.

Rapid Response: VW piezometers respond very quickly to changes in pore-water pressure.

Reliable Signal Transmission: With properly shielded cable, signals from the VW piezometer can be transmitted long distances.

STANDARD VW PIEZOMETERS

3.5 bar (50 psi) Piezometer 52611020
7 bar (100 psi) Piezometer 52611030
17 bar (250 psi) Piezometer 52611040
35 bar (500 psi) Piezometer 52611050
Signal Cable 50613524

The standard VW piezometer is suitable for most applications. The piezometer can be installed without a sand filter when the borehole is back-filled with bentonite-cement grout.

VW PIEZOMETERS WITH CABLE

Standard VW Piezometers, 3.5 bar (50 psi)
with 15 m (50') cable 52611028
with 30 m (100') cable 52611024
with 45 m (150') cable 52611027
with 60 m (200') cable 52611026

Standard VW Piezometers, 7 bar (100 psi)
with 30 m (100') cable 52611033
with 45 m (150') cable 52611034
with 60 m (200') cable 52611035
with 90 m (300') cable 52611036

PUSH-IN VW PIEZOMETERS

3.5 bar (50 psi) Piezometer 52621020
7 bar (100 psi) Piezometer 52621030
17 bar (250 psi) Piezometer 52621040
35 bar (500 psi) Piezometer 52621050
Signal Cable 50613524
Adapter for EW Drill Rod. 50718042
EW Coupling 50718010

The push-in piezometer has a special housing that allows it to be pushed a short distance into soft, cohesive soils.

Adaptor for EW drill rod extends the length of the piezometer by 0.6m and provides a left-hand thredad for easy disconnect of the drill rod. Order one adapter per piezometer.

Coupling (pin) threads into the drill rod and has a left-hand thread for easy disconnect from the adaptor. Coupling can be reused, so only one is needed.

HEAVY-DUTY VW PIEZOMETERS

3.5 bar (50 psi) Piezometer 52610520
7 bar (100 psi) Piezometer 52610530
17 bar (250 psi) Piezometer 52610540
35 bar (500 psi) Piezometer 52610550
Signal Cable, Armored 50613586

This piezometer features a strong double wall housing and is normally supplied with armored signal cable.

LOW-PRESSURE VW PIEZOMETERS

0.7 bar (10 psi) Piezometer 52611610
1.8 bar (25 psi) Piezometer 52611625
Signal Cable 50613524

The low-pressure piezometer is designed to monitor very small changes in pore-water pressure. It can also be used to monitor water levels.

CORROSION-RESISTANT VW PIEZO

7 bar (100 psi) Piezometer 52621230
17 bar (250 psi) Piezometer 52621240
PVC Signal Cable. 50613824

The wetted parts of the corrosion-resistant VW piezometer are protected by a heat-bonded PTFE coating and a PVC housing. PVC signal cable has four 22-gauge conductors. Consult factory if other configurations are required.

VW PIEZOMETER SPECIFICATIONS

Sensor Type: Pluck-type vibrating wire sensor with built-in thermistor or RTD.

Range: Standard ranges are listed at left. Custom calibration ranges are available.

Resolution: 0.025%FS.

Accuracy: ±0.1% FS for 0.7 - 7 bar sensors, ±0.3% FS for 17 and 35 bar sensors.

Maximum Pressure: 1.5 x rated range.

Filter: 50-micron, sintered stainless steel. Add y part 92611065 for 1-bar high-air-entry filter.

Temperature Coefficient: < 0.04% FS per °C.

Materials: Stainless steel.

Size: Standard: 19 x 195 mm (0.75 x 7.75")
Low-Pressure: 29 x 191 mm (1.125 x 7.5").
Heavy-Duty: 29 x 191 mm (1.125 x 7.5").
Push-In: 35 x 270 mm (1.385 x 10.5").
Corrosion-Resistant: 29x191mm (1.125 x 7.5").

Weight: Standard: 0.16 kg (0.3 lb).
Low-pressure: 0.45 kg (1 lb).
Heavy-Duty: 0.8 kg (1.75 lb).
Push-in: 1.2 kg (2.75 lb).

SIGNAL CABLE SPECIFICATIONS

Standard Signal Cable. 50613524

Shielded cable with four 22-gauge tinned-copper conductors and polyurethane jacket.

Armored Signal Cable 50613586

Shield cable with four 22-gauge tinned-copper conductors, inner polyurethane jacket, steel braid armor, and outer high-density, polyethylene jacket. For heavy duty piezometer only.

READOUT & TERMINAL BOXES

VW Data Recorder. 52613500
Jumper Cable for Terminal Box . . .52613557
Terminal Box for 6 sensors 57711606
Terminal Box for 12 Sensors 57711600
Terminal Box for 24 Sensors 977711624

See separate datasheet for VW Data Recorder. Terminal boxes provide terminals for 6, 12, or 24 sensors. Sensors are selected by rotary switch. 6-sensor box is 240 x 190 x 120 mm (9.5 x 7.5 x 4.75"). 12 and 24-sensor boxes are 290 x 345 x 135 mm (11.5 x 13.5 x 5.25").

DATA LOGGERS

VW MiniLogger for 1 Sensor 52613310
VW Quattro Logger for 4 Sensors .52614000
Campbell Scientific Data Loggers

VW piezometers connect directly to the VW MIniLogger and Quattro Logger. The CR1000 requires an AVW200 vibrating wire adaptor.

Multi-Level VW Piezometer

Application

The multi-level VW piezometer is used to monitor pore-water pressure at multiple zones in a borehole.

Operation

The VW piezometers are standard units. Each is attached to a short length of plastic pipe, as shown in the photo above.

Longer lengths of pipe, measured to place each piezometer at its intended depth, are assembled as the system is installed. Signal cable from each piezometer run through the pipe up to the surface.

In addition to providing a way to place the piezometers, the pipe also protects signal cable as drill casing or augers are removed, serves as a grout delivery pipe, and prevents channeling of water along the length of the cables.

When the components of the system are in place, bentonite-cement grout is pumped through the pipe to back-fill the entire borehole, including the area surrounding each piezometer.

When the grout cures, each piezometer is isolated from the zones above and below it, but is highly responsive to changes in pore-water pressures at its own elevation.
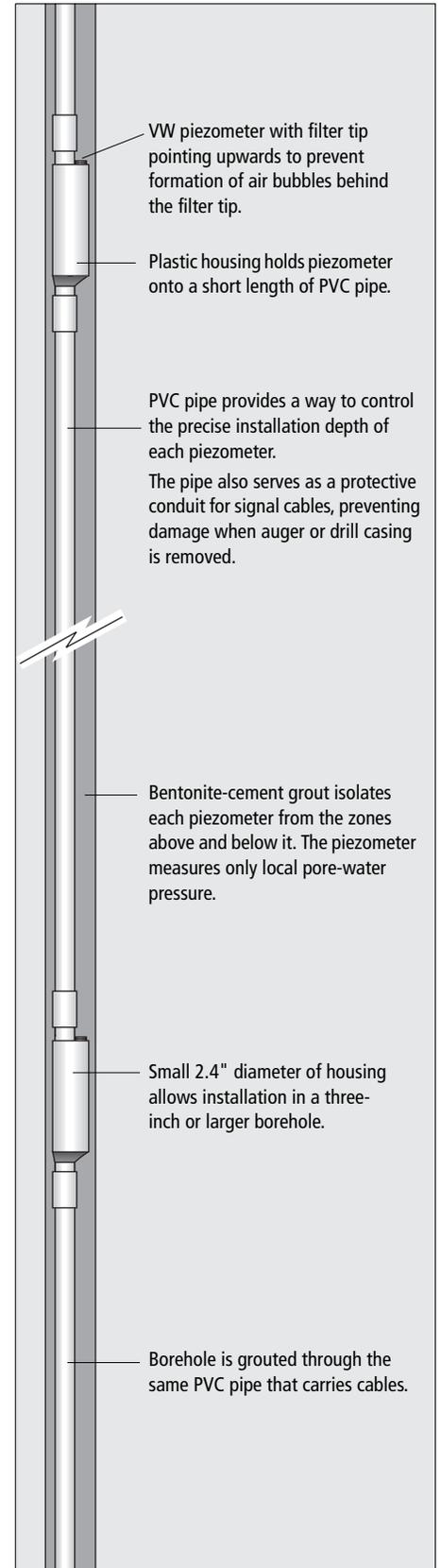
Advantages

Simple Installation: The grout-in technique is simple and quick. It eliminates the need for sand intake zones and bentonite seals.

Precise Placement: The depth of each piezometer is controlled by the plastic pipe.

Protected Cables: Signal cables are enclosed in pipe and protected when the drill casing or auger is removed. This eliminates twisted or pulled out cables.
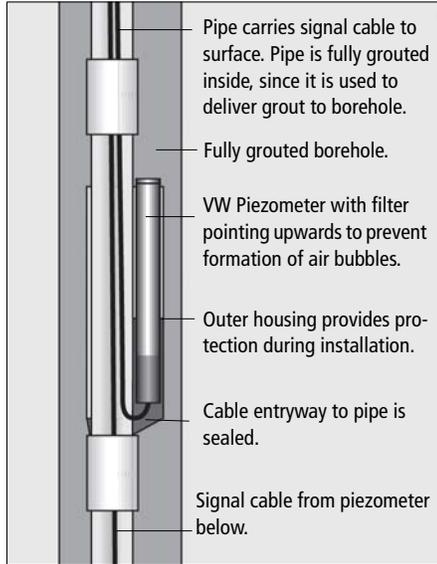
Superior Isolation: Since cables are sealed inside a pipe, the pipe is grouted, and the borehole is grouted, water cannot flow between the zones intersected by the borehole.

Easy to Automate: To automate readings, simply connect signal cables to a data logger.

VW piezometer with filter tip pointing upwards to prevent formation of air bubbles behind the filter tip.

Plastic housing holds piezometer onto a short length of PVC pipe.

PVC pipe provides a way to control the precise installation depth of each piezometer.

The pipe also serves as a protective conduit for signal cables, preventing damage when auger or drill casing is removed.

Bentonite-cement grout isolates each piezometer from the zones above and below it. The piezometer measures only local pore-water pressure.

Small 2.4" diameter of housing allows installation in a three-inch or larger borehole.

Borehole is grouted through the same PVC pipe that carries cables.

ORDERING INFORMATION

Three components must be ordered: a multi-level housing, a VW piezometer, and signal cable. The three are assembled into one unit at the factory.

Pipe carries signal cable to surface. Pipe is fully grouted inside, since it is used to deliver grout to borehole.

Fully grouted borehole.

VW Piezometer with filter pointing upwards to prevent formation of air bubbles.

Outer housing provides protection during installation.

Cable entryway to pipe is sealed.

Signal cable from piezometer below.

ABOUT GROUT-IN INSTALLATION

The references below discuss the theory and practice of grout-in installation of piezometers.

McKenna, G.T. (1995), "Grouted-in Installation of Piezometers in Boreholes," Canadian Geotechnical Journal, Volume 32, pp 355-363.

Mikkelsen, P.E. and Slope Indicator (2000), "Grouting-in Piezometers" in Technical Notes available from Slope Indicator website.

Penman, A.D.M. (1961), A Study of the Response Time of Various Types of Piezometer," in Pore Pressure and Suction in Soils, British Geotechnical Society, Butterworks, London, pp 53-58.

Tofani, G.D. (2000), "Grout In-Place Installation of Slope Inclinometers and Piezometers," in Seminar on Geotechnical Field Instrumentation held at the University of Washington by the ASCE Seattle Section, Geotechnical Group.

Vaughan, P. R. (1969), "A Note on Sealing Piezometers in Boreholes," Geotechnique vol 19, No 3, pp 405-413.

MULTI-LEVEL HOUSING

Multi-Level Housing 52611100
Length: 305 mm (12").

Diameter: 71mm (2.8").

Couplings: 1.25" schedule 40 slip coupling.

Pipe Requirements: 1.25 inch, schedule 40 PVC pipe can accommodate signal cables for a maximum of six piezometers and offers convenient handling to depths of 30 m (100').

Weight: 0.64 kg (1.4 lb).

VW PIEZOMETER FOR HOUSING

3.5 bar (50 psi) piezometer 52611020
7 bar (100 psi) piezometer 52611030
Sensor Type: Pluck-type vibrating wire sensor with built-in thermistor or RTD.

Range: 3.5 or 7 bar (50 or 100 psi).

Resolution: 0.025%FS.

Accuracy: ±0.1% FS.

Maximum Pressure: 1.5 x rated range.

Filter: 50-micron sintered stainless steel.

Temperature Coefficient: < 0.04% FS per °C.

Materials: Stainless steel.

SIGNAL CABLE

Signal Cable 50613324
Small diameter shielded cable with two twisted pairs of 24-gauge wire and polyurethane jacket.

PVC PIPE

1.25" schedule 40 PVC pipe, slip couplings, and PVC cement and can be purchased economically at local plumbing or hardware stores.

GROUT FITTING

Grout Fitting 52611150
Optional grout fitting provides a convenient way to keep cables out of the way while grouting the borehole. Fits 1.25" schedule 40 PVC pipe.

TERMINAL BOXES

Terminal Box for 6 sensors 57711606
Terminal Box for 12 Sensors 57711600
Terminal Box for 24 Sensors 97711624
Sensors are selected by rotary switch. The Small 6-sensor box measures 240 x 190 x 120 mm (9.5 x 7.5 x 4.75"). Larger 12 and 24-sensor box measures 290 x 345 x 135 mm (11.5 x 13.5 x 5.25").

READOUTS

VW Data Recorder 52613500
This easy to use readout displays and records VW sensor data in Hz or Hz^2, and thermistor or RTD data in degrees C. See separate data sheet for details.

DATA LOGGERS

Campbell Scientific Data Loggers

The Campbell Scientific data logger with a VW interface and the AM16/32 multiplexer can accommodate 16 piezometers with temperature readings or 32 piezometers without temperature readings. See separate datasheet.

Vented VW Pressure Transducer

Vented VW Pressure Transducer

Applications

The vented pressure transducer is designed specifically for monitoring changes in water level. Typical applications include:

- Monitoring water levels in wells and standpipes.
- Monitoring water levels in stilling basins installed in reservoirs and streams.

Operation Overview

The VW pressure transducer converts water pressure to a frequency signal via a patented* arrangement of diaphragm, a tensioned steel wire, and an electromagnetic coil.

The pressure transducer is designed so that a change in pressure on the diaphragm causes a change in tension of the wire. An electromagnetic coil is used to excite the wire, which then vibrates at its natural frequency. The vibration of the wire in the proximity of the coil generates a frequency signal that is transmitted to the readout device.

The readout or data logger stores the reading in Hz. Calibration factors are then applied to the reading to arrive at a pressure in engineering units.

Advantages

Designed for Wells & Standpipes: Pressure transducers placed in wells and standpipes sense barometric pressure as well as water pressure. This leads to measurement uncertainty (error) since barometric pressure changes independently of water pressure. The vented design of this pressure transducer eliminates the barometric component, which results in more reliable readings.

Special Vent Tube: The extra large diameter vent tube provides quick response to changes in atmospheric pressure and cannot be blocked by condensation.

Oversize Desiccant Chamber: The large capacity, low maintenance desiccant chamber keeps vent tube dry for 3 to 6 months.

US Patent #4,938,068

VENTED PRESSURE TRANSDUCER

22 PSI Vented Transducer 52612402
50 PSI Vented Transducer 52612405

Sensor Type: Pluck-type vibrating wire sensor with built-in thermistor or RTD.

Range: 1.5 bar (22 psi) or 3.45 bar (50 psi).

Resolution: 0.025%FS with VW Data Recorder.

Calibration Accuracy: ±0.1% FS.

Maximum Pressure: 2 x rated range.

Filter: 50-micron sintered stainless steel.

Calibration: Eleven-point calibration.

Temperature Coefficient: < 0.02% FS per °C).

Materials: Stainless steel.

Dimensions: 29 x 191 mm (1.125 x 7.5").

Weight: 0.45 kg (1 lb).

VENTED SIGNAL CABLE

Vented Cable 50614410

Shielded cable with four 22-gauge tinned- copper conductors, 0.25" vent tube, and polyurethane jacket. For use between transducer and desiccant chamber. Specify feet or meters.

Splice Kit for Vented Cable 50614415

Contains components required to splice five conductors conductors and vent tube.

Non-Vented Signal Cable 50613524

Shielded cable with four 22-gauge tinned- copper conductors for use between desiccant chamber and readout station or data logger. Specify feet or meters.

DESICCANT CHAMBER

Desiccant Chamber 52612495

Prevents moisture from entering cable and vent tubing. Desiccant can be renewed in an oven. Protects one transducer. 108 x 108 x 64 mm deep (4.25 x 4.25 x 2.5").

Extra Desiccant Pack 02540003

Anhydrous calcium sulfate in moisture proof container. Sufficient to replace desiccant in one chamber.

READOUTS

VW Data Recorder. 52613500

This easy to use readout displays and records VW sensor data in Hz or Hz^2, and thermistor or RTD data in degrees C. See separate data sheet.

DATA LOGGERS

VW MiniLogger 52613310

The VW MiniLogger is a reliable, low-cost data logger designed to monitor a single vibrating wire sensor. See separate dataset for details.

CR1000 Data Logger

Compatible data loggers include the Campbell Scientific CR1000 with VW interface. AM16/32 multiplexer can accommodate 16 pressure transducers with temperature readings or 32 pressure transducers without temperature readings. See separate dataset for details.

Titanium Pressure Transducer

Applications

Designed for compatibility with industrial data loggers, the titanium pressure transducer is used to monitor pore-water pressure and water levels.

Typical applications include:

- Monitoring pore-water pressures in corrosive environments such as salt water and landfills.
- Monitoring rapid changes in pore-water pressure such as those produced by earthquakes.
- Monitoring water levels in pumping tests.

Operation

The pressure transducer is typically suspended in a well. Signal cable from the transducer is terminated at a readout station, where it can be connected to a data logger or readout device.

Water pressure acts on diaphragm of the transducer. Semiconductor strain gauges bonded to the inside of the diaphragm sense the pressure and output a signal that is proportional to the pressure on the diaphragm.

The signal is transmitted to the data logger or readout device via a 4-20mA loop circuit.

Advantages

High Resistance to Corrosion: All metal parts, including the diaphragm, are made from titanium.

High Resistance to Noise: The piezometers electronics are highly resistant to electrical noise and mechanical vibration, such as that generated by pumps.

4-20mA Compatibility: The titanium pressure transducer incorporates a 4-20mA transmitter to provide compatibility with standard industrial data acquisition systems.

Suitable for Dynamic Monitoring: The titanium pressure transducer can be read continuously.

PRESSURE TRANSDUCER

20 psi 56410020

50 psi 56410050

100 psi .56410100

250 psi 56410250

Sensor Type: Diaphram pressure transducer incorporating Micron Technology semi-conductor strain gauges with a 4-20mA output. The built-in temperature device is a 3K ohm thermistor.

Range: 20, 50, 100, 250 psi.

Resolution: 0.02% FS with a Campbell CR10X and a 120 ohm resistor.

Linearity: ± 0.5 % FS BFSL.

Compensated Temp Range: 30 to 130°F.

Over-Range: 2 x rated range.

Long Term Stability: ± 2% FS/year or better.

Supply Voltage: 12-24 V nominal supply, 8 V min at the transducer.

Materials: Wetted metal parts are made from titanium. The filter is polyethylene.

Dimensions: 0.625" diameter x 5.75" long.

SIGNAL CABLE

Polyurethane Jacket 50613524

Shielded cable with four 22-gauge tinned-copper conductors and polyu rethane jacket. Two wires are used for the 4-20mA loop circuit. The other two wires are used for the thermistor.

DATA LOGGERS

Industrial data loggers and readouts capable of supplying 12-24 volts to the transducer.

For easiest connection to Campbell Scientific CR10X or CR1000 loggers, order a Current Shunt Terminal Input Module, part number 56701940.

Pneumatic Piezometer
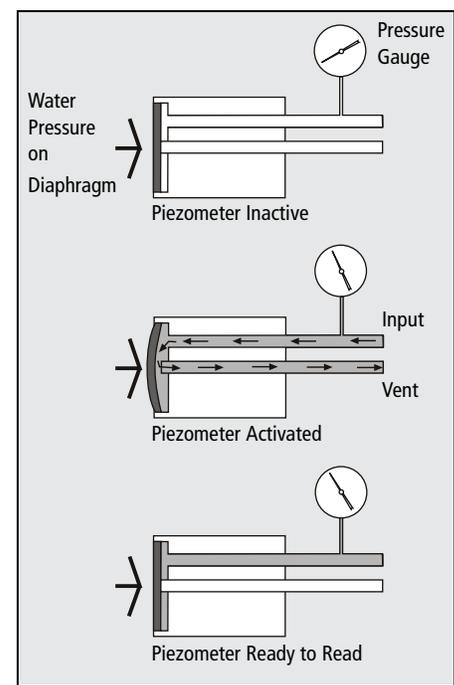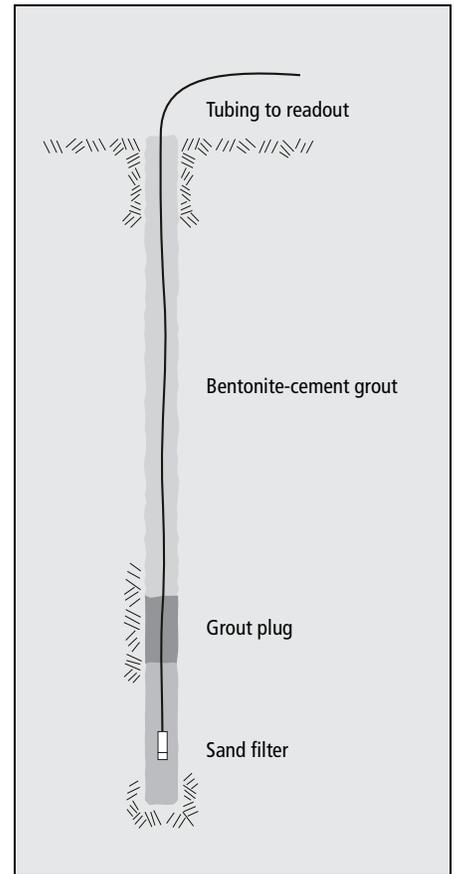
Applications

Pneumatic piezometers are used to measure pore water pressure in saturated soils. Applications include:

- Monitoring pore pressures to determine safe rates of fill or excavation.
- Monitoring pore water pressures to determine slope stability.
- Monitoring the effects of dewatering systems used for excavations.
- Monitoring the effects of ground improvement systems such as vertical drains and sand drains.
- Monitoring pore water pressures to check the performance of earth fill dams and embankments.
- Monitoring pore water pressures to check containment systems at land fills and tailings dams.

Advantages

Slope Indicator's pneumatic piezometers employ a simple and reliable transducer that is inherently free from drift.

Long term performance is enhanced by corrosion-resistant plastic construction, polyethylene tubing, and in-line filters in all connectors.

Twin-tube design is compatible with both "flow" and "no-flow" reading techniques.

Operating Principle

In a typical installation, the piezometer is sealed in a borehole, embedded in fill, or suspended in a standpipe. Twin pneumatic tubes run from the piezometer to a terminal at the surface. Readings are obtained with a pneumatic indicator.

The piezometer contains a flexible diaphragm. Water pressure acts on one side of the diaphragm and gas pressure acts on the other.

When a reading is required, a pneumatic indicator is connected to the terminal or directly to the tubing. Compressed nitrogen gas from the indicator flows down the input tube to increase gas pressure on the diaphragm. When gas pressure exceeds water pressure, the diaphragm is forced away from the vent tube, allowing excess gas to escape via the vent tube.

When the return flow of gas is detected at the surface, the gas supply is shut off. Gas pressure in the piezometer decreases until water pressure forces the diaphragm to its original position, preventing further escape of gas through the vent tube.

At this point, gas pressure equals water pressure, and a reading can be obtained from the pressure gauge on the indicator.

Operating Principle

PNEUMATIC PIEZOMETER

Sensor Type: Twin-tube pneumatic transducer.

Range: Pressure rated for 27.5 bar or 400 psi. Working range depends on gauge supplied with pneumatic indicator.

Gauge Accuracy: ±0.25% FS.

Diaphragm Displacement: 0.01 ml typical.

Filter: Sintered stainless steel, 50 micron pores.

Materials: ABS and PVC plastic body, synthetic rubber diaphragm.

Diameter: 25.4 mm (1").

PIEZOMETER ONLY

Pneumatic Piezometer 51417800

Part number includes only piezometer. Tubing is attached to piezometer at factory and must be ordered at same time as piezometer.

PIEZOMETER WITH TUBING

Piezometer & 50' of tubing 51417801
Piezometer & 100' of tubing 51417802
Piezometer & 150' of tubing 51417803
Piezometer & 200' of tubing 51417804

Order numbers specify a pneumatic piezometer with tubing and quick-connect plug. These piezo-meters are stocked for faster delivery.

TUBING & CONNECTORS

Twin Tubing 51416900

Two polyethylene tubes bundled in polyethylene jacket.

Tubing Size: 4.76 mm with 1 mm wall (3/16" with 0.04" wall).

Jacket: 12 mm x 7 mm with 1.1 mm wall (0.46" x 0.28" with 0.045" wall).

Burst Pressure: 3.4 MPa (500 psi).

Minimum Bending Radius: 75 mm (3").

Tubing Buoyancy: 0.021 kg per m (0.014 lb per foot).

Weight: 0.06 kg per meter (0.04 lb per foot).

Splice Kit 51401723

Includes 3 brass unions, self-vulcanizing mastic pad, and sealing tape.

Quick Connect Plug 51407302

Brass quick-connect fitting for input tube. Plug includes in-line filter and 90° elbow for insertion into panel.

PNEUMATIC INDICATOR

With 0.25% Analog Gauge 51425601
With 0.25% Digital Gauge 51425602

See separate datasheet for details.

INSTALLATION ACCESSORIES

Small Canvas Bag 06240000
Large Canvas Bag 06240001

Creates a sand filter around piezometer. Also assists with sinking the piezometer in water-filled boreholes. Small bag is 64 x 457 mm (2.5 x 18"). Large bag is 114 x 457 mm (4.5 x 18").

Push-In Well Point 51400099

Steel well point for piezometer, 30 x 610 mm (1.25 x 24"), 2 kg (4.4 lb). This part number includes labor to insert piezometer into well point, but does not include piezometer, tubing, or quick-connect plug.

Standpipe Piezometer & Water Level Indicator

Standpipe Applications

Standpipe piezometers are used to monitor piezometric water levels. Typical applications include:

- Monitoring pore-water pressure to determine the stability of slopes, embankments, and landfill dikes.
- Monitoring the effectiveness of dewatering schemes.
- Monitoring seepage and ground water movements in embankments, landfill dikes, and dams.

Components

The standpipe piezometer consists of a filter tip joined to a riser pipe. The filter has 60 to 70 micron pores and is made from polyethylene or porous stone. The riser pipe is typically made from PVC plastic pipe.

A water level indicator is used to monitor the piezometric water level.

Installation

After the borehole is drilled, the filter tip and riser pipe are assembled and installed downhole.

Sand is tremied to the bottom of the borehole to form a sand intake zone around the filter tip. A bentonite seal is placed above the intake zone and the orehole is backfilled with a bentonite-cement grout.

The riser pipe is terminated above ground level and capped to prevent entry of rain water.

Standpipe Operation

Pore-water pressure around the intake zone drives water into the standpipe. The water level in the standpipe rises or falls with changes in pore-water pressure.

A water level indicator is used to monitor the changes.

Advantages

- Economical components.
- Simple to read.
- No active downhole parts.

Water Level Indicator

Water level indicators are used to monitor water levels in standpipes and wells.

Operation

The indicator consists of a probe, a cable with laser-marked graduations, and a cable reel. The hub of the cable reel contains batteries, electronics, a bright LED lamp, and a beeper.

The operator lowers the probe into the standpipe or well. When the probe contacts the surface of the water, the LED illuminates and the beeper sounds.

The operator then reads the depth-to-water measurement from the graduations on the cable.

Advantages

Small Probe fits into most standpipes and wells. Weight can be attached to the probe tip

Convenient Cable stores neatly on the reel. Steel conductors provide strength and excellent dimensional stability.

Laser-Marked Graduations are as durable as the cable itself. English-unit and metric-unit graduations are available.

Sturdy Reel is built for years of daily use. It features bronze bearings and aluminum plate sides.

Water Level Indicator & Filter Tips
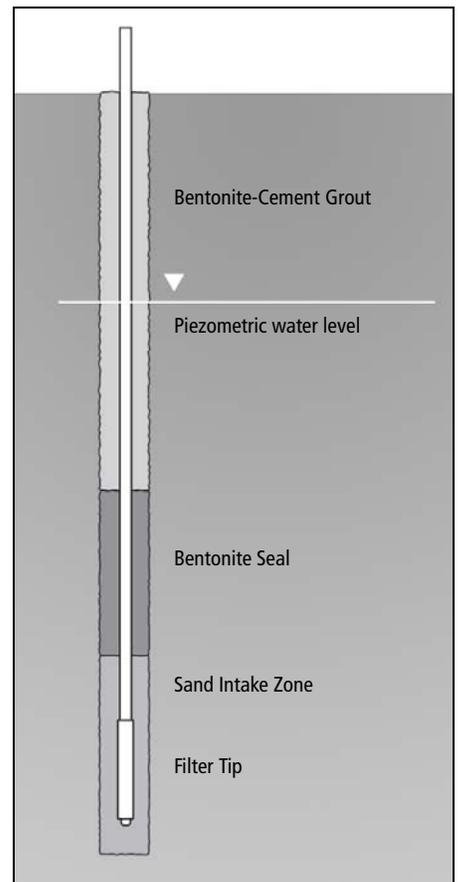
Water level in standpipe is produced by pore-water pressure at the filter tip.

STANDPIPE FILTER TIPS

Polyethylene Tip, 12" (305 mm) . .51417402
Polyethylene Tip, 24" (610 mm) . .51417404
Porous Stone Tip, 12" (305 mm) . .51405102
Porous Stone Tip, 24" (610 mm) . .51405104
Optional Adapter to 1.25" pipe . .50712521
Optional Adapter to 1.5" pipe . . .50712531

Standpipe filter tip is used with plastic riser pipe. Tip mates directly with 0.75" slip coupling and is supplied with an adapter kit (51405150), which includes adapters for 0.5" and 1"pipe.

Filter Material: Polyethylene tip is made from hydrophilic polyethylene and has 60 micron pores. Porous stone filter is made from fused aluminum oxide (Norton Alundum) and has 68 micron pores.

Filter Size: Filter is 1.5" diameter cylinder, 12 or 24 inches long.

The smallest reel has a handle and clips to hold the probe.

WATER LEVEL INDICATOR SPECS

Probe: Stainless steel body and tip, polyethylene insulator. 10 x 170 mm (3/8" x 6.6").

Cable: 3.2 mm (1/8") diameter polyurethane jacket with two copper-clad, steel conductors inside. Graduations are marked with laser and connot be rubbed off. Clean cable with laboratory grade detergent, such as Alconox® or Liquinox®.

Reel Construction: Heavy-gage aluminum plate sides, PVC spool, rotating knob. Larger reels are equipped with a stand made of strong steel tubing, a probe holder, and a reel brake.

Sensitivity Control provides consistent results in different well and water conditions and helps eliminates false triggering.

LED and beeper provide a positive indication of contact with water.

Test button is used to check the batteries, beeper, and LED.

Battery cover provides easy access to two AA batteries. Low-power circuits provide excellent battery life.

ENGLISH-UNIT WLI

Cable	Reel	Weight	Part Number
100'	7"	3.5 lb	51690010
150'	7"	4 lb	51680014
100'	9"	5 lb	51690012
150'	9"	5.5 lb	51690015
300'	9"	7.5 lb	51690030
500'	11"	11 lb	51690050
1000'	11"	17 lb	51690100

METRIC-UNIT WLI

Cable	Reel	Weight	Part Number
30 m	180 mm	1.6 kg	51690303
50 m	180 mm	1.8 kg	51690304
30 m	230 mm	2.3 kg	51690300
50 m	230 mm	2.5 kg	51690305
100 m	230 mm	3.4 kg	51690310
150 m	280 mm	4.7 kg	51690315
200 m	280 mm	5 kg	51690320
300 m	280 mm	7.7 kg	51690330

English Graduations: 0.01 foot graduations with labels at 0.1 foot and 1 foot intervals.
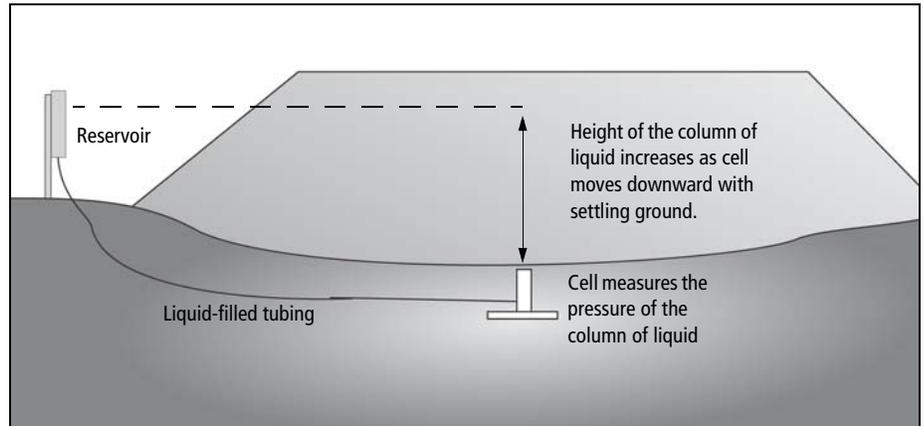
18 ft   18.1 ft   18.18 ft
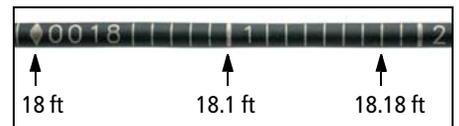
Metric Graduations: Centimeters are marked and labelled. Numbers in the label serve as 2 mm graduations, as shown below

5 m   5.02 m   5.046 m

Sensitivity Control
Test Button
LED & Beeper
Battery Cover
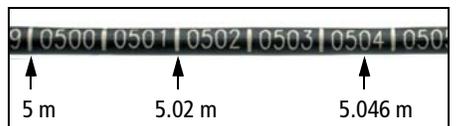
VW Settlement Cells
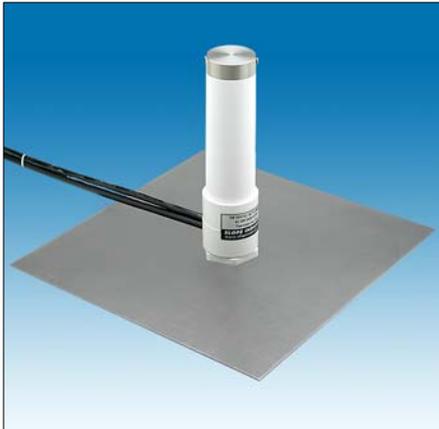
Vented VW settlement cell with settlement plate.

Settlement cells provide settlement measurements with no interference to construction activities.

Reservoir

Height of the column of liquid increases as cell moves downward with settling ground.

Liquid-filled tubing

Cell measures the pressure of the column of liquid

Applications

VW settlement cells are used to monitor settlements in soil. Typical applications include:

- Monitoring settlement in fills.
- Monitoring settlement due to dewatering or preloading.
- Monitoring settlement or heave in embankments.
- Monitoring subsidence due to tunneling.
- Monitoring consolidation of soil under storage tanks.

Non-Vented VW Settlement Cell

Operation

The main components of a VW settlement cell are a reservoir, liquid-filled tubing, and a pressure transducer.

The reservoir is located on stable ground, away from the construction area. The liquid-filled tubing runs from the reservoir down to the pressure transducer, which is embedded in fill or installed in a borehole.

The transducer measures the pressure created by the column of liquid in the tubing. As the transducer settles with the surrounding ground, the height of the column is increased and the transducer measures higher pressure.

Settlements are calculated by converting the change in pressure to millimeters or inches of liquid head.

Advantages

Remote Readout: The reservoir and readout station can be located away from the construction area. The cell and tubing are buried and do not interfere with construction activities.

Three Ranges: Use the 22 psi vented settlement cell to monitor smaller settlements with greater precision. Use the 50 and 100 psi non-vented cells to monitor larger settlements.

Manual or Automated Monitoring: The VW settlement cell can be read manually with a portable indicator, or automatically with a data logger.

SYSTEM CONFIGURATION

Vented Settlement Cells: Components include the vented cell, settlement plate, vented signal cable, tubing, reservoir, desiccant chamber, non-vented signal cable, and readout or datalogger.

Non-Vented Cells: Components include the non-vented cell, settlement plate, tubing, signal cable, reservoir, readout or data logger, and a barometer.

Tubing and Signal Cable: Tubing and signal cable run from the buried cell to the reservoir at the surface. Lateral runs up to 300 m (1000') are possible if tubing is buried to minimize temperature changes and deviations from the upward slope of the tubing are kept very small.

Reservoir: The small reservoir accommodates one settlement cell. The level of the liquid in the reservoir must be maintained regularly.

Dessicant Chamber: Required for vented cells only. Prevents moisture from entering cable and vent tubing.

Barometer: Non-vented settlement cells are sensitive to changes in atmospheric pressure. This can degrade the accuracy of readings. For example, a given area may see annual variations of 10 millibar. Uncorrected, this would appear as variations of 100 mm (4") of settlement or heave. For this reason, barometer readings should be obtained at the same time as the settlement reading. Barometer readings from weather radios and airports are not generally not adequate for this purpose. If your system is automated, order the barometer for data loggers. It has an accuracy better than ±0.3 mb, which is equivalent to ± 6 mm or ± 0.24 inches of water. Check for a similar accuracy if you purchase a portable barometer.

Readouts: The VW Data Recorder is recommended for manual readings. The CR000 data logger or VW MiniLogger can be used for automated readings of the VW sensor. See separate data sheets for features and specifications.

Performance Specifications: Range is the maximum vertical distance between the buried cell and the reservoir. Resolution is based on readings obtained with a VW Data Recorder. Calibration accuracy is determined during calibration. Repeatability depends on proper installation of cell, tubing, and maintenance of the reservoir level, maintenance of deaired fluid, and application of any appropriate corrections.

VENTED VW SETTLEMENT CELL

Vented VW Settlement Cell 52612420

Sensor Type: Vented vibrating wire sensor with built-in thermistor or RTD. Sensor automatically compensates for changes in barometric pressure.

Range: 14 m (47').

Resolution: 0.025% FS.

Calibration Accuracy: ± 0.1% FS.

Repeatability: ±0.25% FS to ±1% FS.

Dimensions: 64 x 280 mm (2.5 x 11")

Materials: Stainless steel and PVC plastic.

SETTLEMENT PLATE

Settlement Plate 51410100

305 x305 mm (12 x 12") steel plate helps maintain required upright orientation of cell.

TUBING AND SIGNAL CABLE

Tubing 51416950

Twin 1/4-inch tubes inside polyethylene jacket. Tubes are filled with de-aired liquid and terminated with quick-connect sockets for connection to reservoir. Specify length.

Vented Signal Cable 50614410

Shielded cable with four 22-gauge tinned- copper conductors, 0.25" vent tube, and polyurethane jacket. For use between cell and desiccant chamber. Specify length.

Splice Kit for Vented Cable 50614415

Contains components required to splice five conductors and vent tube.

Non-Vented Signal Cable 50613524

Shielded cable with four 22-gauge tinned-copper conductors for use between dessicant chamber and readout or data logger. Specify length.

DESICCANT CHAMBER

Desiccant Chamber 52612495

Prevents moisture from entering cable and vent tubing. Desiccant can be renewed in an oven. For one cell. 108 x 108 x 64 mm (4.25 x 4.25 x 2.5").

Extra Desiccant Pack 02540003

Anhydrous calcium sulfate in moisture proof container. Sufficient for one chamber.

RESERVOIR

Small Reservoir 51419500

Accommodates one settlement cell. Includes mounting hardware, two quick-connect plugs, and small bottle of de-aired liquid.

NON-VENTED SETTLEMENT CELLS

50 psi VW Settlement Cell. 52612020
100 psi VW Settlement Cell. 52612030

Sensor Type: Non-vented vibrating wire sensor with built-in thermistor or RTD.

Range: 33 m (108') with 50 psi cell; 66 m (216') with 100 psi cell.

Resolution: 0.025% FS.

Calibration Accuracy: ± 0.1% FS.

Repeatability: ±0.25% FS to ± 1% FS.

Dimensions: 64 x 179 mm (2.5 x 7").

Materials: Stainless steel.

SETTLEMENT PLATE

Settlement Plate 51410100

305 x305 mm (12 x 12") steel plate helps maintain required upright orientation of cell.

TUBING AND SIGNAL CABLE

Tubing 51416950

Twin 1/4-inch tubes inside polyethylene jacket. Tubes are filled with de-aired liquid and terminated with quick-connect sockets for connection to reservoir. Specify length.

Non-Vented Signal Cable 50613524

Shielded cable with four 22-gauge tinned-copper conductors and polyurethane jacket. Does not include connecton. Specify length.

RESERVOIR

Small Reservoir 51419500

Accommodates one settlement cell. Includes mounting hardware, two quick-connect plugs, and small bottle of de-aired liquid.

BAROMETERS

Barometer for Datalogger 52612080

INSTALLATION ACCESSORIES

De-Aired Liquid 51419552

One quart of ethylene glycol-water 50% mixture for maintaining fluid level in reservoir. Mixture has a relative density of 1.065.

Sondex Settlement System

Applications

The Sondex settlement system is used with inclinometer casing to monitor settlement and heave in excavations, foundations, dams, and embankments.

Data from the Sondex indicates the depths at which settlement has occurred as well as the total amount of settlement.

Operation

The Sondex system consists of a portable readout, sensing rings, and Sondex pipe.

The drawing at right shows Sondex pipe with sensing rings installed in a borehole. The sensing rings can be attached to the pipe at regular intervals or at depths of interest.

The annulus between the borehole wall and the Sondex pipe is filled with soft grout. This couples the pipe to the surrounding ground, so that the pipe and rings move with settlement or heave.

The readout consists of a reel with a built-in voltmeter, a cable, and the Sondex probe. The probe has an eyelet for connecting a graduated metal tape, which is recommended for highest accuracy.

To obtain measurements, the operator draws the probe up through the inclinometer casing. The buzzer sounds when the probe nears a ring, and the voltmeter peaks when the probe is aligned with the ring. The operator then refers to the graduated tape and records the depth of the ring.

Settlement and heave are calculated by comparing the current depth of each ring to its initial depth.

Downhole Components

Inclinometer Casing: Use flush coupled casing, such as Slope Indicator's QC casing, so that the Sondex pipe can move freely.
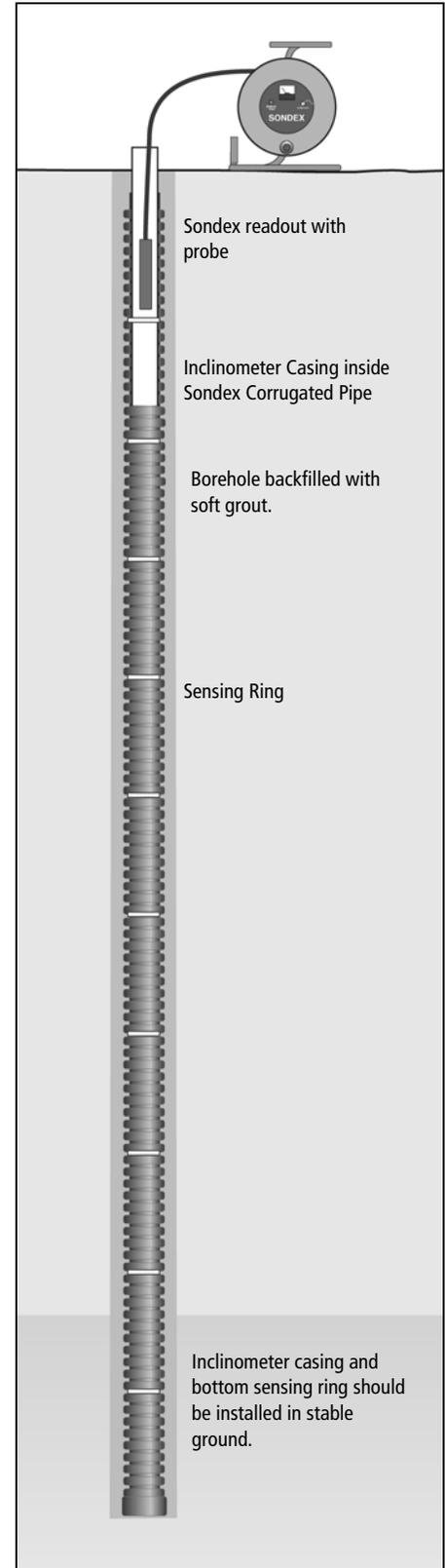
Sondex Pipe and Couplings: Sondex pipe is usually cut to ten-foot lengths for easier installation with the inclinometer casing, which is also supplied in 10-foot lengths.

The Sondex pipe must be sealed at the bottom and at each coupling so that grout does not enter the space between the pipe and the casing.

Sensing Rings: Sensing rings, (stainless steel straps) can be fixed to the Sondex pipe by the user. Factory attachment is also available.

Advantages

- Measurements indicate not only the total settlement, but also the "incremental" settlement at the depth of each ring. Any number of the economical sensing rings can be installed.
- Sondex pipe slides freely along inclinometer casing, eliminating the need for telescoping casing sections.

Sondex readout with probe

Inclinometer Casing inside Sondex Corrugated Pipe

Borehole backfilled with soft grout.

Sensing Ring

Inclinometer casing and bottom sensing ring should be installed in stable ground.

SONDEX READOUT

Readout with 50 m cable 50810305
Readout & 100 m cable 50810310
Readout & 150 m cable 50810315
Readout & 150' cable 50810015
Readout & 300' cable 50810030
Readout & 500' cable 50810050

Sondex readout includes reel, electronics, batteries, laser-marked cable, and probe. Survey tape is not included.

Resolution: Metric gauging tapes have 1 mm graduations. English gauging tapes have 1/16 inch graduations. The laser-marked cable that is connected to the probe has 2mm or 0.01 foot graduations.

Repeatability: When the system used with a reference stand, precision approaches resolution of the tape.

Probe Diameter: 43mm (1.7") OD.

Temp Range: -20- 50°C (0- 120°F).

Batteries: 3 AA batteries.

Reel Diameter: 230 or 280 mm (9 or 11").

SONDEX PIPE

Sondex Corrugated Pipe, 3" ID . . 50801600
Sondex Corrugated PIpe, 4" ID . . 50801700

Corrugated polyethylene drain pipe, generally installed in 10 foot lengths. Use 3" pipe (3.625"OD) with 70 mm inclinometer casing. Use 4" pipe (4.3"OD) with 85mm casing.

Pipe is rated to 80°C (176°F). Specify number of feet required. Does not include couplings and sensing rings.

Coupling, 3" ID 50801602
Coupling, 4" ID 50801702

For joining lengths of corrugated pipe.

Cap, 3" ID. 50801601
Cap, 4" ID. 50801701

For bottom of corrugated pipe.

Mastic Tape 51003800

For sealing Sondex pipe couplings. Mastic is applied to gaps in coupling. Tape is then wrapped over coupling. Finally, cable-ties are strapped on to provide strength.

SENSING RINGS

Sensing Ring, Factory Installed . . .50801800
Sensing Ring, User Installed 02842004

Stainless steel straps can be factory installed at user-specified intervals. Factory installation includes overwrapping with mastic and tape to protect against corrosion. Rings can also be installed by the user.

INCLINOMETER CASING

Choose a casing that has flush couplings, such as Slope Indicator's QC casing or Standard casing. See data sheet for casing.

Magnet Extensometer

Applications

The magnet extensometer is used to monitor settlement and heave in excavations, foundations, dams, and embankments.

Readings obtained with the extensometer indicate the depths at which settlement has occurred as well as the total amount of settlement.

Operation

The system consists of a probe, a graduated cable, a reel with built-in light and buzzer, and a number of magnets positioned along the length of an access pipe. The magnets move with settlement or heave of the surrounding ground.

Readings are obtained by drawing the probe through the access pipe to find the depth of the magnets. When the probe enters a magnetic field, a reed switch closes, activating the light and buzzer on the reel at the surface. The operator then refers to the graduations on the cable and notes the depth of the magnet.

Settlement and heave are calculated by comparing the current depth of each magnet to its initial depth. Movement is generally referenced to the datum magnet, which is anchored in stable ground.
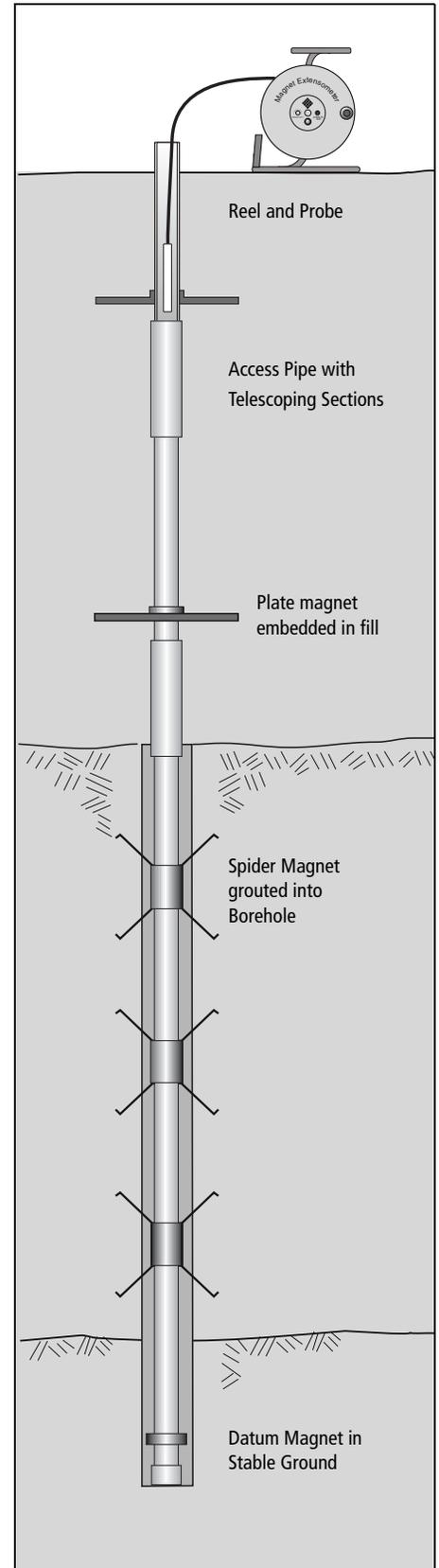
Installed Components

Access Pipe: Subsurface access for the probe is provided by plastic inclinometer casing or one-inch pipe. Telescoping pipe sections are used to help accommodate settlement.

Plate Magnet: The plate magnet is used in fill. It is positioned at the specified elevation and then covered with fill material that is compacted to the same specification as the surrounding fill.

Spider Magnet: The spider magnet, named for its appearance, is used in boreholes. The legs are compressed for installation and are released when the magnet is positioned at the specified depth. The borehole is then backfilled with a soft grout.

Datum Magnet: The datum magnet is fixed directly to the bottom section of access pipe. A datum magnet is used when the bottom of the pipe is anchored in stable ground.

Pipe Magnet: The pipe magnet (not shown) is factory attached to telescoping sections of 1" PVC pipe, eliminating the need for spider magnets and simplifying installation.

Reel and Probe

Access Pipe with Telescoping Sections

Plate magnet embedded in fill

Spider Magnet grouted into Borehole

Datum Magnet in Stable Ground

READOUT (PROBE AND REEL)

Readout with 30m cable 51817203
Readout with 50m cable 51817205
Readout with 100m cable 51817210

Readout with 100' cable 51817310
Readout with 150' cable 51817315
Readout with 300' cable 51817330

The readout consists of a reed-switch probe, a graduated cable, and a reel that contains a power switch, indicator light, and batteries.

Probe: Stainless steel, 16 x 203mm (5/8 x 8").

Cable: 3.5mm (0.125") diameter, twin steel conductors for good dimensional stability, polyurethane jacket for high resistance to abrasion, indelible graduations marked by a laser marking machine. Metric cable have 2 mm graduations. English cables have 0.01' graduations.

Reel: 230 or 280mm (9 or 11") in diameter, depending on cable length. Mounted on a steel-tube stand with a durable finish.

Batteries: The readout operates on three 1.5 volt alkaline AA cells. Battery life depends on usage.

Precision: Readings are typically repeatable to ±3 to 5 mm or ±0.1 to 0.2 inches.

MAGNETS FOR 1-INCH PIPE

Datum Magnet 51817303
Spider Magnet 51817503
Plate Magnet 51817703
Pipe Magnet 91821450

Datum magnet has 34 mm ID (1.34"). Body is PVC plastic.

Spider magnet has legs that are compressed for downhole installation and released when magnet is in place. Compression wires and release pin are included. Release cord is not included. OD of magnet is 86 mm (3.4") with legs compressed, so borehole should have a diameter of 100 to 200 mm (4 to 8"). ID of magnet ID is 34 mm (1.34"). Spring force of legs is 2.7 kg (6 lb). Legs are spring steel, body is PVC plastic.

Plate magnet measures 300 x 300 mm (12 x 12"). ID is 34mm (1.34"). Body is PVC plastic.

Pipe magnet is fixed directly to telescoping sections of 1-inch pipe (50711048), eliminating spider magets and simplifying installation. Up to two magnets can be attached to each telescoping section.

1-INCH PIPE

Pipe Section, 3.05m (10') 50711408
Telescoping Section 50711458
Pop Rivet, AD-42H 51003303
End Cap 50711428

Pipe section is 3.05 m (10') long PVC pipe. Threaded ends provide flush joints.

Telescoping section is 3.05m (10') long when expanded and 2m (7') long when collapsed. It has threaded ends for coupling to PVC pipe above. OD is 43 mm (1.7").

Pop rivets hold telescoping sections open during installation. Use 2 per telescoping section.

End cap is glued on with PVC cement.

MAGNETS FOR 70MM CASING

Datum Magnet 51817346
Spider Magnet 51817546
Plate Magnet 51817746

Datum magnet has an ID of 71mm (2.8").

Spider magnet has legs that are compressed for downhole installation and released when a pin is pulled. Compression wires and release pin are included. Release cord is not included. Magnet OD is 122 mm (4.8") with legs compressed, so borehole diameter should be 125 to 305 mm (5 to 12"). Magnet ID is 71 mm (2.8"). Legs have spring force of 2.7 kg (6 lb). Legs are spring steel, body is PVC plastic.

Plate magnet measures 300 x 300 mm (12 x 12"). ID is 71 mm (2.8").

MAGNETS FOR 85MM CASING

Datum Magnet 51817366
Spider Magnet 51817566
Plate Magnet 51817766

Datum magnet has an ID of 85 mm (3.36") and is made of PVC plastic.

Spider magnet has legs that are compressed for downhole installation and released when a pin is pulled. Compression wires and release pin are included. Release cord is not included. Magnet OD is 122 mm (4.8") with legs compressed, so borehole diameter should be 125 to 305 mm (5 to 12"). Magnet ID is 85 mm (3.36"). Legs have spring force of 2.7 kg (6 lb). Body is PVC plastic. Legs are spring steel.

Plate magnet measures 300 x 300 mm (12x12") and has an ID of 85 mm (3.36"). Body is PVC plastic.

INCLINOMETER CASING

See data sheet for inclinometer casing for part numbers.

Settlement Point with Borros-Type Anchor

Application

The Borros-Type Anchor is used with steel pipe to monitor settlement under surcharges or embankments. It is also used to monitor heave (uplift) resulting from excavation or grouting.

The Borros-type anchor is designed for soft clays. It is difficult to extend the prongs of the anchor in other types of soil, such as stiff, over-consolidated clays, shales, dense sand, or sand and gravel.

Description

The settlement point consists of a three-pronged anchor, a ¼-inch inner pipe, and a one-inch outer pipe, both steel. The inner pipe is attached to the anchor and is free to move inside the one-inch outer pipe.

An optical survey is used to determine the elevation of the top of the inner pipe. Changes in its elevation indicate an equivalent amount of settlement or heave at the anchor.

Typical Installation

Drill a borehole to a depth slightly shallower than the intended depth of the anchor. Flush debris from the borehole.

Remove the special coupling supplied with the anchor and thread it onto the bottom length of one-inch pipe. Tighten it with a wrench so that it will not loosen.

Thread the first full length of ¼ inch pipe onto the pipe supplied with the anchor and tighten it with a wrench.

Next, grease the one-inch threads on the anchor. Then slide the one-inch pipe over the ¼ inch pipe until it meets the anchor. Hand-tighten the one-inch-pipe to the anchor. Do not over-tighten, since the pipe must be detached from the anchor later.

Lower the anchor and pipe into the borehole, adding additional pipe sections of both sizes as needed.

When the anchor reaches the bottom of the borehole, push or drive the one-inch pipe into the ground until the anchor is at the specified depth.

Secure the top of the one-inch pipe to hold the anchor in place. With the outer pipe held securely, push the inner pipe downwards about 7 inches to fully expand the legs of the anchor. Use the drill rig to do this.

Detach the one-inch pipe from the anchor by rotating it in a clockwise direction for at least 15 complete turns. Then pull the one-inch pipe upwards, away from the anchor, until the distance between the bottom of the pipe and the anchor is slightly greater than the maximum expected settlement or heave.

It is important, both during and after installation, to prevent rocks or other debris from entering the annular space around the inner pipe.

Withdraw the drill casing, if used, and backfill the annular space around the one-inch pipe with bentonite grout or as specified.

Protect the installation with an empty 50 gallon drum or some other large, highly visible object.

As the embankment continues to rise, add sections of inner and outer pipe to maintain the top of the pipe 1 to 5 feet above the surface of the fill. Place the fill around the pipe by hand to avoid damaging the installation. The top of the inner pipe should be optically surveyed before and after adding each section. If this is not possible, be sure to measure the added length of the inner pipe.

In excavations, sections of inner and outer pipe are removed to maintain the top of the pipe at a manageable 1 to 5 feet above the surface. The top of the inner pipe should be optically surveyed before and after removing each section. If this is not possible, be sure to measure the subtracted length of the pipe.


Borros-Type Anchor
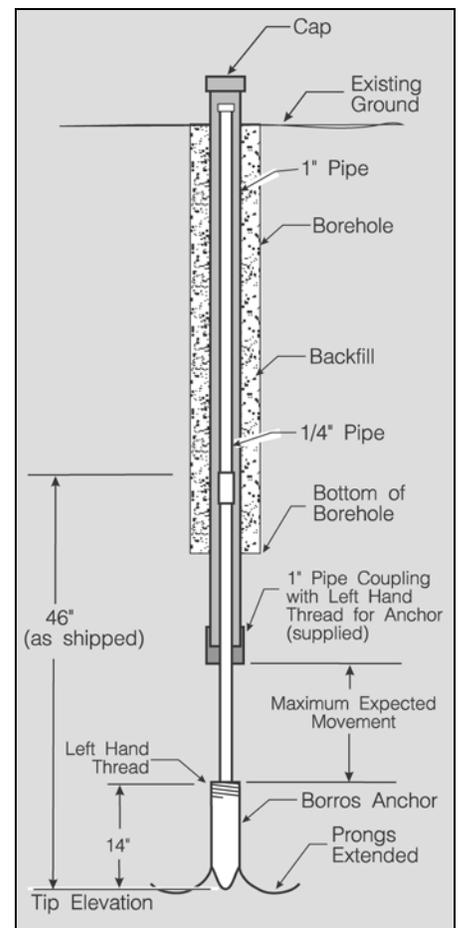
Typical Installation

ORDERING INFORMATION

Borros-Type Anchor. 51808000

The anchor is approximately 14 inches (356 mm) tall. The permanently attached ¼ inch pipe extends approximately 32 inches (813 mm) above the top of the anchor. A special left-hand threaded coupling is included with the anchor.

Users should obtain the required lengths of ¼ inch and one-inch pipe locally. The anchor has standard NPT threads. Users in UK should order, or obtain locally, BSP to NPT thread adaptors for both the 1-inch and ¼ inch pipes. Users with other size pipes and threads can usually find adaptors to NPT or BSP threads locally.

Rod Extensometer
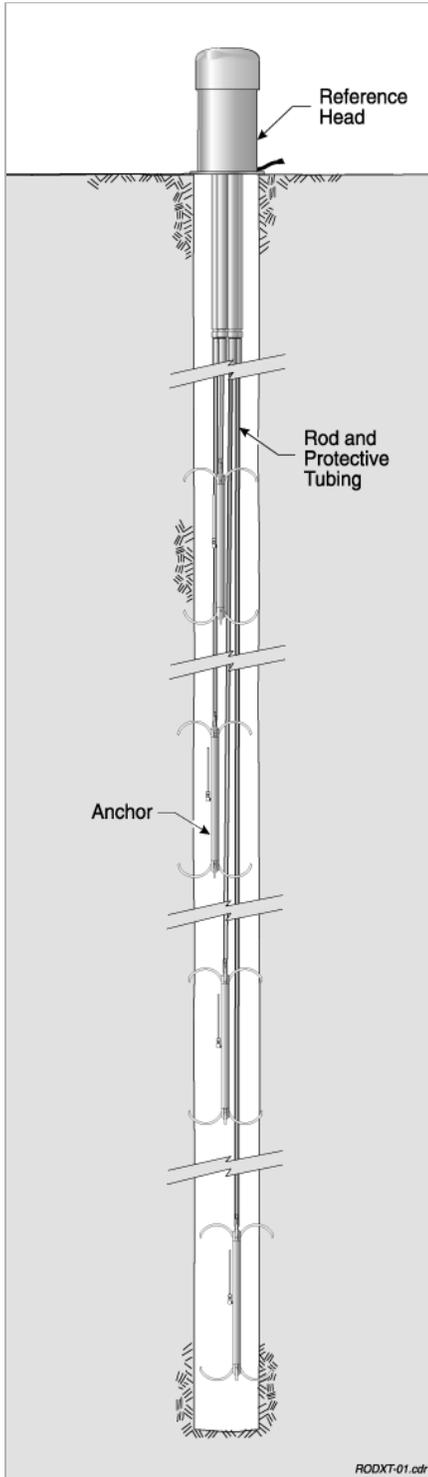
Applications

Rod extensometers monitor settlements in foundations, subsidence above tunnels, displacements of retaining structures, and deformations in underground openings.

Operation

Components of a rod extensometer include anchors, rods, protective pipe, and a reference head.

The anchors are attached to rods and installed in the borehole. The rods span the distance from the anchors to the reference head at the surface. The protective plastic pipe prevents bonding between rods and grout backfill.

Readings are obtained at the reference head by measuring the distance between the top (near end) of the rod and a reference surface. A change in this distance indicates that movement has occurred.

Movements are referenced to a stable elevation, typically a downhole anchor. The resulting data can be used to determine the zone, rate, and acceleration of movements, and to calculate strain.

Anchors

Groutable anchors are suitable for most applications. The hydraulic anchor is used in soft soil.

Rods

Rods are fiberglass or stainless steel. Fiberglass rod extensometers are assembled at the factory and shipped to the site, ready to install. The flexibility of these extensometers also makes them easier to install in confined areas, such as tunnels.

Stainless steel rod extensometers are assembled on site. However, their stiffer rods can be used for deeper anchor depths.

Reference Heads

Mechanical reference heads can be used when there is easy access to the extensometer. Measurements are obtained with a depth micrometer.

Electric reference heads are used when access to the reference head is difficult or where continuous monitoring is required. Measurements are obtained with displacement sensors and a readout or data logger.

PERFORMANCE NOTES

System Accuracy: The main variables in system accuracy are site conditions and the quality of the installation. In general, the best performance is achieved when the borehole is straight and rods are held in tension to keep them straight while the grout backfill cures.

Maximum Recommended Rod Length: In general, rods in tension can be longer than rods in compression, and steel rods can be longer than fiberglass rods. In non-vertical installations, friction between rods and the protective pipe becomes a limiting factor. The table below suggests maximum lengths for rods in tension and compression.

Max Rod Lengths: Tension / Compression		
Orientation	Fiberglass	Steel
Vertical Down	20 / 15 m	40 / 30 m
Vertical Up	45 / 30m	60 / 45 m
45° Down	25 / 20 m	40 / 30 m
45° Up	35 / 25 m	55 / 40 m
Horizontal	35 / 20 m	45 / 30 m

Number of Monitored Points: The rod extensometer can monitor up to six points. In practice, the number of monitored points is limited by the size of the borehole, the type of anchor used, the diameter of the protective pipe, and the amount of tubing required for activating anchors and grouting. A 76 mm (3") borehole will accommodate six groutable or hydraulic anchors

ANCHORS

Groutable Anchor 51815852
Made from rebar, 19 x 365 mm (0.75 x 14.5").

Hydraulic Anchor. 51703952
Double-acting hydraulic anchor drives 150 (6") mm prongs into soil. 32 x 620 mm (1.25 x 24.5"). Requires hydraulic tubing & pump.

FIBERGLASS RODS

Fiberglass Rod 51815855
Protective Tubing. 51815860
Rod Completion Kit 51836240

Fiberglass rod has a diameter of 5 mm (3/16") and is supplied in continuous lengths. Protective polyethylene tubing is supplied in continuous lengths. Rod completion kit includes components for top and bottom of rod. Order 1 kit per anchor.

STAINLESS STEEL RODS

Stainless Steel Rod. 51704310
Protective Pipe. 51704321
Rod Completion Kit 51836210

Stainless steel rod has a diameter of 6.4 mm (0.25") and is supplied in 10' lengths, each threaded and tapped for assembly. Protective pipe is supplied in 10' lengths and includes couplings. Requires PVC solvent cement, which can be obtained locally. Rod completion kit includes components for top and bottom of rod. Order 1 kit per anchor.

MECHANICAL REFERENCE HEAD

Single-Point Head 51836110
Multi-Point Head 51836120
Digital Depth Micrometer 51809620

Single-point head works with 1 rod and anchor. Multi-point head works with up to 6 rods and anchors. Readings are obtained with depth micrometer. Digital depth micrometer displays readings in inches and millimeters. 150 mm (6") range, 0.01 mm (0.001") resolution.

ELECTRIC REFERENCE HEAD

Single-Point Head 51836130
Multi-Point Head 51836140
VW Sensor, 60 mm range 52636305
VW Sensor, 100 mm range 52636325
Potentiometer, 60 mm range 51836152
Potentiometer, 100 mm range . . . 51836154

Single-point head works with 1 rod and anchor. Multi-point head works with up to 6 rods and anchors. Displacement sensors are supplied with 0.6 m (2') of signal cable.

VW sensor provides resolution of 0.01% FS. Potentiometer provides resolution of 0.1% FS. Repeatability is better than ±0.5% FS.

Special ranges and waterproof ratings can be quoted on request.

VW sensors are read with a VW readout or a data logger: VW minilogger for single points, Quattro logger for four points, or Campbell Scientific logger for multiple points.

Potentiometers are read with the Extensometer Indicator, a or a Campbell Scientific data logger.

SIGNAL CABLE

Signal Cable, 4-Wire 50613524
For one VW sensor. Not required if 12 wire cable above is used.

Signal Cable, 6-Wire 53102900
For one potentiometer. Not required if 12 wire cable above is used.

Signal Cable, Multicore. . . . **Contact Factory**

Universal Terminal Box 57711600
For use with portable readout. Not required with data logger. Splashproof fiberglass box is 290 wide x 345 high x 135 mm deep (11.5 x 13.5 x 5.25").

INSTALLATION ACCESSORIES

Pipe Adapter 51835170
Optional adapter for anchoring reference head to 76mm (3") diameter steel pipe installed at collar of borehole.

Flange 51836175
Optional adapter for anchoring reference head to concrete pad at borehole collar. 190 mm (7.5") plastic flange with 152 mm (6") bolt circle.

Grout Tubing 50721008
Used to deliver grout from the grout pump to the borehole. 12.7mm OD (0.5") polyethylene tubing rated for 30 bar (425 psi).

Hydraulic Tubing 51702701
Used to activate hydraulic anchors. 6.35mm (0.25") nylon tubing filled with oil.
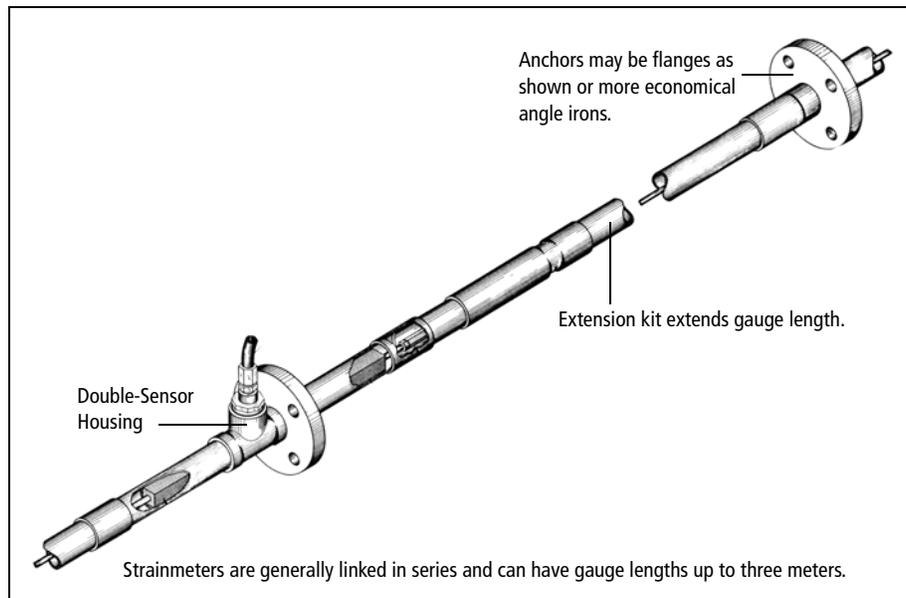
Hydraulic Anchor Tools 51704600
Hydraulic pump with gauge, T-connection, oil volume indicator, 1 gallon of oil, and adapter for filling hydraulic tubing.

Spare Nut & Ferrule. 51703950
Replacement hardware for connecting hydraulic tubing to anchor.

Soil Strainmeter

Anchors may be flanges as shown or more economical angle irons.

Extension kit extends gauge length.

Double-Sensor Housing

Strainmeters are generally linked in series and can have gauge lengths up to three meters.

Applications

Typical applications for soil strainmeters include:

- Monitoring horizontal strain in embankment dams.
- Monitoring tension cracks in earth structures.
- The stainless steel version can be used in rockfill dams.

Operation

Each soil strainmeter consists of two anchors connected by a rod and a displacement sensor. The gauge length of the strainmeter, which is the distance between anchors, may be as long as 6 meters.

Strainmeters are usually linked in a series along the axis of anticipated deformation. They may also be arranged in arrays or in groups with different alignments.

The initial reading of the strainmeter is used as a datum. As soil movements occur, the distance between the anchors grows or shrinks. This changes the output of the displacement sensor.

Subsequent readings are compared to the datum to calculate the magnitude, rate, and acceleration of movement.

The strainmeter sensor is available as a double sensor or a single sensor. The double-sensor provides potential savings on cable costs.

Advantages

Easy Installation: The strainmeter is designed for easy assembly, easy extension of gauge lengths, and easy adjustment.

Reduced Cable Costs: The double-sensor version allows a single cable to service two sensors, resulting in reduced cable cost.

Manual or Automatic Readout: Strainmeters can be read manually with a portable indicator or can be connected to a data logger for unattended readings.

Standard or Stainless: The standard strainmeter is designed for use in soil. The stainless strain-meter is designed for use in rockfill dams.

STANDARD SOIL STRAINMETER

Single-Sensor Strainmeter 51705600
Double-Sensor Strainmeter. 51705620

Single-Sensor components include one sensor housing with with one potentiometer, one stainless steel all-thread rod, telescoping PVC pipe, and two anchors. Signal cable is ordered separately.

Double-Sensor components include one sensor housing with two potentiometers mounted back to back, two stainless steel all-thread rods, telescoping PVC pipe, and three anchors. Signal cable is ordered separately.

Gauge Length: Gauge length for each sensor is adjustable between 480 to 1525 mm (19 to 60"). Longer gauge lengths are made by adding one or more gauge extension kits.

Sensor Type: Linear potentiometer.

Sensor Range: 150 mm (6").

Sensor Linearity: ±0.3% FS.

Resolution: 0.01% FS with extensometer indicator.

Materials: PVC Plastic and Stainless Steel.

GAUGE LENGTH EXTENSION KITS

Standard 1.5m Extension Kit. . . .51705650

Adds 1.5-meter (5') extension to gauge length of strainmeter. One or more kits can be added to the strainmeter. However, it is recommended that the total distance between anchors does not exceed 6 meters. Assembly requires PVC-ABS cement.

Standard 3m Extension Kit 51705660

Adds 3-meter (10') extension to gauge length of strainmeter. One or more kits can be added to the strainmeter. However, it is recommended that the total distance between anchors does not exceed 6 meters. Assembly requires PVC-ABS cement.
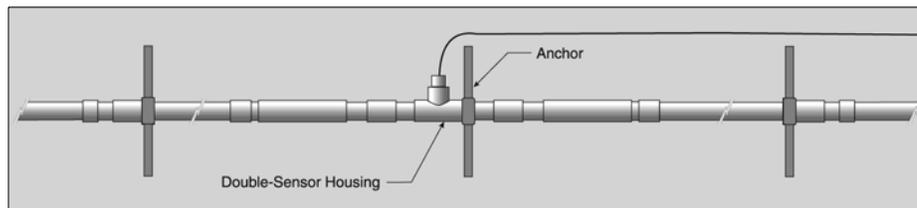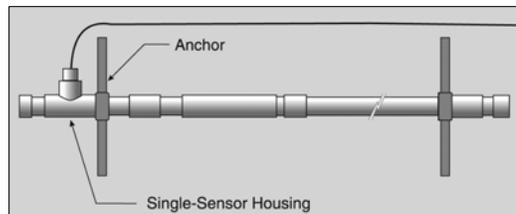
STAINLESS STRAINMETER

Single-Sensor Strainmeter 91707610
Double-Sensor Strainmeter 91707620

Single-Sensor components include stainless steel housing with one potentiometer, one stainless steel all-thread rod, telescoping stainless steel pipe, and two steel anchors. Signal cable is ordered separately.

Double-Sensor components include stainless steel housing with two potentiometers mounted back to back, two stainless steel all-thread rods, telescoping stainless steel pipe, and three steel anchors.

Gauge Length: Gauge length is adjustable between 480 to 1525 mm (19 to 60"). Longer gauge lengths are made by adding one or more gauge extension kits.

Sensor Type: Linear potentiometer.

Sensor Range: 150 mm (6").

Sensor Linearity: ±0.3% FS.

Resolution: 0.01% FS with extensometer indicator.

Materials: Stainless Steel.

STAINLESS EXTENSION KITS

Stainless 1.5m Extension Kit 91707630

Adds 1.5-meter (5') extension to gauge length of strainmeter. One or more kits can be added to the strainmeter. However, it is recommended that the total distance between anchors does not exceed 6 meters.

Stainless 3m Extension Kit. 91707640

Adds 3-meter (10') extension to gauge length of strainmeter. One or more kits can be added to the strainmeter. However, it is recommended that the total distance between anchors does not exceed 6 meters.

SIGNAL CABLE

Signal Cable 50613524

Shielded cable with four 22-gauge, tinned copper conductor with polyurethane jacket.

Double-Sensor Signal Cable 50613527

Shielded cable with seven 22-gauge tinned-copper conductors with polyurethane jacket.

Universal Terminal Box 57711600

Provides connections for 12 sensors and an indicator. Sensors selected by rotary switch. Weatherproof fiberglass box measures 290 mm wide x 345 mm high x 135 mm deep.

EXTENSOMETER INDICATOR

Extensometer Indicator 51810100

Portable indicator for reading potentiometers used in soil strainmeter and rod extensometers. Includes battery, charger, and jumper cable. Specify charger and jumper.

Displayed Units: Percent of full scale.

Resolution: 0.01% of full scale.

Display: Large, backlit 4.5 digit LCD.

Selector Switch: Provides switching to eight different sensors when connected to suitably wired signal cable.

Batteries: Rechargeable 6 volt, 6Ah lead-acid battery. Battery life is 12 hours.

Environmental Limits: -20 to 50°C (-4 to 122°F). Splashproof, non-submersible. Connector socket is waterproof when capped or in use.

Dimensions: 127 x 178 x 178 mm (5 x 7 x 7").

Weight: 3.5 kg (7.5 lb).

DATA LOGGERS

Compatible data loggers include the Campbell Scientific CR1000. 8 double-sensor strainmeters or 16 single-sensor strainmeters can be connected to each AM16/32 multiplexer.

Total Pressure Cells

Total Pressure Cell

Jackout Total Pressure Cell

Applications

The total pressure cell measures the combined pressure of effective stress and pore-water pressure. Typical applications include:

- Monitoring total pressure exerted on a structure to verify design assumptions.
- Determining the magnitude, distribution, and orientation of stresses.

Principle of Operation

Total pressure is the intergranular pressure in the soil (effective stress) combined with the pressure of water in the voids between soil grains (pore water pressure).

The pressure cell is formed from two circular plates of stainless steel whose edges are welded together to form a sealed cavity. The cavity is filled with a non-compressible fluid.

The cell is installed with its sensitive surface in direct contact with the soil. The total pressure applied to that surface is transmitted to the fluid inside the cell and measured with a pneumatic or vibrating wire pressure transducer.

Installation

Total pressure cells are typically embedded in fill or fixed to a structure. In fill, cells are often installed in arrays. Each cell is placed in a different orientation and covered with hand-compacted fill. When mounted on a structure, the cell is placed into a recess so that its sensitive side is flush with the surface of the structure.

The jackout total pressure cell is specially designed for installation in cast-in-place structures, such as diaphragm walls. Its name is derived from the use of a hydraulic jack that is activated to keep the cell in contact with the soil during concreting. See drawing on back.

Advantages

Conformance: To minimize bridging effects, the total pressure cell has a low profile and a modulus similar to that of a typical soil. Fluid in the cell is de-aired to maximize sensitivity.

Pneumatic or Vibrating Wire: The total pressure cell is available in a pneumatic or vibrating wire version.

Manual or Automatic Readout: The vibrating wire version can be read with a portable indicator or a data logger. The pneumatic version must be read with a portable readout.
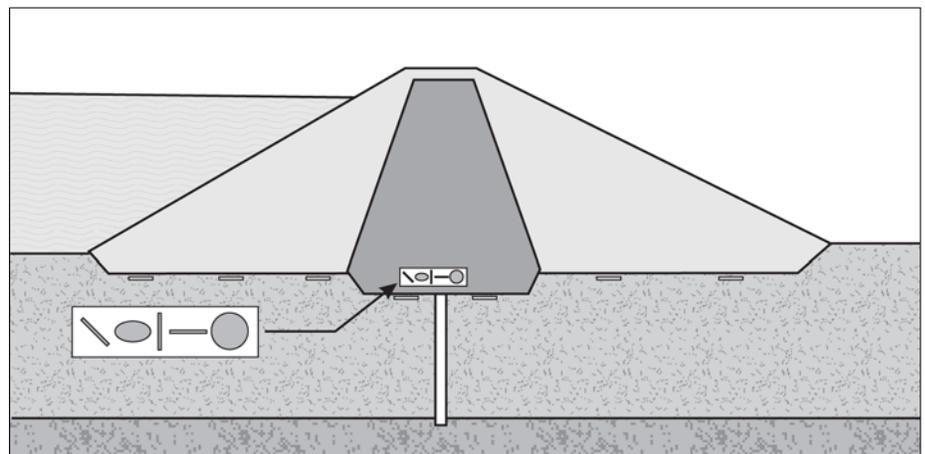
Total pressure cells in an embankment dam. Detail shows multi-directional orientation of cells in an array.

VW PRESSURE CELLS

3.5 bar (50 psi) Pressure Cell. 52608220
7 bar (100 psi) Pressure Cell 52608230
17 bar (250 psi) Pressure Cell 52608240
35 bar (500 psi) Pressure Cell 52608250

Part numbers above specify a pressure cell, a VW pressure sensor, and thermistor or RTD for temperature measurement. Requires signal cable.

Resolution: 0.025% FS.

Repeatability: ±0.5% FS.

Max. Pressure: 150% rated range.

Fluid: Ethylene glycol, de-aired to 2 ppm.

Dimensions: Cell is 230 mm diameter and 11 mm thick (9 x 0.43"). Transducer and connecting tube is 410 mm (16") long. Dimension from sensitive surface to connector end of transducer is 180 mm (7").

Weight: 3.2 kg (7 lb).

SIGNAL CABLE

Polyurethane Cable. 50613524

Shielded cable with four 22-gauge tinned-copper conductors and polyurethane jacket. Attached to pressure transducer at factory.

Universal Terminal Box 57711600

Not used if pressure cells are connected to data logger. Provides connections for 12 sensors and an indicator. Sensors selected by rotary switch. Weatherproof fiberglass box measures 290 x 345 x 135 mm (11.5 x 13.5 x 5.25").

VW READOUTS

Compatible readouts include the VW Data Recorder and other pluck-type VW readouts. See separate data sheets for details.

DATA LOGGERS

Compatible data loggers include the Campbell Scientific CR1000 data logger with VW interface and AM16/32 multiplexer. Multiplexer can accommodate 16 transducers with temperature readings or 32 transducers without. See separate data sheet for features and specifications.

VW Jackout Cells

7 bar (100 psi) Jack-Out Cell 52618230
17 bar (250 psi) Jack-Out Cell . . . 52618240
35 bar (500 psi) Jack-Out Cell . . . 52618250

The VW jackout cell includes the cell, a VW pressure transducer mounted on the center of the cell, and a thermistor or RTD for temperature measurement. Requires signal cable. The rigid steel support plate, reaction plate, and double-acting hydraulic jack are supplied by the user.

Installation of the Jackout Cell The jack-out cell is installed in the reinforcing cage, as shown in the drawing above. The signal cable and hydraulic hose are secured, and the cage is lowered into the slurry trench.

When the cage is in position, the jack is activated and locked, forcing the cell into contact with the soil. The jack acts on the support plate, rather than directly on the cell, to prevent distortion of the cell. An equal force is applied to the reaction plate.

The trench is then concreted. In the illustration above, the jack has been activated, and the cell is in contact with the soil. Concrete is being delivered through a tremie pipe and will eventually displace the slurry.
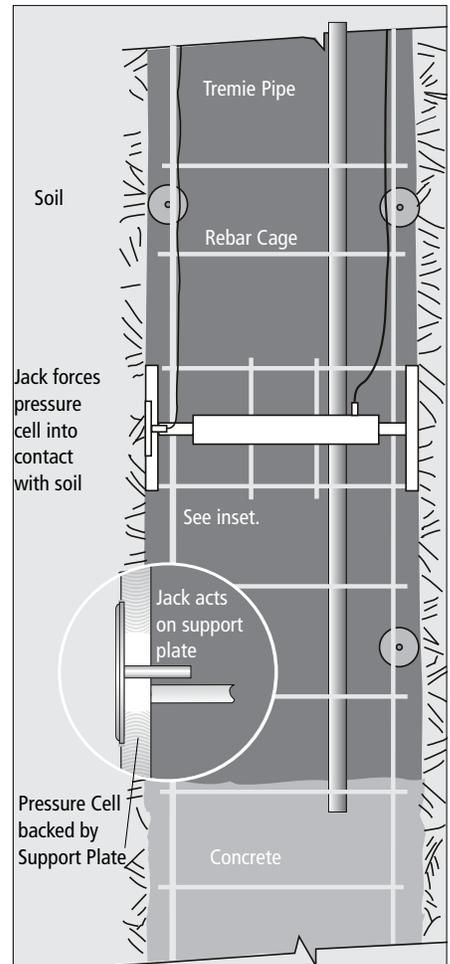
Goodman Jack

Applications

The Goodman Jack is used for in-situ investigations of the deformability of rock masses. It is designed to be used in 3" (76 mm) boreholes.

Two models are available: a twelve-piston model for use in hard rock, and a three-piston model for determining the consolidation-time properties of soft rock, soil, and stiff clays.

Goodman Jack for Hard Rock

Goodman Jack for Soft Rock

Operation

The Goodman Jack is coupled to the drill rod and inserted into the borehole, along with its hydraulic lines and signal cable.

When the jack is in position, a hand pump is used to activate the pistons within the jack. The pistons push a curved bearing plate against the borehole wall, producing a uniform, uni-directional stress field.

The applied pressure is measured with a pressure gauge, and the deformation of the rock is measured by two linear variable differential transformers (LVDT). The indicator displays the LVDT readings.

After the test, the bearing plates are retracted and the jack is withdrawn from the borehole.

The modulus of deformation is calculated using formulae derived empirically from in-situ testing. Then correction factors are applied, using factors that were developed by laboratory testing.

The Goodman Jack conforms to ASTM standard D4971-08.

References

Goodman, R.E., Van, T.K., and Heuze, F.E., The Measurement of Rock Deformability in Bore Holes, Symposium on Rock Mechanics, May 1968, University of Texas, Austin, Texas.

Heuze, F.E., Suggested Method for Estimating the In-Situ Modulus of Deformation of Rock Using the NX-Borehole Jack, Geotechnical Testing Journal, December, 1984.

Heuze, F.E. Heuze and Amadei, B., The NX-Borehole Jack: A Lesson in Trial and Error, International Journal of Rock Mechanics, Vol 22, No.2 1985, Pergamon Press Ltd.

HARD ROCK JACK

Number of Pistons: 12.

Max Bearing Pressure: 64,000 kPa (9,300 psi).

Maximum Force: 703 kN (158,100 lbf).

Borehole Size: 76 mm, 3" nominal.

Minimum Diameter: 70 mm (2.75").

Maximum Diameter: 83 mm (3.25").

Linearity: ±0.5% for range of 73.7 to 78.7 mm (2.9 to 3.1"), ±1% for range of 72.4 to 80 mm (2.875 to 3.15").

Maximum Hydraulic Pressure: 69,000 kPa (10,000 psi).

Operating Temp: -32 to 60 °C (-25 to 140 °F).

Temp. Coefficient: ±(0.04% Reading + 0.02% FS) per °C. ±(0.02% Reading + 0.01% FS) per °F.

Dimensions: 70 x 445 mm (2.75 x 17.5").

Weight: 15 kg (33 lb).

SOFT ROCK JACK

Number of Pistons: 3.

Max Bearing Pressure: 38,200 kPa (5,540 psi).

Maximum Force: 419 kN (94,200 lbf).

Borehole Size: 76mm, 3" nominal.

Minimum Diameter: 70 mm (2.75").

Maximum Diameter: 83 mm (3.25").

Linearity: ±0.5% for range of 73.7 to 78.7 mm (2.9 to 3.1"), ±1% for range of 72.4 to 80 mm (2.875 to 3.15").

Maximum Hydraulic Pressure: 69,000 kPa (10,000 psi).

Operating Temp: -32 to 60 °C (-25 to 140 °F).

Temp. Coefficient: ±(0.04% Reading + 0.02% FS) per °C. ±(0.02% Reading + 0.01% FS) per °F.

Dimensions: 70 x 445 mm (2.75 x 17.5").

Weight: 15 kg (33 lb).

DISPLACEMENT INDICATOR

Display: Dual LCDs with 3-digit signed values.

Operating Time: 10 hours with fully charged batteries.

Battery Charger: Internal from 115/230 VAC or 10-15 VDC.

Temp. Coefficient: ±(0.015% Reading +0.001% F.S.) per °C. ±(0.008% Reading +0.0006% F.S.) per °F.

Operating Temp: -18 to 49°C (0 to 120 °F).

Resolution: 0.01 mm with Metric Indicator. 0.001" with English Indicator.

Dimensions: 280 x 230 x 180 mm (11 x 9 x 7").

Weight: 5 kg (11 lb).

HAND PUMP

Hydraulic Pump: Enerpac P-84.

Maximum Pressure: 69,000 kPa 10,000 psi.

Pressure Gauge: 50 psi (345 kPa) resolution with accuracy of ±0.5% FS.

Dimensions: 690 x 180 x 150 mm (27 x 7 x 6").

Weight: 13 kg (29 lb). Hose and cable add 10 kg per 15 m (22 lb per 50').

PART NUMBERS

Goodman Jack, Hard Rock 52100100
Hydraulic borehole probe for in situ tests in hard rock. Includes two LVDT displacement transducers, waterproof electrical connector, two self-sealing hydraulic quick-connectors, and threaded BX adapter.

Goodman Jack, Soft Rock. 52100200
Hydraulic borehole probe for in situ tests in soft rock. Includes two LVDT displacement transducers, waterproof electrical connector, two self-sealing hydraulic quick-connectors, and threaded BX adapter.

Displacement Indicator
English Unit 52102700
Metric Unit. 52102710
Portable instrument for indicating displacement of the instruments bearing plates. Two illuminated LCDs for reading both LVDT sensors simultaneously. Includes 6-foot jumper cable, rechargeable internal battery, and cable for 110-volt AC operation.

Electrical Cable Assembly 52100500
Shielded, multi-conductor cable, waterproof connectors on each end, 15 m (50').

Hydraulic Hose Assembly 52100600
High Pressure Hydraulic Hose, 1/4-inch (6.4 mm.) I.D., double steel wire braid, SAE 100R2 Type A, with self-sealing quick-connectors each end, 50 ft (15 m).

Note: Operation of Goodman Jack requires two hydraulic hoses, one for expansion and one for retraction of pressure plates.

Hydraulic Pump, Model P-84. 52100700
Two-stage, 10,000 psi (70 MPa), with selector valve.

Hydraulic Tee Assembly 52100800
Includes three self-sealing quick-connectors for easily connecting hydraulic hose, pressure gauge and hydraulic pump.

Pressure Gauge, Model 200 52100900
Bourdon-type, 4.5" diameter gauge with accuracy of 0.5% and twin tip pointer to eliminate reading errors. Range: 10,000 psi (70 MPa). Other ranges available on request.

Hydraulic Oil, HF-101 52102400
Note: Carriers require surcharge and separate documents for air shipments of hydraulic oil.

Carrying Case, For Jack 52101500
Wooden carrying case for shipping and storage of Goodman Jack and accessories.

Carrying Case, For Pump 52101501
Wooden carrying case for shipping and storage of pump and accessories.

EL Beam Sensors & Tiltmeters

Horizontal Beam Sensor

Vertical Beam Sensor

Tiltmeter with Rotating L-Bracket

Applications

Tiltmeters and beam sensors employ narrow-angle, high-resolution EL tilt sensors to monitoring changes in the inclination of a structure. Typical applications include:

- Monitoring stabilization measures, such as pressure grouting and underpinning.
- Monitoring structures for the effects of tunneling and excavating.
- Monitoring the behavior of structures under load.
- Monitoring the deflection and deformation of retaining walls.
- Monitoring the rotation of retaining walls, piers, and piles.
- Monitoring convergence and other movements in tunnels.

Operation

The EL tilt sensor consists of an electrolytic tilt sensor housed in a compact, weatherproof enclosure. The sensor can be configured as a beam sensor or a tiltmeter.

Beam Sensors: Anchors are installed in the structure. Beams are fitted to the anchors. Beams serve as long gauge lengths for the sensor. A tilt sensor is mounted to each beam. Beam sensors can be linked into an array to monitor differential movements.

Tiltmeters: An anchor is installed in the structure. A bracket is bolted to the anchor and the tilt sensor is mounted on the bracket. The right angle bracket holds the tilt sensor perpendicular to the wall. The flat bracket holds the tilt sensor parallel to the wall.
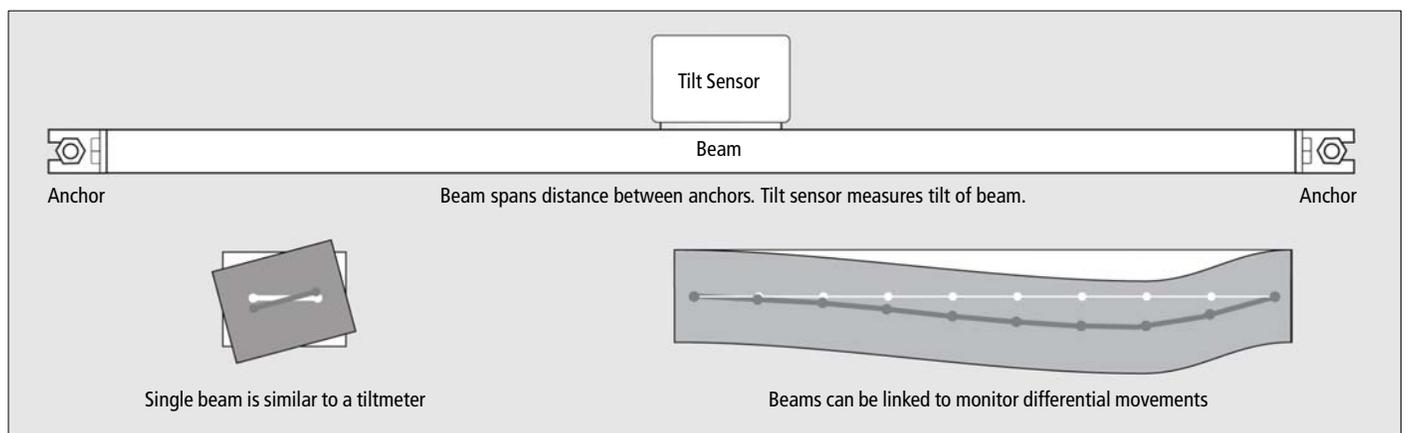
Advantages

High Resolution: The EL tilt sensor can detect a change in tilt as small as one second of arc.

Robust & Reliable: The sensor has no moving parts and is protected by a weatherproof enclosure.

Easy to Install: Versatile brackets allow quick and easy placement of the sensors.

Re-Configurable: The EL tilt sensor can be configured to site requirements. For example, it can be used as tiltmeter at one site and as a beam sensor at another site.

Cost Effective: The EL tilt sensor provides reliable, high-resolution measurements, installs quickly, can be removed and reused, and is available at a competitive price.

Tilt Sensor

Beam

Anchor

Beam spans distance between anchors. Tilt sensor measures tilt of beam.

Anchor

Single beam is similar to a tiltmeter

Beams can be linked to monitor differential movements

EL TILT SENSOR

EL Tilt Sensor, Standard 56802100
EL Tilt Sensor, SC 56802120

Sensor: Uniaxial electrolytic tilt sensor housed in a weatherproof aluminum enclosure with terminals and cable gland for signal cable. Does not include bracket, beam, or anchors.

The standard version of the tilt sensor works with Campbell Scientific CR1000, CR800, and CR10X data loggers.

The SC version of the tilt sensor includes a signal conditioning board and a temperature sensor. It works with Campbell Scientific data loggers, the M-Logger, and readouts such as the EL/MEMS data recorder.

Range: ±40 arc minutes.

Resolution: 1 arc second using a Campbell Scientific CR1000 data logger.

Repeatability: ± 3 arc seconds.

Adjustment Range: The sensors provides an adjustment range of ±4° to ease installation.

Operating Temperature: −20 to +50°C.

Dimensions: 125 x 80 x 59 mm deep (4.9 x 3.2 x 2.3").

SIGNAL CABLE

Signal Cable for Standard Sensor .50612804
Shielded cable with four 24-gauge tinned-copper conductors and PVC jacket.

Signal Cable for SC Sensor 50613527
Shielded cable with seven 22-gauge tinned copper conductors and polyurethane jacket.

BEAM SENSOR CONFIGURATION

Order a tilt sensor, a bracket, a beam, and anchors to secure the beam to the structure.

Omni Bracket 56801355K
The Omni-bracket holds the tilt sensor onto horizontal, vertical, or inclined beams. Self-tapping screws are included to fasten the bracket to the beam.

1 meter Beam.	56801612
2 meter Beam.	56801614
3 meter Beam.	56801616
3 foot Beam	56801623
6 foot beam	56801626
10 foot Beam	56801630
Spare End-Bracket	56801815

38 x 38 mm square-section aluminum beam includes two end-brackets. Beams are sized to provide a gauge length that is measured from anchor to anchor. Anchors are not included.

Groutable Anchors 56801910K
Groutable anchor for beam Includes one all-thread stud, low-friction bushings, and other hardware. For stand-alone beam sensors, order two anchors. For linked beams that share an anchor, order one anchor for each beam plus one additional anchor for the last beam.

TILTMETER CONFIGURATION

Order a tilt sensor, a bracket, and an anchor for each sensor.

Rotating L-Bracket 56801350K
The L-bracket holds the tilt sensor perpendicular to the structure. The bracket rotates nearly 360 degrees, so it can be mounted on inclined structures, floors, and ceilings, as well.

Omni Bracket 56801355K
The Omni-bracket holds the tilt sensor parallel with the structure.

Expansion Anchor 57803128
The expansion anchor is installed in a 9.5 x 64 mm (3/8 x 2.5 in) drill hole and includes a bolt and washer to hold the L-bracket.

Groutable Anchor. 57803130K
The groutable anchor is installed in a 13 x 90 mm (0.5 x 3.5 in) drill hole and includes a bolt and washer to hold the L-bracket. Requires epoxy grout available locally or ordered below.

Epoxy Grout Kit 57803133
Includes plastic dispenser and cartridge of quick-set epoxy grout. Sufficient for 15 anchors.

DATA LOGGERS & READOUTS

Campbell Scientific Data Loggers
The CR1000 Logger can monitor 12 standard or 3 SC sensors directly. Up to 32 standard sensors or 16 SC sensors can be connected to an AM16/32 multiplexer. See separate datasheet.

M-Logger
The M-Logger can monitor one SC sensor directly or 16 SC sensors connected to an AM16/32 multiplexer. See separate datasheet.

EL / MEMS Data Recorder 56813500
This portable readout displays and records readings from SC sensors. Tilt readings are displayed in volts; temperature readings in degrees C. It can also be used for nulling the sensors. See separate datasheet.

EL Nulling Device 56803300
The EL Nulling device provides a convenient way to zero sensors at installation time. The nulling device is compatible with both standard and SC tilt sensors.

DGSI East 2175 West Park Court, Stone Mountain, GA USA 30087 Tel: +1-770-465-7557
DGSI West 12123 Harbour Reach Drive, Mukilteo, WA, USA 98275 Tel: +1-425-493-6200

MEMS Tiltmeter

Applications

The MEMS tiltmeter is a compact, waterproof tiltmeter with a range of ±10° from vertical. It is used to monitor changes in the inclination of a structure. Applications for the tiltmeter include:

- Monitoring rotation of retaining walls, piers, and piles.
- Providing early warning of potential structural damage.
- Documenting any effects of nearby deep excavations.

Operation

The MEMS tiltmeter measures tilt over a range of ±10° from vertical and is available in uniaxial and biaxial versions. Signal conditioning makes the tiltmeter compatible with most data loggers.

The tiltmeter is fixed to the structure via an angle bracket that can be welded to steel or bolted to an anchor set into concrete or rock. Because the tiltmeter has a relatively wide range, careful zeroing of the sensor is not required.

Readings are obtained with a data logger or a portable readout. The initial reading is used as a baseline. Changes in the inclination of the structure are found by comparing current readings to the initial.

Advantages

Mounts Anywhere: The tiltmeter is supplied with a bracket that can be welded to steel or bolted to anchors.

Wide Range: The tiltmeter has a range of ±10°, so it can be installed without careful zeroing.

Uniaxial or Biaxial: The tiltmeter is available in uniaxial and biaxial versions.

Waterproof: The tiltmeter can tolerate submersion.

Suitable for Automatic Readings: The tiltmeter outputs a voltage signal that can be read by most data loggers. It can also be read manually with the EL/MEMS Data Recorder.
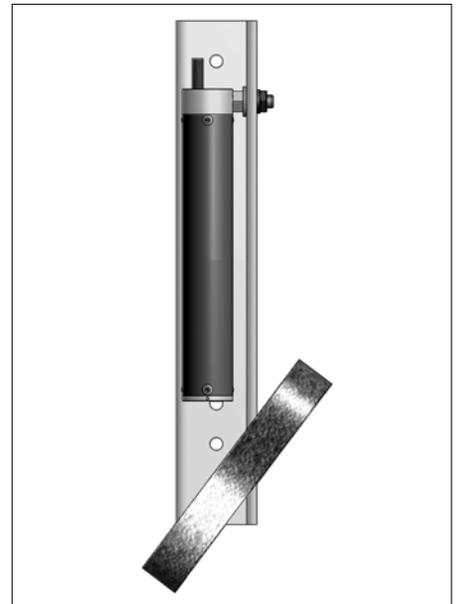
The tiltmeter can be fixed to most structures via the included angle bracket. The bracket can be anchored to rock or concrete and welded to steel.

An optional embedment mounting bracket provides a way to stand tiltmeters on sloping surfaces, such as the concrete face of a rock-fill dam.

TILTMETER SPECIFICATIONS

MEMS Tiltmeter, Uniaxial 57803101
MEMS Tiltmeter, Biaxial 57803102

Tiltmeter includes angle bracket, 5 m of signal cable, calibration record, an user manual. Anchor is not included.

Sensor Type: MEMS (Micro Electro-Mechanical Systems) sensor for tilt readings and a 3K ohm thermistor for temperature readings.

Range: ±10 degrees.

Resolution: 9 arc seconds, using a 13 bit readout device such as the CR10 datalogger.

Repeatability: ±22 arc seconds.

Calibration: 11-point calibration taken at three temperatures from -8 to 40 °C.

Input Power: 8 to 15 Vdc.

Output Signal: ±2.5 Vdc.

Body: Stainless steel. Waterproof to 20m.

Dimensions: 32 x 190 mm (1.25 x 7.5 "). Mounting stud is M8.

M8 stud includes nuts and washers.

197mm
7.75 "

32mm
1.25 "
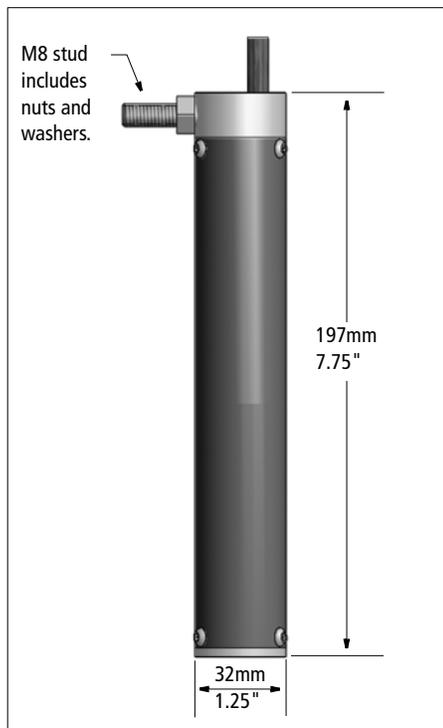
SIGNAL CABLE

Signal Cable 50613527

Cable has seven 22-gauge tinned-copper conductors, shield, and polyurethane jacket. The standard product includes 5 m of cable. Custom lengths of cable can be special ordered.

MOUNTING BRACKETS

Angle Bracket. . . . . included
The angle bracket included with the tiltmeter is suitable for most applications. It can be welded to steel or bolted to an anchor. The bracket does not include an anchor.

Embedment Mounting Bracket . . 97803115
This special-order bracket provides a way to stand the tiltmeter on sloping surfaces, such as the concrete face of a rock-fill dam. The bracket is grouted into a drill hole.

ANCHORS

Anchors are used in concrete or rock. Order one anchor per tiltmeter.
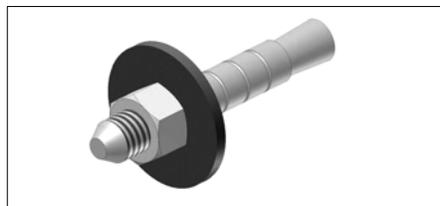
Expansion Anchor 57803128
Includes anchor, bolt, and washer. Install in 9.5 x 64 mm (3/8 x 2.5") drill hole.

Groutable Anchor with Bolt 57803130
Includes anchor, bolt, and washer. Install in 13 x 90mm (0.5 x 3.5") drill hole. Requires epoxy grout below.

Epoxy Grout Kit 57803133
Includes plastic dispenser and cartridge of quick-set epoxy grout. Sufficient for 15 anchors.

PORTABLE READOUT

**EL/MEMS Data Recorder 56813500**
Terminal Box for 12 Sensors 57711600
Jumper Cable 56813557
The EL/MEMS Data Recorder is a portable readout that displays and stores tilt readings in volts and temperature readings in degrees C. Includes software for transferring stored readings to a Windows PC.

Terminal box allows connection of up to 12 tiltmeters. Sensors are selected by a rotary switch. Fiberglass box measures 290 x 345 x 135mm (11.5 x 13.5 x 5.25 ").

Jumper cable is required to connect the Data Recorder to the terminal box.
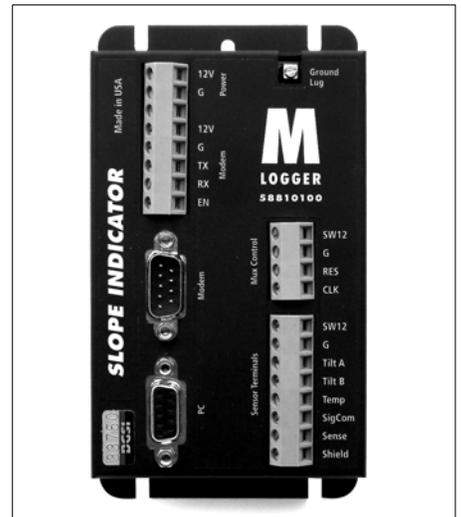
DATA LOGGERS

M-Logger 58810100
The M-Logger, shown above, is a simple data logger dedicated to MEMS sensors. It reads one tiltmeter connected directly or up to 16 sensors via a multiplexer. See separate datasheet.

Campbell Scientific Loggers
The Campbell Scientific CR1000 data logger allows direct connection of two biaxial sensors or three uniaxial sensors. Adding a multiplexer increases the capacity to 16 uniaxial or biaxial sensors. Up to five multiplexers can be added to the CR1000 data logger. See separate datasheet.

Portable Digitilt Tiltmeter
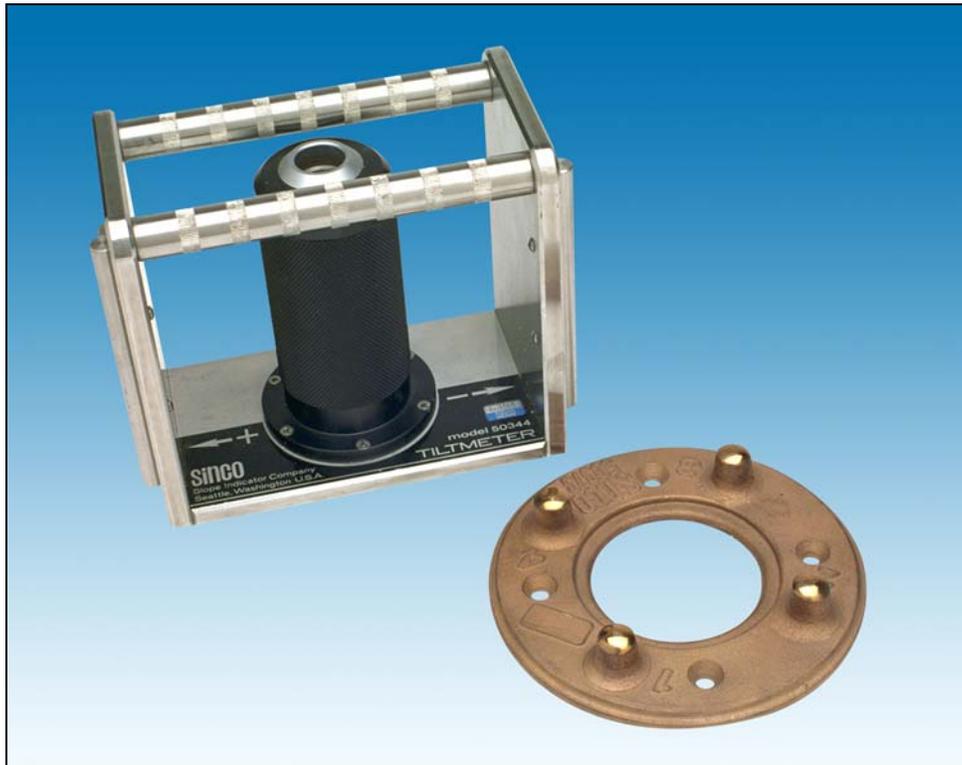
Applications

The portable tiltmeter system includes tilt plates, the portable tiltmeter, and a readout unit.

The system is used to monitor changes in the inclination of a structure.

Typical applications are:

- Monitoring rotation caused by mining, tunneling, soil compaction, or excavation.
- Monitoring rotation of retaining walls, piers, and piles.

Operation

Tilt plates are mounted in specified locations on the structure. They are typically bonded to the structure, but may also be screwed to the surface.

To obtain readings, the operator connects the tiltmeter to the readout unit and positions the tiltmeter on the tilt plate. The bottom surface of the tilt-meter is used with horizontal tilt plates, and the side surfaces of the tiltmeter are used with vertical tilt plates.

After noting the displayed reading, the operator rotates the tiltmeter 180° and obtains a second reading. The two readings are later combined.

Changes in tilt are found by comparing the current reading to the initial reading and converting the results to angles or displacements.

Advantages

Economical: One tiltmeter can be used to monitor any number of inexpensive tilt plates.

Easy to Install: Bronze tilt plates can be bonded or screwed to the structure.

Easy to Use: Tilt readings are obtained quickly and easily by a single operator.

Rugged, Reliable, and Accurate: The tiltmeter uses the same proven force-balanced, servo-accelerometer technology used in the Digitilt inclinometer probe.

METRIC TILTMETER

Metric Tiltmeter 50304410

Includes case and jumper cable (3 m) for connecting to readout.

Sensor: Digitilt uniaxial force-balanced servo-accelerometer.

Range: ±53° from vertical.

Resolution: 8 arc seconds.

System Repeatability: ±40 arc seconds.

Materials: Stainless steel frame, anodized aluminum housing.

Dimensions: 152 x 89 x 178 mm.

Weight: 4.5 kg.

ENGLISH TILTMETER

English Tiltmeter 50304400

Includes case and jumper cable (10') for connecting to readout.

Sensor: Digitilt uniaxial force-balanced servo-accelerometer.

Range: ±35° from vertical.

Resolution: 10 arc seconds.

System Repeatability: ±40 arc seconds.

Materials: Stainless steel frame, anodized aluminum housing.

Dimensions: 7 x 10 x 7 inch.

Weight: 10 lb.

TILT PLATES

Tilt Plate 50307300

Mounting Method: Epoxy bonding compound or screws.

Material: Bronze.

Diameter: 140 mm (5.5").

Height: 24 mm (0.95").

Center Hole: 63 mm (2.5").

Weight: 0.68 kg (1.5 lb).

Tilt Plate Cover 50307350
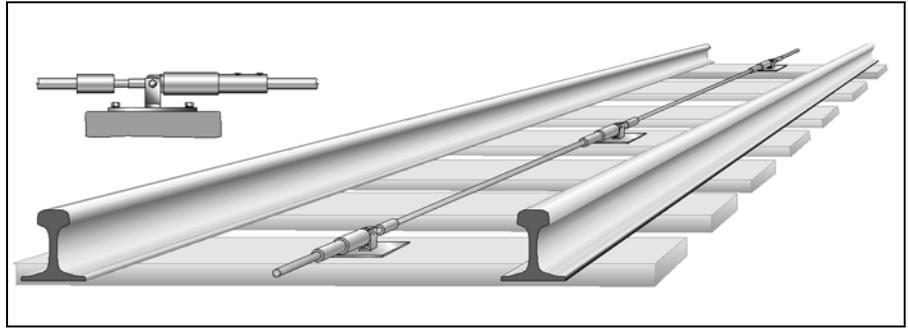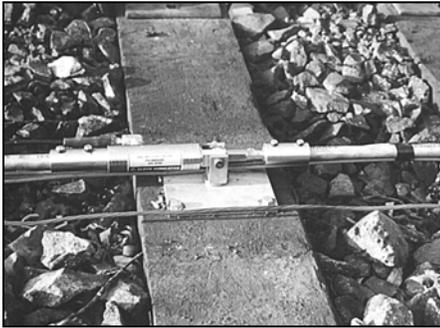
Includes anchors.

Epoxy Bonding Compound 50305500

0.45 kg (1lb). For mounting up to five tilt plates. Requires ambient temperature above 4.5 °C (40 °F) for curing.

READOUTS

Compatible readouts include the Digitilt DataMate and the retired Digitilt 09.

Track Monitoring System

Application

Track monitoring systems can help maintain the safety of railroad tracks by monitoring settlement and twist.

The systems are installed on tracks that may be affected by nearby tunneling or excavation. They can also be installed on tracks that cross potential washout and landslide areas.

System Components

Track Settlement Sensors: Track settlement is monitored by linked sensors that are installed parallel with the rail alignment.

Track Twist Sensors: Track twist is monitored by separate sensors that are installed perpendicular to the rail alignment.

Data Acquisition System: A data logger continuously monitors the sensors. The logger is linked to the control house or office by direct cable or radio telemetry.

Data Processing: Readings are forwarded to web-based monitoring software, such as Atlas, which checks for alarm conditions and can produce graphs and reports.

System Features

Single Cable Installation: Each sensor connects to the next in line, effectively reducing the number of signal cables to one.

Durable Components: Sensors, gauge tubes with telescoping sockets, and mounting brackets are designed to withstand vibration, temperature changes, and repositioning.

Continuous Monitoring: The track monitoring system is designed to provide readings 24/7. It can be configured to provide on-sites as well as remote alarms.

Compatible with Atlas: The Atlas web-based monitoring system provides profile plots, trend plots, three levels of alarms, watchdog alarms and much more.

SYSTEM CONFIGURATION

A track monitoring system consists of settlement sensors and twist sensors. Settlement sensors are mounted parallel to the rails and typically linked together. Twist sensors are mounted parallel to the ties.

Settlement Sensor: Sensors can be placed up to 3m apart. Each sensor includes signal cable to connect to the next sensor. Settlement sensors require a mounting bracket and gauge tubing.

Mounting Bracket: . Bracket includes swivel for settlement sensor and telescoping socket for gauge tube. Order one mounting bracket for each settlement sensor.

Gauge Tubing: Gauge tubing defines the gauge length of the settlement sensor. Order one gauge tube for each settlement sensor.

Twist Sensor: Twist sensors can be placed within 3m of any settlement sensor. Each sensor includes signal cable to connect to a settlement sensor. Twist sensors are supplied with a mounting bracket and do not need gauge tubing.

Jumper Cable: The jumper cable connects the sensor bus to a data logger. Order one jumper cable per installation.

End Plug: The end plug terminates one end of the sensor bus. Order one end plug per installation.

Other: Screws or anchor bolts are required to fasten mounting brackets to rail ties. These are best sourced by the user.

PART NUMBERS

Track Settlement Sensor 97806550
Gauge Tubing, 3m / 10 ft 97806558
Mounting Bracket 97806555
Track Twist Sensor 97806570
Bottom Plug 57804510
Jumper Cable, 25 m 57804525

Sensor Type: MEMS tilt sensor . 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.

Sensor Repeatability: ±22 arc seconds or ±0.1 mm/m, subject to site conditions.

Calibration: 11-point calibration taken at three temperatures from -8 to 40 °C

Signal Cable: Cable for 3m gauge length supplied with each sensor. Connectors are fully waterproof.

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

Number of Sensors	Max 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

DATA LOGGERS

M-Logger

The 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.

Campbell Scientific CR1000

The Campbell Scientific CR1000 data logger can operate up to 6 chains of serial sensors. The CR800 logger can operate 3 chains of serial sensors.
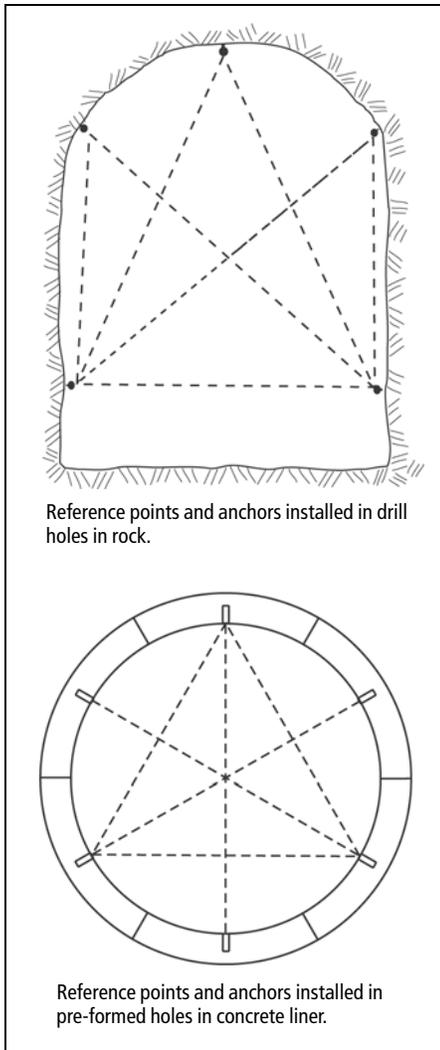
ATLAS WEB-BASED MONITORING

Readings retrieved from the data logger can be processed manually by spreadsheet or automatically by the Atlas web-based monitoring system. See separate data sheet for details.

Digital Tape Extensometer

Applications

The tape extensometer is used to determine changes in the distance between pairs of reference points. Typical applications include:

- Monitoring convergence of tunnel walls.
- Monitoring deformations in underground openings.
- Monitoring displacement of retaining walls, bridge supports, and other concrete structures.

Reference points and anchors installed in drill holes in rock.

Reference points and anchors installed in pre-formed holes in concrete liner.

Operation

Stainless steel reference points are installed at measurement stations along the tunnel or structure. The points may be secured directly to the structure or threaded into groutable anchors or expansion anchors.

To obtain a measurement, the operator stretches the tape between two reference points, hooking the free end of the tape to one point and the instrument body to the other.

The operator tensions the tape by turning a knurled collar until two index marks are aligned, and then notes the reading from the tape and the digital display. The sum of these readings is the distance between the two reference points. (Note that the tape extensometer is intended for relative measurements and cannot be used as a surveyor's chain.)

By comparing current readings to initial readings, the operator can calculate the change in distance between the two points.

Advantages

Repeatable Measurements: The digital tape extensometer provides measurements repeatable to ±0.13 mm or ±0.005"over spans up to 30 meters or 100 feet.

Quick-Connect Reference Points: The hook and eyebolt system used by the tape extensometer is more economical and faster to use than threaded systems. The system provides unrestricted movement of the tape and is very easy to keep clean.

Compact, Strong, & Lightweight: The tape extensometer with tape reel is only 610 mm (24") long and weighs only 2 kg (4.5 lb). Precision parts are protected by a strong aluminum body and a shatterproof plastic lens.

METRIC TAPE EXTENSOMETER

Unit with 20 m tape 51811510
Unit with 30 m tape 51811530

Display Resolution: 0.01mm.

Measurement Repeatability: ± 0.10 mm.

Steel Tape: 13 mm x 20 m or 13 mm x 30 m, perforated at 50 mm intervals, graduated in mm. Thermal coefficient of expansion is 11.6 ppm per degree.

Dimensions: 70 mm OD, 610 mm overall length.

Weight: Approximately 2 kg.

Batteries: SR44 silver oxide cell. Battery life is approximately 3 years.

Operation Temperature: 0 to 40 °C.

ENGLISH TAPE EXTENSOMETER

Unit with 66' tape 51811500
Unit with 100' tape . . . . Special Order

Display Resolution: 0.0005 inch.

Measurement Repeatability: ± 0.005".

Steel Tape: 0.5" x 60 or 0.5" x 100', perforated at 2-inch intervals with 1/8" graduations. Thermal coefficient of expansion is 6.45 ppm per degree F.

Dimensions: 2.75" OD, 24" overall length.

Weight: Approximately 4.5 lb.

Batteries: SR44 silver oxide cell. Battery life is approximately 3 years.

Operation Temperature: 0 to 40 °C.

REFERENCE POINTS

Reference Point. 51812000
Stainless steel eyebolt with lock nut. Threads into groutable or expansion anchor.

Groutable Anchor 51804304
Steel rebar tapped to accept reference point. #5 rebar x 4" long (16 x 101 mm).

Expansion Anchor 51812050
Tapped for reference point. Requires 35 mm (1.375") drill hole.

ACCESSORIES

Carrying Case 51812100
Sturdy vacuumed formed ABS plastic carrying case with foam lining for shock protection.

Metric Replacement Tape, 20 m . .11801370

English Replacement Tape, 66' . . .11801380

VW Spot-Weldable Strain Gauge

Applications

Spot-weldable vibrating wire strain gauges are used with strain gauge sensors to measure strain in steel. Typical applications include:

- Monitoring structural members of buildings and bridges during and after construction.
- Monitoring changes in load on ground anchors and other post-tensioned support systems.
- Measuring strain in tunnel linings and supports.
- Monitoring areas of concentrated stress in pipelines.
- Monitoring distribution of load in pile tests.

Operation

The strain gauge operates on the principle that a tensioned wire, when plucked, vibrates at a frequency that is proportional to the strain in the wire.

The gauge is constructed so that a wire is held in tension inside a small diameter, thin-walled tube that welded to the structural member. Loading of the structural member changes the length of the tube and results in a change in the tension of the wire.

An electromagnet in the strain gauge sensor is used to pluck the wire and return a frequency signal. Strain is then calculated by applying calibration factors to the frequency measurement.

Installation

Rust is removed with a sander and a flat surface is created with a grinder. When the surface is clean, the gauge is welded onto it using a spot welder.

Corrosion protection is applied to the gauge, and then the strain gauge sensor is placed on top of the sensor. After test readings, the sensor is fixed to the gauge either by weldable steel straps or by tie-wraps. The gauge and sensor are then wrapped with mastic and tape.
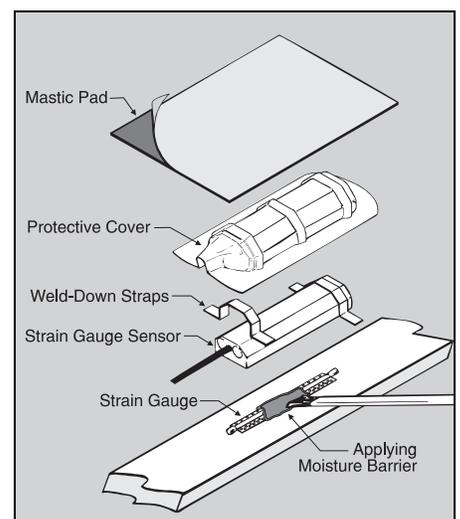
Advantages

Preset Gauges: The spot-weldable is available in three tension ranges to match virtually any application. This eliminates the time-consuming process of tensioning the vibrating wire element in the field.

Full-Length Welding Flange: The full length welding flange allows reliable coupling of the gauge to the structural member and prevents misalignment of the end points of the gauge, a common problem with other strain gauges.

Very Low Profile: The vibrating wire element is positioned only 0.96 mm (0.038") above the measured member. This patented, low-profile design reduces errors caused by bending of the structural member.

Stainless Steel Construction: The outer components of the strain gauge are constructed from stainless steel for corrosion resistance. The wire itself is steel, selected to match the thermal characteristics of structural steel.

Spot-weldable strain gauge installed on reinforcing bar. The gauge is later waterproofed with mastic and

Installation of strain gauge and sensor on flat surface. Protective cover and mastic pad are optional.

SPOT-WELDABLE STRAIN GAUGE

Gauge Set Midrange 52602100
Gauge for Compressive Strain . . .52602101
Gauge for Tensile Strain 52602102

Vibrating wire strain gauge for spot welding to steel. Requires strain gauge sensor below.

Range: Approximately 2,500 microstrain.

Gauge Length: 62 mm (2.45").

Height of Wire: 0.96 mm (0.038") above measured member.

Thermal Coefficient: 10.8×10^{-6} per °C, 6×10^{-6} per °F.

Materials: Stainless steel flange and tube, steel wire.

Dimensions: 66.7 x 7.6 x 1.8 mm, (2.65 x 0.3 x.07 inch).

VW STRAIN GAUGE SENSOR

Strain Gauge Sensor 52623000

VW strain gauge sensor is a pluck-type vibrating wire sensor for spot-weldable strain gauge. Includes a thermistor or RTD for temperature measurements and two stainless steel weld-down straps for fixing sensor to structure. Does not include signal cable.

Frequency Range: 0.8 to 2.4 kHz.

Temp Rating: -29 to 105 °C, -20 to 220 °F.

Waterproof Rating: 10.4 bar, 150psi.

Materials: Resin-filled ABS plastic case.

Dimensions: 80 x 26 x 16 mm, 1 x 3.17 x 0.64".

Weight: 28 g (1 oz).

SIGNAL CABLE

Signal Cable 50613524

Shielded cable with four 22-gauge tinned-copper conductors and polyurethane jacket that is rated for 80 °C (176 °F). Attached to sensor at the factory.

Universal Connector. 57705001

Universal Terminal Box. 57711600

Provides connections for 12 sensors and an indicator. Sensors selected by rotary switch. Weatherproof fiberglass box measures 290 mm wide x 345 mm high x 135 mm deep (11. 5 x 13.5 x 5.25").

INSTALLATION ACCESSORIES

Scotchkote 06700019
For applying moisture barrier. 440 ml (15oz) can.

Spare Weld-Down Straps 52623110
Two weldable stainless steel straps designed to hold sensor onto structure.

Protective Cover 52623120
Formed stainless steel cover for sensor.

3M Mastic Pad 06700180
Self-vulcanizing sealing material.

Spot Welder, 115VAC 52602550
Includes tip, hand piece, welding unit, battery, and case.

Spot Welder, 220VAC 52602560
Includes tip, hand piece, welding unit, battery, and case.

READOUTS

Compatible readouts include the VW Data Recorder and other pluck-type VW readouts. See separate data sheets for features and specifications.

DATA LOGGERS

Compatible data loggers include the Campbell Scientific CR1000 with VW interface and an AM16/32 multiplexer. Multiplexer can accommodate 16 strain gauge sensors with temperature readings or 32 sensors without temperature readings. See separate data sheet.

VW Arc-Weldable Strain Gauge

Installation on Steel

The arc-weldable strain gauge is supplied with two mounting blocks. The mounting blocks are attached to a spacer bar and welded to the structural member.

After the welds cool, the spacer bar is removed and the strain gauge is inserted in its place. The gauge is then connected to a readout and adjusted to measure tension, compression, or both.

Installation on Concrete

The strain gauge can also be used with groutable mounting blocks, which are anchored in holes drilled into the concrete structure.

Advantages

Permanently Attached Coils: The coils used to excite and read the vibrating wire are permanently attached to the gauge. This prevents accidental separation from the strain gauge body during installation.

Install on Steel or Concrete: Use the weldable mounting blocks for steel and the groutable mounting blocks for concrete.

Field Adjustable: The strain gauge can be adjusted so that most of its range is available to measure compression or tension, as required by the application.

Reliable Signal Transmission: The arc-weldable strain gauge provides a strong signal which can be transmitted reliably over long distances with properly shielded cable.

Applications

Arc-weldable strain gauges are used to measure strain in steel. With the use of groutable anchors, the strain gauges can also be mounted to concrete surfaces. Typical applications include:

- Monitoring strain in structural members of buildings and bridges, during and after construction.
- Monitoring load in struts used to brace deep excavations.
- Measuring strain in tunnel linings and supports.
- Monitoring areas of concentrated stress in pipes.

Operation

The strain gauge operates on the principle that a tensioned wire, when plucked, vibrates at its resonant frequency. The square of this frequency is proportional to the strain in the wire.

The gauge is constructed so that a wire is held in tension between two mounting blocks that are welded to the structural member. Loading of the structural member changes the distance between the two mounting blocks and results in a change in the tension of the wire.

An electromagnet is used to pluck the wire and measure the frequency of vibration. A change in strain is the difference between the current reading and the initial reading multiplied by a gauge factor.

An electromagnet is used to pluck the wire and measure the frequency of vibration. Strain is then calculated by applying calibration factors to the frequency measurement.

ARC-WELDABLE STRAIN GAUGE

Strain Gauge for Steel. 52640306

For monitoring strain in steel. The part number includes strain gauge with thermistor and two weldable mounting blocks. Signal cable is ordered separately.

Range: 3,000 microstrain. User can set tension to maximize range for the application.

Resolution: 1 microstrain with VW Indicator.

Accuracy: ± 0.1% FS.

Thermal Coefficient: 11ppm / °C.

Length: 150 mm (5.875"). Long base gauges are available on special order.

Mounting-Block: 38 x 10 x 19 mm (1.5 x 0.375 x 0.75").

CONCRETE SURFACE GAUGE

Strain Gauge for Concrete 52640406

For monitor strain in concrete. The part number includes strain gauge with thermistor, and two mounting blocks with groutable anchors. Signal cable is ordered separately.

Range: 3,000 microstrain. User can set tension to maximize range for the application.

Resolution: 1 microstrain with VW Indicator.

Accuracy: ± 0.1% FS.

Thermal Coefficient: 11ppm / °C.

Length: 150 mm (5.875").

Mounting-Block: 38 x 10 x 19 mm. (1.5 x 0.375 x 0.75). Anchor is 76mm (3") long.

INSTALLATION ACCESSORIES

Installation Kit 52630330

Kit includes one spacer rods, an allen wrench, and four spare set-screws.

Spare Weldable Blocks 52630350

Two mounting-blocks with set-screws. Used if gauge is repositioned.

Spare Groutable Blocks. 52640410

Two mounting blocks with 3" long groutable anchors attached. Used if gauge is repositioned.

SIGNAL CABLE

Signal Cable 50613324

Shielded cable with four 24-gauge tinned-copper conductors and flexible polyurethane jacket rated to 80°C (176°F).

Terminal Box for 6 sensors 57711606
Terminal Box for 12 Sensors. 57711600
Terminal Box for 24 Sensors. 97711624

Provides terminals for signal cable from 6, 12, or 24 sensors. Sensors are selected by rotary switch. Dimensions of 6-sensor box are 240 x 190 x 120 mm (9.5 x 7.5 x 4.75"). Dimensions of 12 and 24-sensor boxes are 290 x 345 x 135 mm (11.5 x 13.5 x 5.25").

Universal Connector. 57705001

For terminating a single cable. Connector not required when sensors are connected to a terminal box, a data logger, or to the terminal posts on the VW Data Recorder.

READOUT

VW Data Recorder. 52613500
Jumper Cable for Terminal Box . . .52613557

The VW Data Recorder displays VW sensor readings in Hz or $H^2/1000$ and thermistor data in degrees C. It can also record the readings. See separate datasheet.

The jumper cable is required when the VW Data Recorder is to be connected to a terminal box or to a connector attached to signal cable.
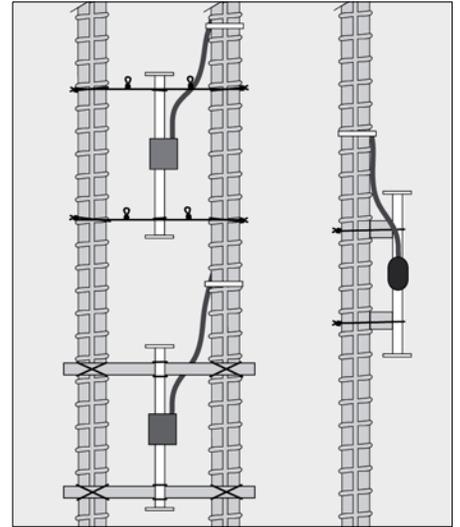
DATA LOGGERS

VW MiniLogger 52613310

The VW MiniLogger is a compact, low-cost data logger for one sensor. See separate datasheet.

Campbell Scientific Data Loggers

Campbell data loggers with a VW interface and the AM16/32 multiplexer can accommodate 16 sensors with temperature readings or 32 sensors without without temperature readings.

60 www.slopeindicator.com
solutions@slope.com
DGSI East 2175 West Park Court, Stone Mountain, GA USA 30087 Tel: +1-770-465-7557
DGSI West 12123 Harbour Reach Drive, Mukilteo, WA, USA 98275 Tel: +1-425-493-6200

VW Embedment Strain Gauge

Applications

VW Embedment Strain Gauges are used to measure strain in reinforced concrete and mass concrete structures.

Operation

The strain gauge operates on the principle that a tensioned wire, when plucked, vibrates at its resonant frequency. The square of this frequency is proportional to the strain in the wire.

The gauge is constructed so that a wire is held in tension between two end flanges. Loading of the concrete structure changes the distance between the two flanges and results in a change in the tension of the wire.

An electromagnet is used to pluck the wire and measure the frequency of vibration. A change in strain is the difference between the current reading and the initial reading multiplied by a gauge factor.

Installation

In reinforced or pre-stressed concrete, the strain gauge is usually tied to the reinforcing cage, as shown above. Some specifications require that the gauge be cast in a concrete briquette prior to installation.

In mass concrete applications, the gauge may be installed either before or immediately after placement of the concrete.

Advantages

Permanently Attached Coils:
The coils used to excite and read the vibrating wire dare permanently attached to the gauge. This prevents accidental separation of the coil from the body during installation.

Built-in Temperature Sensor:
The temperature sensor is useful for monitoring temperature and for making temperature corrections.

Reliable Signal Transmission:
The strain gauge provides a strong signal that can be transmitted reliably over long distances with properly shielded cable.

EMBEDMENT STRAIN GAUGE

VW Embedment Strain Gauge. . . .52640226

Vibrating wire strain gauge for monitoring strain in reinforced or mass concrete. Includes a built-in thermistor or RTD. Signal cable not included.

Range: 3,000 microstrain, set mid-range.

Resolution: 1 microstrain with VWP Indicator.

Accuracy: ± 0.5% FS. ± 0.1% FS special order.

Thermal Coefficient: 11.5 ppm /°C.

Length: 171.4 mm（6.75"）.

SIGNAL CABLE

Signal Cable 50613324

Shielded cable with four 24-gauge tinned-copper conductors and flexible polyurethane jacket rated to 80°C(176°F).

TERMINAL BOXES

Terminal Box for 6 sensors 57711606
Terminal Box for 12 Sensors. 57711600
Terminal Box for 24 Sensors. 97711624

Sensors are selected by rotary switch. 6-sensor box is 240 x 190 x 120 mm (9.5 x 7.5 x 4.75"). Dimensions of 12 and 24-sensor boxes are 290 x 345 x 135 mm (11.5 x 13.5 x 5.25").

Universal Connector. 57705001

For terminating a single cable. Connector not required when sensors are connected to a terminal box, a data logger, or to the terminal posts on the VW Data Recorder.

READOUT

VW Data Recorder. 52613500
Jumper Cable for Terminal Box . . .52613557

The VW Data Recorder displays VW sensor readings in Hz or $H^2/1000$ and thermistor data in degrees C. It can also record the readings. See separate datasheet.

The jumper cable is required when the VW Data Recorder is to be connected to a terminal box or to a connector attached to signal cable.
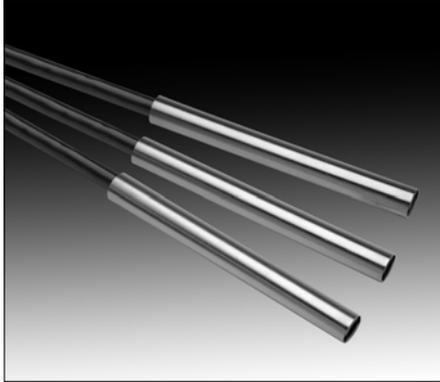
DATA LOGGERS

VW MiniLogger 52613310

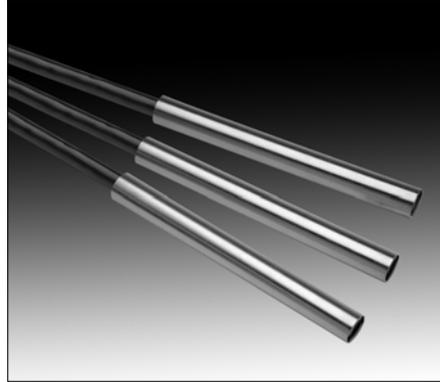The VW MiniLogger is a compact, low-cost data logger for one sensor. See separate datasheet.

Campbell Scientific Data Loggers

Campbell data loggers with a VW interface and the AM16/32 multiplexer can accommodate 16 sensors with temperature readings or 32 sensors without without temperature readings.

Temperature Sensors

Thermistor ensors

RTD Sensors

VWSensors

Applications

Temperature sensors are used to monitor the heat of hydration in mass concrete.

Slope Indicator can provide VW, Thermistor, or RTD sensors.
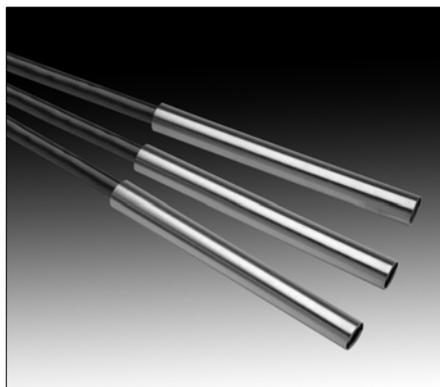
Operation

The thermistor and RTD sensors are resistence devices that return a voltage. The voltage must be converted to temperature values by the readout or logger. This is normally done automatically.

The VW temperature sensor consists of a stainless steel vibrating wire sensor and signal cable. It returns a frequency signal that must be converted to temperature values by application of calibration factors.

Advantages

Accurate: Temperature sensors are accurate to ± 0.5 °C

Compatible: The themistor and RTD versions can be ready by almost all readouts and loggers. The VW version can be read by most devices that can read other vibrating wire sensors.

VW TEMPERATURE SENSOR

VW Temperature Sensor 52631510

Sensor Type: Pluck type vibrating wire sensor with built-in thermistor or RTD and transient protection device.

Range: -20 to 80°C (100° Span). Other ranges available on special order.

Resolution: 0.025% FS.

Calibration Accuracy: ±0.5% FS.

Response Time: 2.5 minutes for 60% of full thermal equilibrium.

Full Thermal Equilibrium: 15 minutes.

Dimensions: 19 x 115 mm (0.75 x 4.5").

Materials: Brass body.

Weight: 145 g (0.32 lb.).

SIGNAL CABLE FOR VW SENSOR

Signal Cable 50613524

Shielded cable with four copper conductors and cable jacket rated to 80°C. Specify cable length required for each sensor.

RTD AND THERMISTOR SENSORS

RTD Temperature Sensor 92600056
Thermistor Temperature Sensor. . 92600057

These economical temperature sensors employ resistance temperature devices rather than vibrating wire transducers. When read by standard VW readouts, they return a reading in degrees C. Otherwise, they return a voltage reading that can be converted to units of temperature by applying calibration factors.

Sensor Type: RTD (2K ohm) or Thermistor (3 k ohm).

Range: -20 to 80°C. Other ranges available.

Resolution: 0.2°C with VW Data Recorder.

Accuracy: ±0.5°C FS

Dimensions: 9.5 x 101 mm (0.375 x 4").

Materials: Brass body.

Weight: 50g (0.11 lb.).

Signal Cable: Same as VW temperature sensor.

Readout and Data Loggers: VW Data Recorder and most types of data loggers.

SIGNAL CABLE

Signal Cable 50613524

Shielded cable with four copper conductors and cable jacket rated to 80°C. Specify cable length required for each sensor. Can be used with VW, RTD, or Thermistors

High-Temperature Signal Cable . .52602320

For use only with RTDs or thermistors. Shielded cable with two copper conductors and thermal rubber jacket rated to 115°C.

READOUTS

VW Data Recorder. 52613500
Jumper to Terminal Box 52613557

VW Data Recorder reads VW sensors and returns a reading in volts. It also reads RTDs and Thermistors and returns a reading in degrees C.

TERMINAL BOXES

Terminal Box for 6 sensors 57711606
Terminal Box for 12 Sensors 57711600
Terminal Box for 24 Sensors 97711624

Provides terminals for signal cable from 6, 12, or 24 sensors. Sensors are selected by rotary switch. Small 6-sensor box is 240 x 190 x 120 mm (9.5 x 7.5 x 4.75"). Larger 12 and 24-sensor box measures 290 x 345 x 135 mm (11.5 x 13.5 x 5.25").
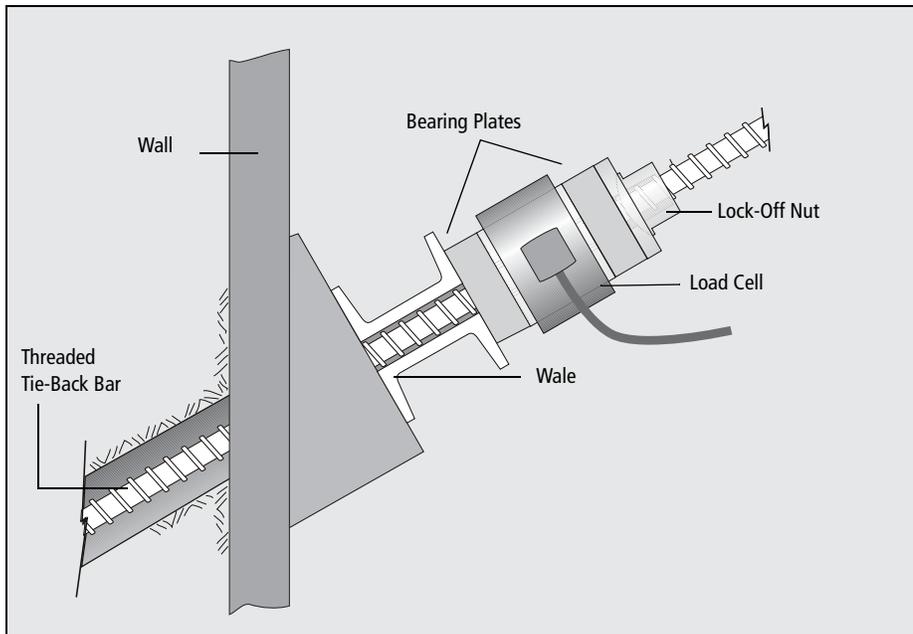
DATA LOGGERS

VW Temperature Sensors: Campbell Scientific CR1000 with AVW200 has capacity for 2 VW sensors. With an AM16/32 multiplexer connected, capacity increases to 16 or 32.

Campbell Scientific CR1000 has capacity for 8 RTDs or Thermistors. With an AM16/32, capacity increases to 32 RTDs or Thermistors.

Center-Hole Load Cell

Center-Hole Load Cells

Load Cell installed to monitor tieback

Applications

Center-hole load cells are designed to measure loads in tiebacks, rock bolts, and cables. Applications for these load cells include:

- Proof testing and long-term performance monitoring of tiebacks, rock bolts, and other anchor systems.
- Monitoring loading of vertical supports in underground openings.

Operation

The load-bearing element of the load cell is a spool of heat-treated steel alloy. Four or more strain gauge rosettes are bonded to the spool. Each rosette consists of two strain gauges, one oriented to measure axial strain; the other oriented to measure tangential strain. The rosettes are spaced evenly around the periphery of the spool and are wired together to provide a single output.

The strain gauge rosettes are protected from moisture and impact damage by a strong aluminum housing filled with a high-density resin.

For best results, the load cell is centered on the bar and bearing plates are placed above and below the cell. Bearing plates must be able to distribute the load without bending or yielding.

Advantages

Single Reading: The outputs of the strain gauges are integrated into a single reading, eliminating the switch box, multiple readings, and averaging normally associated with other types of center-hole load cells.

Easy Centering: Centralizers keep the load cell centered on the bar, bolt, or cable.

Manual or Automatic Readout: Load cells are read manually with a portable readout or automatically with a data logger.

LOAD CELL SPECIFICATIONS

Sensor Type: Resistance strain gauges wired to provide a single output of 2.5mv/v ±10%.

Part Numbers, Range, & Dimensions: See table at below.

Linearity: 1% FS.

Overload Capacity: 100%.

Centralizer: Centralizer is used to center load cell on tiebacks or rock bolts. User can adjust inside diameter of centralizer within range listed in table.

Signal Cable: Attached to load cell at factory. Must be ordered at same time as load cell.

SIGNAL CABLE & CONNECTORS

Signal Cable **50613527**
Shielded cable with seven 22-gauge tinned-copper conductors and polyurethane jacket. Specify cable length required for each load cell.

Universal Connector. **57705001**
Connector is not required when load cell is used with data logger.

Universal Terminal Box. **57711600**
Provides connections for 12 sensors and an indicator. Sensors selected by rotary switch. Weatherproof fiberglass box measures 290 x 345 x 135 mm (11.5 x 13.5 x 5.25"). Not required when load cell is connected to data logger

READOUTS & DATA LOGGERS

CR10X Data Logger **56701110**
CR10X can read the centerhole load cell. Up to five load cells can be connected to each AM16/32 multiplexer. See separate data sheet.

DataMate MP **57710900**
DataMate MP readout can read center hole load cells. See separate data sheet.

Load Cell Indicator **51300900**
Portable indicator for center-hole load cells. Displays, but does not record readings. Includes battery, charger, and jumper cable. Specify plug type needed for charger. Also specify if you are using the universal connector or terminal box, since they require a special jumper.

LOAD CELL PART NUMBERS, RANGE, AND DIMENSIONS

English Unit Specifications					
Load Cell	**Capacity US Ton**	**ID x OD x Height Inches**	**Bearing Area Inch^2**	**Centralizer**	**Centralizer ID, Inch**
51301050	50	1.67 x 3.5 x 3.25	1.67	51302117	0.5 to 1.5
51301100	100	1.67 x 3.5 x 3.25	3.33	51302117	0.5 to 1.5
51301152	150	2 x 4.25 x 3.5	5	51302120	0.5 to 1.5
51301153	150	3 x 5 x 4.5	5	51302130	1.0 to 2.5
51301225	200	2.5 x 5 x 4.5	6.67	51302125	1.0 to 2.0
51301235	200	3.5 x 6 x 5.5	6.67	51302135	1.5 to 3
51301330	300	3 x 6 x 4.5	10	51302130	1.0 to 2.5
51301340	300	4 x 6.63 x 6	10	51302140	1.5 to 3.5

Metric Equivalent of Specifications Above					
Load Cell	**Capacity Metric Ton**	**ID x OD x Height mm**	**Bearing Area mm^2**	**Centralizer**	**Centralizer ID mm**
51301050	45	42 x89 x83	1077	51302117	13 to 38
51301100	90	42 x 89 x 83	2148	51302117	13 to 38
51301152	135	51 x 108 x 89	3225	51302120	13 to 38
51301153	135	76 x 127 x 114	3225	51302130	26 to 64
51301225	180	64 x 127 x 114	4303	51302125	26 to 51
51301235	180	89 x 152 x 140	4303	51302135	38 to 76
51301330	270	76 x 152 x 114	6451	51302130	26 to 64
51301340	270	102 x 168 x 152	6451	51302140	38 to 89

Conversion Table	lb	kips	US Ton	kg	Metric Ton
lb	1	0.001	0.0005	0.4535	0.0045
kips	1000	1	0.5	453.5	0.4535
US Ton	2000	2	1	907.2	0.9072
kg	2.205	0.0022	0.0011	1	0.001
Metric Ton	2204	2.205	0.907	1000	1
Directions: Choose starting unit at left. Multipliers in same row yield unit at top.					

Displayed Units: Percent of full scale.

Resolution: 0.01% of full scale.

Display: Large, backlit 4.5 digit LCD with heater for cold weather operation.

Selector Switch: Provides switching to eight different sensors when connected to suitably wired signal cable.

Batteries: Rechargeable 6 volt, 6Ah lead-acid battery. Batter life is 12 hours with fully charged battery. LCD heater reduces operating time up to 50% when temperature is below 5°C (40°F).

Environmental Limits: -20 to 50°C. (-4 to 122°F). Splashproof, non-submersible. Connector socket is waterproof when capped or in use.

Dimensions: 127 x 178 x 178 mm (5 x 7 x 7").

Weight: 3.5 kg (7.5 lb).

VW Crackmeter

Applications

The VW crackmeter is suitable for surface monitoring of movement at joints and cracks in concrete structures or rock. Typical applications include:

- Monitoring joints for unexpected movement to provide early warning of performance problems.
- Monitor joints and cracks in structures that may be affected by nearby excavation and construction activities.
- Monitor cracks in structures that experienced seismic activity.

Operation

The VW crackmeter consists of a VW displacement sensor and a set of groutable anchors. The anchors are installed on opposite sides of the crack. The sensor is then fixed to the anchors via ball joints, which accommodate movement in other planes.

Readings are taken with a VW readout or a data logger. Calibration factors are applied to the frequency readings to convert them to a distance in mm or inches.

The initial reading establishes a baseline. Subsequent readings are compared to the baseline to determine the magnitude of changes in the distance across the crack.

Advantages

High Resolution: The crackmeter can detect movements of 0.15 mm with a repeatability of ±0.3 mm.

Two Ranges: The VW crackmeter is available in 60mm and 100 mm ranges (2.4 and 4 inch).

Twist-Proof Shaft: The crackmeter has a unique, twist-proof shaft that prevents accidental damage to the sensor during installation.

Suitable for Data Logging: The crackmeter is easily connected to a data logger for unattended monitoring. It can also be read manually.

VW CRACKMETER KITS

60mm, Splashproof 52636081
60mm, Waterproof 52636088

100mm, Splashproof 52636082
100mm, Waterproof 52636089

The VW Crackmeter consists of two components: a vibrating wire displacement sensor and a set of anchors. Part numbers for these components are listed below. Signal cable, ordered separately, is connected to the sensor at the factory.

Kit 52636081 includes displacement sensor 52636381 and anchor set 52636080.

Kit 52636088 includes displacement sensor 52636388 and anchor set 52636080.

Kit 52636082 includes displacement sensor 52636382 and anchor set 52636080.

Kit 52636089 includes displacement sensor 52636389 and anchor set 52636080.

Sensor Type: Vibrating wire. A built-in thermistor or RTD provides temperature measurements.

Range: 60 mm or 100 mm.

Resolution: 0.025% FS with VW Data Recorder.

Calibration Accuracy: ±0.1% FS.

Repeatability: ±0.5% FS.

Waterproof Rating: Waterproof crackmeter is rated to 17 bar (250 psi).

Materials: Stainless steel body and shaft, Neoprene O-rings, plated-steel swivels, mild-steel anchors.

Nominal Length: 60 mm crackmeter is 400 mm (15.7") long; 100 mm crackmeter is 530 mm (21") long.

SIGNAL CABLE

Signal Cable 50613524

Shielded cable with four 22-gauge tinned copper conductors and polyurethane jacket. Specify cable length for each sensor.

EXTRA ANCHORS

Anchor Set 52636080

Set of two groutable anchors. Needed if the crackmeter is moved to a new location.

Ball Joint 02700196

One ball joint. Needed if either of the original ball joints supplied with the crackmeter are damaged or corroded.

TERMINAL BOXES

Terminal Box for 6 sensors 57711606
Terminal Box for 12 Sensors 57711600
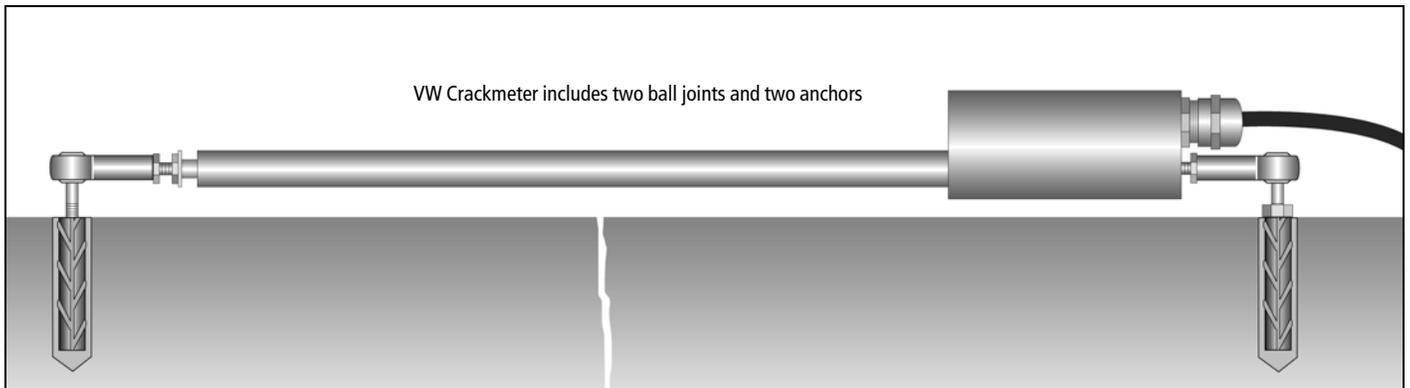**Terminal Box for 24 Sensors** 97711624

Provides terminals for signal cable from 6, 12, or 24 sensors. Sensors are selected by rotary switch. Small 6-sensor box is 240 x 190 x 120 mm (9.5 x 7.5 x 4.75"). Larger 12 and 24-sensor box is 290 x 345 x 135 mm (11.5 x 13.5 x 5.25").
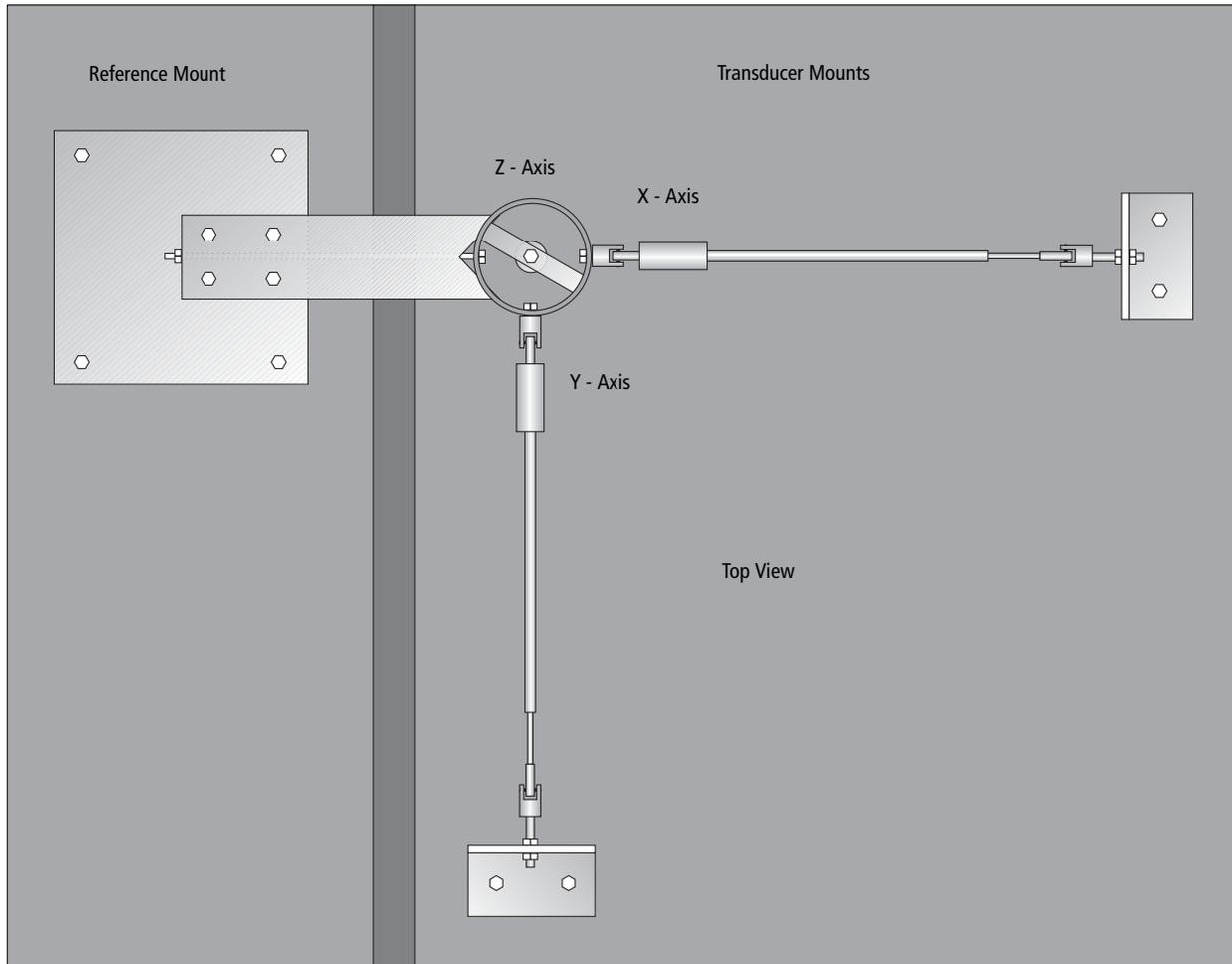
READOUTS

Compatible readouts include the VW Data Recorder and other pluck-type VW readouts. See separate data sheets for details.

DATA LOGGERS

Compatible data loggers include the VW MiniLogger and the Campbell Scientific CR1000 data logger. The CR1000 with a VW interface and an AM16/32 multiplexer reads 16 crackmeters with temperature or 32 crackmeters without temperature. See data sheets for features and specifications.

VW Crackmeter includes two ball joints and two anchors

VW 3-D Jointmeter

Reference Mount

Transducer Mounts

Z - Axis

X - Axis

Y - Axis

Top View

Applications

The VW 3-D jointmeter is used to monitor movement at joints and cracks. Designed to withstand extended submersion, the jointmeter is suitable for applications such as:

- Monitoring movement at submerged construction joints in concrete-face dams.
- Monitoring joints or cracks in tunnels and tanks.

Operation

The jointmeter consists of 3 waterproof VW displacement transducers, the 3-D mounting system, and groutable anchors.

The groutable anchors are installed on opposite sides of the joint. The mounting system is secured to the anchors, and the VW displacement transducers are positioned to provide the required range. Signal cables from the sensors are routed to a readout station.

A VW indicator or data logger is used to read the transducers. The initial reading serves as a datum. Subsequent readings are compared to the initial to calculate the magnitude and rate of changes.

Advantages

Submersible: The jointmeter is rated for 17 bar (250 psi) of water pressure.

Multi-Axis Monitoring: The jointmeter monitors the X, Y, and Z axes.

Easy Installation: Installation requires small, shallow drill holes in the concrete slab.

Manual or Automatic Readings: The jointmeter is easily connected to a data logger for unattended monitoring.

3D JOINTMETER COMPONENTS

The VW 3-D Jointmeter consists of several components that are ordered separately. Required components include three VW displacement sensors, signal cable for the sensors, and one 3-D mounting system. Accessories include anchors and a reusable mounting template.

3-D MOUNTING SYSTEM

Sensor Mount and Target 52632205

Three aluminum brackets, six universal joints, and necessary hardware. Does not include anchors.

Overall dimensions of the 3-D jointmeter, with transducers,are: 965mm deep, 790 mm wide, and 520 mm high (38" x 31" x 20.5").

Anchor Kit 52632210

Nine M10x 250mm stainless steel all-thread anchors with washers and nuts. Does not include epoxy grout.

Drilling Template. 52632206

Reusable template aids placement of drill holes for anchors..

VW DISPLACEMENT TRANSDUCER

60 mm VW Transducer 52636388

Type: Vibrating wire.

Range: 60 mm.

Resolution: 0.025% FS.

Calibration Accuracy: ±0.1% FS.

Repeatability: ± 0.5% FS.

Non-Linearity: < 0.5% FS.

Temperature Rating: -20 to + 80°C.

Waterproof Rating: 17 bar (250 feet).

SIGNAL CABLE

Signal Cable 50613524

Order signal cable for each transducer. Shielded cable with four 22-gauge, tinned copper conductors and polyurethane jacket.

READOUTS

Readouts

VW Data Recorder and other pluck-type VW readouts. See separate data sheets for details.

Universal Terminal Box 57711600

Optional terminal box provides connections for 12 sensors and an indicator. Sensors selected by rotary switch. Weatherproof fiberglass box measures 290 mm wide x 345 mm high x 135 mm deep (11.5 x 13.5 x 5.25 ").
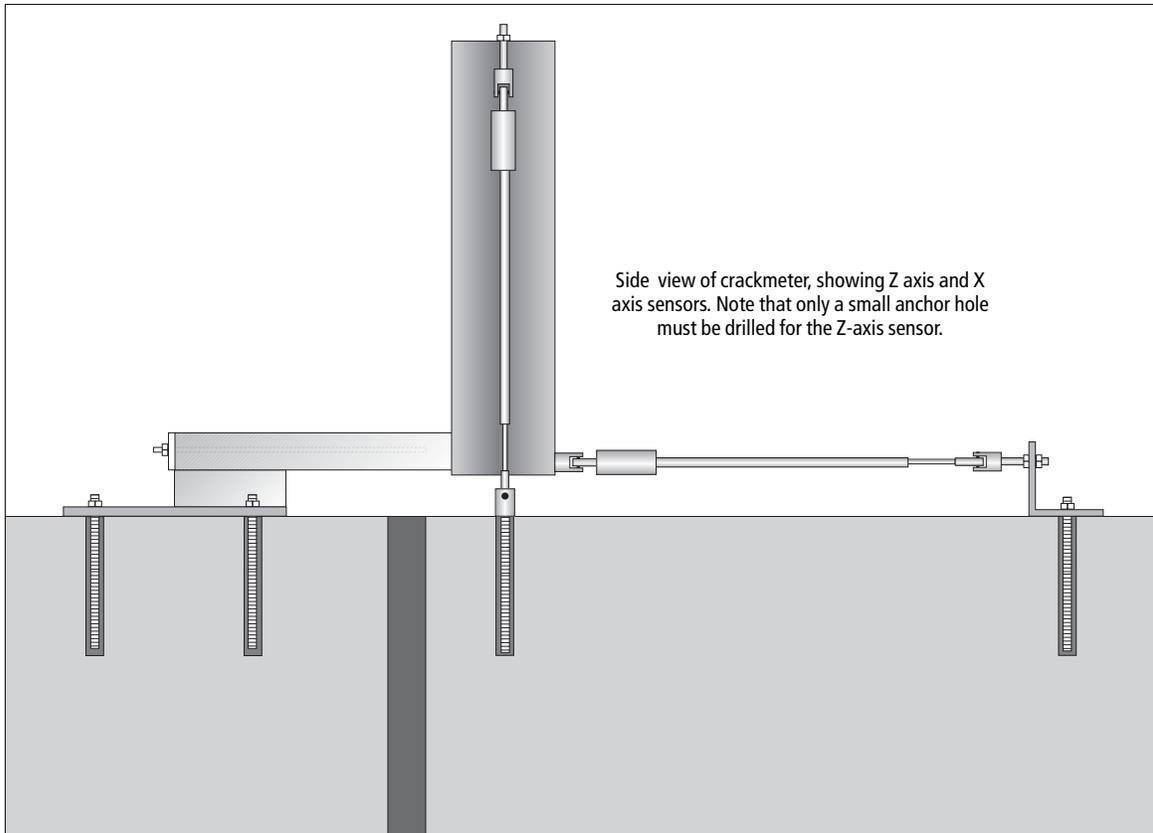
Universal Connector 57705001

Optional connector. Not required for terminal box or data logger.

DATA LOGGERS

Data Loggers

Campbell Scientific CR10X data logger with a VW interface and an AM16/32 multiplexer can accommodate 16 jointmeters with temperature readings or 32 jointmeters without temperature readings. See separate data sheet.

Side view of crackmeter, showing Z axis and X axis sensors. Note that only a small anchor hole must be drilled for the Z-axis sensor.

Mechanical 3D Crackmeter

Applications

The mechanical 3D crackmeter is used with a dial indicator to monitor movement at joints and cracks. Typical applications include:

- Monitoring construction joints to evaluate structural performance.
- Monitoring cracks in structures near active construction sites.
- Monitoring movement of rock masses in natural rock formations.

Installation

The crackmeter consists of a long-arm component that extends across the crack and a reference block. The two components are installed on opposite sides the the crack.

Mark location for anchors and drill the holes. See spacing, diameter, and depth in the specifications.

Use the alignment block, screws, and wrench to join the two components of the crackmeter, as shown in the photo. Check that surfaces are orthagonal.

Use the provided alignment block, screws, and wrench to prepare the crackmeter for installation.

Fill the drill holes with a non-shrinking epoxy grout, then insert the anchors. Check that the alignment has not changed. Allow the grout to harden. Afterwards, remove the alignment block. Optional: consider fabricating a dust cover for the crackmeter.

Operation

Readings are obtained by inserting a the probe of a dial indicator through the access holes to contact opposite component.

Take three sets of XYZ readings to ensure that you have a good baseline for comparison.

Compare subsequent readings to the baseline. Changes indicate that movement has occurred.

Advantages

Easy Installation: Installation requires only two drill holes. Welding plates are also available.

Simple Operation: The crackmeter is read manually with a digital micrometer.

MECHANICAL 3D CRACKMETER

Aluminum 3D Crackmeter 51708800
Stainless 3D Crackmeter 91708800

The mechanical 3D crackmeter consists of a long arm component and a reference component with integral anchors, an alignment block, screws, and a wrench. Dial indicator is not included.

Range X, Y, Z: 0 to 12.5 mm (0 to 0.5 in).

Materials: Aluminum or stainless steel body, stainless steel anchors.

Length, Width, Height: 190x 50 x 45 mm, (7.5 x 2 x 1.75 in), excluding anchors.

Anchors: 12.5x 76 mm (0.5 x 3 in).

Anchor Spacing: 140 mm (5.5 in), center to center.

Suggested Drill Holes: 25 mm x 76 mm (1 x 3 in) to accommodate anchor and grout. At least 50 mm (2 in) of anchor should be embedded in grout.

Suggested Grout: Epoxy, non-shrinking.

DIGITAL DIAL INDICATOR

Dial Indicator with Collar 51708868K
Alignment Collar Only 51708867

Digital dial indicator provides range of 50mm (2 in) and resolution of 0.01mm (0.001 in). The alignment collar is included.

Alignment collar greatly improves measurement precision. Collar is included indicator above, but available separately for user-supplied indicators. Fits 9.5mm (0.375 in) stem and accomodates shaft diameters to 4.8 mm (0.190 inch).

ACCESSORIES

Weldable Anchor Kit 51708855

Weldable anchor kit includes two weldable plates for mounting the crackmeter on steel structures.

Data Acquisition Systems

Introduction

A complete data acquisition system consists of data logger components, data retrieval components, and software components.

Data Logger Components

Data Loggers: Campbell Scientific data loggers are known for their field reliability and offer compatibility with a wide range of sensors and data retrieval options.

A single data logger can read a large number of sensors provided they are concentrated into a small area. Additional loggers should be deployed if sensors are distributed over a wide area. This keeps signal cables short, reduces problems with noise, and minimizes the potential for damage from construction activities and electrical transients. Cost savings on cable can sometimes pay for the additional loggers.

Interface Modules: Certain types of sensors require additional interfaces. For example, vibrating wire sensors require a VW interface, which is connected between the data logger and a multiplexer.

Multiplexers: Multiplexers increase the number of sensors that can be monitored by a data logger. For example, the CR1000 can control up to seven multi-plexers, each capable of handling 16 to 32 sensors. In practice, the data logger usually controls one or two multiplexers, and additional loggers and multiplexers are employed if there are more sensors.

Power Supplies: A power supply provides regulated power to the logger and sensors. Power is drawn from a battery that is charged from AC mains power or a solar panel.

Weatherproof Enclosures: All field components must be housed in weatherproof enclosures.

Data Retrieval Options

Wired Links: Wired links for data retrieval include direct connection to the PC, telephone modems, short haul modems, and multidrop networks.

Wired links are usually less expensive and easier to set up. They are also better for real-time data retrieval.

Wireless Links: Wireless links for data retrieval include cell modems, and spread-spectrum radio modems.

Wireless links are useful when distances, site traffic, or other obstacles make wired links impractical. Also, to the degree that wireless links eliminate surface runs of cable, they also reduce problems caused by electrical transients.

Software Components

Logger Control Software: LoggerNet software is used to create monitoring programs and to retrieve data from logger to PC.

Custom Programming: Slope Indicator offers custom monitoring programs for Campbell data loggers. The programs, which are created with LoggerNet and can be modified by the user, significantly reduce the time and expense required to deploy the data acquisition system.

Web-Based Monitoring: Processing and distribute the data collected by data loggers can be a daunting task. Atlas Monitoring Software provides an efficient and cost-effective solution to this problem.

Atlas automatically processes readings, checks for alarms, displays graphs, and generates reports. Distribution is immediate because Atlas works on the internet. With only their web browsers, users can view and download data, whether they are at work, at home, at a client's office, or half-way around the world.

See the Atlas data sheet or visit www.slopeindicator.com for more information on Atlas.

DATA LOGGER COMPONENTS

CR800 Data Logger 56700800
CR1000 Data Logger 56701000
PS100 Power Supply 56703120
AC Adapter, 90 to 260 VAC 56703124
RS-232 Interface Cable 50306869
USB Interface Cable 56704018
ENC 16/18 Enclosure 56705020
AVW200 VW Interface 56701550
AM16/32 Multiplexer 56702110
System Integration Per Logger . . .96700000

A minimum logger system consists of the CR800 or CR1000, a power supply with an AC adapter or large capacity battery, an interface cable for communication with PC, a weatherproof enclosure for all outdoor components, and LoggerNet software for the PC. A VW interface is required for vibrating wire sensors.

An expanded system could include additional data loggers, power supplies, multiplexers, enclosures, and data retrieval options.

The ENC 16/18 enclosure can house a logger with power supply, VW interface, one AM16/32 multiplexer, and a communications module, such as a telephone modem. A second multiplexer can sometimes fit in the same box. Battery powered systems require a separate box for the battery.

The capacity of an AM16/32 multiplexer depends on the type of sensor connected. In general, the AM16/32 multiplexer can operate 32 two-wire sensors or 16 four-wire sensors of the same type. The table below shows multiplexer capacity for common sensors:

Sensor Type	AM16/32 Capacity
Vibrating wire sensors without RTD or thermistor readings	32
Vibrating wire sensors with RTD or thermistor readings	16
EL beam sensors and EL tiltmeters without RTD or thermistor readings	32
EL beam sensors and EL tiltmeters with signal conditioning board.	16
EL uniaxial in-place inclinometers EL uniaxial monopod tiltmeters	16
EL biaxial in-place inclinometers EL biaxial monopod tiltmeters	16

BASIC DATA RETRIEVAL OPTIONS

Com200 Telephone modem 56704410

The COMM200 telephone modem is designed specifically for Campbell Scientific data loggers. One modem is placed with each data logger and connected to a telephone line with a dedicated number. Communication is typically initiated by the computer which uses LoggerNet to dial the logger and retrieve the data. Real-time data transfers are possible while connected.

OTHER DATA RETRIEVAL OPTIONS

Voice Modems: Voice modems, a variation of the telephone modem, can deliver messages to preset phone numbers. Voice modems generally require extra set up time.

Short Haul Modems: Short-haul modems are placed with each logger and provide a reliable real-time link between the logger and a computer. The short-haul modem transmits data up to 8 km over a four-wire cable that is routed by the user.

MD9 Multidrop Interface: The MD9 is placed with each logger. A single coaxial cable links the MD9s into a network. The network can be connected to the controlling computer or to a telephone or radio modem.

Cell Phone Modems: Cell phone modems are placed with each data logger. Some cell services offer IP connections to the modem, so that the long-distance portion of the transmission is carried on the internet.

Spread-Spectrum Radio Modems: Spread-spectrum modems are placed with each data logger. Communication is typically initiated by the computer. Most countries do not require licenses for these modems.

SOFTWARE COMPONENTS

LoggerNet Software 56708020
Custom Programming 96701000

LoggerNet Software: This software is required for each data logging system. It is used to write and compile monitoring programs, to transfer the program to the data logger, and to retrieve data by direct wire, modem, or radio telemetry.

Custom Programming: Slope Indicator offers custom programs written in CR Basic. A typical program excites the sensors, obtains readings, and stores data at preset intervals, but it does not perform data reduction operations. Users can modify the program as needs evolve.

ATLAS WEB SERVICE

Atlas Activation Fee 58851000
Atlas Monitoring Service 58851050

Atlas is a web service with monthly plans based on the number of sensors to be monitored. The activation fee includes a partial setup of a project. Monitoring service is a monthly change and includes monitoring of 50 sensors. Additional sensors can be added for a nominal fee.

M-Logger for MEMS Sensors

Logger Components

M-Logger: Each M-Logger can monitor up to 16 sensors.

Power Supply: The M-Logger is normally powered by a 12V battery. Long-term deployment or wireless communications require a charging regulator for the battery and a power source such as an AC adaptor or a solar panel.

Multiplexer: Serial sensors eliminate the need for a multiplexer. However, a multiplexer is required to connect multiple, non-serial sensors.

Weatherproof Enclosure: Small and medium size enclosures are available. The small enclosure is suitable for a system monitoring a single sensor or a chain of serial sensors. The medium enclosure is required if a multiplexer is used.

Advantages

Simple Setup: M-Loggers are very easy to configure. The user enters a list of sensors, sets a start time, and specifies a logging interval. After that, the logger is ready for work.

Reduced Costs: M-Loggers are a cost-effective alternative to central-ized data acquisition systems. They can be affordably deployed close to the sensors, enhancing reliability and reducing costs by eliminating the long, expensive, and vulnerable runs of signal cable required with central-ized logging systems.

Spreadsheet Friendly: CSV files from the logger are ready for import, with dates and numbers formatted to the regional settings in Windows.

Automation-Ready: Data formats for automatic processing include the Campbell Scientific table format and the Slope Indicator ID format.

Applications

M-Loggers are used to monitor Slope Indicator MEMS sensors. They are also compatible with EL-SC sensors.

Simple to use and economical to deploy, M-Loggers can be placed close to sensors, enhancing reliability and keeping cable costs down.

Typical applications include:

- Top-of-hole monitoring of in-place inclinometer sensors.
- Local monitoring of beam sensors and track sensors.
- Monitoring in areas where heavy traffic or electrical noise make short signal cables necessary.
- Monitoring sensors that are too far apart to connect to a centralized data acquisition system.

M-LOGGER

M-Logger . . . .**.58810100**

Manager software and a serial interface cable are included with the logger.

Function: The M-Logger is a data logger for Slope Indicator MEMS sensors and EL SC sensors.

Capacity: One chain of 16 serial sensors, or one Campbell Scientific multiplexer with 16 standard sensors, or 1 standard sensor connected directly.

Memory: Non-volatile flash memory holds 7,900 records for each sensor. Each record includes time and date, A and B-axis tilt readings, and temperature reading.

Logger Resolution: 0.004% FS (16-bit) for tilt readings. 0.1°C for temperature readings.

Logger Accuracy: ±0.02% of tilt reading at 20 °C or ±0.06% of tilt reading at -20 to +50 °C.

Logging Interval: 30 second minimum interval; 7 day maximum interval.

Serial Ports: PC port for serial communications with PC. Interface cable is included with logger.

Power In: Nominal 12Vdc (8 to 15Vdc).

Power Out: Switched 12V output for serial sensors or multiplexer.

Environmental: Temperature rated for -20 to +50 °C. Logger normally housed in an enclosure.

Dimensions: 120 x 80 x 40 mm. (4.7 x 3 x 1.6").

M-LOGGER MANAGER

M-Logger Manager . . . . **Download**

Function: Used to configure the logger. Can also display real-time readings and retrieve data.

System Requirements: Runs on Windows XP, Vista, and Windows 7. Communicates with logger via an RS-232 serial connection. If PC has only USB ports, a USB-serial adaptor is required.

Settings: Logger ID, real-time clock, memory mode, sensor list, multiplexing mode, logging schedule, and communications parameters.

Real-Time Readings: The Manager program can display real-time readings of sensors when PC is connected to the logger.

Data Retrieval: Works with interface cable or line-of-sight radio. Retrieves new or all readings. Can clear data from logger memory.

File Formats: CSV, Campbell Scientific, and Slope ID. CSV uses Windows regional settings for date, time, and numbers and is suitable for spreadsheets. The Campbell Scientific format and Slope ID formats are useful for automation and monitoring software, such as Atlas.

MULTIPLEXER OPTION

AM16/32 Multiplexer **56702110**
Terminal Board **26811615**

Connection of multiple standard sensor requires a multiplexer and a terminal board. The terminal board is used to connect power wires from multiple sensors. Note that the multiplexer option is not needed when serial sensors are connected to the logger.

POWER OPTIONS

Battery, 12V 7ah **01940004**
Battery Bracket **58810160**
Charging Regulator **58810161**
AC Adaptor. **58810165**
Solar Panel, 10W **56703310**
Solar Panel, 20W **56703325**

A battery and battery bracket are normally ordered with every system. A 12V 7ah battery can power an M-Logger taking hourly readings for about 140 days.

For longer term deployment , the charging regulator and a power source are required.

The power source can be an AC charger or a solar panel. The AC charger includes various wall plugs. The solar panel includes hardware for mounting on pole.

WEATHERPROOF ENCLOSURES

Small Enclosure **56705005**
Medium Enclosure **56705010**
System Assembly **96700005**

Weatherproof enclosures are required for outdoor applications. These strong fiberglass enclosures provide an internal panel for mounting components, an external grounding lug, and an opening for cable entry.

The small enclosure is suitable for systems that monitor serial sensors or a single standard sensor. Dimensions are 305 x 356 mm (12 x 14").

The medium enclosure is required for systems with a multiplexer. Dimensions are 356 x 406mm (14 x 16").

The system assembly charge is required when components are mounted in the enclosures at the factory.

ATLAS WEB SERVICE

Atlas Monthly Web Service **58851050**
Atlas Prepaid Web Service **58851090**
Atlas Activation Fee **58851000**

Atlas web-based monitoring software is offered as a hosted web service with monthly or prepaid plans. The service includes an unlimited number of projects, graphs, reports, and users, and includes 50 sensors. More sensors can be added for an additional fee. Accounts for large scale monitoring are also available.

The web service is not only easy to use, but also cost effective. Data are stored at a secure data center that provides automatic backups and multiple connections to the internet. Users need only their web browsers, so there is no software to install and maintain. Finally, the service does not require a long-term commitment.

VW Quattro Logger

Quattro Logger Advantages

Cost-Effective: Quattro Loggers are the right size for many projects. Two or three Quattro Loggers can be deployed for less than the cost of a single full size, centralized logger.

Simple to Use: Learn how to use the Quattro Logger in minutes, not hours. There are no programs to write and no switches to set.

Reliable: The Quattro Logger is rated for temperatures from -20 to +70°C, and its encapsulated electronics are impervious to humidity and condensation. Readings are stored in secure, non-volatile memory.

Spreadsheet Friendly: Logger Manager software retrieves readings and applies calibration factors, if present, to generate data files that contain both raw and processed readings. Thus data can be used immediately in the spreadsheet.

Applications

The VW Quattro Logger is a compact data logger designed to monitor four vibrating wire sensors. Typical applications include:

- Monitoring small projects, where only a few sensors are installed.
- Monitoring multilevel piezometers, multipoint rod extensometers, or crackmeters.
- Monitoring sensors that are too far away to connect to a centralized data acquisition system.
- Monitoring critical sensors during early phases of construction when the centralized data acquisition system is not ready.

Overview of Operation

The Quattro Logger is simple to use and set up takes only a few minutes.

Connect the logger to your computer and use Logger Manager software to specify a start time and reading schedule.

On site, connect sensor signal cables to the logger. You can view readings in real time if you have a PC with you. Then close the logger and walk away. Three D-cell batteries power the logger for up to 6 months.

Return to the site to retrieve readings with your PC. Logger Manager saves the readings in an ASCII file, ready for your spreadsheet.

Finally, import the file into your spreadsheet for processing and plotting.

LOGGER SPECIFICATIONS

VW Quattro Logger 52614000
VW Quattro Logger, External USB . . . 52614020

USB interface cable and batteries are included with the logger. Download manual and software from www.slopeindicator.com.

Measurement Range: Reads VW sensors operating in the range of 450 to 6000 Hz. Reads thermistors or RTDs in the range of -20 to 120 °C.

Logger Resolution: 0.01% FS for vibrating wire sensors, 0.1 °C for temperature sensors.

Logger Accuracy: ±0.02 % of Hz reading for vibrating wire sensors, ± 1 °C for temperature sensors.

Data Storage: Stores 43,000 records for each sensor in secure, non-volatile memory. Each record includes a VW reading, a temperature reading, and the time and date. When memory is full, recording either stops or continues by overwriting the earliest readings, according to user preference.

Logger Settings: Date, time, and memory mode. Memory mode determines if logging stops when memory is full or if logging continues by overwriting earliest readings.

Logging Schedule: Logger start time can be set to a specific date and time so that readings are synchronized with other loggers. Reading intervals can be specified by day, hour, minute, and second. Maximum interval is days. Minimum interval is 20 seconds.

Sensor Settings: Sensor ID, serial number, calibration factors, and sweep range for each sensor. Choice of thermistor or RTD for temperature channels.

Power: Three D-cell batteries provide power for six months in moderate temperatures, assuming readings are taken every hour.

Weatherproofing: Quattro Logger electronics are encapsulated in waterproof resin and housed in an IPC66 metal box. Plugs are provided for unused cable ports.

Interface Cable: Male A/B USB 2.0 cable, the same cable commonly used for USB printers. 2m length (6 feet).

Dimensions: 240 x 160 x 81 mm (9.5 x 6.3 x 3.2 inches).

LOGGER MANAGER SOFTWARE

Logger Manager. . . . . **Download**

Logger Manager software is used to set up the logger and later to retrieve data from the logger. Download from www.slopeindicator.com.

Choice of output file formats: ASCII format ready for import into a spreadsheet or in format that is compatible with the CR1000 data logger.

Automatic Engineering Units: The Quattro Logger stores readings in Hz. It also stores calibration factors for each sensor. Logger Manager retrieves the calibration factors along with the readings, then applies the calibration factors to generate a reading in engineering units (both raw and generated readings are stored in the file). Temperature readings are stored in degrees C only.

Real-Time View of Logging: Logger Manager can show real-time readings when the PC is connected to the logger. This is useful to verify that sensors, connections, and loggers are working properly.

Clock Syncronization: The Manager program can synchronize the logger's clock to the clock in the PC.

VW MiniLogger

MiniLogger Advantages

Economical: It is possible to deploy four or five MiniLoggers for less than the cost of a full-size logger. Cable costs are also reduced, since the MiniLogger can be placed near each sensor.

Simple to Use: Learn how to use the MiniLogger in minutes, not hours. There are no programs to write, no switches to set, and only four wires to connect.

Reliable: The MiniLogger is rated for temperatures from -20 to +50°C. Its encapsulated electronics are impervious to humidity and condensation. Readings are stored in secure, non-volatile memory.

Spreadsheet Friendly: Logger Manager software retrieves readings and applies calibration factors, if present, to generate data files that contain both raw and processed readings. Thus data can be used immediately in the spreadsheet.

Wireless Option: The wireless option provides easy data retrieval when access to the logger is difficult or when frequent retrieval is required.

VW MiniLogger Applications

The VW MiniLogger is a reliable, low-cost data logger designed to monitor a single vibrating wire sensor, such as a VW piezometer or crackmeter. Typical applications include:

- Monitoring small projects, where only a few sensors are installed. Note that one MiniLogger is required for each sensor.
- Monitoring single sensors that are too far away to connect to a centralized data acquisition system.
- Monitoring single sensors in areas where heavy traffic or electrical noise prevents use of long cables.
- Monitoring single sensors during early phase of construction when centralized data acquisition system is not ready.

Overview of Operation

The MiniLogger is simple to use and takes only a few minutes to set up.

Connect the MiniLogger to your PC and run Logger Manager software to specify a start time and reading interval for data logging.

On site, connect the sensor signal cable to the MiniLogger and walk away. D-cell batteries provide power for up to six months in temperatures as low as -20° C.

Return to the site with your PC and run Logger Manager to retrieve the readings and save them in a file that is ready for your spreadsheet.

Finally, open the file with your spreadsheet for processing and plotting.

VW MINILOGGER

VW MiniLogger 52613310

VW MiniLogger includes interface cable and two D-cell batteries.

Sensor Compatibility: Reads VW sensors operating in the range of 450 to 6000 Hz. Also reads temperature sensors (RTD and thermistor).

Data Storage: Stores 8,000 records in secure, non-volatile memory. Each record includes a VW reading, a temperature reading, and the time and date. When memory is full, recording either stops or continues by overwriting the earliest readings, according to user preference.

Logger Settings: Assign a logger ID, specify whether to stop when memory is full or to overwrite earliest readings.

Sensor Settings: Assign a sensor ID, set sweep range for excitation, store calibration factors, and set temperature sensor to RTD or thermistor.

Reading Schedule Starts recording on power up or at specified date and time. Records readings at intervals from one reading every two seconds to one reading per week.

Logging Schedule: Set logger to start recording on power up or at a specific date and time (to synchronize readings with other MiniLoggers or data loggers). Set reading intervals to day, hour, minute, and second.

Power: Two D-cell batteries provide power for approximately six months at temperatures from -20 to +50°C, assuming readings are taken every half-hour.

Weatherproofing: MiniLogger electronics are completely encapsulated in waterproof resin. Polycarbonate box has O-ring seal and cable gland for signal cable.

Dimensions: 100 x 100 x 90 mm high (4 x 4 x 3.5").

Data Retrieval: Readings are retrieved via RS-232 serial connection or by wireless link to computer running Logger Manager.

2.4 GHZ WIRELESS OPTION

Radio Lid, 2.4 Ghz 52613360
Radio Base Station, 2.4 Ghz 52613455

Radio lid replaces standard lid of MiniLogger and includes spread-spectrum radio, interface cable, and half-wave antenna.

Base station works with PC and includes spread-spectrum radio, USB cable, half-wave antenna, and CD.

Frequency: 2.4 Ghz.

Radio Type: Spread Spectrum.

Transmission Power: 40 mW.

Range: Up to 0.6 km (0.4 miles) line of sight.

Power: Powered from MiniLogger's batteries. Average life is about 2 months, assuming 4-daily downloads. Base station is powered by computer's USB port.

WIRELESS ACCESSORIES

**Advanced Programming Cable.** . . 52613340

Optional cable allows user to change configuration of radio lid. Works with both 900 Mhz and 2.4Ghz radios.

LOGGER MANAGER SOFTWARE

Logger Manager Software . . . . . Download

Logger Manager is used to set MiniLogger's reading schedule and to retrieve recorded readings. Readings can be stored in a Campbell Scientific compatible format or in a spreadsheet-ready format.

Atlas Web-Based Monitoring
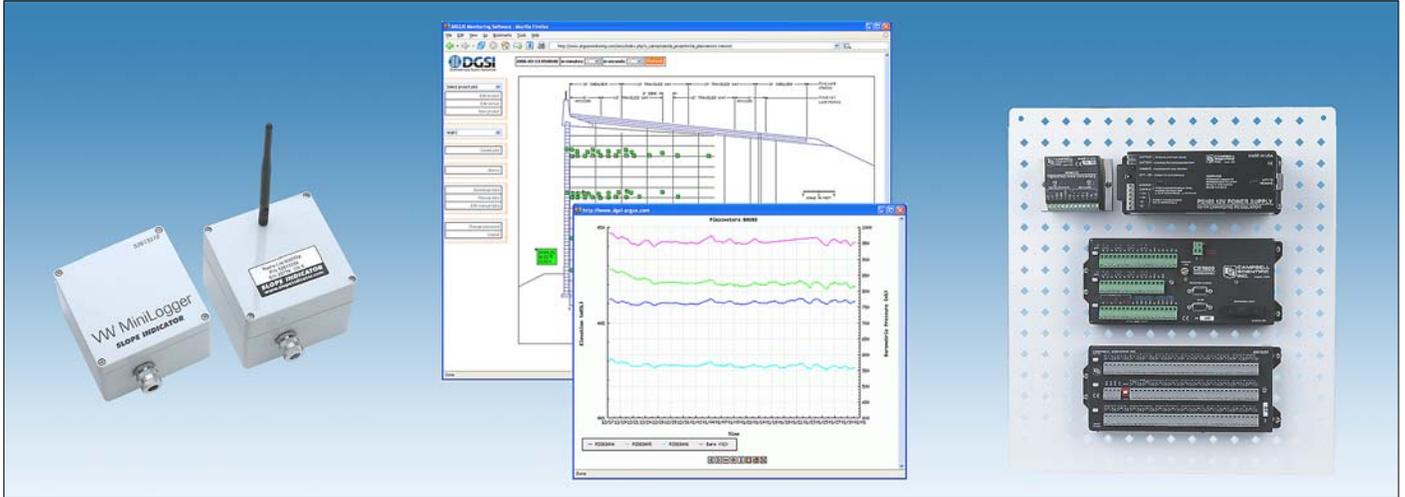
Application

Atlas web-based monitoring solves the two central main problems of data acquisition: timely processing of data and timely distribution of the results.

Operation Overview

Atlas runs on a web server and looks like a web site. The service is hosted at a data center with excellent connectivity and security.

Users work with Atlas via their web browsers and click on links to access graphs and data.

Certain users have rights to set up Atlas projects, graphs, reports, and alarms. Once a project is set up, Atlas is ready for data.

In most cases, a PC retrieves readings from the loggers at the site and forwards the data to Atlas. Atlas also accepts data entered manually via web browsers.

Atlas scans incoming data for alarm conditions, sends out notifications as required, and then stores the data in a dedicated project database.

In a matter of seconds, Atlas has processed the data and made the results immediately available via the web. When users log on, graphs and reports are just a few clicks away.

Data Presentation

Plan Views show a site drawing or photograph overlaid with small boxes representing sensors. The sensor boxes show current readings and change color to indicate alarms.

Trend Plots show readings against time. The plots are preconfigured and when selected, use the most current data. Clicking on a plot displays a table of the data values.

Profile Plots show displacement data from in-place inclinometers, beam sensors, and similar sensors.

Image Plots are graphs generated by other programs, such as Excel or DigiPro inclinometer software.

Correlation Plots show one series of data values plotted against another series of data values.

Alarm Notifications are sent by email, which can be forwarded to cell phones.

Logbook shows commentary and site photographs entered by users.

Reports compile selected plots, data, alarm records, and logbook entries into a PDF file that is emailed to selected users, daily, weekly, or monthly. Reports can also be generated on demand to allow inclusion of extended commentary and analysis.

Advantages

Atlas never sleeps: Atlas works day and night. It scans for alarm conditions, processes data, and always presents up to date information.

Atlas is web-enabled: Data and graphs are available anywhere there is a connection to the web: at home, at the client's office, or half-way around the world.

Atlas is efficient: Atlas automates and standardizes data processing and presentation, so results are fast, reliable, and immediately available.

Atlas is familiar: Most users need no training at all, since they already know how to use web browsers.

Atlas provides continuity: Atlas keeps sensor calibrations, processing routines, and data in a secure, central location. Services that depend on Atlas are not affected by workplace events such as computer crashes or changes in personnel.

Atlas is affordable: Atlas is a web service with monthly plans sized to match your projects. Atlas is also available in an enterprise edition.

ATLAS OVERVIEW

Atlas web-based monitoring software is specially designed to process and distribute data collected from geotechnical sensors. Atlas runs on a web server, and users access Atlas with their web browsers.

DATA INPUT

Automatic Import: Atlas automatically imports data files that are sent to its input folder. In a typical scenario, a PC automatically retrieves readings from data loggers at the site and forwards them to Atlas via the internet. Data files can also be copied to the input folder when Atlas is operating on a local area network or a stand-alone computer.

Atlas supports the Atlas format, Campbell Scientific's CR10 and CR1000 formats, a geodetic format for total station data. Other input formats are in development. Custom input filters can be programmed on request.

Manual Entries: Atlas allows users to enter data manually using their web browsers. This is useful for values that are not normally logged, such as fill height or standpipe water levels.

Graphic Uploads: Atlas can store and display graphics generated by other programs, such as DigiPro inclinometer software or Excel.

Logbook Entries: Atlas provides a logbook in which users can enter observations and photographs of site activities and incidents. Each entry is time stamped and can be included with the automated reports.

DATA PROCESSING

Processing Overview: Atlas always stores raw (unprocessed) readings in the project database. When it receives a request for data, Atlas processes readings on the fly. This ensures that any corrections to calibration factors, processing methods, or data values are always included in the results that Atlas presents.

Atlas performs the same on-the-fly calculations when it first imports the readings. This allows Atlas to scan for alarm conditions.

Conversions and Calculations: Atlas converts raw readings to data in engineering units as specified in an equation stored for each channel of each sensor. Equations can reference datum readings and also readings from other sensors. This allows Atlas to calculate changes, perform corrections for temperature or atmospheric pressure. It also allows for cumulative calculations required for beam sensors or in-place inclinometers.

Exports: Atlas can export ASCII data formatted appropriately for spreadsheets.

DATA PRESENTATION

Atlas organizes data presentation by project. A project can have its own logo and front page, and any number of plan views, trend plots, and reports. All data presentation features can be configured by users. No high-level administration is required.

Plan Views: Plan views show a background image with an overlay of small boxes or symbols representing sensors. Boxes show the current reading for each sensor. If boxes would overlap, the user can choose to display sensors as various symbols. When the cursor runs over a symbol, the current reading is displayed. Both boxes and symbols are displayed in green, yellow, or red to indicated alarm status. Clicking on a measurement value displays a trend plot, allowing the user to quickly evaluate whether the alarm condition is the result of a trend or just a one-time event.

Plots: Four types of trend plots are available: trend plots, profile plots, correlation plots, and image plots. Plots are generated as graphic files, so they can be saved and attached to emails or used in documents. Clicking on a plot will display the data values used in the plot.

PDF Reports: Atlas can generate PDF reports on daily, weekly, or monthly schedule and automatically email the reports to selected users. Reports can also be generated on demand, if automation is not needed.

Reports start with a cover page with the normal text, a graphic ,and date. Optional commentary pages are next. Following those pages, are pages for plots (the same plots that Atlas displays on screen). Plots can be added in any order and later sorted or toggled on or off. A paragraph of text is allowed before and after each plot and after each plot. If tabular data are needed, a data table, which holds all the plotted values, can be toggled on to appear after the plot. Optional sections following the plots include a summary of alarms and selected logbook entries.

ALARMS AND NOTIFICATIONS

Alarm Detection: Atlas scans incoming readings for alarms conditions. Alarm thresholds can be based on fixed values or the results of a calculation and may be set for any channel of any sensor. Watchdog alarms can be set to warn if no readings are received.

Alarm Warnings: When Atlas detects an alarm condition, it generates on-screen warnings, registers the alarm in an alarm table, and puts the alarm in a notification queue.

Alarm Notifications: Atlas sends out alarm notifications by email to selected users, who can

receive the email on their cell phones. To avoid flooding email boxes with alarms, Atlas sends out just one notification per alarm condition. In addition, Atlas provides a variety of filters that can be used to consolidate notifications or to suppress them until certain conditions have been met.

ADMINISTRATION

User Levels: Atlas supports three user levels. Administrators can set up projects, sensors, graphs, and other users. Users can view data, download data, enter data, edit data, and set up one-time graphs. Guests can only view data.

Passwords: Atlas emails passwords to each user that administrators enter. Users can modify their passwords as required.

Email Groups: Administrators assign users to an email groups and then assign email groups to receive PDF reports and alarm notifications.

Backup & Archives: Administrators can create backups and archives from data in the database.

ATLAS PLANS

Atlas Monthly Web Service 58851050
Atlas Prepaid Web Service 58851090
Atlas Activation Fee 58851000

Atlas is offered as a web service with monthly or prepaid plans. The service includes an unlimited number of projects, graphs, reports, and users, and includes 50 sensors. More sensors can be added for an additional fee. Accounts for large scale monitoring are also available.

The web service is not only easy to use, but also cost effective. Data are stored at a secure data center that provides automatic backups and multiple connections to the internet. Users need only their web browsers, so there is no software to install and maintain. Finally, the service does not require a long-term commitment.

VW Data Recorder

Advantages

Wide Compatibility: The VW Data Recorder reads any pluck-type VW sensor from any manufacturer.

Simple Operation: Learn how to use the VW Data Recorder in just a few minutes. Most operations are performed by pressing a single key. Data retrieval is just as easy.

Reliable: Readings are stored in secure, non-volatile memory that keeps data even when batteries are fully discharged.

Spreadsheet Friendly: Logger Manager software retrieves readings and from the logger stores them in ASCII file, ready to open and process with your spreadsheet program.

No Setup: The VW Data Recorder is always ready to use. There are no sensor lists or calibration factors to load.

No Special Parts: The VW Data Recorder uses standard cables and batteries. Built-in terminals eliminate the need for a jumper cable. The serial interface cable can be replaced at any computer store, and the standard D-cell batteries eliminate the need for a charger.

Applications

The VW Data Recorder is a recording readout for pluck-type vibrating wire sensors, RTDs, and thermistors.

The VW Data Recorder is simple to operate, stores up to 8000 readings, and can transfer the readings to a PC for processing.

Basic Operation

The VW Data Recorder has just three controls: an on/off switch, an Enter key, and a Change key.

To take a reading, switch on the power, connect the sensor, and press the Enter key. The reading appears.

To save a reading, press Enter twice more, once to confirm a sensor ID, and once to record the reading.

Settings

To change a setting, press the Change key. You can set the display to show Hz, Hz^2 or microstrain and choose thermistor or RTD for the type of temperature device built into your sensor. The Change key also lets you set a sensor ID when you save a reading.

Transferring Readings to a PC

Connect the VW Data Recorder to your PC and run Logger Manager software. Specify a file name and location for the readings, and two mouse clicks later, the data is on your PC, ready for your spreadsheet program.

SavedAs	RecTime	Hz	Temperature
1	8/16/2001 3:46:48 PM	1287.743	28.83559
1	8/16/2001 3:46:54 PM	1287.697	28.64272
3	8/16/2001 3:47:24 PM	1291.314	28.83803
4	8/16/2001 3:47:46 PM	1289.615	28.71596
5	8/16/2001 3:48:11 PM	1289.162	28.87845
6	8/16/2001 3:48:47 PM	1288.859	28.76469
7	8/16/2001 3:49:08 PM	1289.017	28.76371
8	8/16/2001 3:49:28 PM	1288.689	29.07914
9	8/16/2001 3:49:54 PM	1289.171	28.80046
10	8/16/2001 3:50:26 PM	1289.358	28.95915
14	8/16/2001 3:50:46 PM	1289.025	28.96159
17	8/16/2001 3:51:18 PM	1289.341	

Retrieving Readings with Manager Software

VW DATA RECORDER

VW Data Recorder. 52613500

The VW Data Recorder includes batteries and an interface cable.

Sensor Compatibility: Reads any pluck-type vibrating wire sensor that operates between 450 and 6000 Hz. Also reads thermistor and RTD temperature sensors.

Range: 450 to 6000 Hz.

Resolution: 0.01% FS.

Accuracy: ±0.02% of Hz reading.

Temperature Measurement: -20 to 120 °C with ±1°C accuracy.

Displayed Units: Hz, Hz^2, microstrain, degrees C. Microstrain units are dedicated to VW spot-weldable strain gauge.

Sensor IDs: Stored readings are identified by date, time, and sensor ID, which is a number between 0 and 31. User assigns ID when saving a reading.

Memory Capacity: 8000 readings with ID, date, and time.

LCD: 2 line x 20 character, high contrast LCD with extended temperature rating.

Controls: On/Off switch with auto-off timer, keypad with two keys.

Connectors: Panel-mounted terminal for sensor cables, DB9 connector for serial interface cable.

Interface Cable: Included part 50306869 is a modem-type serial interface cable with DB9 connectors on either end.

Batteries: Two 1.5 volt alkaline D-cells provide about 60 hours of continuous use at 20 °C.

Environmental Limits: -20 to 50 °C.

Dimensions: 235 x 190 x 108 (9.25 x 7.5 x 4.25").

Weight: 1.5 kg (3.3 lb.).

LOGGER MANAGER SOFTWARE

Logger Manager. . . . . Download

Logger Manager software can be downloaded from www.slopeindicator.com.

System Requirements: Windows computer with serial port. If no serial port is available, a USB to serial adaptor is required.

Settings: Synchronize recorder's internal clock with PC or specify different date and time; set default sweep frequency; set default type of temperature sensor.

Data Retrieval: Choose to retrieve all readings or a selected range of readings. Readings are stored in ASCII format ready for import into a spreadsheet. VW readings are stored in Hz or Hz^2. VW spot-weldable strain gauge readings are stored in microstrain or Hz. Temperature readings are stored in degrees C.

OPTIONAL JUMPER CABLES

Jumper to Terminal Box 52613557
Jumper with Alligator Clips 52613550

Jumper to terminal box is required if sensors are terminated at universal terminal box 57711600. Approximately 2 m (6') long.

Jumper with alligator clips is useful for locations where the signal cable from the sensor is not easily connected to the terminals on the panel. Approximately 2 m (6') long.

TERMINAL BOXES

Terminal Box for 6 sensors 57711606
Terminal Box for 12 Sensors 57711600
Terminal Box for 24 Sensors 97711624

Provides rotary switch for selecting sensors. Small 6-sensor box measures 240x190x120 mm (9.5 x7.5x 4.75"). 12 and 24 sensor boxes measure 290 x 345 x 135 mm (11.5 x 13.5 x 5.25").

EL/MEMS Data Recorder

Applications

The EL/MEMS Data Recorder is a readout for EL SC sensors and MEMS tilt sensors.

Simple to operate, the Data Recorder stores up to 6000 readings, and can transfer the readings to a PC for processing.

Operation

The Data Recorder has just three controls: an on/off switch, an Enter key, and a Change key.

To take a reading, switch on the power, connect the sensor, and press the Enter key. The reading appears.

To save a reading, press Enter twice more, once to confirm a sensor ID, and once to record the reading.

Settings: Change settings with the Change key. You can set the display to show uniaxial or biaxial readings. You can also set the readout to show readings from multiplexed IPI sensors. The Change key also lets you set a sensor ID when you save a reading.

Transferring Readings to a PC: Connect the Recorder to your PC and start the Manager program. Specify a file name and location for the readings, and two mouse clicks later, the data is on your PC, ready for your spreadsheet program.

Advantages

Simple Operation: Learn how to use the Data Recorder in just a few minutes. Most operations are performed by pressing a single key. Data retrieval is just as easy.

Reliable: Readings are stored in secure, non-volatile memory that keeps data even when batteries are fully discharged.

Spreadsheet Friendly: The Logger Manager program retrieves readings and stores them in ASCII file, ready to open and process with your spreadsheet program.

No Setup: The Data Recorder is always ready. There are no sensor lists or calibration factors to load.

No Special Parts: The Data Recorder uses standard cables and batteries. Built-in terminals eliminate the need for a jumper cable. The serial interface cable can be replaced at any computer store, and the standard D-cell batteries eliminate the need for a charger.

EL/MEMS DATA RECORDER

EL/MEMS Data Recorder 56813500

EL/MEMS Data recorder includes readout, batteries and interface cable.

Sensor Compatibility: Reads uniaxial and biaxial EL SC sensors (signal conditioned) and MEMS sensors from Slope Indicator. Also reads thermistors built into these sensors.

Range: 0 to ±2.5V.

Resolution: 0.004% FS.

Accuracy: ±0.1% FS.

Temperature Measurement: -20 to 120 °C with ±1°C accuracy.

Displayed Units: Volts and degrees C.

Sensor IDs: Stored readings are identified by date, time, and sensor ID number. User assigns ID when saving a reading.

Memory Capacity: 6000 readings with ID, date, and time.

LCD: 2 line x 20 character, high contrast LCD with extended temperature rating.

Controls: On/Off switch with auto-off timer, keypad with two keys.

Connectors: Panel-mounted terminal for sensor cables, DB9 connector for serial interface cable.

Interface Cable: Included part 50306869 is a modem-type serial interface cable with DB9 connectors on either end.

Batteries: Three 1.5 volt alkaline D-cells provide about 30 hours of continuous use at 20 °C.

Environmental Limits: -20 to 50 °C.

Dimensions: 235 x 190 x 108 (9.25 x 7.5 x 4.25 ").

Weight: 1.5 kg (3.3 lb.).

LOGGER MANAGER SOFTWARE

Logger Manager. . . . . Download

Logger Manager software is used to retrieve data from the recorder. It is also used to set the recorder's internal clock and a few other options. Download from www.slopeindicator.com.

System Requirements: Windows computer with serial port. If not serial port is available, a USB to serial adaptor must be used.

Data Retrieval: Choose to retrieve all readings or a selected range of readings. Readings are stored in ASCII format ready for import into a spreadsheet. EL readings are stored in volts. Temperature readings are stored in degrees C.

TERMINAL BOX

Terminal Box 57711600
Jumper Cable 56813557

Terminal box provides connections for signal cable from 12 sensors. Sensors are selected by rotary switch. Data Recorder connects to box via jumper cable. Terminal box measures 290 x 345 x 135 mm (11.5 x 13.5 x 5.25 ").

Jumper cable connects Data Recorder to terminal box. Can also be used to connect to connectors on the end of sensor signal cable. Length is 2m.

256 Pneumatic Indicator

256 Pneumatic Indicator

The 256 pneumatic indicator is used to activate and read pneumatic piezometers, total pressure cells, and settlement cells.

The indicator employs top quality components and is constructed to withstand many years of hard use.

Overview of Operation

Before leaving for the site, check that the indicator's tank is charged with gas. The built-in tank holds enough gas for busy reading schedules.

On site, set the pressure regulator. Proper regulation results in lower gas consumption and prevents damage to the pressure gauge.

Connect transducer tubing to the indicator using the included jumper tubing.

Turn on the gas to activate the transducer. Gas flows down through the tubing to the transducer.

Wait for the return-flow indicator to show a return flow of gas, then shut off the gas or use the precision flow-rate valve and flowmeter to slow the flow of gas.

Wait for the pressure reading on the main gauge to stabilize, then write down the reading. Take a second reading for verification, then disconnect and move to the next transducer.

256 Pneumatic Pressure Indicator with Digital Gauge

Advantages

Choice of Pressure Gauges: Both digital and analog gauges are available. See the list of pressure gauges on the next page.

Precision Flowmeter: Use the precision flowmeter when reading with flow or when pressuring long lines.

High Quality Components: The 256 Indicator is built for hard and long use. It employs the best quality tube fittings, tubing, valves, gauges, and tank.

256 Indicator with Analog Gauge

INDICATOR SPECIFICATIONS

Pressure Gauge: 0.25% analog gauge or 0.25% digital gauge. Digital gauge uses two 9 volt batteries.

Working Range: 1000 kPa (145 psi). Standard regular outputs a maximum pressure of 1030 kPa (150 psi).

Internal Tank: 1.38 liter (84 in^3), rated for 1390 MPa (2015 psi). Recommended gas is dry nitrogen, 3 ppm H$_2$0 maximum.

Precision Flowmeter: The flowmeter provides a repeatability of ±0.5% FS and is pressure rated for 1.7 MPa (250 psi). It is graduated in millimeters. When reading with flow, the recommended setting is a flowrate of 30 mm, which is equivalent to 0.1 SCFH or 47 cc/min.

Filler Hose: For filling tank from external nitrogen bottle. 2 m hose (7') with quick-connect fitting for indicator and screw-on fitting for external bottle.

Jumper Tubing: Connects indicator to terminal panel or to transducer tubing. 2 m jumper (7') with quick-connect fittings at each end. Twin-tube or triple-tube jumper is supplied, depending which options are ordered.

Weight: About 11 kg (24 lb) including full tank and jumper hose. Exact weight depends on pressure gauge.

Size: 508 x 457 x 178 mm (20 x 18 x 7"").

256 INDICATOR

With 0.25% Analog Gauge. 51425601
With 0.25% Digital Gauge 51425602

Twin-tube indicator includes pressure gauge, precision flowmeter, filler hose, twin-tube jumper, and manual.

Please specify range and units for pressure gauge. See choices. Indicators shipped by air have empty tank.

GAUGE CHOICES

Gauge	PSI	kPa
±0.25% Analog Gauge	60	-
	100	700
	160	-
±0.25% Digital Gauge	100	700