

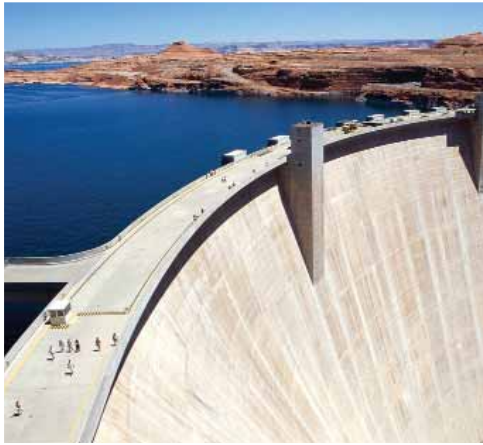


Geotechnical Instrumentation



GEOSENSE

company profile



Geosense is one of Europe's leading manufacturers and suppliers of instrumentation to the geotechnical, civil engineering, mining and environmental industries.

Geosense specialises in the manufacture of vibrating wire sensors which are used to measure strain, load, force, pressure and temperature and are universally recognised for their long-term stability within the harsh environment often found in civil engineering construction sites.

The company also supplies a full range of other instrumentation including inclinometers, tilt sensors, piezometers, data loggers and readouts, settlement systems, convergence monitors and extensometers.

Products are used in the following applications:

- Dam instrumentation**
- Tunnel instrumentation**
- Bridge instrumentation**
- Deep excavation & pile testing**
- Diaphragm & retaining walls**
- Slope stability**
- Pile testing**



The company head office is located on a 1 hectare site in Suffolk, England, where there are more than 3,000 square metres of manufacturing and warehousing facilities, ensuring large stocks of products are available for immediate delivery.

Geosense is the European and MENA (Middle East and North Africa) distributor for RST Instruments of Vancouver, Canada.

Our engineers have been involved with major geotechnical and civil engineering projects throughout the world for more than 30 years.

Geosense is committed to developing new products to meet customers' needs and has the capability to provide custom engineered solutions to site-specific problems. Many products have been designed in conjunction with clients' input following field testing or are based on project requirements. When requested, in-depth technical support is provided and relevant staff members are available to work with clients until a solution is found.



Established in 1992, Geosense is a division of Marton Geotechnical Services Ltd.



Geosense is officially certified to ISO 9001:2000 – the internationally-recognised quality management system which covers responsibility, design control, inspection and testing, delivery, internal quality audit procedures, training and servicing. With ISO 9001:2000 certification, Geosense guarantees to customers that a quality control management system is in place and strictly adhered to.

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portable digital mems inclinometers



VERTICAL MEMS INCLINOMETER SYSTEM



Cutting edge MEMS (Micro-Electro-Mechanical Systems) technology for the measurement of lateral displacement of soil, rock and structures.

Used for monitoring:
Direction of movement and shear-plane identification in natural and cut slopes

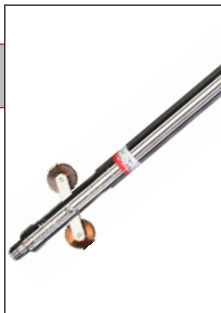
Lateral displacement of dams & embankments
Deflection of bridge piers and abutments
Deflection of dam membranes, diaphragm and retaining walls
Stability of tunnels, shafts, underground workings and piled foundations

KEY FEATURES & SPECIFICATIONS

Probe-based microcontroller with digital calibration
24-bit A/D converter for digital data output
Bluetooth™ wireless communication with Pocket PC data collector
High strength, lightweight digital cable with Kevlar® strain relief
Slimline 25mm diameter probe for all casing sizes

Probe Diameter	25.4mm
Probe Length	710mm
Wheelbase	0.5m
Resolution	0.005mm per 500mm
Range	±30° from vertical
Temperature Range	-40 to +70°C
Repeatability	±0.003°

Imperial system also available



INCLINED MEMS INCLINOMETER



Cutting edge MEMS (Micro-Electro-Mechanical Systems) technology for the measurement of lateral displacement.

Used for monitoring:
Down stream face of concrete faced rock filled dams

KEY FEATURES & SPECIFICATIONS

Probe-based microcontroller with digital calibration
24-bit A/D converter for digital data output
Bluetooth™ wireless communication with Pocket PC data collector
High strength, lightweight digital cable with Kevlar® strain relief
Slimline 25mm diameter probe for all casing sizes

Probe Diameter	25.4mm
Probe Length	710mm
Wheelbase	0.5mm
Resolution	0.005mm per 500mm
Range	±15° from 45°
Temperature Range	-40 to +70°C
Repeatability	±0.003°

Imperial system also available



HORIZONTAL MEMS INCLINOMETER



For monitoring settlement or heave under structures and observation of ground movement caused by construction excavation or fill placement. A local microcontroller in the probe manages the data collection, applies precision digital calibration and transmits the data in digital format for best of class accuracy.

Applications:
Embankments
Dams
Roadways
Storage Tanks
Landfills

KEY FEATURES & SPECIFICATIONS

Digital precision and efficient data collection with a high-level user interface that has instant USB synchronisation with office computers
Probe may be used with RST's Vertical in-place MEMS inclinometer system
Probe may be purchased with or without a system

Sensor Type	Uniaxial, MEMS inclinometer
Repeatability	±0.003°
Range	±30° from horizontal
Linearity	±0.02% F.S.
Casing Size	70mm or 85mm
Readout	Ultra rugged field PC

Imperial system also available

in-place digital mems inclinometers



VERTICAL IN-PLACE MEMS INCLINOMETER



In-place MEMS inclinometers (IPI) are designed for continuous automatic monitoring where early warning of movement is essential for protecting life and equipment.

A series of inclinometers are connected together and suspended inside the casing which can

provide a continuous profile of the inclinometer casing which can be data logged in real time.

Used for monitoring: Stability adjacent to excavations; Deflection of piles & retaining walls; Dams and embankments; Landslides and slope stability

KEY FEATURES & SPECIFICATIONS

- Optional single cable BUS system
- Lower cost than servo-accelerometer systems
- On board electronics
- Removable
- High precision wheeled probe
- Tilt & temperature calibration
- Easily adaptable to datalogging

Range	±15°
Resolution	±5 arc sec (±0.025mm/m (10HzBW) or better, readout technique dependent)
Non-linearity	±0.05%FS (±0.025%FS digital)
Sensor	MEMS (Micro-electro-Mechanical Systems) inclinometer
Operating Temp	-40 to 85°C
Gauge Length	0.5-3 m



INCLINED IN-PLACE INCLINOMETER



In-place MEMS inclinometers (IPI) are designed for continuous automatic monitoring where early warning of movement is essential for protecting life and equipment.

A series of inclinometers are connected together and suspended inside the casing which provides

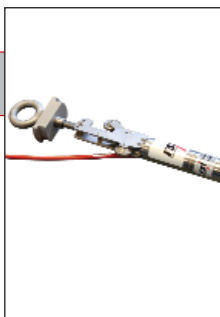
a continuous profile of the inclinometer casing which can be easily data logged in real time.

Used for monitoring: Deflection of dam up-stream face

KEY FEATURES & SPECIFICATIONS

- Optional single cable BUS system
- Lower cost than servo-accelerometer systems
- On board electronics
- Removable
- High precision wheeled probe
- Tilt & temperature calibration
- Easily adaptable to datalogging

Range	±15° from 45°
Resolution	±5 arc sec (±0.025mm/m (10HzBW) or better, readout technique dependent)
Non-linearity	±0.1%FS
Sensor	MEMS (Micro-electro-Mechanical Systems) inclinometer
Operating Temp	-40 to 85°C
Gauge Length	0.5-3 m



HORIZONTAL IN-PLACE INCLINOMETER



In-place MEMS inclinometers (IPI) are designed for continuous automatic monitoring where early warning of movement is essential for protecting life and equipment.

A series of inclinometers are connected together inside the casing which can provide a continuous

profile of the inclinometer casing which can be easily data logged in real time.

Used for monitoring settlement or heave in: Tank foundations; Embankments and dams; Landfills

KEY FEATURES & SPECIFICATIONS

- Optional single cable BUS system
- Lower cost than servo-accelerometer systems
- On board electronics
- Removable
- High precision wheeled probe
- Tilt & temperature calibration
- Easily adaptable to datalogging

Resolution	±5 arc sec (±0.025mm/m (10HzBW) or better, readout technique dependent)
Non-linearity	±0.1%FS
Sensor	MEMS (Micro-electro-Mechanical Systems) inclinometer
Operating Temp	-40 to 85°C
Gauge Length	0.5-3 m

inclinometer casing & accessories



INCLINOMETER SPIRAL SENSOR



The RST Digital MEMS Inclinometer Spiral Sensor is used to determine down-hole helical deformation of installed inclinometer casing.

Spiralling is typically of concern only in deep installations, however, should poor installation be suspected or installed spiral of interest,

measurement of the installed groove azimuth can be carried out with this instrument.

Operation is similar to an inclinometer, using the same cable and readout instruments, however it is necessary to read only one groove set, and not take a 180 degree second reading set.

KEY FEATURES & SPECIFICATIONS

Compatible with RST's Digital Inclinometer System. Simply connect the probe to the reel's connector and get spiral readings on the spot
No additional software required; The Inclinalysis™ software used for the digital inclinometer system is also used to process the spiral data
Compact and lightweight design

Material	Stainless steel
Weight	1kg
Overall length	570mm
Gauge length	400mm
Accuracy	± 0.25% F.S.
Resolution	0.01°



INCLINOMETER CASING SS- SNAP SEAL

Snap Seal (SS) inclinometer casing is manufactured from virgin ABS material and flush coupled and offers the ultimate in quality and accuracy. This is obtained through the shape and the machining process of the keyways to provide minimum spiral deviation. Telescopic sections are

available where vertical heave or settlement is anticipated to exceed 1-2%. Available in 85mm heavy duty version for rock fills.

Applications include: Slopes & landslides; Diaphragm walls; Sheet pile walls; Retaining walls; Dams; Tunnels; Subsidence & heave

KEY FEATURES & SPECIFICATIONS

Flush coupled with Quick Connect joints and O-ring seal provides rapid and easy installation especially in deeper holes through the elimination of glue, rivets and tape

Telescopic sections are available where vertical heave or settlement is anticipated to exceed 1-2%

Colour: Orange/Red

Diameter	70mmOD x 59mmID 85mmOD x 73mmID
Casing Length	1.5 or 3m
Casing Weight	1.27kg/m 1.49 kg/m
Material	ABS Plastic
Groove spiral	<0.3 deg/3m



INCLINOMETER CASING EC - EXTERNAL COUPLER

EC inclinometer casing is manufactured using high tolerance extrusion and provides a cost effective alternative to Snap Seal. It is joined using an external coupler in combination with glue, rivets and tape to seal against water or grout ingress and is suitable for all types of inclinometer systems.

Aluminium casing also available: Pipes - Length 3m, Nominal OD 58mm; Coupling - Length 30cm, OD 62.5mm.

Applications include: Slopes & landslides; Diaphragm walls; Sheet pile walls; Retaining walls; Dams; Tunnels; Subsidence & heave

KEY FEATURES & SPECIFICATIONS

EC inclinometer casing has internally extruded keyways offering high accuracy together with the flexibility of being able to cut lengths on site and join using the external coupler

Telescopic sections are available where vertical heave or settlement is anticipated to exceed 1-2%

Colour: Green

Casing Diameter	70mmOD x 60mmID
Coupler Diameter	80mmOD x 70mmID
Coupler Length	140mm
Casing Length	1.5 or 3m
Casing Weight	1kg/1m
Material	ABS Plastic
Groove spiral	<0.5 deg/3m

inclinometer casing & accessories



INCLINOMETER CASING ANCHORS & ACCESSORIES

Inclinometer Casing Anchors are fixed to the bottom of the casing prior to installation to prevent uplift, usually due to buoyancy forces of water or grout. As soon as the anchor exits the bottom opening of the drill rod/borehole, the spring-loaded arms of the anchor are automatically extended to grip the borehole wall.

Anchors available for 70 and 85mm casing in both snap seal and glue and socket coupling styles

Grouting version of the anchor available
Magnetic targets can also be integrated

ACCESSORIES

General Casing Accessories also available include:

Repair couplings
Caps
Grout Caps

Suspension Caps
Alignment Tool
Anti-Flotation Tool



SLIP INDICATOR SYSTEM

An economical method of determining within a soil mass the location of a zone where movement is occurring.

A flexible slip indicator pipe with base plate is inserted into the base of a borehole and surrounded with sand. When lateral movement of

the soil occurs, the flexible tube becomes deformed in the zone of movement.

Indicator probes attached to a length of support rope are used to determine the zone of movement.

KEY FEATURES & SPECIFICATIONS

Can be installed in 70mm boreholes or larger
Cost-effective way to measure movement in soils
Simple to install
No readout required
Probes can be made to suit individual requirements



PORTABLE MEMS TILT METER



The Portable MEMS tiltmeter uses a MEMS sensor to measure tilt in either one or two axial planes perpendicular to the surface of the base plate. It has a demountable sensor and is designed for applications where a large number of measuring points are to be observed.

Applications:

- Monitor tilt of retaining and building walls
- Tilt of concrete dams
- Landslide monitoring & ground subsidence
- Bridge Piers

KEY FEATURES & SPECIFICATIONS

Uniaxial or biaxial sensors available for horizontal or vertical applications
 Readout units & portable sensor
 Lightweight & easy to use
 Datalogger compatible; High accuracy & repeatability
 Operational range & temperature coefficients exceed that of bubble sensor devices

Range	±15° (other ranges on request)
Resolution	±5 arc sec (±0.025mm/m (10HzBW) or better, readout technique dependent)
Non-linearity	±0.1%FS
Sensor	MEMS (Micro-electro-Mechanical Systems) inclinometer
Weight	10.38lbs (4.710kg)



IN-PLACE MEMS TILT METER



Used to measure tilt in either one or two axial planes perpendicular to the surface of the base plate. Designed to be permanently installed to provide long-term observation with maximum resolution and sensitivity and for manual or remote data acquisition.

Applications include: Monitoring tilt of

- retaining & building walls
- Tilt of concrete dams; Structural load testing; Landslide monitoring; Building safety along adjacent excavations; Observation of benches & berms in open pit mines; Bridge pier monitoring; Ground subsidence

KEY FEATURES & SPECIFICATIONS

Uniaxial or biaxial sensors available
 Horizontal or vertical applications
 Analog, digital & frequency outputs available
 Datalogger &/or manual readout compatible
 NEMA 4X (IP-65) weatherproof enclosure
 Signal outputs: Voltage, 6-20mA, Digital, Digital BUS, Frequency

Range	±15° (other ranges on request)
Resolution	±5 arc sec (±0.025mm/m (10HzBW) or better, readout technique dependent)
Non-linearity	±0.05%FS (±0.025%FS digital)
Sensor	MEMS (Micro-electro-Mechanical Systems) inclinometer
Excitation	8-15V DC
Operating Temp	-40 to 85°C



SUBMERSIBLE MEMS TILT METER



The RST Submersible Tiltmeter provides precision real-time remote monitoring of tilt of submerged structures.

It consists of a MEMS sensor and electronics mounted inside a rugged waterproof enclosure machined from solid stainless steel bar, providing

extreme endurance for long-term, high-pressure underwater service. The cable entry is a submarine grade connector, which can be connected underwater and provides watertight performance at depths to 2,000m, making it an excellent choice for monitoring dams & off-shore structures.

KEY FEATURES & SPECIFICATIONS

Solid construction for extreme endurance over long-term, high-pressure underwater situations
 Substantial mounting base provides for in-place levelling with excellent rigidity and strength of the completed installation
 Signal outputs: Voltage, 6-20mA, Digital, Digital BUS, Frequency
 High accuracy and repeatability
 Built-in transient protection & watertight performance

Range	±15° (other ranges on request)
Resolution	±5 arc sec (±0.025mm/m (10HzBW) or better, readout technique dependent)
Non-linearity	±0.1%FS
Sensor	MEMS (Micro-electro-Mechanical Systems) inclinometer
Excitation	8-15V DC
Operating Temp	-40 to 85°C



MEMS TILT BEAM



For the measurement of differential movements in structures in the following applications:

Monitoring the effect of excavation and diaphragm walling adjacent to buildings and other structures.

The movement of tunnels and their effect

on adjacent structures.

Structures being underpinned & compensation grouted

The deflection of bridges and beams under load

Railway track monitoring

KEY FEATURES & SPECIFICATIONS

Simple construction with no moving parts to damage

Simple to install on any structure & easy to use

Beams can be linked together to monitor movement over long distances

Signal outputs: Voltage, 6-20mA, Digital, Digital BUS, Frequency

Easily adaptable to datalogging

Range	±15° (other ranges on request)
Resolution	±5 arc sec (±0.025mm/m (10HzBW) or better, readout technique dependent)
Non-linearity	±0.1%FS
Sensor	MEMS (Micro-electro-Mechanical Systems) inclinometer
Excitation	8-15V DC
Operating Temp	-40 to 85°C



RXTX TELEPENDULUM SYSTEM

For monitoring and measuring lateral movements in structures including:

Relative displacement between the base and top of a dam or between the dam and its foundation

Structural and foundation movements of tall buildings

Horizontal displacement of bridges, rock and building foundations

KEY FEATURES & SPECIFICATIONS

Precise optoelectronic detection system for monitoring x, y and z axes

Available as both direct & inverted systems

Local microprocessor for real-time recording

Weatherproof housing

On-board data protection system

Ability to connect to several types of dataloggers

Data storage	370 events
Local software	EPROM
Communication ports	RS232C, V.24; RS485
Modem port	Hayes™ 2400/9600bps
Range	50x50x25mm
Power	9 Va
Voltage	117 Vac



PENDULUM

Simple and reliable systems used to monitor internal lateral deformations of concrete dams, dam foundations and abutments, tall industrial buildings and bridge piers.

The direct pendulum (plumbline) consists of a stainless steel wire attached to a fixed point at the

top of a structure, a weight and a tank of damping fluid to damp movements. Displacements relative to the wire are measured by optical reading stations and telependulum.

The inverted pendulum uses the same readout units but the wire is anchored in the foundation.

KEY FEATURES & SPECIFICATIONS

Simple, reliable and accurate for long-term use

Available as both direct & inverted systems

Inverted pendulum measures absolute deformation of structure and can be used to monitor movement during construction; also as reference for geodetic surveying

Telependulum for remote monitoring and datalogging

AVAILABLE ITEMS
Direct pendulum c/w tensioning weight & tank
Inverted pendulum
Stainless steel wire for pendulums
Portable co-ordinator
RxTx telependulum



TIME DOMAIN REFLECTOMETRY

Metallic Time Domain Reflectometry is a simple and economical way of detecting and interpreting rock and soil mass response to underground and surface mining. It can be used effectively to locate rock and soil mass movements.

Used for monitoring rock and soil movement,

monitoring subsidence above abandoned underground mines and high wall slope monitoring in open pit mines.

KEY FEATURES & SPECIFICATIONS

Economical installation and data acquisition costs

Ability to monitor deformation along the entire length of the borehole



VW PIEZOMETER VWP-3000 SERIES



Vibrating Wire Piezometers are used for accurate measurement of pore water pressure in fully or partially saturated soil and rock.

Applications: Pore pressure measurements in foundations, embankments retaining walls and dams

**Fluid pressures in hydro-fracture & pump tests
Stability monitoring of tunnels, pipelines, mines and other underground engineering works**

Draw down and recovery testing in pumping and observation wells

KEY FEATURES & SPECIFICATIONS

Reliable long-term performance; suitable for demanding environments
High accuracy
Signal insensitive to long cable lengths
Sintered stainless steel or ceramic filter options
Drive-in & heavy duty versions
Vented version available

Standard Ranges kPa	70, 173, 345, 518, 690, 1034, 2068, 3447, 5171, 6895 kPa
Over-range	Min twice rated pressure
Resolution	0.025% F.S. (min)
Accuracy	±0.1% F.S.
Non-linearity	<0.5% F.S.
Temp range	-20°C to +80°C



STRAIN GAUGE PIEZOMETER

The strain gauge piezometer series of transducers/transmitters is specifically designed to meet the rigorous environments encountered in level measurement applications. These transmitters provide repeatable, precision depth measurements under the most adverse conditions.

Applications:

Ground water and surface water monitoring; Well monitoring; Percolation tests; Hydrostatic pressure; Site remediation; Deep aquifer measurement; Sea water depth; Drawdown; Dewatering; Dams; Slug tests

KEY FEATURES & SPECIFICATIONS

High static accuracy and repeatability guarantees reproducible measurements
Welded 316 SS construction for demanding environments (Optional titanium construction for corrosive environments)
Full temperature compensation provides accurate data over extreme excursions
Output: Voltage, 4-20mA

Pressure Range	345 to 6895kPa
excitation	9-30 VDC
Static Accuracy (%FS)	±0.1% - ±1% (depending on model)
Thermal Error (%FS)	0.05 - 0.1 (depending on model)
Comp Temp Range	10-50°C (depending on model)
Temp range	-10°C to 60°C



GROUTABLE MULTI-POINT PIEZOMETER STRING



Allows multiple vw piezometers to be simply and reliably installed in a single borehole and be connected to a tough urethane jacketed Kevlar® reinforced single cable which prevents vertical void channels. Used primarily where multi-zone monitoring is needed at single locations. No

conductors are shared ensuring the independent reliability of each sensor reading.

Applications: Earth fill dams & embankments; Slope stability; Pressures behind retaining & diaphragm walls; Pore pressures during fill or excavation.

KEY FEATURES & SPECIFICATIONS

No inter-zone leakage
Simple installation
Field proven reliability & accuracy
Data logger compatible
In-built thermistor as standard
Integral lightning protection

Standard Ranges kPa	70, 173, 345, 518, 690, 1034, 2068, 3447, 5171, 6895 kPa
Over-range	Min twice rated pressure
Resolution	0.025% F.S. (min)
Accuracy	±0.1% F.S.
Non-linearity	<0.5% F.S.
Temp range	-20°C to +80°C



CASAGRANDE PIEZOMETER

Simple and economic measurement of groundwater pressures in soil and rock.

Applications:
Dams, reservoirs & embankments
Slope stability

Groundwater levels for dewatering & drainage
Groundwater sampling
Permeability testing
Contaminated soil monitoring

KEY FEATURES & SPECIFICATIONS

Water level measurements are normally taken using a water level meter (dipmeter) or in the case of artesian pressure a Bourdon pressure gauge is attached to the top

POROUS PLASTIC ELEMENT	Material	HDPE
	Mean Pore Size	60 microns
	Permeability	$3 \times 10^{-4} \text{m/s}$
	Porosity	35%
CERAMIC ELEMENT	Material	Alumo Silicate
	Mean Pore Size	60 microns
	Permeability	$3 \times 10^{-4} \text{m/s}$
	Porosity	45%



PNEUMATIC PIEZOMETER

RST pneumatic piezometers utilise a direct reading pneumatically-operated diaphragm, making operation simple while ensuring long-term stability and high accuracy at low cost.

Applications:
Measurement of water pressures in soil and rock

Stability monitoring of foundations, earth fill dams & embankments
Slope stability investigations
Monitoring water levels in wells & standpipes
Monitoring pressures behind retaining & diaphragm walls

KEY FEATURES & SPECIFICATIONS

More than 25 years proven, long-term reliability & accuracy & more than 50,000 installations worldwide
 Lowest displacement available pneumatic piezometer available
 Available in standard & mini versions
 No internal metal parts – components are corrosion-resistant nylon
 Flow or non-flow methods supported
 Compatible with most brands of readout

Sensitivity	0.1%F.S.
Displacement	0.002cc
Materials	Nylon 12 with EP diaphragm
Accuracy	$\pm 0.25\%$ F.S.
Range	0-2000kPa/ 0-200psi
Repeatability	$\pm 0.35 \text{kPa} / \pm 0.05 \text{psi}$



WATER LEVEL METER

For the measurement of water level within soil and rock.

Applications: Ground investigation
 Hydrogeological studies
 Groundwater lowering and control
 Temporary & permanent drainage systems

Stability investigations for slopes & embankments
In-situ permeability tests
Pumping tests
Environmental studies

KEY FEATURES & SPECIFICATIONS

Simple and easy to use with audible and visual signals
 Slimline 14mm probe (minimum displacement)
 High accuracy
 Easy to clean
 Robust
 Available with temperature readout option

Probe Diameter	14mm
Probe Length	150mm
Tape Type	Steel mm markings
Tape Lengths	30, 50,100,150, 200, 250, 300 metres Special lengths on request
Audible Indicator	88 dB (A) buzzer



GEO-XM™ MAGNETIC SETTLEMENT SYSTEMS

The GEO-XM™ settlement system is used typically to monitor settlement and heave in foundations, excavations, embankments and dams as well as behind retaining structures such as diaphragm walls and sheet piles. It can also be used in tunnels and shafts.

Settlement is identified by the depth/position at which settlement has occurred as well as measurement of the total amount of settlement.

The GEO-XM™ system comprises a reed switch probe and a series of magnetic targets positioned on the outside of the flush jointed access or inclinometer tube. For soils where settlement is expected, telescopic joints or an

outer corrugated pipe can be installed to de-bond the inner pipe from the surrounding grout/soil which is subject to settlement. For other ground types the magnetic target rings can just be attached directly to telescopic joint couplings.

Applications: Foundations; Excavations; Dams; Embankments; Sheet piles; Retaining walls; Slurry walls; Tunnels & shafts



KEY FEATURES & SPECIFICATIONS

Available in the following types: All flush coupled with 3 or 6 leaf spider or plain magnetic targets:

GXM100 Access tube with magnetic targets (including spider type)

GXM100P With settlement plates

GXM100T With telescopic joints

GXM200* Inclinometer casing with magnetic targets (including spider type)

GXM200T* With telescopic joints

GXM300 Access tube & corrugated pipe with magnetic targets

GXM300I* Inclinometer casing & corrugated pipe with magnetic targets

*System provides the option to measure both settlement & inclination

INCLINOMETER CASING		
Casing OD	70mm	85mm
Casing ID	59mm	73mm
Casing Length	1.5 or 3m	1.5 or 3m
Material	ABS	ABS
Groove Spiral	<0.005 rad/3m	<0.005 rad/3m

INCLINOMETER TELESCOPIC SECTION		
Telescopic Section	70mm	85mm
Compressed Length	508mm	508mm
Extended Length	660mm	660mm
Range	152mm	152mm
Material	ABS	ABS
Groove Spiral	<0.005 rad/3m	<0.005 rad/3m

ACCESS TUBING TELESCOPIC SECTION	
Telescopic section OD	42mm
Telescopic section ID	35mm
Length	500mm
Range	200mm
Material	PVC

ACCESS TUBING	
Casing OD	33mm
Casing ID	25mm
Casing Length	1.5 or 3m
Material	PVC

CORRUGATED PIPE	
Pipe OD	42, 80, 100mm
Pipe ID	35, 71, 91mm
Length	3 or 50m coil
Material	PP, PVC

ACCESSORIES	
Coupling	42,80,100mm
Magnetic targets	90, 117mm
Reed switch probe	30,50,100, 150, 200mm



REED SWITCH PROBE

The reed switch probe is used to determine the location of magnetic sensors in magnetic settlement systems. When the reed switch passes through a magnetic field it closes, completing a circuit, and a buzzer is activated. The elevation of the magnet target is read directly from the tape.

KEY FEATURES & SPECIFICATIONS

Slimline probe
High accuracy
Simple to use
Easy to clean
Robust construction

Probe Diameter	14mm
Probe Length	150mm
Probe Material	Austenitic Stainless Steel
Tape Type	Steel mm markings
Tape Width	9.5mm
Tape Coating	Polyethylene
Tape Lengths	30, 50, 100, 150, 200m Special lengths on request



ROD SETTLEMENT SYSTEM

Single point devices used to monitor sub-surface settlement or heave of ground. The system comprises a series of inner and outer rods together with plates when positioned on ground before fill or Borros type anchors when used in boreholes.

Applications: A datum for standard surface settlement plates, negating the need for costly survey; Settlement monitoring under fills, preloads and embankments; Bottom heave in excavations; Settlement and rebound associated with tunneling; Heave as a result of grouting

KEY FEATURES & SPECIFICATIONS

- Simplicity of operation
- Uses locally-sourced common steel riser pipe
- Low cost



LIQUID SETTLEMENT SYSTEM



The vibrating wire liquid settlement system is designed for remote measurement of settlement or heave in soils and manmade structures.

A vibrating wire pressure sensor is attached to a settlement plate located at the point of settlement. The sensor is connected via two

liquid-filled tubes, extending laterally, to a reservoir located on stable ground. The sensor measures the hydraulic head of liquid between the sensor and reservoir locations. A vented cable runs from the sensor to a remote readout location.

KEY FEATURES & SPECIFICATIONS

Standard configuration includes one reservoir for each cell. Where settlements of two or more points long the same monitoring profile are of interest multi-position reservoirs are available

Also available as a Pneumatic Liquid Settlement Monitoring System. Similar to the VW system, but it uses a pneumatic pressure sensor. A reservoir is mounted at a higher elevation than the sensor in an area not subject to settlement

Settlement Cell Width	150mm
Cell Height	550mm
Accuracy	±0.3mm
Ranges	50mm, 100mm
Water height	<100mm
Reference Cell Size	162mmx550mm



PRECISION LIQUID SETTLEMENT SYSTEM



The liquid settlement system is an automated multi-cell settlement monitoring system used to monitor heave and/or settlement where a high degree of accuracy is required. The system configuration is very versatile, limited only by local conditions and site specifications.

Applications:
Monitoring structures that may be exposed to settlement as a result of nearby construction, tunneling or natural phenomena
Monitoring compensation grouting

KEY FEATURES & SPECIFICATIONS

- Reference cell ensures a common liquid level, removes cell inter-dependency and allows cell isolation
- De-aired fluid keeps the continuity of fluid consistent
- Surfactant reduces the adverse effects of surface tension
- Temperature compensation stabilises temperature effects on fluid density

Settlement Cell Width	150mm
Cell Height	550mm
Accuracy	±0.3mm
Ranges	50mm, 100mm
Water height	<100mm
Reference Cell Size	162mmx550mm



HYDROSTATIC PROFILER



A portable device designed to measure profiles of heave and settlement beneath structures.

A sensitive vibrating wire pressure sensor is located in a cylindrical metal housing which is pulled through a buried pipe. The sensor is connected, via a liquid-filled tube, to a reservoir

located on stable ground. The sensor measures the hydraulic head between the reservoir and its location.

Applications: Beneath fills, embankments, roadways, storage tanks, structures etc

KEY FEATURES & SPECIFICATIONS

Independent measurements of settlement can be made at closely spaced intervals providing a detailed profile of differential settlements over a wide area

The sensor is vented so that barometric pressure fluctuations have no effect on readings

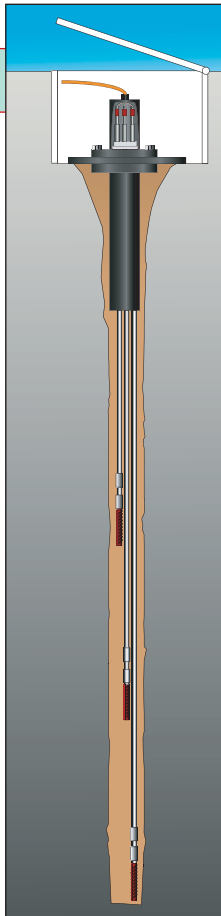
Range*	7m
Resolution	0.025%FS
Sensor Accuracy*	0.1%FS
Temp Range	-20°C to +80°C
Length x Diameter	203 x 35mm (probe) 178 x 610mm (reel)

*Other ranges available on request; Total system accuracy subject to site specific variables

convergence monitors & extensometers



ROD EXTENSOMETERS - GEO-XB™



The GEO-XB™ rod type extensometer range is used to measure and locate settlement, displacement and deformation in soil and rock.

It consists of a reference head and one or more in-hole anchors each of which is placed at a known depth and connected to the reference head by either a rigid or flexible rods running inside sleeves which keep the rods de-bonded from the grout.

As the soil or rock deforms the anchors' positions change and the relative movement can be measured in the reference head.

The magnitude, distribution, rate and acceleration of deformation can be accurately measured at the reference head.

The GEO-XB™ rod type extensometer range is available in a wide range of reference heads, anchors, rods and measuring sensors.

APPLICATIONS

Deformation of dam abutments & foundations

Ground movement around tunnels & mines

Ground movement behind retaining walls & sheet piles

Fracturing in roofs of underground caverns

Deformation of concrete piles

Settlement & heave in soft soil excavations

KEY FEATURES & SPECIFICATIONS

- Quick & easy to install in uphole applications
- Easy access & adjustment to sensors
- Mechanical & electrical combination possible
- Integral grout holes in head make grouting easy
- Accurate & reliable

REFERENCE HEAD TYPES

- Flanged
- Flangeless

MEASUREMENT OPTIONS

- Mechanical
Reading is carried out using a dial indicator or depth micrometer
- Electrical
Reading is carried out using an electrical sensor
- Combination
Reading can be carried out both mechanically and electrically

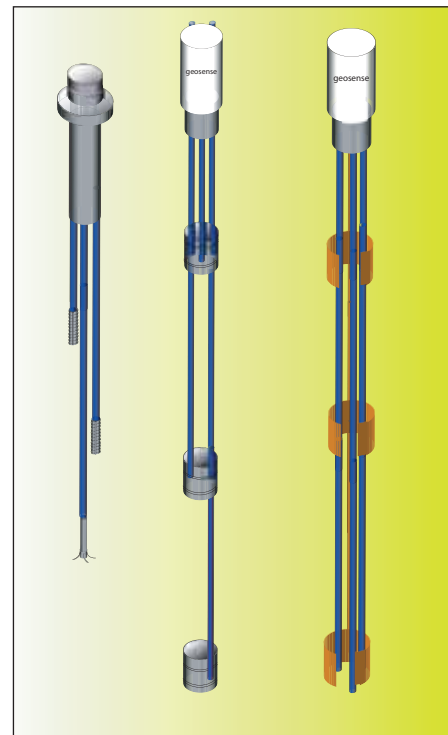
SENSORS

- Vibrating wire displacement gauge
- Linear Potentiometer
- Linear Variable Displacement Transducer (LVDT)
- All of the above can be used in combination with a mechanical system.

RODS

- Rigid type - 6mm stainless steel M6 threaded flush coupled joints available in 1,2,3m lengths
- Flexible type - 5mm GRP in lengths up to 400m

Description	Ranges
Manual	0-150mm
Vibrating Wire	25, 50, 75, 100, 150, 200mm
Linear Potentiometer	10, 20, 30, 50, 100, 125, 150mm
LVDT	25, 50, 75, 100, 150mm



SLEEVES

Available in rigid PVC with flush threaded joints or flexible nylon with external couplers.

ANCHORS

- Borros
- Snap Ring
- Groutable
- Hydraulic

VW Specification

Excitation	Pluck or swept frequency
Thermistor	3k Ohms at 25°C
Over-range	Range +20%
Resolution	0.025%FSO min
Accuracy	<0.5%FSO
Operating Range	-20°C to +50°C
Typical Range	3000-1600Hz



convergence monitors & extensometers



RST FLEXIBLE MPBX



Used to measure and locate settlement, displacement and deformation in soil and rock. Applications same as the extensometers featured previously.

Flexible extensometers comprise pre-set lengths of fibreglass which are coiled at the factory and

shipped ready for installation. It is lightweight making it easier to handle and install and less costly to ship. On-site assembly time is minimal and installation simplified.

KEY FEATURES & SPECIFICATIONS

Accuracy at low cost
Unit supplied completely assembled and sealed, ready for installation
Light and easily handled for quick and simple installation
Compact design for installation in boreholes of minimum size (up to 6 rods can be accommodated in a 75mm borehole)
Limited transverse shear accommodated without jamming of rods

Measurement Points	1 to 6
Rod Length	2 to 100 metres
Adjustment Range	±60mm
Rod Material	GRP, Carbon Fibre, Steel
Sleeve Material	Polyethylene/ Nylon
Rod Diameter	5mm
Borehole Diameter	25-75mm



MEASURING ANCHORS



Measuring anchors combine a rock bolt and an extensometer and are used to determine load exerted on rock bolts.

Within an anchor body, four mini extensometer rods have anchor points at different locations. Changes of length or compression between

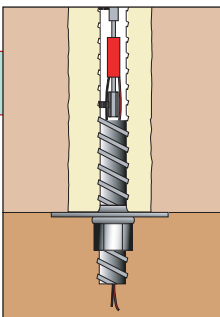
each anchor point can be measured using a mechanical dial gauge, VW, transducer or potentiometer.

Applications: Tunnels, inc NATM; Mines; Dams; Bridge abutments; Retaining walls; Rock formations; Foundations

KEY FEATURES & SPECIFICATIONS

Simple & robust construction
Replaces system anchor
No extra borehole required
Automatic data acquisition possible

Lengths	2,3,4,6 metres
Anchor points	4
Capacity	250 kN
Maximum diameter	38mm
Min borehole diameter	50mm
Range	±10mm
Resolution	0.01mm
Accuracy (VW)	<0.5%FS



INSTRUMENTED ROCK BOLTS



For long or short-term monitoring of strata loads. A vibrating wire strain gauge is inserted into a short length of standard threaded rockbolt or rebar which can be connected to a longer length of the same material for installation in the normal manner, ensuring the strain gauge

remains within the loaded part of the rockbolt. The gauge is read by a portable probe, connected to a strain gauge.

Used to measure loads in: UngROUTED rockbolts; Tiebacks used to stabilise ground around excavations & supporting retaining walls

KEY FEATURES & SPECIFICATIONS

Robust – requires no special handling
Recessed VW gauge can be left unattended for long-term monitoring
The strain gauge is located along the axis of the rockbolt and so is not affected by bending of the bolt
Long-term stability and accuracy

Standard Range	2500µε
Resolution	0.5µε
Accuracy	±0.25% F.S.
Linearity	±0.5% F.S.
Temp Range	-20 to+80°C
Bolt Sizes	25mm, 8 gauge rebar & larger
Length	300mm (standard)

convergence monitors & extensometers



TAPE EXTENSOMETER

For the measurement of surface movement. A portable device designed to measure the relative distance between reference anchors fixed to an excavation or structure.

Deformation of excavations
Measurement of radial movements and

convergence of tunnels, shafts, linings and caverns
Displacement of retaining walls, cuttings, bridge piers arches and abutments
Surface measurement of slope stability

KEY FEATURES & SPECIFICATIONS

Rapid one-man operation
Applicable in any orientation
Rugged, simple design
High accuracy and reliability
Supplied with robust carrying case
Digital and manual versions

Range	15, 20, 30m
Dial Indicator resolution	-0.01mm
Repeatability	+/- 0.25mm
Weight with 20m tape	2.2kg



JOINTMETER



Developed to monitor joints of mass concrete structures.

The instrument consists of two parts - a socket and the main body with a waterproof vibrating wire sensing gauge.

Used to monitor:
Joints of concrete arch, gravity and buttress dams
Joints of concrete-faced rockfill dams
Joints of concrete retaining and training walls and slabs

KEY FEATURES & SPECIFICATIONS

Long-term stability in difficult environments
Suitable for datalogging and remote monitoring
Integral lighting protection
High accuracy and resolution
accommodates shear movement
Not affected by cable length

Ranges	15, 25, 50mm (others available)
Over-range	1.25X range
Resolution	0.02% range
Accuracy	0.1% range
Operating temp	-20 to +80°C
Diameter	51mm
Lengths	15 & 25mm range: 340mm 50mm range: 430mm



CRACK METERS



Designed to measure movement across surface cracks and joints in a number of civil engineering and mining projects.

Available in two versions:
1-D & 3-D, with options of VW, manual & electrical output

APPLICATIONS
Concrete structures
rock and soil structures
Tunnel and shaft linings
Bridge construction

KEY FEATURES & SPECIFICATIONS

Rugged and reliable
Alarm triggered when preset critical rate or value reached
Suitable for remote reading and datalogging
Strong, flexible or screened cable available

Sensor Specifications	
Range	5-200mm
Non-linearity	<0.05%FS
Accuracy	<0.1%FS

convergence monitors & extensometers



CONVERGENCE MONITOR

An economical, robust instrument for the continuous or random monitoring of ground closure in mining and civil engineering projects.

Applications:
Mine development in squeezing ground
Tunnelling

Remnant mining
Road intersections
Subsidence and closure surveys

KEY FEATURES & SPECIFICATIONS

Digital indicator with standard range of 150mm
 Adjustable upper leg
 Option for remote reading by datalogger - useful where continuous monitoring is essential

Standard Range	150mm (others on request)
Resolution	0.01mm
Span	3.7m fully extended, 2.06m retracted



TUNNEL PROFILE MONITORING SYSTEM



The system involves a series of linked rods, fixed to a tunnel wall to monitor deformation. A datalogging system and related software is available to provide near real time displacement and generate a graphical representation of tunnel performance.

For monitoring:
Underground openings during construction for control and safety
Tunnel deformation due to nearby construction
Long-term deformation and performance of existing tunnels

KEY FEATURES & SPECIFICATIONS

Low profile design with multiple arms to fit close to tunnel wall
 Does not interfere with tunnel traffic
 High system accuracy of up to 0.02mm of deformation
 Custom engineered to suit each individual application
 Immune to air density problems inherent in optical systems
 Direct measurement of displacement rather than calculation from tilt measurement

SYSTEM COMPONENTS
Tilt/displacement sensor assembly
Extension tube
Electrical sensor to logger
Reference pin c/w tape extensometer connector
Datalogger system
GeoViewer software & manual



TELL-TALE CRACK MONITOR

Tell-Tales consist of two plates which overlap for part of their length. One plate is calibrated in millimetres and the overlapping plate is transparent and marked with a hairline cursor. As the crack width opens or closes, one plate moves relative to the other and the relationship of the

cursor to the scale represents the amount of movement occurring.

KEY FEATURES & SPECIFICATIONS

Available as:
Standard: For movements across cracks on flat surfaces
Corner: For monitoring movement across internal and external corners
Displacement: For monitoring cracks when one surface moves out of plane with the other
Tell-Tale Plus: Weather resistant, measures to an accuracy of 1.0mm

convergence monitors & extensometers



SOIL EXTENSOMETER



The VW Soil Extensometer monitors lateral and longitudinal deformation of soil and different types of embankments and embankment dams.

It consists of a vibrating wire displacement sensor encased in a sealed body. The body contains a telescopic outer PVC pipe fitted with two flanges

and an inner stainless steel rod.

One end of the rod is attached to the flange while the other is connected to a displacement sensor attached to the other flange. As deformation occurs, the telescopic pipe moves with the soil causing the rod to operate the displacement sensor.

KEY FEATURES & SPECIFICATIONS

- Easy installation and maintenance
- Suitable for remote reading and datalogging
- VW displacement sensor assures long-term stability
- Robust and accurate
- Wide measuring range

Gauge Length	1m, with 0.5, 1, 2 & 3m extension kits
Sensor Range	25, 50, 75, 100 & 150mm
Accuracy	±/-0.5% FSR
Resolution	0.02% FSR
Non-Linearity	0.5% FSR



VW LOAD CELL



For the measurement and control of compressive or tensile load. Available in both solid and annular styles.

Applications:
Ground anchors & tendons
Rock bolts

Structural beams
Piles
Tunnel lining segments
Proof loading & pull-out testing of trial anchors

KEY FEATURES & SPECIFICATIONS

Proven long-term stability and accuracy
 High sensitivity & accuracy; datalogger compatible
 Will accommodate eccentric loading
 Frequency output of vibrating wire resistant to external electrical noise
 Able to tolerate wet wiring without signal degradation
 Signal capable of being transmitted several kilometres

Capacity	225 to 10675kN
Over-range Capacity	150% F.S.
Sensitivity	0.01% F.S.
Accuracy	0.5% F.S.
Material	High tensile steel
Hole Size	16 to 280mm



HYDRAULIC LOAD CELL

Hydraulic Load Cells provide measurement of compressive loads between structural members. The load is distributed equally over the loading area of the cell by a thick, machined steel distribution plate. The load, when applied to the cell, causes a pressure increase in the hydraulic

fluid and this change can be measured.

Two designs available: An annular cell and a solid cell.

Used for rock and soil anchors, concrete pre and post-tensioning and for the measurement of compressive loads between structural members.

KEY FEATURES & SPECIFICATIONS

Simple, reliable hydraulic operation
 Automated data acquisition systems available.
 Readout methods: A Bourdon Tube Gauge, the simplest method, or various types of electrical transducers
 Low profile
 Remote readout capability
 Can be converted to VW & strain gauge output



STRAIN GAUGE ANCHOR LOAD CELL (7000 series)



SGLC-7000 series consists of a hollow cylinder of high strength steel and a series of electrical resistance strain gauges connected around the periphery of the spool as a Wheatstone Bridge and provides a single mV/V signal output.

Applications
To measure tensile loads in tie-back anchors and rock bolts or compressive loads in structures.

KEY FEATURES & SPECIFICATIONS

Manufactured from high tensile, heat treated, stress relieved steel and with precision bearing surfaces
 Multi sensor configuration makes it possible to obtain more accurate readings under mildly eccentric loading conditions
 Connection to the load cell is via a heavy duty multi-core sheathed cable which can be connected to a direct portable readout, switched terminal units or a data logging system

Range	300 to 25005kN
Over-range Capacity	150% F.S.
Sensitivity	0.005% F.S./°C
Accuracy	0.01% F.S.
Temp range	-10°C to +55°C
Excitation	10 V DC
Output	mV/V



VW TOTAL PRESSURE CELL



Used to monitor total pressure in earth fill dams and embankments or placed at the interface between structures and the excavation wall. Available in three transducer outputs: VW, pneumatic and strain gauge.

Applications:

- Embankments & dams
- Retaining walls, piers and abutments
- Foundations
- Underground excavations, rock walls of caverns and tunnels

KEY FEATURES & SPECIFICATIONS

- Long-term stability
- High accuracy & sensitivity
- Constant monitoring capability
- Easy datalogging
- Stainless Steel construction

	Pneumatic	Strain Gauge	Vibrating Wire
Range	Up to 13,800kPa	Up to 34,500kPa	Up to 34,500kPa
Accuracy	.25 or .15%FS	To ±0.1%FS dependent on sensor	0.1%FS
Over-range	2000psi max	200-500%FS dependent on sensor	200%FS
Resolution	Equal to readout instrument	Infinite	0.1%FS
Operating Temp	-20° to +80°C	-20° to +80°C	-20° to +80°C
Excitation	n/a	Dependent on sensor	5Vsq Wave



VW NATM STRESS CELL



NATM stress cells are designed to measure total stress in concrete (shotcrete) linings in tunnels and other underground workings.

The instrument is associated with monitoring & control of construction by the New Austrian Tunnelling Method (NATM), also known as

Sprayed Concrete Lining and sequential Excavation Method.

It is used for the monitoring of radial and tangential stresses within and on shotcrete lining, along with measurement of tunnel convergence and deformation.

KEY FEATURES & SPECIFICATIONS

- High accuracy and sensitivity
- Vibrating wire transducer assures long-term stability
- Easily connected to datalogging

Over-range	200% F.S.
Accuracy	to 0.1% F.S.
Resolution	0.025% F.S.
Signal output	2000-3000Hz



BOREHOLE PRESSURE CELL



For strain measurement in both elastic and viscoelastic rock.

Cells are available in two basic configurations: a miniature flatjack version and a cylindrical pressure cell.

Both involve stainless or copper plates welded together at the edges. The space between is filled with fluid. Once the cell is grouted in the borehole, the fluid is pressurised. Stress changes can then be determined by the corresponding change in hydraulic pressure.

KEY FEATURES & SPECIFICATIONS

- Reliable long-term performance & low cost
- Stainless or copper construction
- Suitable for demanding environments
- Remote readout available
- Datalogger compatible

Range	0-10,000 PSI
Sensitivity with gauge readout	40 PSI
Accuracy with gauge readout	1%



PUSH-IN PRESSURE CELL



A Push-in Pressure Cell is designed to be pushed into the ground where it can measure total earth pressure and pore water pressure within the soil. It can be used as a site investigation tool to determine the in-situ stress

state, both vertical and horizontal, depending on the direction of installation.

KEY FEATURES & SPECIFICATIONS

- Integrated pore pressure measurement
- Long-term stability
- High accuracy & sensitivity
- Constant monitoring capability
- Ease of data logging
- Range of transducers

Range	70, 170, 350, 700kPa 1, 2, 3, 5 MPa
Over Range	150% FS
Accuracy	±0.1% FS
Temperature Range	-20°C to +80°C
Filter	50 micron sintered (high air entry 1,3,5 bar available)
Length	524mm



JACKOUT EARTH PRESSURE CELL



Used to measure active and passive pressures on diaphragm walls.

Applications:
Measurement and control of contact pressures on diaphragm walls

Verifying design assumptions, assuring pressures are not larger than those the structure was designed to withstand

KEY FEATURES & SPECIFICATIONS

- Choice of pneumatic, strain gauge or vibrating wire pressure transducers
- High accuracy and sensitivity
- Suitable for remote monitoring or datalogging
- Cell designed to have stiffness similar to that of typical soils
- Rugged, easy to install and operate
- Fluid pressure calibrated

(Vibrating wire version)	
Range	up to 5000psi
Accuracy	to 0.1% F.S.
Resolution	0.1% F.S. (min)
Operating temp	-29°C to + 65°C



PILE TIP LOAD CELL



Custom-manufactured to suit site specific requirements. Cells can be any shape to suit different pile types. They operate on principles similar to total earth pressure cells.

The cell is typically divided into between 1 and 4 independent sections, each connected to a

pressure transducer. Each of these reacts to the change in fluid pressure in each section and the sum of these gives the total load on the pile tip.

Used for measurement of load at the tips of driven piles, cast-in-place piles and drilled shafts

KEY FEATURES & SPECIFICATIONS

- Water resistant
- Can be datalogged
- Signal output options: VW; Pneumatic & strain gauge options

ANCILLARY EQUIPMENT

- Readout units
- Datalogger
- Pile tell-tales
- Load cells
- Strain gauges for measuring stress distribution
- Sister bars



VW-2100 EMBEDMENT STRAIN GAUGE



Particularly suitable for the long-term monitoring of concrete structures. Consists of two end flanges with a tensioned steel wire between them. As concrete undergoes strain, the end blocks will move and the tension in the wire changes. A vibrating wire readout generates voltage pulses in the magnet/coil at

the centre of the gauge and measures the resonant frequency of vibration.

Monitors stress and/or strain determination in: Driven and bored piles; Tunnels and deep excavations; Concrete Dams; Mass concrete pours; Building foundations; Retaining Walls

KEY FEATURES & SPECIFICATIONS

Reliable long-term performance and accuracy
Rugged, suitable for demanding environments
Not affected by long cable lengths
Suitable for direct embedment in concrete
Output resistant to electrical noise
Thermally aged to minimise long term drift & calibration changes

Resolution	1 μ e
Strain Range	3000 μ e
Accuracy	\pm 1% to \pm 0.5% FS
Non Linearity	<0.5%
Temperature Range	-20°C to +80°C
Lengths	50 to 260mm



VWS-2000 SURFACE MOUNT STRAIN GAUGE



Used for the long-term monitoring of steel or concrete structures. Gauges may be attached to steel structures by arc welding or by using alternative end blocks bonded or grouted into concrete. The arc weldable surface mounting blocks are designed so the complete strain gauge can be

mounted in them after welding.

Monitors stress and /or strain determination in or on: Steel struts; Excavation support systems; Tunnel linings; Driven and bored piles; Bridges; Arches

KEY FEATURES & SPECIFICATIONS

Reliable long-term performance and accuracy
Rugged, suitable for demanding environments
Not affected by long cable lengths
Coils permanently attached to strain gauge
Output resistant to electrical noise
Thermally aged to minimise long term drift & calibration changes

Resolution	1 μ e
Strain Range	300 μ e
Accuracy	\pm 0.1% to \pm 0.5%FS
Non Linearity	<0.05%FS
Temperature Range	-20 to +80°C



VWS-2020 SPOT WELD STRAIN GAUGE



Designed primarily to measure strains on the surface of steel structures. Consists of two end blocks with a tensioned steel wire between. As the surface undergoes strain the blocks move changing tension in the wire. A VW readout generates voltage pulses and measures the resonant frequency of vibration.

Available in two versions: Gauge with integral coil housing; Gauge only with separate coil housing

Monitors stress and /or strain determination in or on: Struts and support systems; Pipelines; Bridges & Dams; Buildings; Tunnel linings; Piles & Mass Concrete

KEY FEATURES & SPECIFICATIONS

Small - can be used in confined spaces
Easily tensioned on site
Reliable long-term performance
Rugged, suitable for demanding environments
Insensitive to long cable lengths.
Suitable for remote reading and data logging
Attached by spot welding

Gauge Length	49mm
Overall Length	65mm
Strain Range	3000 μ e
Resolution	0.4 μ e
Accuracy	\pm 0.1% to \pm 0.5%FS
Non Linearity	<0.5%FS
Temp range	-20°C to +80°C



REBAR STRAIN METER & SISTER BARS



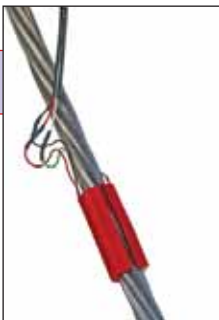
Designed to be embedded in concrete for measuring strains due to imposed loads. It is welded into and becomes an integral part of the existing rebar cage. (Sister bars are tied-in, not welded.) Particularly applicable for pours where placing of concrete is remote and uncontrolled, typically in diaphragm walls and deep piles.

Rebar strain meters are usually installed in pairs on either side of the neutral axis. The extensions are long enough to ensure perfect contact with the surrounding concrete so that measured strains inside the steel are equal to the strains in the surrounding concrete.

KEY FEATURES & SPECIFICATIONS

Reliable long-term performance
 Suitable for demanding environments
 High accuracy
 Insensitive to long cable lengths
 Direct concrete embedment

Excitation	Pluck or swept frequency
Thermistor	3k Ohms at 25°C
Over-range	Range +20%
Resolution	0.025% FSO (min)
Accuracy	<0.8% FSO
Operating range	2500 micro strain
Typical range	3200-1600Hz



TENSMEG TENSION MEASURING GAUGE

The TENSMEG (Tension Measuring Gauge) for monitoring strand tendons is a spiral strain gauge comprising a Teflon® coated resistance wire extending between two hard rubber end anchors.

It is a highly effective, simple to use means to

examine load and strain in rock and soil anchors and also in cable bolts used for rock support.

Used to measure load and strain in rock and solid anchors in the bond or stressing zone and in pre-stressed and post-tensioned concrete

KEY FEATURES & SPECIFICATIONS

Exceptional linear response and accuracy in a low-cost system
 Simple to use and implement on site
 Sturdy design provides ultimate reliability and durability
 Performance not compromised when embedded in concrete or surrounded by grout
 Water resistant

Full Scale Tension	Exceeds 50,000με
Full Scale Compression	3000μ*
Resolution	1με
Accuracy	2% F.S.

* Dependent on level of pre-tension applied during installation



GEOLOGGER SERIES

A multi-channel datalogger designed for reliable remote monitoring under demanding geotechnical conditions. It is capable of monitoring all types of sensors with the following outputs: voltage, 4-20mA, digital, digital BUS, frequency.

Applications:

Remote datalogging of various types of geotechnical instrumentation used in dams, tunnels, bridges, mines and natural slopes
Real time datalogging and analysis

KEY FEATURES & SPECIFICATIONS

Ability to read virtually any geotechnical sensor
 Large range of data retrieval options
 Alarm triggered when movement reaches a preset critical rate or levels reach a present value

Data retrieval by several methods:

RS232 Cable/USB
Storage Modules
Radio Frequency
Wireless Short Haul Modems
Phone Modems
Satellite



DT2055 DATALOGGER



The DT2055 Vibrating Wire Data Logger is a low cost, battery-powered data logger, designed for reliable, unattended monitoring of up to 10 sensors which may be any mix of vibrating wire sensors and thermistors, typically 5 vibrating wire sensors with their associated thermistors.

It is a purpose-built logger ideal for remote locations or instruments that require frequent reliable data recording.

Ideal for applications that require reliable, unattended monitoring of up to five vibrating wire sensors.

KEY FEATURES & SPECIFICATIONS

Robust construction & Weather resistant
 4MB memory
 NEMA 4X (IP65) enclosure
 Battery powered for remote sites.
 100 year memory backup
 Compatible with all VW sensors (excluding those with auto resonant circuitry)

Accuracy	0.1% full scale
Resolution	1 part in 65,000
Memory	Over 120,000 records
Memory	4mb
Data Transfer	5,000 data points/sec
Temp Range	-40 to 60°C



SINGLE CHANNEL VW DATALOGGER



A single channel, low cost battery-powered datalogger designed for reliable unattended monitoring of a single vibrating wire sensor and thermistor.

Ideal for remote locations or instruments that

require frequent reliable data recording.

It connects to all geotechnical vibrating wire sensors including piezometers, crack meters and strain gauges via a IP68 bayonet connector.

KEY FEATURES & SPECIFICATIONS

Frequency output immune to external electrical noise
 Tolerates wet wiring without signal degradation
 Transmits over several kilometres without loss

Accuracy	0.01% F.S.
Resolution	1 part on 65,000
Memory	Over 30,000 readings
Temperature range	-40°C to 60°C
Power Source	2 AA batteries
Data stores in CSV format and opens in Microsoft Excel.	



SURGE ARRESTER

Wiring, particularly long horizontal wiring, can convert transient electrical fields to destructive voltages at sensors and data logger terminals. The Surge 4D (4-Wire & Shield Transient Protector) can be used to divert these transients to ground, increasing installed system reliability.

The ELLP4501 transient protector is a multi-stage device which is capable of protecting against high speed (100 volts per microsecond) transients of up to 20,000 amps, letting only 77 volts through before clamping to 4 volts.

KEY FEATURES & SPECIFICATIONS

Protects against high-speed transients of up to 20,000 amps
 Low resistance in dormant state
 Self re-setting for uninterrupted operation after transient completed
 Compatible with most devices, including VW sensors, data loggers, 4-20 mA transmitters and other DC-powered sensors*
 Compact user-friendly devices

*For continuously powered DC devices, a fuse in series with the DC supply is recommended

Lines protected	4+2 shields
Max transient current per line	20,000 Amps
Min conduction threshold	77 Volts
Output clamp voltage	4 Volts
Series resistance per line	1/6 Ohms
Max leakage current	5 Microamps
Hold current	150 Milliamps
Max AC current (1 line cycle)	30 Amps RMS
Max continuous current	2 Amps



VW0420 VW ISOLATED ANALOG INTERFACE



The VW0240 provides an interface between vibrating wire instruments and factory automation systems which support 4-20 mA sensors. The VW section measures the natural frequency and

temperature of the sensor. The measurements are then converted into engineering units etc, as required, and scaled to the 4-20 mA outputs.

KEY FEATURES & SPECIFICATIONS

Straightforward setup using Windows host program via USB cable
 Four dialectically isolated ground subsystems (for power, sensor and one each for outputs) means maximum flexibility in connecting the system

VW sensor types	Piezometer, strain gauge, displacement sensor etc
Sweep types	A, B, C, D, E, F, user defined
Current resolution	0.002%
Current conversion accuracy	0.02%
Frequency input	250-6000hz
Update rate	2 seconds
Operating temperature	-40 to 55°C



FLEXI-MUX MULTIPLEXER

The Flexi-Mux allows a single channel of dataloggers to be sequentially connected to numerous sensors. Each Flexi-Mux can sequentially multiplex 5 groups of 4 lines for a total of 20 lines. Internal DIP switch settings permit the multiplexing of 10 groups of 2 lines.

The Flexi-Mux is used to monitor numerous types of sensors in conjunction with a datalogger. It is compatible with most sensors including load cells, pressure transducers, vibrating wire sensors, thermistors, potentiometers and numerous other speciality sensors.

KEY FEATURES & SPECIFICATIONS

Unlimited connections to datalogger using cascading method
 Slim and compact design utilises box space efficiently
 Quick access and detachable screw terminals simplify the wiring process
 Built-in transient protection on every line

Power	12Vdc (under load)
Current drain	10µ quiescent; 8mA active
Operating temp	-40°C to 70°C
Reset Active Levels	2.0V (max)
Clock Active Levels	2.0V (max)
Clock Pulse Width	1ms (min)
Actuation Relay	20ms (max)



GEOWAVE



A wireless datalogger, fully featured and providing a complete cable-free datalogging and remote data monitoring solution which can be connected to any vibrating wire instrumentation.

Built-in vibrating wire technology provides an all-in-one data acquisition and monitoring

solution. It collects readings directly from radio sensors, storing them in a non-volatile memory. Data retrieval is via purpose-designed software.

**Applications: Geotechnical Instrumentation
Structural Monitoring**

KEY FEATURES & SPECIFICATIONS

Cable-free monitoring
Range up to 600m
Long Battery life
Remote data acquisition
Remote interval adjustment
Alarm triggering

TRANSMITTER	
Power	9V standard 6-24 optional
Battery life	3 years (5 min intervals)
Range	600m (in line of sight)
Frequency	2.4GHz

TRANSCEIVER	
Power	12-24v (via datalogger)
No of sensors	Up to 127
DATALOGGER	
No of transceivers	30
No of sensors	Up to 1,200
Power	12-24V
Memory	1mb non volatile



RUGGED FIELD PC



The Ultra-Rugged Field PC functions as a data collector for a wide range of instruments, including inclinometers, tilt meters and tilt beams, and can download information from other data loggers using Field Book 5 software.

It allows 'on site' data analysis and comparison to

previous data sets and instant USB synchronization with office computers.

Wireless communication is available with the RST MEMS Inclinometer and via a USB-RS485 cable for a wide range of other MEMS sensors and data loggers.

KEY FEATURES & SPECIFICATIONS

20 hour battery life & easily charged in the field
Real time clock & date even without battery
Lightweight
Waterproof & dustproof to IP67
Large easy to read viewing screen
Shockproof

Operating system	Windows® Mobile
Software	Field Book 5
Memory (RAM)	128MB
Data Storage	256/512mb Flash disc
Temperature Range	-30°C to 50°C
Size	165Lx43Wx89H mm
Weight	482g
Enclosure	IP67



SINGLE CHANNEL VW2106 READOUT



The VW2106 Vibrating Wire Readout is a weatherproof, portable device which reads, displays and logs both vibrating wire sensors and thermistors. The user-friendly format allows the user to programme the calibration factors for up to six different types of gauges. The maximum

download time is just 15 seconds.

Operating it is simple - connect the gauge, select the correct gauge type and press 'Enter' to log the data. A large backlit display and sealed control permits operation under demanding site conditions.

KEY FEATURES & SPECIFICATIONS

Durable, compact design
Large graphics display with a convenient backlight.
Readings in raw or engineering units
Built-in multiplexer for load cells
Up to 6 vibrating wire gauges
Field-replaceable AA alkaline batteries eliminate need for bulky 12V battery

VW Excitation Range	400Hz to 6000Hz, 5V Square Wave
Resolution	0.01µs
Timebase Accuracy	±50ppm
Temperature Accuracy	±0.1°C
Temperature Range	-50°C to 80°C
Memory Capacity	11,400 labelled points



VW200 VW READOUT



The VW200 vibrating wire readout is an easy-to-use portable direct readout for use with all vibrating wire sensors. Fitted with a highly audible plucking tone, it provides a simple and easy-to-use readout.

KEY FEATURES & SPECIFICATIONS

Durable compact design
Large easy to read display
Audible pluck for easy operator check
Readings in micro-seconds

Overall size	10 x 180 x 44mm deep
Weight (approx)	500 grams
Case material	Black ABS plastic
Pluck voltages	14 or 21vdc,switchable
Display	Large 6 digit LCD
Temperature range	-10°C to 70°C
Battery life	40 hrs (speaker off), 5 hrs (on)



MEMS TILTMETER READOUTS

Used to monitor tiltmeters or in-place inclinometer sensors utilising MEMS technology. The readout is simple to connect and two versions are available with output displays in mV or Sine Angle. It is extremely useful for checking tiltmeter/beams or in-place inclinometers prior to connection to a data acquisition system.

KEY FEATURES & SPECIFICATIONS

Lightweight
Rugged construction
Easy to use
Large LCD display
Colour-coded inputs

Power supply	±12 VDC, 250 mA
Continuous Work Time	28 hours
Operation Temp	-10°C to +60°C
Relative Humidity	<95% at +40°C
Range	300mV
Angle	±4.2° in-place inclins, ±1.2° tilt sensors



INTELLIGENT TRANSDUCER READOUT

A portable battery-powered field instrument designed to monitor strain gauge type transducers with readout directly in engineering units, or as a Voltage.

Compatible with a wide range of gauges.

Microprocessor intelligence provides a wide range of features and the simplicity of design allows the non-technical user to operate the readout with a minimum amount of instruction.

All set-up data is stored in a non-volatile memory.

KEY FEATURES & SPECIFICATIONS

Readout in ANY preferred engineering unit
Rugged and Reliable
rechargeable battery-powered operation
Monitors both unterminated and connector equipped gauges
Automatic internal calibration function

Monitors:
ANY wheatstone full bridge based transducer
Strain gauge piezometers & load cells
Pressure transducers
CSIRO hollow inclusion stress cells
CSIRO yoke gauges
ANZSI stress cells



PNEUMATIC READOUT C108

Pneumatic readout instruments provide the most accurate and reliable monitoring of pneumatic piezometers, pressure cells and settlement systems with a simple one switch operation. Pneumatics are especially suited to projects where manual readings are required and are

excellent for projects where lightning-immune backup to electrical sensors is needed.

Applications include monitoring of all pneumatic transducers, including Total Earth Pressure Cells and 'Bubbler' readout for monitoring standpipe piezometers.

KEY FEATURES & SPECIFICATIONS

Sealed weatherproof case and electronics & automatic shut-off
 The standard FC-100 automatic flow controller ensures accurate repeatable readings. Operator error in adjusting flow rate valve and reading of flow meter is eliminated
 Pressure ranges to 2000psi (14,000kPa)
 Economical low operating rate of 35cc/min
 File format compatible with Microsoft Excel® and other spreadsheets

Available in

Analogue (C-102) & Digital (C-108) models.

The newly-developed C-108 stores up to 170 instrument locations per route, each with a convenient test label and up to 20 time/date stamped data points.



THERMISTOR READOUT

The portable TH2016 Thermistor Readout reads, displays and logs up to 16 thermistor string points at the push of a button. Unprecedented accuracy, flexible memory options and ease of use make the TH2016 invaluable for projects requiring temperature

monitoring involving thermistor strings. Maximum download time is only 15 seconds.

The TH2016 combines maximum accuracy with efficiency. Housed in a compact and rugged case, the complete readout operates with only 3 AA batteries and has a large graphics display.

KEY FEATURES & SPECIFICATIONS

Durable, compact design for excellent portability and field use.
 Readings in raw or engineering units
 Stores up to 254 thermistor string locations per route, each with a text label, date stamp, previous data, and up to 3,000 arrays of 16 points
 Data transfer to a host computer via USB in a compatible file format for Microsoft Excel® and other spreadsheets. User-friendly host software for Microsoft Windows® included

Temp Curve Conformance	± 0.05°C
Resistance Accuracy	± 0.02%
Temp Readout Range	-50°C to 80°C
Max Thermistor locations	254
Operating Temperature	-20°C to 60°C
Download Speed	15 secs (full memory)
Location ID string	Up to 20 characters



DEPTH GAUGES

Used to gain extensometer measurements. The depth micrometer is suitable when there is easy access to the reference head. When access to the reference head is difficult or where real-time or continuous monitoring is required, a sensor is the better option. Available with digital or dial display.

Used with Rod Extensometers in applications including: Tunnels, Roof and wall stability; Subsidence; Dams; Bridge abutments; Retaining walls

KEY FEATURES & SPECIFICATIONS

Large, easy to read display
 Tolerance, relative and absolute modes
 Complete with 6 flat end depth rods
 In fitted case (digital only)

Range	0-150mm
Diameter of rods	4.5mm
Base width	100mm
Resolution	0.001mm
Display	Digital, Dial



INTERFACE PROBE

The OWP oil/water interface probe is used to determine the thickness of hydrocarbons, in light non-aqueous phase (LNAPL) and dense non-aqueous phase (DNAPL) in groundwater. It consists of a stainless steel shroud with a specially designed float and conductive probe to minimise surface tension errors thus providing

unparalleled accuracy.

As the probe is lowered into the LNAPL, a single audible buzz is heard and a green light shows.

Once the probe reaches the water at the oil/water interface, a two-tone buzzer is heard and both the green and red lamps show.

KEY FEATURES & SPECIFICATIONS

- Slimline 20mm probe
- High accuracy
- Simple to use
- Easy to clean
- Robust construction
- Compact design

Shroud Diameter & length	20mm x 225mm
Shroud Material	Austenitic st. steel
Tape Type	Steel, mm markings
Tape Lengths	30, 50 & 100 metres
Float Diameter	10mm
Reel Diameter	230mm
Power	9 Volt PP3 battery



ANTIFOAM DIP METER

The Anti-Foam Dipmeter has been designed to measure the leachate level within gas/leachate wells or sumps.

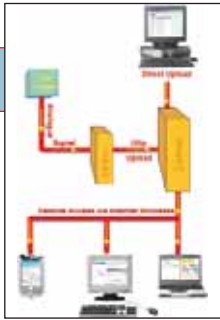
Its special shroud is unaffected by the presence of leachate foam found within wells, particularly where leachate is being pumped and/or positive

gas extraction occurs, thus eliminating false readings. Once the float comes in contact with liquid (NOT FOAM) an audible buzz is heard, together with a visible red light.

KEY FEATURES & SPECIFICATIONS

- Simple and easy to use with audible and visual signals
- Slimline 21mm probe (minimum displacement)
- High accuracy
- Easy to clean
- Robust
- Available with temperature readout option

Probe Diameter	21mm
Probe Length	200mm
Tape Type	Steel, mm markings
Tape Lengths	30, 50, 100, 150, 200, 250, 300 metres
Audible indicator	88bB (A) buzzer



GEOSENSE VIEWER WEB-BASED SOFTWARE

An Internet browser-based package which allows the viewing of remote data from geotechnical instrumentation anywhere and at any time, removing the need for a dedicated PC on site. All the data and analysis power from field instruments is made immediately available.

To access it, users simply log on to their dedicated secure DataSense site through their web browser using a unique access code and password. They can then check for readings, alarms, graphs and reports - all in real time.

KEY FEATURES & SPECIFICATIONS

Secure UK-managed server	Data filtering
Loads directly from dataloggers or by manual upload	Simple data upload
Fully interactive graphing	No software needed
User or project graph saving	From single to multi-instrument readings
Data export	
Real time display	



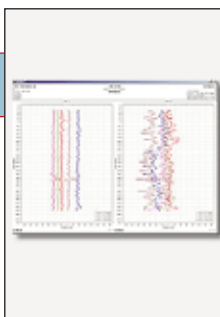
GEOVIEWER SOFTWARE

Designed to simplify data interpretation, GeoViewer software allows the user to retrieve data from loggers in near-real time and graphically process the information.

APPLICATIONS:
Assess settlement effects on various civil structures
Correlating data obtained from various monitoring instrumentation used on the same project

KEY FEATURES & SPECIFICATIONS

Software in both English and customised to the user's specified language	Multiple alarm functions with user programmable rate/magnitude thresholds provisions
Superimposition of original images over post deformation data	Cross platform data export abilities to Windows™95, 98, 2000, NT™ and XP™ operating systems
Automated collection and processing of data updating in near-real time	Export on-screen data representation as JPEG image for internet or email use



INCLANALYSIS SOFTWARE

RST Inclanalysis™ Software is a powerful companion to the RST Digital Inclinometer System.

Compatible with other manufacturers' data files.

It allows the user quickly and efficiently to reduce large volumes of inclinometer data in a variety of formats suitable for analysis and presentation.

KEY FEATURES & SPECIFICATIONS

Create custom graph, text views, vector or time plots
 Single click views for mean deviation, incremental displacement, absolute position, cumulative displacement, checksum, time plot and vector plot
 User defined settings for X and Y-axis properties such as scale, units, labels, ticks and gridlines
 Trial software is available at <http://www.rstinstruments.com/software.html>



PM LOGGER

Software for use with the Geowave wireless datalogger (see Page 28).

KEY FEATURES & SPECIFICATIONS

System Requirements: PC operating systems Windows 95 and XP

Set Clock: Synchronise with PC or set different time

Data Retrieval: CSA via modem. Stored in Hz & engineering units. Temperature reading in °C



BOREHOLE PACKERS

Pneumatically or hydraulically inflatable packers that incorporate one fixed and one sliding head attached to a centre shaft.

The sliding head allows the packer gland to retract about the centre shaft as it inflates.

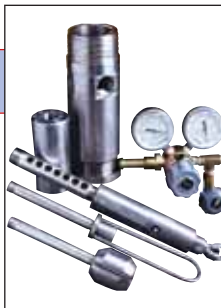
Applications: Permeability testing
 Hydro-fracturing of formations
 Monitoring well sampling
 Sealing artesian flows in boreholes
 Packer piezometers
 Pressure grouting

KEY FEATURES & SPECIFICATIONS

Steel reinforced, or fabric reinforced, abrasion resistant glands are easily replaced in the field
 Hollow centre shaft for placement of sampling and monitoring equipment or for passing water through the packer during permeability testing or hydrofracturing
 Suitable for a wide variety of applications in open or cased holes

Ancillary Equipment

Sampling Pumps	Pressure Transducers
Dataloggers	Air-driven
Flow Meters	Inflation Pumps
Inflation Regulator	Perforated Spacer Pipe



BOREHOLE PACKER ACCESSORIES

A large number of Borehole Packer Accessories are available for use with borehole applications. Items include: inflation regulators, lifting bails, stuffing boxes, seating cones, feed-through adapters, flow systems, water inflation systems,

portable inflation line reel, packer inflation systems and other numerous spare parts.

KEY FEATURES & SPECIFICATIONS

Inflation Regulators - control inflation of the borehole packers

Lifting Bails - raise and lower the packer assembly by utilising the wireline

Stuffing Boxes - provide a seal on the drill rods and against the wireline and inflation line

Seating Cones - used to set the packer assembly in place at the drill bit

Feed-through Adapters - allow instrument leads to be passed through the packers to pumps and other equipment in the zone below the packer

Flow System - to monitor and control water during down-hole testing

Water Inflation System - to inflate borehole packers hydraulically, useful in high pressure applications

The Portable Inflation Line Reel - a convenient and easy way of controlling inflation line during testing and storage

Packer Inflation System - all the features of an inflation regulator with the added convenience of all items being enclosed in a weatherproof case

CARLSON INSTRUMENTS - PRINCIPLE OF OPERATION

CARLSON instruments are elastic wire strain meters containing two coils of highly elastic steel wire, one of which increases in length and electrical resistance when a strain occurs, while the other decreases. The ratio of the two resistances is independent of temperature (except for thermal expansion) and therefore the

change in resistance ratio is a measure of strain. The total resistance is independent of strain since one coil increases the same amount as the other decreases due to a change in length of the meter. Therefore, the total resistance is a measure of temperature.

CABLE

The cable most commonly used is heavy duty, neoprene rubber-covered, with either three or four conductors. Alternate cable types are available to suit site specific conditions.

The CARLSON model MA-6B and later series readout instruments, while compatible with both three and four wire systems, require only three

conductors to monitor both temperature and resistance. Earlier versions require four conductors to monitor both parameters. We recommend the total design length of cable be attached at the factory to ensure system integrity. Should the final design length not be known at the time of order, specify the total

length of cable to be supplied in bulk, and that a 1m length of either three or four conductor be attached. As conductor diameter is determined by lead length, please specify the approximate total length. While field splicing is possible, the instructions in the CARLSON field manual must be followed.



CARLSON JOINT & FOUNDATION METERS

Joint meters and foundation meters are similar to strain meters except they have greater range. This is accomplished by having a coil spring in series with each of two loops of elastic wire. The foundation meter is the same as the joint meter except that it has its range mainly in contraction.

The joint meter is used mainly to measure the opening to joints and therefore it has most of its range in expansion. Range is allowed by spring-loading the elastic wire. Both measure temperature as well as expansion or contraction in the same way that strain meters do.

KEY FEATURES & SPECIFICATIONS

Carlson Model No	JOINT METERS			FOUNDATION METERS		
	J0.1	J0.25	J0.5	F0.1	F0.25	F0.5
Range Contraction	0.51mm	0.25mm	0.25mm	2.0mm	6.1mm	10.2mm
Range Expansion	2.0mm	6.1mm	10.20mm	0.51mm	0.25mm	2.5mm
Resolution	0.005mm	0.013mm	0.025mm	0.005mm	0.013mm	0.025mm
Resolution Temp	0.05°C	0.05°C	0.05°C	0.01°C	0.01°C	0.01°C



CARLSON STRESS CELLS

CARLSON Stress Cells are 178mm diameter plates with a strain-meter sensing element mounted on one face. The plate has a mercury film at its thickest and a flexible rim, with the result that any stress through the plate is applied to the mercury film.

Extraneous deformation such as drying shrinkage has very little effect on stress through the plate (and the mercury) so the calibration is in terms of compressive stress per 0.01 per cent reduction in the resistance ratio of the sensing element. Available for both soil and concrete.

KEY FEATURES & SPECIFICATIONS

Description	Soil Stress Cells				Concrete Stress Cells		
	S25	S50	S100	S200	C400	C800	C1500
Carlson Model No	S25	S50	S100	S200	C400	C800	C1500
Range	25psi	50psi	100psi	200psi	400psi	800psi	1500psi
Resolution	0.1psi	0.2psi	0.4psi	0.8psi	3psi	5psi	10psi
Resolution Temp	0.05°C	0.05°C	0.05°C	0.05°C	0.05°C	0.05°C	0.05°C
Modus of Elasticity	60,000psi	120,000psi	240,000psi	480,000psi	2x10 ⁶	4x10 ⁶	6x10 ⁶
Effective Area of Meter	42in ²	42in ²	42in ²	42in ²	35in ²	35in ²	35in ²



CARLSON PIEZOMETER

Water pressure in the pores of a granular material like soil reduces the internal friction and therefore the stability. This pore pressure can be measured by a device which separates the water pressure from the intergranular pressure. In the CARLSON pore pressure cell, the water

pressure is admitted to an internal diaphragm through a porous disc which holds back the soil or other granular material. The deflection of the internal diaphragm is measured with the same sensing element as is used in the stress meters.

KEY FEATURES & SPECIFICATIONS

- Zero displacement
- 50 year track record
- Integral temperature measurement
- Proven CARLSON design

Carlson Model No	P25	P50	P100	P200
Range	25psi	50psi	100psi	200psi
Resolution	0.1psi	0.2psi	0.4psi	0.8psi
Resolution Temp	0.05°C	0.05°C	0.05°C	0.05°C
Weight	1.02kg	1.02kg	1.02kg	1.02kg



CARLSON REINFORCED CONCRETE METER

The CARLSON Reinforced Concrete Meter is a rod-like device which simulates a bar of reinforcing steel. The rod is hollow to accommodate a miniature strain meter which measures the change in length from which the stress is derived. What makes this meter unique

is that it measures the change in length of the steel rod regardless of the occurrence of fine cracking which is common to reinforced concrete. It measures the average strain over most of the rod's length.

KEY FEATURES & SPECIFICATIONS

- Robust Construction
- Ease of installation
- Proven CARLSON design
- Integral temperature measurement
- Self temperature compensating

Range (micro-strain)	±950
Resolution (micro-strain)	3.4
Resolution (stress in steel)	100 psi
Resolution Temperature	.05°C
Maximum Street	±44,000psi
Weight	2.5kg



CARLSON RESISTANCE THERMOMETER

The CARLSON Resistance Thermometer is used for the remote reading of temperature where quick response is not required. It is well sealed against moisture and its diffusivity is approximately that of concrete; therefore it is

especially suited for embedment in concrete to measure internal temperature.

The active element consists of a coil of copper wire wound non-inductively on an insulated spool in such a way as to be stress free.

KEY FEATURES & SPECIFICATIONS

- Long-term reliability
- Simplified Readings
- Ideal for direct embedment in concrete
- Proven Carlson design

Model	TM-1
Standard Range	-18 to +82°C
Resolution	0.05°C
Weight	227 grams
Dimensions	22mm X 95mm
Cable	3 conductor X#16gauge<183m 3 conductor X#14gauge<183m



CARLSON STRAIN METER

The CARLSON Strain Meter is a device which can be embedded in concrete to reveal the internal deformations. It responds to any change in dimension of the concrete due to stress, creep, temperature change, moisture change or chemical growth. The main purpose of the strain meter is to determine stress indirectly. Quick

changes in stress are revealed simply by multiplying the measured strain by the modulus of elasticity. But for stress which develops over a long period of time, account must be taken for changes in modulus of elasticity and of deformations due to creep and to all causes other than stress.

KEY FEATURES & SPECIFICATIONS

The standard strain meter may be embedded in concrete or attached to a surface with saddle mounts. The standard comes in three lengths from 20cm to 51cm and the mini, for embedment where small size is essential, in three lengths from 10cm to 20cm.

Description	Standard Concrete Strain Meters				Mini Concrete Strain Meters		
	Carlson Model No	A8	A10	A10S**	A20	M4	M8
Range (micro strain)*	2600	2100	2100	1050	3900	2000	1600
Resolution (micro strain)*	3.6	2.9	2.9	1.5	5.8	2.9	2.3
Resolution Temp	.05°C	.05°C	.05°C	.05°C	.05°C	.05°C	.05°C
Gauge Length	20.3cm	25.4cm	25.4cm	50.8cm	10.2cm	20.4cm	25.4cm
Weight	.36kg	.59kg	.59kg	.82kg	86g	145g	186g

*Normally set at factory for 2/3 to 3/4 or range in compression. Without limits, other settings may be specified.

** Saddle mount. Mounting diameter is 1-1/16 inches.



CARLSON MA-6B READOUT

Reads all CARLSON instruments.

Displays data in: Degrees (F and C), Resistance in Ohms and Resistance Ratio. Display: 2X20 character LCD

Analog Circuit: Provides excitation circuit, A-D converter, and EMI & RFI protection. 16 bit A-D

output accuracy equivalent to 4½ digits or 1:10,000

CMOS Digital Circuit: Stores output of A-D converter, performs necessary mathematical calculations, and displays data. Readings are automatically updated once per second.

KEY FEATURES & SPECIFICATIONS

- Auto selection of gauge type; Simple one button operation
- Auto error detection; 3 and 4 wire compatible
- Allows use of economical 3 wire cable; Sealed case
- Rechargeable batteries; Field rugged and reliable
- Optional, heated, backlit display; Auto off to conserve battery power



DIVER® RANGE

The Diver® is a robust and compact datalogger for the automatic, accurate and reliable measuring and monitoring of groundwater levels. The Diver® range, manufactured by Schlumberger Water Services, is available in different models that can measure temperature, groundwater level and conductivity. All have a built-in battery with a lifespan on approximately 10 years and come with a three-year warranty.

APPLICATIONS: Hydrometric studies; Pump testing; Salt water intrusion and Groundwater remediation

KEY FEATURES

Available in four types: Micro-Diver; Mini-Diver, Cera-Diver and CTD Diver
Measurement range varies from 10 m H₂O to 100 m H₂O and a resolution varying 0.2 cm H₂O to 2 cm H₂O

Slimline for discrete installation
In-built datalogger
Rapid data retrieval
Field programmable
Variable sampling intervals
Free software package



MICRO-DIVER

The smallest Diver® in the range, just 18mm in diameter and small enough to fit in standard 19mm internal diameter monitoring wells. Its accuracy of ±0.1% F.S. assures extremely precise recording of the groundwater level. Various measuring methods: Fixed, event

dependent, averaging & pumping tests;

APPLICATIONS

Monitoring projects

Groundwater monitoring network automation

Pumping tests

KEY FEATURES & SPECIFICATIONS

Long-term & frequent measurements; Temperature corrected measurement; Large memory capacity; Hermetically sealed in stainless steel housing.

Type	DI 601	DI 602	DI 605	DI 610	DI 500(bar)
Range	10 mH ₂ O	20 mH ₂ O	50 mH ₂ O	100 mH ₂ O	1.5 mH ₂ O
Accuracy	1 cmH ₂ O	2 cmH ₂ O	5 cmH ₂ O	10 cmH ₂ O	0.5 cmH ₂ O
Resolution	0.2 cmH ₂ O	0.4 cmH ₂ O	1 cmH ₂ O	2 cmH ₂ O	0.1 cmH ₂ O

Dimensions	18mm x19mm
Memory (non-volatile)	48,000 measurements
Sample rate	0.5 sec to 99 hours *
Material housing/ sensor	RVS 316L/ceramic
Temperature Range	-20-80°C
Accuracy	±0.1°C
Resolution	0.01°C
Compensated Range	0°C to 40°C

* various measuring methods (fixed, event based, and pumping tests)



MINI-DIVER

The original Diver®, now enhanced with new electronics and now even shorter in length. Will fit in virtually any monitoring well.

Like the other Diver® models the Mini-Diver is hermetically sealed to external effects, to ensure that the measurement result will be unaffected by

moisture and/or electrical influences.

APPLICATIONS

Monitoring projects

Groundwater monitoring network automation

Long-term & frequent measurements; Temperature corrected measurement; Reliable & accurate measurement data; Non-volatile memory; Compact.

Type	DI 501	DI 502	DI 505	DI 510	DI 500(bar)
Range	10 mH ₂ O	20 mH ₂ O	50 mH ₂ O	100 mH ₂ O	1.5 mH ₂ O
Accuracy	0.5 cmH ₂ O	1 cmH ₂ O	2.5 cmH ₂ O	5 cmH ₂ O	0.5 cmH ₂ O
Resolution	0.2 cmH ₂ O	0.4 cmH ₂ O	1 cmH ₂ O	2 cmH ₂ O	0.1 cmH ₂ O

Dimensions	22 mm x 90 mm
Memory (non-volatile)	24,000 measurements
Sample rate	0.5 sec to 99 hours
Material housing/ sensor	RVS 316L/ceramic
Temperature range	-20°C to 80°C
Accuracy	±0.1°C
Resolution	0.01°C
Compensated Range	0°C to 40°C



CERA-DIVER

The same size as the Mini-Diver, but constructed entirely in ceramic to prevent any possibility of corrosion in aggressive groundwater. The new Cera-Diver has been specifically developed for semi-saline water projects and seawater-intrusion projects and for the monitoring

of landfill sites, locations where the use of stainless steel as material for the pressure sensor and casing is inappropriate due to the threat of corrosion.

APPLICATIONS: Monitoring projects; Groundwater monitoring network automation

KEY FEATURES & SPECIFICATIONS

Robust construction - ceramic, corrosion resistant; Various measuring methods: Fixed, event dependent & pumping tests

Type	DI 701	DI 702	DI 705	DI 710	DI 500(bar)
Range	10 mH ₂ O	20 mH ₂ O	50 mH ₂ O	100 mH ₂ O	1.5 mH ₂ O
Accuracy	0.5 cmH ₂ O	1 cmH ₂ O	2.5 cmH ₂ O	5 cmH ₂ O	0.5 cmH ₂ O
Resolution	0.2 cmH ₂ O	0.4 cmH ₂ O	1 cmH ₂ O	2 cmH ₂ O	0.1 cmH ₂ O

Dimensions	22 mm x 90 mm
Memory (non-volatile)	48,000 measurements
Sample rate *	0.5 sec to 99 hours
Material	Ceramic (ZrO ₂) & (Al ₂ O ₃)
Temperature range	-20°C to 80°C
Accuracy	±0.1°C
Resolution	0.01°C
Compensated Range	0°C to 40°C

* various measuring methods (fixed, event based, and pumping tests)



CTD-DIVER

In addition to a pressure and temperature sensor, the CTD-Diver has a four-electrode sensor for determining conductivity across a large temperature range. It is accommodated in a ceramic casing which is resistant to the most aggressive substances.

APPLICATIONS: Aquifer recharge projects; Saltwater intrusion projects; Surveillance against (illegal) discharges; Surveillance on waste disposal sites; Monitoring groundwater or surface water quality

KEY FEATURES & SPECIFICATIONS

Various measuring methods: fixed & event dependent; Simple calibration; Measures conductivity, temperature & pressure.

Type	DI 261	DI 263	DI 265	DI 500(bar)
Range	10 mH ₂ O	30 mH ₂ O	100 mH ₂ O	1.5 mH ₂ O
Accuracy	1 cmH ₂ O	3 cmH ₂ O	10 cmH ₂ O	0.5 mH ₂ O
Resolution	0.2 cmH ₂ O	0.6 cmH ₂ O	2 cmH ₂ O	0.1 mH ₂ O

Dimensions	22 mm x 183mm
Memory	16,000 measurements (non-volatile)
Sample rate*	0.5 sec to 99 hours
Housing Material	Ceramic ZrO ₂
Temperature range	-20°C to 80°C
Accuracy	±0.1°C of reading
Resolution	0.01°C of reading

* various measuring methods (fixed & event based)



DIVER MATE

Plug-in, download and store data right in the field. Diver-Mate is a simple storage device which connects directly to Diver data cables.

It is cost effective & minimizes need for carrying laptops into the field.

KEY FEATURES & SPECIFICATIONS

The MiniSD card (2GB) means the Diver-Mate stores an almost unlimited number of full Diver memory reads
Powered by an internal rechargeable battery (charged by USB port), with time to read more than 500 Divers



DIVER OFFICE

A desktop solution which simplifies readout and programming of the Diver in the office and prepare data in advance using the Waterloo Hydrogeologic Software suite.

KEY FEATURES & SPECIFICATIONS

Built-in features include CTD-Diver Calibration Wizard and Barometric Compensation Wizard

Export to various file formats for advanced analysis (eg) CSV, MON, NITG etc)

Requirements: Windows 2000, XP and Vista, USB port and one Serial COM port



DIVER-POCKET

SIMPLE SOFTWARE SOLUTION FOR IN THE FIELD

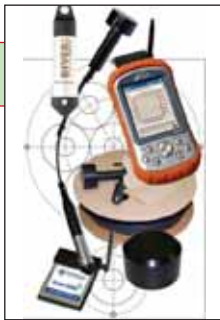
A Personal Digital Assistant (PDA) software package which can be used on a PocketPC for programming Divers and reading stored measurements.

KEY FEATURES & SPECIFICATIONS

Available in two versions:

Diver-Pocket Reader which reads data

Diver-Pocket Manager which also includes the Diver programming facility.



DIVER-NETZ



A COMPLETE WIRELESS GROUNDWATER MONITORING SYSTEM

From wireless field data collection and recording to project execution in the office, Diver-NETZ is a network of first class technologies which integrate superior field instrumentation with the latest communication and data management.

Collecting and assessing vital groundwater field data is now quite literally in the palm of your hands!

KEY FEATURES & SPECIFICATIONS

Connect wirelessly to groundwater monitoring networks
 A complete solution of groundwater dataloggers, transceivers, acquisition instrumentation and software
 Dramatically improves data collection in the field - up to 70% more efficient than traditional methods

DIVER DXT

Diver **D**ata **E**xchange **T**ransceiver expands Diver dataloggers to a wireless solution.

Acquire data and adjust settings wirelessly.

The DXT connects directly to Diver dataloggers in the well and instantly links to you hand-held device.

KEY FEATURES & SPECIFICATIONS

Built-in power supply with up to five-day battery life (based on typical use)
 Standard lengths (1, 2, 2.5, 5, 10, 20, 40, 160, 320 meters) with the option to further customise lengths in the field
 Transmits data following AES-128 data encryption

	DIVER-DXT
Description	Radio for Diver
Interface	Optical for Diver
Dimensions housing	Ø18mm (insertion well) Ø44mm (well top)
Operating Temp	-20°C to 80°C
Storage/Transport Temp	-40°C to 85°C
Time to Connect	Typical 15 sec
Battery life expectancy	5 years @ 20°C
Radio Range	<150m
Max Cable Length	320m

DIVER DXD

The Data Exchange Dongle wireless connects to the Diver DXT in the field and instantly downloads Diver data. A detachable 'antenna' offers secure data streaming to the handheld device.

KEY FEATURES & SPECIFICATIONS

Operates with most PDA compact flash drives
 Powerful transmission of up to 150 meter range (may vary according to site conditions)
 Secure data transmission using AES-128 data encryption

	DIVER-DXD
Description	Dongle for Diver
Interface	Compact Flash
Dimensions housing	CF Type II
Operating Temp	-20°C to 80°C
Storage/Transport Temp	-40°C to 85°C
Time to Connect	Typical 15 sec
Battery life expectancy	
Radio Range	<150m
Max Cable Length	



VW TEMPERATURE SENSOR



Used for the measurement of temperature in rock, concrete and soil.
It consists of a stainless steel body, a tensioned wire, an electromagnetic coil and signal cable. The body of the sensor expands and contracts with changes in temperature, increasing or decreasing the tension of the wire.

When a readout is connected, it sends an electric pulse to the coil, which plucks the wire and causes it to vibrate at its natural frequency. A second coil picks up the vibration and returns a frequency to the readout. The reading is converted to units of temperature by applying calibration factors.

KEY FEATURES & SPECIFICATIONS

High accuracy

VW compatible: The VW temperature sensor is especially convenient when there are other VW sensors at the site.

Manual or automatic readings: Read manually using the VW Data Recorder or automatically using a data logger.

Reliable signal transmission over long distances

Measuring Range	-20 to +80°C
Accuracy	±0.1% F.S.
Resolution	0.025°C
Response Time	2.5 minutes for 60% of full thermal equilibrium
Full Thermal Equilibrium	15 minutes



THERMISTOR STRINGS

RST thermistor string assemblies are environmentally hardened to provide accurate and reliable long-term measurements under demanding conditions. The strings incorporate interchangeable curve tracking, negative temperature coefficient (NCT) thermistors.

As the thermistors are curve matched to desired temperature tolerance over selected temperature ranges, this permits the use of multiple sensors with a single readout or datalogger, eliminating the need for costly calibration procedures.

Readout instruments available.

KEY FEATURES & SPECIFICATIONS

High reliability, ensured by triple encapsulation
Precision matched, interchangeable thermistors
Pre-assembled to specific lengths and spacing
Heavy duty, direct burial cable standard
Also available with digital RS485 output

DESCRIPTION	HIGH PRECISION	STANDARD PRECISION	SUPER-STABLE HIGH PRECISION
Interchangeability Tolerance	±0.1°C	±0.2°C	±0.05°C
Interchangeability Temp range	0 to +75°C	0 to +75°C	0 to +75°C
Operating Temp Range	-80 to +75°C	-80 to +75°C	-80 to +75°C
Stability	0.01°C or better /100months at 0°C	0.01°C or better /100months at 0°C	0.01°C or better /100months at 0°C
Resistance at 25°C	2252, 3k, 5k, 10k Ohms	2252, 3k, 5k, 10k Ohms	2252, 3k, 5k, 10k Ohms



VW V-NOTCH WEIR SENSOR



A precise water level monitoring system which uses a vibrating wire transducer as a highly sensitive and stable means of monitoring levels. The system employs a stainless steel weir plate through which the flow to be measured is

channelled. A measuring point is located at a suitable position upstream of the weir.

Applications: Weirs, Tanks, Stream Levels, Reservoir Levels, Drainage Systems in dams & tunnels

KEY FEATURES & SPECIFICATIONS

High sensitivity & stability
Low maintenance
Force transducer immune to zero drift & has low response to temperature changes
Not affected by long signal cables
Measured by portable readout or datalogger

Standard Ranges	150,300,500, 1500mm
Accuracy	±0.1% F.S.
Resolution	0.025% F.S. (min)
Linearity	<0.5% F.S.
Stability	±0.05% F.S. per year
Temp Range	+1 to +80°C



GROUT MONITORS

Available as either Compaction or Permeation Systems providing operators and engineers real time or near-real time displays of key grouting parameters to enhance the understanding of site conditions.

The monitor is invaluable in providing a

permanent record of key grouting parameters for quality assurance, documented quantities, pressure & flow readings.

The monitors have a 1 million readings/2mb standard memory.

KEY FEATURES & SPECIFICATIONS

- Non-invasive
- Doppler ultrasonic
- Low maintenance diaphragm seal
- Digital flow and analog pressure
- Real-time computer display
- Customisable display

COMPACTION GROUT MONITOR	
Flow:GPM	0.5 to 25 and 8-400GPM
Temperature	-20°C to 85°C
Dissolved Solids	0-40%
Accuracy	±1% above 1 FPS
Pressure Trans	0-1000 PSI 0.25% FSO
Output	4-20mA or 0-2.5V

PERMEATION GROUT MONITOR	
Flow:CFM	.40 to 40.1CFM (3-30GPM)
Temperature	-20°C to 85°C
Materials	Compaction & low mobility grouts
Accuracy	±2% above 0.3 FPS
Pressure Trans	0-1000 PSI 0.25% FSO
Output	4-20mA or 0-2.5V



TERMINAL SWITCH BOXES & ACCESSORIES

Terminal boxes are available to connect up to 12, 23 or 34 instruments.

They are equipped with up to three 12-position rotary switch boards with connectors for readout output. Housed in a waterproof IP67 wall mounting plastic or steel lockable enclosure.

Different models of waterproof junction boxes are available for single or multiple cable entry together with a full range of cable ducting, cable end protection, slicing kits, flying and Jumper cables.

KEY FEATURES & SPECIFICATIONS

- Simple to use & install
- Reduces monitoring time
- IP67 protection
- Robust construction
- Compatible with readouts & data loggers



REFLECTIVE TARGETS

Model GSRT2 is a 2-dimensional reflective Bireflex target used primarily for tunnel convergence monitoring. It has reflectors on both sides.

Models GSRT3/4 are 3-dimensional triple mini prism targets primarily used for measuring the deflection of buildings. Both are mounted on

universal joints so they can be orientated in any direction required and are made from high impact and resistant plastic with a bottom fitting which allows them to be mounted on a wide range of fixings such as convergence and reference bolts and prism poles.

KEY FEATURES & SPECIFICATIONS

- High precision
- Range of retro reflective targets available
- Robust construction
- Range of reflective targets available
- Range of prism diameters
- WILD/LEICA compatible

Description	GSRT2	GSRT3	GSRT4
Prism diameter	60mm	25mm	38mm
Cut Accuracy	NA	<0.5"	<0.5"
Off Set (prism constant)	2mm	-17.5mm	-34mm
Range	10-150m	~1000m	~1000m
Materials	Polyamide	Polyamide	Polyamide
Weight	0.2kg	0.2kg	0.2kg



CABLES

Geotechnical instrumentation used to measure the performance and safety of structures requires secure and reliable connections between the sensors and the data retrieval location.

Geosense uses the highest quality cables made to British and European standards. They have excellent strength and flexibility which makes them ideal for installation within applications such as dams, tunnels, bridges etc.

They are suitable for direct burial within selected graded material such as clay cores and filter sand.

APPLICATIONS

Standard sensor installations

Heavy loading applications

High temperature environments

Abrasion resistant requirements

KEY FEATURES & SPECIFICATIONS

OUTER SHEATHING

Standard Geosense cables are fitted with PUR outer sheaths but other materials such as PVC, PE, Neoprene and Teflon are available.

CABLE CONDUCTORS

The number of conductors required is normally determined by the number & type of sensors that need to be connected. Standard Geosense cables have Stranded Tinned Copper (22-24 AWG) conductors. Other sizes are available.

SHIELDING & INSULATION

Shielding gives protection from electromagnetic interference from nearby sources such as generators and other construction equipment and all Geosense cables are fitted with Mylar type shields to minimise these effects. Other types of shield are available to suit individual project requirements..

Insulation of the individual conductors is normally with PE or PVC insulation.

Specialist insulations to meet environmental conditions are also available.

ARMOUR

Where extra protection against point loads is required typically within rock fills, landfills, embankments etc, wire-armoured cable is often used. A wide range of armouring is available to suit the individual protection requirement.

VENTED CABLES

Vented cable can be used for products such as vented piezometers and liquid level settlement systems to allow a path for the changes in barometric pressure to act upon both sides of the sensing element and thus negate the need for barometric compensation calculations.

ACCESSORIES

A wide range of splicing kits, cable end protectors and connectors are also available to ensure cabling connections on site are quick & easy.

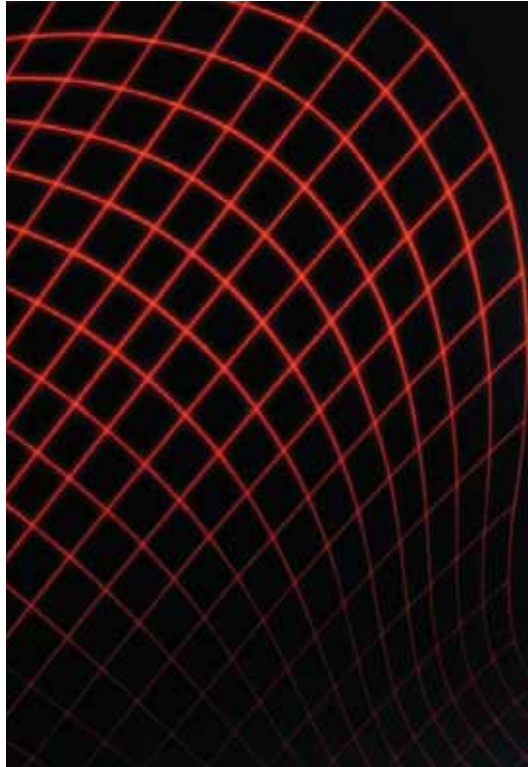
CABLE TYPE	TYPE 900/1	TYPE 900/2	TYPE 910/8	TYPE 910/12	TYPE 910/30
Outer Sheath Type	PUR	PUR	PE	PE	PE
Outer Sheath OD	6.5mm	4.9mm	8.9mm	10.1mm	12.5mm
Outer Sheath Colour	Orange, black, red, grey	Orange, black, red, grey	Orange, black, red, grey	Orange, black, red, grey	Orange, black, red, grey
Conductor Type	Stranded tinned copper	Stranded tinned copper	Stranded tinned copper	Stranded tinned copper	Stranded tinned copper
Conductor Number	4 core	4 core	4 twisted pair	6 twisted pair	15 twisted pair
Conductor Size	22 AWG 0.5mm ² , 0.25mm	24 AWG 0.35mm ² , 0.25mm	24 AWG 0.35mm ² , 0.25mm	24 AWG 0.35mm ² , 0.25mm	24 AWG 0.35mm ² , 0.25mm
Conductor Insulation	PE	PE	PVC	PVC	PVC
Shield	Aluminium foil	Aluminium foil	Aluminium foil	Aluminium foil	Aluminium foil
Resistance	60 ohms per km	104 ohms per km	82 ohms per km	82 ohms per km	82 ohms per km
Temperature Range	-30 to +80°C	-30 to +80°C	-30 to +80°C	-30 to +80°C	-30 to +80°C
Weight kg/km	44	28	72	93	170

DENSITY					
Tonne/m³ Mg/m³ g/cm³	kg/m³	lb/in³	UK ton/yd³	US ton/yd³	lb/ft³
1	1000	0.03613	0.75247	0.8428	62.423
10 ⁻³	1	3.613x10 ⁻⁵	7.525x10 ⁻⁴	8.428x10 ⁻⁴	6.243x10 ⁻²
27.680	27680	1	20.828	23.238	1.728x10 ³
1.3289	1.328x10 ³	4.801x10 ⁻²	1	1.12	82.955
1.1865	1.186x10 ³	4.287x10 ⁻²	0.8929	1	74.074
1.602x10 ⁻²	16.019	5.787x10 ⁻⁴	1.205x10 ⁻²	1.35x10 ⁻²	1

FORCE & WEIGHT					
MN	kN	N	kgf	tonf	lbf
1	1000	10 ⁶	1.0196x10 ⁵	100.4	2.248x10 ⁵
10 ⁻³	1	10 ³	101.96	0.1004	224.82
10 ⁻⁶	10 ⁻³	1	0.10196	1.004x10 ⁻⁴	0.2248
9.807x10 ⁻⁶	9.807x10 ⁻³	9.807	1	9.842x10 ⁻⁴	2.2048
9.964x10 ⁻³	9.964	9964	1016	1	2240
4.448x10 ⁻⁶	4.448x10 ⁻³	4.448	0.45355	4.464x10 ⁻⁴	1

PERMEABILITY					
m/s	cm/s	m/year	Darcy	ft/yr	ft/day
1	100	3.156x10 ⁷	1.04x10 ⁵	1.035x10 ⁶	2.835x10 ⁵
0.01	1	3.156x10 ⁵	1.04x10 ³	1.035x10 ⁶	2.834x10 ³
3.169x10 ⁻⁸	3.169x10 ⁻⁶	1	3.28x10 ³	3.281	8.982x10 ⁻³
9.66x10 ⁻⁶	9.66x10 ⁻⁴	304	1	1000	2.74
9.658x10 ⁻⁹	9.659x10 ⁻⁷	0.3048	10 ⁻³	1	2.378x10 ⁻³
3.527x10 ⁻⁶	3.527x10 ⁻⁴	111.33	0.365	365.25	1

PRESSURE, STRESS & MODULUS OF ELASTICITY										
MN/m² MPa	kN/m² kPa	kp kpf/cm²	bar	atm	m H₂O	ft H₂O	mm Hg	Tonf/ft²	psi lbf/in²	lbf/ft²
1	1000	10.197	10.000	9.869	102.2	335.2	7500.6	9.320	145.04	20886
0.001	1	1.019x10 ⁻²	0.0100	9.87x10 ⁻³	0.1022	0.3352	7.5006	0.0093	0.14504	20.886
9.807x10 ⁻²	98.07	1	0.9807	0.9678	10.017	32.866	735.56	0.9139	14.223	2048.1
0.100	100.0	1.0197	1	0.9869	10.215	33.515	750.06	0.9320	14.504	2088.6
0.1013	101.33	1.0332	1.0132	1	10.351	33.959	760.02	0.9444	14.696	2116.2
9.788x10 ⁻³	9.7885	9.983x10 ⁻²	9.789x10 ⁻²	9.661x10 ⁻²	1	3.2808	73.424	9.124x10 ⁻²	1.4198	204.45
2.983x10 ⁻³	2.9835	3.043x10 ⁻²	2.984x10 ⁻²	2.945x10 ⁻²	0.3048	1	22.377	2.781x10 ⁻²	0.43275	62.316
1.333x10 ⁻⁴	0.1333	1.3595x10 ⁻³	1.333x10 ⁻³	1.315x10 ⁻³	1.362x10 ⁻²	4.469x10 ⁻²	1	1.243x10 ⁻³	1.934x10 ⁻²	2.7846
0.1073	107.3	1.0942	1.0730	1.0589	10.960	35.960	804.78	1	15.562	2240.0
6.895x10 ⁻³	6.895	7.031x10 ⁻²	6.895x10 ⁻²	6.805x10 ⁻²	0.7043	2.3108	51.714	6.426x10 ⁻²	1	144.00
4.788x10 ⁻⁵	4.788x10 ⁻²	4.883x10 ⁻⁴	4.788x10 ⁻⁴	4.725x10 ⁻⁴	4.891x10 ⁻³	1.605x10 ⁻²	0.3591	4.464x10 ⁻⁴	6.944x10 ⁻³	1



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