

Integrated Monitoring Solutions

Product Catalog

Jewell
Instruments

“No problem can withstand the assault of sustained thinking.” – **Voltaire**

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Welcome to the Jewell Instruments 2012-2013 Geophysical and Integrated Monitoring Solutions Catalog. Jewell Instruments is a world leader in the manufacture and distribution of panel meters, avionics components, inertial sensors, geotechnical instrumentation and precision solenoids. Jewell Instruments provides custom solutions for a diverse group of industries, including aerospace, medical, industrial, telecommunications, civil engineering and many more. Jewell Instruments' experienced engineering team works with customers to produce high quality, reliable products that meet or exceed all customer requirements.

As you will see in this year's catalog, Jewell continues to lead the instrumentation industry with cutting-edge technology. With proven products like the Lily Tiltmeter and 3DTracker GPS system, we have equipment to provide monitoring solutions for the most complex civil engineering and mining projects.

Our products also solve tough measurement problems in the scientific and industrial arenas. Our tiltmeters and inertial sensors are key components in advanced leveling systems for large radars and radio telescopes. Offshore they measure pitch and roll of underwater vehicles and detect the angular position of ocean-bottom instrument packages in tsunami warning systems. In recent years we have added monitoring services to our established instrumentation expertise. These new capabilities are summarized in section 10.



I encourage you to contact a Jewell Instruments office to find out more about our products and services. Our corporate headquarters are located in Manchester, New Hampshire. We also have qualified re-sellers around the world, searchable online at www.jewellinstruments.com.

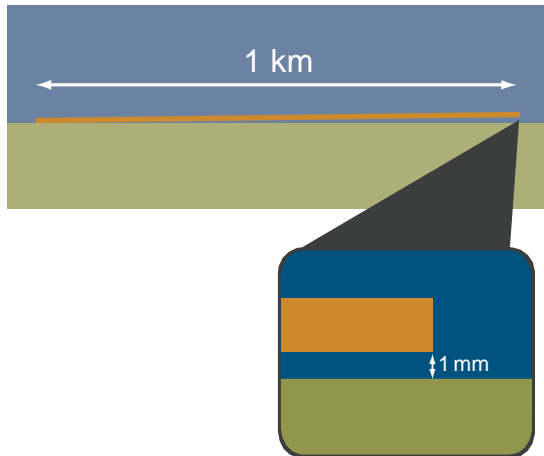
On behalf of the entire Jewell Instruments team, we look forward to working with you!

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Tiltmeters and Clinometers

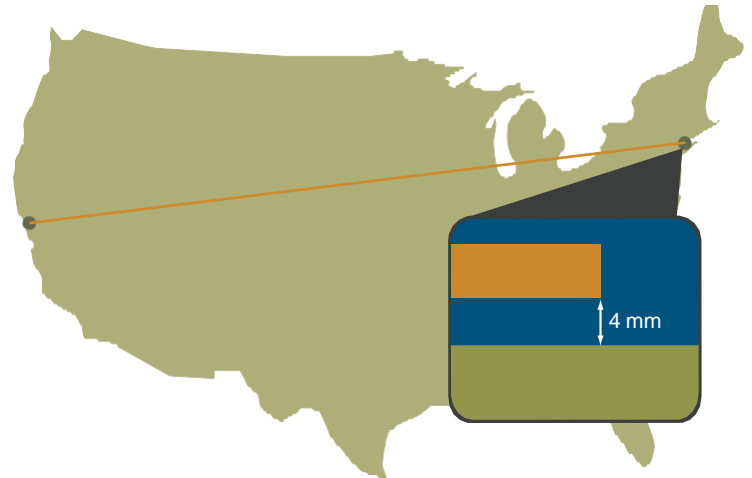
WHAT IS A MICRORADIAN?

Let's say you have a beam that is 1 km long. If you raise one end of the beam by 1 mm, you have tilted it by a microradian.



WHAT IS A NANORADIAN?

Now let's say you have a beam that stretches from San Francisco to New York City (about 4,000 km). If you raise one end by 4 mm, you have tilted it by a nanoradian.



1 DEGREE = 3600 ARC SECONDS = 17,453 MICRORADIANS = 17,453,000 NANORADIANS

The words *tiltmeter*, *inclinometer* and *clinometer* all refer to an inertially referenced device that measures angular rotation with respect to a vertical gravity vector, the most stable of all external references. At Jewell Instruments we denote our highest-precision instruments as *tiltmeters*. We use the name *clinometer* for our general-purpose 900-Series products.

All Jewell Instruments tiltmeters and clinometers include full signal conditioning electronics that produce stable output signals over a wide range of input voltages. This important feature means you can be confident that your measurements represent actual movement and not power supply variations. The high-level voltage, current, and serial outputs provided by our electronics assure reliable data delivery over long cables and wireless data links. As an added bonus, all of our tiltmeters include temperature measurement in their output.

We divide our tiltmeters into four different Series based on measurement resolution and angular range. Certain instruments report resolution in microradians or even nanoradians: a reflection of their high level of sensitivity. The Series Selection Table will help you decide which Series is best suited for your application. You can also use the conversion chart at the end of this catalog to convert microradians to other common units of angle, such as arc seconds and degrees.

Electrolytic Tilt Sensors

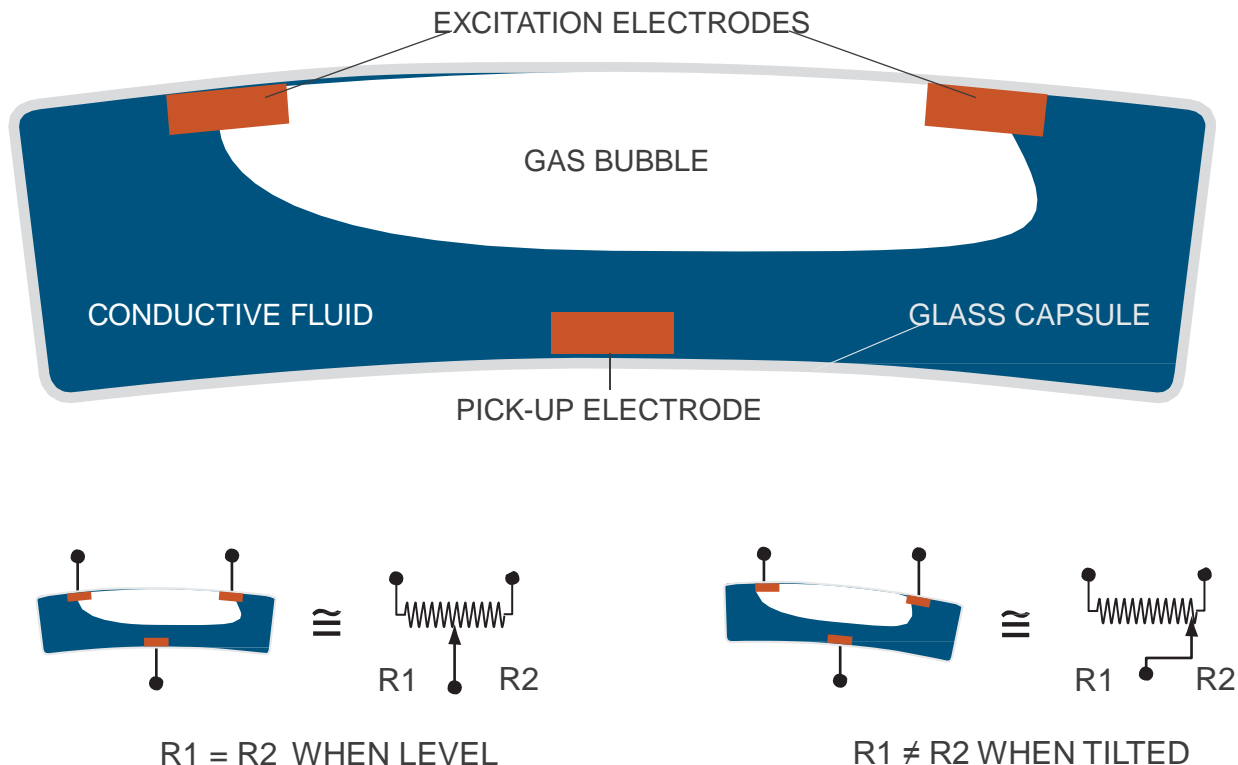
Jewell Instruments tiltmeters and clinometers each contain one or more electrolytic tilt sensors. These sensors consist of a sealed glass or alumina vial that is partially filled with electrolytic liquid. This conductive fluid covers three or five internal electrodes according to the sensor type. The sensor's operation is based on the fundamental principle that an enclosed bubble, suspended in a liquid, always orients itself perpendicular to the vertical gravity vector. Traditional applications of this phenomenon include the humble carpenter's level and spirit levels on surveyor's transits and navigational sextants.

Electrolytic tilt sensors have no mechanical moving parts to break or wear out, and because tilt is referenced to gravity, they can be installed anywhere without the need for complicated levers or fixtures.

Electrolytic tilt sensors offer amazing performance in a small and affordable package. Dynamic range is the maximum measurement range divided by the smallest angle that can be detected with the sensor. Some of our sensors achieve a dynamic range greater than 120 db (>1,000,000:1).

How They Work

When the sensor is level, the conductive liquid covers an equal area on each excitation electrode; the AC resistances, R1 and R2, between the excitation electrodes and the pickup electrode are equal. When the sensor is tilted, however, the liquid covers more of one excitation electrode than the other and R1 and R2 are not equal.

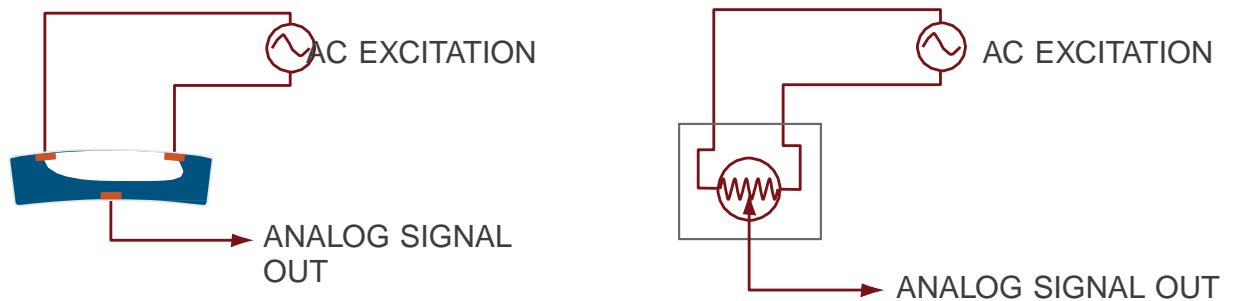


How They're Used in the Tiltmeter

Jewell Instruments tiltmeters operate electrolytic tilt sensors as AC voltage dividers (potentiometers). The tiltmeter's electronic circuitry creates a balanced AC signal that is applied differentially to the two excitation electrodes. The amplitude and phase of the output signal, measured at the pickup electrode, indicate the magnitude and direction of tilt movement.

Tilt sensors can also be operated as the active half of a Wheatstone bridge. The Wheatstone bridge circuit is mainly used for nulling (leveling) applications. Regardless of which type of circuit is used, only AC excitation may be applied to the sensor. Direct current damages the sensor by causing plating of the electrodes.

Our uniaxial tiltmeters use a single tilt sensor. Biaxial tiltmeters in our 500, 700 and 800-Series use two tilt sensors, oriented orthogonally. Our 900-Series biaxial clinometers use an electrolytic tilt sensor with five electrodes, arranged in the pattern of a cross. In this instance, biaxial tilt measurements are made by alternately exciting orthogonal pairs of electrodes.



Series Selection Table

Series	Resolution	Angular Range	Typical Applications
900	To 0.004 degree	To ± 50 degrees	OEM, marine, geotechnical/structural, general test & measurement
800	To 1 microradian	To ± 75 degrees	Geotechnical/structural, marine, precision test & measurement, platform leveling
700*	To 0.1 microradian	To ± 75 degrees	Precision test & measurement, volcanology, high-energy physics, astronomy, aerospace, platform leveling
500	To 5 nanoradians	To ± 10 degrees (adjustment range)	Precision test & measurement, geophysical research, platform leveling, physics, astronomy

* Includes Miniature Tilt Sensors with external Signal Conditioners.

Within each Series we offer a comprehensive range of models to meet the demands of our customers. The Feature Selection Table summarizes some of the key features of each model and is designed to help you identify the model that best meets your requirements. After you have narrowed the field to the most promising candidates, refer to the product descriptions in the following pages for additional details, or contact us by phone or email to discuss your application.

Feature Selection Table

Series & Model	Unhoused	Housed	Submersible	Borehole	Analog Voltage Output	4-20 mA Output	RS232 and/or RS422 Output	Biaxial	Uniaxial
900 Series									
Models 900, 901, 902 Biaxial Clinometer	•				•			•	
Tulip Clinometer	•					•			•
IRIS Tilt Switch & Controller	•						•	•	
Model 904-T Clinometer Pak		•			•			•	
Clinometer Pak 420		•				•			•
MD900-T Digital & Analog Clinometer		•			•		•	•	
Pro 3600 Digital Protractor with Display		•					•		•
Model 906 Little Dipper In-Place Inclinometer			•	•	•	•		•	•
800 Series									
Model 801 Tuff Tilt		•			•				•
Tuff Tilt 420		•				•		•	•
Tuff Tilt Digital		•					•	•	•
Model 802 DeepWater			•		•				•
DeepWater 420			•			•		•	•
DeepWater Digital			•				•	•	•
Model 800P Portable Tiltmeter		•			•			•	•
Beamer—Tilt Beam Sensor		•			•	•			•
Beamer LT		•			•	•		•	•
700 Series									
Model 701-2 Platform Tiltmeter		•			•			•	
Model D701 Platform Tiltmeter		•					•	•	
Models 711-2, 716-2 Floor and Wall Mount		•			•			•	
Model D711 Floor Mount Tiltmeter		•					•	•	
500 Series									
Model 520 Geodetic Platform Tiltmeter		•			•			•	
LILY Self-Leveling Borehole Tiltmeter		•	•	•			•	•	
Miniature Tilt Sensors									
All Models	•				Output depends on signal conditioner			•	•

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Specifications

Range	$\pm 12^\circ/\pm 30^\circ$
Resolution	0.005°/0.01°
Output	± 3.0 VDC or 4-20 mA
Power Requirement	+8 to +24 VDC @ 7mA (voltage output) -12 - 29 VDC (4-20 mA output)
Temperature Range	-25 to +70°C
Dimensions	241 X 39 mm
Housing	ABS polymer, 5 atmospheres pressure rating

Model 906 Little Dipper In-Place Inclinometer

The Little Dipper is an in-place inclinometer system for monitoring slopes, embankments, deep excavations, tunnels, tank foundations, retaining walls and other types of ground movement. Installed as a string of vertical or horizontal sensors inside inclinometer casing, or by direct burial, this instrument provides a continuous record of ground deformation. Fiberglass rods connect the sensors inside the casing, and fins or universal pivots couple the sensors to the casing walls. The Little Dipper's on-board electronics accept a wide input voltage range and drive long cables without signal loss. Its waterproof and non-corrodible ABS sensor housing also makes the Little Dipper a popular tool for underwater tilt measurements in shallow marine applications. Select analog voltage output (biaxial) or 4-20 mA output (uniaxial only).



Specifications

Range	$\pm 0.5^\circ/\pm 3^\circ/\pm 50^\circ$ uniaxial
Resolution	0.0001°/0.0006°/0.01°
Output	± 5 VDC single-ended and ± 10 VDC differential
Power Requirement	+8 to +18 VDC @ 8mA
Temperature Range	-25 to +70° C
Dimensions	120 x 80 x 60 mm
Housing	Painted, die cast aluminum, NEMA 4X (IP65)

Model 801 Tuff Tilt

The Tuff Tilt is a precise and rugged uniaxial tiltmeter suitable for many different applications. This workhorse is widely used for structural monitoring and for industrial testing and measurement. Housed in a rugged weatherproof enclosure, this analog output tiltmeter may be installed outdoors and in other wet environments. Typical applications include construction monitoring, monitoring of bridges and other large structures, antenna leveling, and rotary position sensing for dam gates and other machinery. Tuff Tilt tiltmeters incorporate a ceramic tilt sensor that delivers low thermal sensitivity, high long-term stability and the best resolution of any sensor in its class. The Model 801 includes a temperature sensor.



Specifications

Range	$\pm 0.5^\circ/\pm 3^\circ/\pm 50^\circ$ uniaxial or biaxial
Resolution	0.0001°/0.0006°/0.01°
Output	4-20 mA (2-wire current loop, per channel)
Power Requirement	-12 to 29 VDC
Temperature Range	-40 to +85°C
Dimensions	120 x 80 x 60 mm
Housing	Painted, die cast aluminum, NEMA 4X (IP65)

Tuff Tilt 420

The Tuff Tilt 420 delivers the great performance of the Model 801 in a tiltmeter with 4-20 mA output. It combines precision, long-term stability and rugged durability in a compact and reliable instrument. It is current loop powered, so tilt measurements can be made over long cables using an economical 2-wire pair. Its 4-20 mA output is great for long cable runs, and it includes a thermistor for correlating tilt changes with temperature induced movement. Use The Tuff Tilt 420 in the same places you would use The Model 801, but where 4-20 mA output is required.



Specifications

Range	$\pm 3.0^\circ/\pm 50^\circ$ uniaxial or biaxial
Resolution	0.0001°/0.002°
Output	RS232 or RS422, full duplex
Power Requirement	+7 to +28 VDC @ 27mA
Temperature Range	-40 to +85° C
Dimensions	120 x 80 x 60 mm
Housing	Painted, die cast aluminum, NEMA 4X (IP65)

Tuff Tilt Digital

This product is the digital member of our Tuff Tilt family. Use it for test and measurement projects requiring serial data communications, high precision, compact size, and robustness. Among its standard features are 16-bit A/D resolution, onboard data logging, a real-time clock, and measurement of temperature. User-selectable firmware commands include autozero, sampling frequency, low-pass filtering, and output data format. The Tuff Tilt Digital supports a variety of output formats that are easily read by GPS receivers for simultaneous measurements of displacement and tilt. We also offer wireless connectivity and tilt alarm capabilities for these devices.



Model 904-T Clinometer Pak



The Model 904-T Clinometer Pak unites our Model 900 Biaxial Clinometer with a weatherproof NEMA 4X (IP65) enclosure for indoor or outdoor applications that demand mechanical and environmental protection. Choose the high-gain, standard or wide-angle version, each with a different angular range. Clinometer Pak's internal circuitry accepts a wide input voltage range and provides stable, low-impedance analog outputs for measurement by dataloggers, PLC's, digital voltmeters and other recording devices. A temperature sensor is included as a standard feature. Options include viscous damping and 0-5 Volt output. This product is also available in a submersible stainless steel enclosure.

Specifications

Range	$\pm 10^\circ/\pm 25^\circ/\pm 50^\circ$
Resolution	0.005°/0.01°/0.02°
Output	± 2.5 VDC or 0-5 VDC
Power Requirement	8-24 VDC @ 7mA (10.5-26 VDC for 0-5 VDC output)
Temperature Range	-40 to +85°C
Dimensions	120 x 80 x 60 mm
Enclosure	Painted, die cast aluminum, NEMA 4X (IP65)

Clinometer Pak 420



The Clinometer Pak 420 is the packaged version of our Tulip 4-20 mA clinometer. Its rugged aluminum enclosure provides mechanical and environmental protection for indoor or outdoor use. This uniaxial instrument is current loop powered, so measurements can be made over long cables using an economical 2-wire pair. It also measures temperature using a built-in thermistor. Use it to monitor the angular position of conveyers, booms, ramps and machinery; perform antenna tilt error corrections; and track the pitch and roll of ships, buoys, ROV's and towfish.

Specifications

Range	$\pm 10^\circ/\pm 25^\circ/\pm 50^\circ$
Resolution	0.005°/0.01°/0.02°
Output	4-20 mA (2-wire current loop)
Power Requirement	-12 to 29 VDC
Temperature Range	-40 to +85°C
Dimensions	120 x 80 x 60 mm
Housing	Painted, die cast aluminum, NEMA 4X (IP65)

Model MD900-T Digital & Analog Clinometer



This economical biaxial clinometer has a wide variety of industrial, scientific and GPS uses. Many thousands are used today for antenna positioning, surface and subsea marine applications, structural monitoring, and industrial test and measurement. The clinometer is housed in an easily mountable enclosure and provides an RS232 serial interface and analog outputs via a 6-pin NEMA 4X connector. User-selectable firmware features include auto zero, sampling frequency, low-pass filtering and on-board data storage. Factory calibration values are stored in nonvolatile memory, and output data (X tilt, Y tilt, temperature, serial no.) are provided in several GPS-compatible formats. Options include extended memory, real-time clock, RS422 output, viscous damping and submersible housings.

Specifications

Range	$\pm 10^\circ/\pm 25^\circ/\pm 50^\circ$ biaxial
Resolution	0.002°/0.004°/0.01°
Output	RS232 (tilt & temperature), 0-4.75 VDC (tilt only)
Power Requirement	7-28 VDC @ 30mA
Temperature Range	-40 to +85°C
Dimensions	120 x 80 x 60 mm
Housing	Painted, die cast aluminum, NEMA 4X (IP65)

Pro 3600 Digital Protractor



This revolutionary, handheld measuring tool provides an immediate, digital reading of all angles in a 360° circle. As the protractor is moved, the liquid in the sensor seeks a new position, resulting in changes in the sensor's electrical capacitance. A microprocessor analyzes the changes and calculates the angles seen on the display. The Pro 3600 also outputs its measurements in a continuous RS232 data stream that can be read by computers, data loggers and printers. Normally, level is displayed as 0.00°. However, a new reference point for 0.00° can easily be established by pushing the ALT ZERO button. You can also "freeze" any displayed angle by pushing the HOLD button. Display resolution is 0.01° near level (0.00° to 9.99°) and 0.1° at all other angles (10.0° to 90.0°). The bottom surface contains a V-groove and threaded mounting holes. The Pro 3600 is easily recalibrated by the user in just a few minutes without any special fixtures.

Specifications

Range	360°
Resolution	0.01° near level (0.00° to 9.99°), 0.1° above 10.0°
Output	ASCII, RS232, 9600 baud, continuous on request
Power Requirement	9-Volt battery or external
Temperature Range	-5 to +50°C operating
Dimensions	154 x 51 x 30 mm

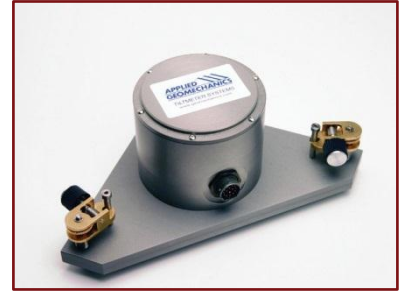
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Specifications

Range (Biaxial)	Low: ± 1400 Middle: ± 160 High: ± 16 μ radians
Resolution	< 10 nanoradians (< 0.01 μ radians)
Output	± 8 VDC single-ended and ± 16 VDC differential
Power Requirement	± 11 to ± 15 VDC @ 15 and 7mA
Temperature Range	-25 to $+70^{\circ}\text{C}$
Dimensions	Tiltmeter: 230 x 230 x 129 mm Switch box: 230 x 200 x 140 mm
Housing	Anodized aluminum, O-ring seals

Model 520 Geodetic Platform Tiltmeter

Our top performer for surface applications, Model 520 is designed for projects demanding maximum resolution and stability. Applications include leveling and alignment of platforms and antennae, measurement of earth tides and crustal deformation, and volcano monitoring. With resolution finer than 10 nanoradians, Model 520 is excellent for use in all static tilt applications, or as a sensitive long-period accelerometer. Each system includes the tiltmeter, a rugged fiberglass switch box and a 3-meter interconnect cable. Select among three gains and two low-pass Butterworth filters using switches in the switch box. Leveling and user calibration of the tiltmeter are performed with built-in micrometers or worm gear legs. Mechanical adjustment range is ± 3 degrees.



Specifications

Range (Biaxial)	$\pm 10^{\circ}$ adjustment range, ± 330 μ radian dynamic
Resolution	5 nanoradians
Output	RS232, RS422, or both; full duplex
Temperature Range	-20 to $+85^{\circ}\text{C}$
Power Requirement	7-28 VDC @ 30mA (< 10 mA in sleep mode)
Dimensions	51 mm dia. x 915 mm
Housing	Stainless steel, rated to 345 bars (5,000 psi)

LILY Self-Leveling Borehole Tiltmeter

LILY is the culmination of over 25 years of experience in the fields of instrumentation and geophysics. We developed LILY for volcanic and tectonic research, ocean bottom applications, and for monitoring of hydraulic fracturing and other subsurface processes in the mining and petroleum industries. LILY's high-pressure stainless steel housing is rated for submergence to depths of 3500 meters. You can attain even greater depths by switching to a titanium housing. The tilt sensors in LILY can self-level on command through a range of ± 10 degrees and have 5 nanoradians resolution over a dynamic range of ± 330 microradians. The self-leveling feature keeps LILY on scale indefinitely at the high gains required for geophysical work. Its versatile RS232 and RS422 serial outputs, and its powerful firmware command set, give you a wide range of measurement and recording options. Data can be stored internally for periodic downloading, or streamed to your external network or recorder. GPS compatible output formats are included.



Specifications

Range	$\pm 5^{\circ}$ from null position
Repeatability	$\pm 0.004^{\circ}$ degree
Power Requirement	9-Volt battery in readout module
Temperature Range	-25 to $+70^{\circ}\text{C}$
Dimensions	143 x 102 x 127 mm (tiltmeter) 140 x 25 mm (tilt plate)
Housing	Stainless steel frame, PVC sensor cover

Model 800P Portable Tiltmeter

The Model 800P Portable Tiltmeter is a versatile and accurate hand-held instrument for monitoring structural and foundation movement. Measurements are taken from tilt plates that have been cemented or bolted to any horizontal or vertical surface. Indexing bars on the bottom and sides of the tiltmeter enable you to reposition it on the tilt plate exactly, every time. The 800P makes surveying fast and economical over an unlimited number of points. When continuous monitoring is not required, The Model 800P is an excellent choice. The Portable Tiltmeter System includes one tiltmeter, one power and display unit, and a tough plastic carrying case. Ceramic or aluminum tilt plates are purchased separately.



Model 802 DeepWater Submersible Tiltmeter



The Model 802 DeepWater is the fully submersible cousin of our Model 801 Tuff Tilt. Performance features are the same, but the DeepWater housing is machined from a solid piece of 316 stainless steel and incorporates a high-pressure neoprene connector. Pressure rating is 250 bars (2500 meters depth). Higher-pressure versions may be special ordered. Temperature rating is governed by the neoprene connector. Wider temperature ranges are available with other connector types. DeepWater tiltmeters are excellent choices for monitoring dams, oil platforms, pipelines and underwater machinery.

Specifications

Range	$\pm 0.5^\circ/\pm 3^\circ/\pm 50^\circ$ uniaxial
Resolution	0.0001°/0.0006°/0.01°
Output	± 5 VDC single-ended and ± 10 VDC differential
Power Requirement	+8 to +18 VDC @ 8mA
Temperature Range	-4 to +60°C
Dimensions	149 x 91 x 82 mm
Housing	316 stainless steel

DeepWater 420



DeepWater 420 is the submersible equivalent of our Tuff Tilt 420. It has 4-20 mA output and is current loop powered, so that tilt measurements can be made using a 2-wire pair. Housing is machined from a solid piece of 316 stainless steel and is rated to 250 bars pressure (2500 meters depth). Higher-pressure versions may be special ordered. The temperature rating is governed by the neoprene connector. Wider temperature ranges are available with other connector types. Use DeepWater 420 in the same places you would use Model 802, but where 4-20 mA output is required.

Specifications

Range	$\pm 0.5^\circ/\pm 3^\circ/\pm 50^\circ$ uniaxial or biaxial
Resolution	0.0001°/0.0006°/0.01°
Output	4-20 mA (2-wire current loop, per channel)
Power Requirement	-12 to 29 VDC
Temperature Range	-4 to +60°C
Dimensions	149 x 91 x 82 mm
Housing	316 stainless steel

DeepWater Digital



DeepWater Digital is the submersible version of our Tuff Tilt Digital tiltmeter. Performance and firmware are the same, but the 316 stainless steel housing is rated for submergence to 250 bars pressure (2500 meters depth). The neoprene connector is wet-mateable. DeepWater tiltmeters are excellent choices for offshore work and other underwater applications.

Specifications

Range	$\pm 5^\circ/\pm 60^\circ$ uniaxial or biaxial
Resolution	0.0001°/0.002°
Output	RS232 or RS422, full duplex
Power Requirement	+7 to +28 VDC @ 27mA
Temperature Range	-4 to +60°C
Dimensions	149 x 91 x 82 mm
Housing	316 stainless steel

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Specifications

Range	$\pm 1^\circ$ uniaxial, adjustable over $\pm 5^\circ$
Resolution	0.0003° (1 arc second)
Output	± 2.5 VDC or 4-20 mA
Power Requirement	8-24 VDC @ 8mA (analog voltage output) ~12-29 VDC (4-20 mA output)
Temperature Range	-40 to +85°C
Dimensions	Cross section: 38 x 38 mm; Length: 1, 2 or 3m
Housing	Square aluminum tube, weatherproof

Specifications

Range	$\pm 5^\circ$ uniaxial (horizontal) or biaxial (vertical)
Resolution	0.005°
Output	± 2.5 VDC or 4-20 mA
Power Requirement	8-24 VDC @ 7mA (analog voltage output) ~12-29 VDC (4-20 mA output)
Temperature Range	-40 to +85°C
Dimensions	Cross section: 38 x 38 mm; Length: 1, 2 or 3m
Housing	Square aluminum tube, weatherproof

Specifications

Range (Biaxial)	Model 701-2A	Model 701-2B
Low-Gain Setting:	$\pm 0.46^\circ$	$\pm 8^\circ$
High-Gain Setting:	$\pm 0.046^\circ$	$\pm 0.8^\circ$
Resolution	0.1 μ radian	1 μ radian
Output	± 8 VDC (single-ended), ± 16 VDC (differential)	
Power Requirement	± 11 to ± 15 VDC @ 11 and 6mA	
Temperature Range	-25 to +70°C	
Dimensions	152 x 152 x 106 mm	
Housing	Anodized & painted aluminum	

Specifications

Range	$\pm 0.46^\circ/\pm 4^\circ$ biaxial
Resolution	1 μ radian/2 μ radians
Output	± 8 VDC (single-ended), ± 16 VDC (differential)
Power Requirement	± 11 to ± 15 VDC @ 11 and 6mA
Temperature Range	-25 to +70°C
Dimensions	152 x 152 x 100 mm
Housing	Anodized & painted aluminum, NEMA 4X (IP65)

Beamer Tilt Beam Sensor

The Beamer beam sensor detects rotation (tilt) between its two fixed end points. Using a known beam length, changes in tilt are easily converted to displacements using simple trigonometry. Beamers span cracks and local discontinuities to measure the overall movement of walls, tunnels, and other structures and can be connected end-to-end to determine cumulative displacement along a horizontal or vertical profile. Units are offered in vertical or horizontal configurations, and in 1, 2 and 3m lengths. A precision ceramic tilt sensor and signal conditioning electronics are included inside the rigid aluminum beam. Sensor null can be manually adjusted over a ± 5 degree range. Choose analog voltage or 4-20mA output. Mounting hardware (part no. 89028) is sold separately.



Beamer LT

The Beamer LT is a low-cost beam sensor that uses a 900 Series Clinometer for tilt measurement and signal conditioning. It is operated the same way as the standard Beamer. Measurement range is fixed at ± 5 degrees, which allows for easy installation. This is a practical tool for measurements in tunnels and other areas of constant temperature. The Beamer LT is available in vertical or horizontal configurations; 1, 2 and 3m lengths; and with analog voltage or 4-20mA output. Mounting hardware (part no. 89028) is sold separately.



Model 701-2 Platform Tiltmeter

The biaxial Model 701-2 Platform Tiltmeter is our most popular design for rapid installation and high precision. Using its built-in Invar leveling legs, it can be set up and operating on any hard horizontal surface within minutes. The two orthogonal tilt sensors parallel the sides of the base plate. Each tiltmeter includes a temperature sensor. The internal electronics drive signals over cable lengths greater than 1000m. The Model 701-2 has two switchable gains and two low-pass filter settings. This tiltmeter is a popular choice for volcano monitoring, platform leveling, and measuring structural response to applied loads.



Model 701-2(4X) Weatherproof Platform Tiltmeter

The biaxial Model 701-2(4X) Platform Tiltmeter delivers high precision and the same ease of installation as Model 701-2, but in a weatherproof housing. With its adjustable Invar legs, you can install and level the unit within minutes. It has fixed gain and filter settings. Typical applications include volcano monitoring, antenna and platform leveling, structural testing and other demanding applications in wet environments.



Model D701 Digital Platform Tiltmeter



Model D701 Digital Platform Tiltmeter is the digital version of our Model 701-2 Platform Tiltmeter. The Invar leveling legs make it a great choice for rapid installation, and its NEMA 4X enclosure provides excellent protection from moisture and wet weather. This precision instrument has a 16-bit A/D converter, low-noise electronics and two orthogonal electrolytic tilt sensors. It comes with a real-time clock and 540K of FLASH memory for on-board data storage. User-selectable firmware commands include auto zero, sampling frequency, low-pass filtering and serial data protocol (RS232 or RS422). Output data format (X tilt, Y tilt, temperature, serial no.) is also user-selectable. Several GPS-compatible formats are provided. Ask us about wireless connectivity for these devices.

Specifications

Range	$\pm 0.5^\circ/\pm 5^\circ$ biaxial
Resolution	1 μ radian/10 μ radians
Output	RS232 and RS422, full duplex
Power Requirement	+7 to +28 VDC @ 27 mA
Temperature Range	-40 to +85°C
Dimensions	152 x 152 x 100 mm
Housing	Anodized & painted aluminum, NEMA 4X (IP65)

Models 711-2 and 716-2 Floor Mount & Wall Mount Tiltmeters



The Model 711-2 and 716-2 Floor Mount and Wall Mount Tiltmeters bolt or clamp to any surface, and are well suited for areas of heavy traffic or vibration. They are identical to our popular Model 701-2 Platform Tiltmeter, but have 0.5-inch (12.7 mm) diameter holes in their three corners instead of adjustable legs. The holes fit over threaded stainless steel studs, provided with each order. Both models have two switchable gains, two low-pass filter settings, and include a temperature sensor. They will drive cables longer than 1000 meters. These precision tiltmeters are widely used for structural monitoring, load testing, and precision alignment of antennae and machinery.

Specifications

Range (Biaxial):	High-Gain	Mid-Range	Wide-Angle
Low-Gain Setting	$\pm 0.46^\circ$	$\pm 8^\circ$	$\pm 70^\circ$
High-Gain Setting	$\pm 0.046^\circ$	$\pm 0.8^\circ$	$\pm 8^\circ$
Resolution	0.1 μ radian	1 μ radian	10 μ radians
Output	± 8 VDC (single-ended), ± 16 VDC (differential)		
Power Requirement	± 11 to ± 15 VDC @ 11 and 6mA		
Temperature Range	-25 to +70°C		
Dimensions	152 x 152 x 106 mm		
Housing	Anodized & painted aluminum		

Model 711-2(4X) Weatherproof Floor Mount Tiltmeter



The Model 711-2(X) with fixed gain and filter is a weatherproof version of our popular Model 711- 2 Floor Mount Tiltmeter. This precision instrument bolts or clamps to any surface and can be used in areas of heavy traffic or vibration. The 711-2(X) also measures temperature, and its internal electronics will drive tilt and temperature signals over cable lengths greater than 1000m. Applications include volcano monitoring, precise alignment of telescopes and antennae, structural monitoring, and other jobs that require precision measurements under harsh operating conditions.

Specifications

Range	$\pm 0.46^\circ/\pm 4^\circ/\pm 70^\circ$ biaxial
Resolution	1 μ radian/2 μ radians/10 μ radians
Output	± 8 VDC (single-ended), ± 16 VDC (differential)
Power Requirement	± 11 to ± 15 VDC @ 11 and 6mA
Temperature Range	-25 to +70°C
Dimensions	152 x 152 x 100 mm
Housing	Anodized & painted aluminum

Model D711 Digital Floor Mount Tiltmeter



The Model D711 Digital Floor Mount Tiltmeter is a precision digital instrument packaged in a weatherproof housing. It delivers the same performance and user-selectable firmware features as the Model D701, but has 0.5 inch (12.7 mm) diameter holes in its three corners instead of adjustable legs. The holes fit over threaded stainless steel studs, provided with each order. RS232 and RS422 outputs are both included as standard features. The RS422 output will drive cables longer than 1000m. Typical applications include alignment of antennae and airframes, structural testing and monitoring, and other jobs that call for top performance under demanding operating conditions.

Specifications

Range	$\pm 0.5^\circ/\pm 5^\circ/\pm 70^\circ$ biaxial
Resolution	1 μ radian/1.75 μ radians/20 μ radians

Output RS232 and RS422, full duplex Power Requirement
+7 to +28 VDC @ 30mA Temperature Range
-40 to +85°C

Dimensions 152 x 152 x 100 mm

Housing Anodized & painted aluminum, NEMA 4X (IP65)



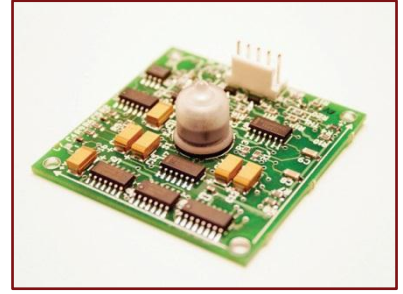
1

Specifications

Range	$\pm 10^\circ/\pm 25^\circ/\pm 50^\circ$
Resolution	0.005°/0.01°/0.02°
Output	± 2.5 VDC or 0-5 VDC
Power Requirement	8-24 VDC @ 7mA 10.5-26 VDC @ 7mA for 0-5 VDC output
Temperature Range	-40 to +85° C
Dimensions	50.8 x 50.8 x 16.3 mm

Model 900 Biaxial Clinometer

The dual-axis Model 900 is an inexpensive, gravity-referenced clinometer with analog voltage output and compact dimensions. Sold without a housing, its small size and performance make it an excellent choice for many OEM, test and measurement applications. It is available in high-gain, standard and wide-angle versions, each with a different angular range. The Model 900 accepts a wide input voltage range and provides high-level single-ended outputs that are easily measured with any voltmeter or digital recording system. Viscous damping and temperature measurement upgrades are available as options.

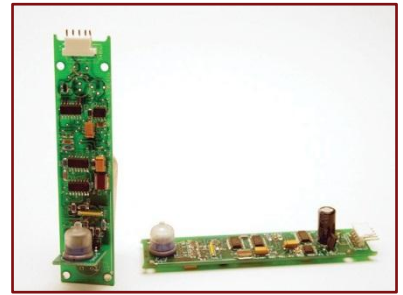


Specifications

Range	$\pm 10^\circ/\pm 25^\circ/\pm 50^\circ$
Resolution	0.005°/0.01°/0.02°
Output	± 2.5 VDC or 0-5 VDC
Power Requirement	8-24 VDC @ 7mA 10.5-26 VDC @ 7mA for 0-5 VDC output
Temperature Range	-40 to +85° C
Dimensions	110.5 x 23.4 x 15.4 (901) or 23.4 mm (902)

Models 901 & 902 Slimline Biaxial Clinometers

Models 901 (horizontal) and 902 (vertical) Biaxial Clinometers accurately measure angular position with the same performance as the Model 900, but in a slim design for use in narrow spaces. These conveniently sized, low-cost units fit neatly into underwater pressure housings, well logging tools, drilling equipment and many other devices. The dual-axis (biaxial) Models 901 and 902 measure rotations about two orthogonal axes. Their high-level voltage outputs allow signals to be delivered over long cables, making these units perfect for projects requiring sensor operation at a distance.

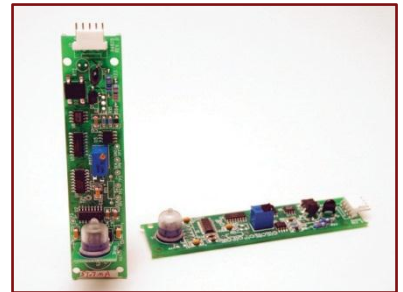


Specifications

Range	$\pm 10^\circ/\pm 25^\circ/\pm 50^\circ$
Resolution	0.005°/0.01°/0.02°
Output	4-20 mA (2-wire current loop)
Power Requirement	-12 - 29 VDC
Temperature Range	-40 to +85° C
Dimensions	110.5 x 23.4 x 15.4 (horiz.) or 23.4 mm (vertical)

Tulip 4-20mA Uniaxial Clinometer

Tulip 4-20mA Uniaxial Clinometers are compact and accurate uniaxial instruments for measuring angular position where space is limited. Dimensions are the same as the Models 901 and 902. High-gain, standard and wide-angle versions are available, each with a different angular range. Tulip clinometers are current loop powered, so measurements can be made over long cable lengths using an economical 2-wire pair. Choose between vertical and horizontal versions. The horizontal version measures either longitudinal or transverse rotation to give you maximum flexibility when designing it into your system. As an added bonus, Tulip clinometers also measure temperature using a built-in thermistor.



Specifications

Range	$\pm 10^\circ/\pm 25^\circ/\pm 50^\circ$
Resolution	0.005°/0.012°/0.025°
Output	RS232 (tilt & temperature), 0-4.75 VDC (tilt only)
Power Requirement	+7 to +28 VDC @ 27 mA
Temperature Range	-40 to +85° C
Dimensions	67 x 67 x 25 mm

IRIS Tilt Switch and Controller

IRIS combines a digital, dual-axis clinometer and a powerful control device in one compact unit. This remarkable instrument enables you to measure and respond to rotational movements in any direction with reference to the unchanging gravity vector. IRIS is an ideal choice for OEM applications, where it can be used to maintain platform levelness, avoid tip-over conditions, prevent out-of-range movement, and perform other control functions. Each unit has 5 user-programmable thresholds that control TTL-compatible CMOS outputs (0-5 VDC), with 3 additional control outputs available for custom applications. Biaxial tilt and temperature are provided in user-selectable RS232 or RS422 output protocols. A powerful selection of firmware commands puts you in charge of sampling frequency, output filtering and many other functions. The versatility of this small device will amaze you!



Miniature Tilt Sensors and Signal Conditioners

Our Miniature Tilt Sensors are standalone electrolytic sensor modules that are well suited for applications with size or weight constraints. These are the same tilt sensors that we use in our fully packaged Tiltmeters and Clinometers. These small modules attach directly to the elements you want to measure, without unbalancing them or affecting their performance. Sensors are operated using one of our standalone Signal Conditioners. The table below summarizes the capabilities of the sensors. Ultimate performance is a function of the sensor/signal conditioner combination.

Miniature Tilt Sensor Selection Table

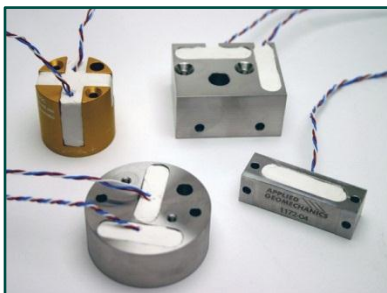
Model	Resolution	Angular Range*	Biaxial	Uniaxial
755-Series High Gain (4 Models)	< 0.1 μ radian	To $\pm 0.8^\circ$	•	•
756-Series Mid Range (4 Models)	< 1 μ radian	To $\pm 10^\circ$	•	•
84053 Mid-Range Ceramic**	1 μ radian	To $\pm 6^\circ$		•
59577 Mid-Range Ceramic	1 μ radian	To $\pm 6^\circ$		•
84064-02 Wide-Angle Ceramic**	< 0.001 $^\circ$	To $\pm 75^\circ$		•
59579-02 Wide-Angle Ceramic	< 0.001 $^\circ$	To $\pm 75^\circ$		•
59560 Biaxial, 5-Pin, Undamped†	0.004 $^\circ$	$\pm 30^\circ$	•†	•
59562 Biaxial, 5-Pin, Damped†	0.004 $^\circ$	$\pm 30^\circ$	•†	•
59580 Wide-Angle Biaxial, 5-Pin, Undamped†	0.01 $^\circ$	$\pm 60^\circ$	•†	•
59585 Wide-Angle Biaxial, 5-Pin, Damped†	0.01 $^\circ$	$\pm 60^\circ$	•†	•

* Depends on signal conditioner settings

** On aluminum mounting bracket

† Biaxial when used with Model 84828 or IRIS SC signal conditioners, otherwise uniaxial

755-Series High-Gain Sensors, 756-Series Mid-Range Sensors



755- and 756-Series Miniature Tilt Sensors contain one or two of our electrolytic tilt transducers in a solid stainless steel or aluminum housing. Housing includes prefabricated holes for vertical or horizontal mounting. These are the same high-precision sensors that we use in our 500- and 700-Series tiltmeters. Several of the models are available in vacuum-compatible versions designed for minimal outgassing under high-vacuum conditions. Two options are available, the high-gain 755-Series and mid-range 756-Series. Typical applications for these compact modules include X-ray mirrors, telescope mounts, wind tunnel models and medical devices. Units may be operated at a distance (cable length) up to 100m from their Jewell Instruments signal conditioner.

Specifications

Range	$\pm 0.8^\circ/\pm 10^\circ$ uniaxial or biaxial
Resolution	< 0.1 μ radian/1 μ radian
Power Requirement	Provided by signal conditioner
Temperature Range	-25 to +80 $^\circ$ C
Materials	304 stainless steel or anodized aluminum
Model:	Dimensions:
755-1172, 756-1172	50.8 x 15.8 x 15.8 mm, uniaxial
755-1150, 756-1150	50.8 x 41.2 x 25.4 mm, biaxial
755-1129, 756-1129	50.3 dia. x 20.8 mm, biaxial
755-1326, 756-1326	34.8 dia. x 31.8 mm, biaxial

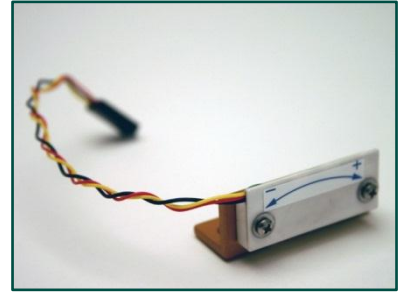
2

Specifications

Range	$\pm 6^\circ$ full, $\pm 3^\circ$ linear (uniaxial)
Resolution	1 μ radian
Power Requirement	Provided by signal conditioner
Temperature Range	-50 to +125°C
Dimensions	44.2 x 23.6 x 18.3 mm
Materials	Alumina sensor, anodized aluminum bracket

Model 84053 Mid-Range Ceramic Sensor Assembly

The Model 84053 Ceramic Sensor Assembly is made with an alumina sensor body that provides superior thermal and mechanical performance. This precision sensor has a fast warm-up, high sensitivity, high repeatability, and excellent long-term stability. It is mounted on an anodized aluminum bracket that strengthens the assembly and simplifies installation and repositioning of this versatile product. These compact sensor modules are used for leveling and positioning in a variety of test and measurement applications.

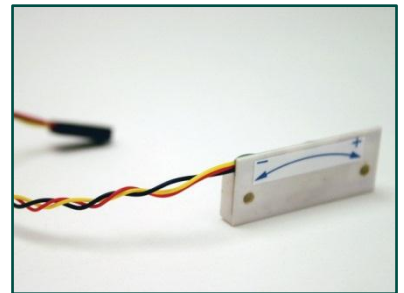


Specifications

Dimensions	38.2 x 5.8 x 16 mm
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Model 59577 Mid-Range Ceramic Sensor

The Model 84053 Ceramic Sensor Assembly is available without the mounting bracket as our uniaxial Model 59577 Ceramic Sensor. Performance is the same. Dimensions of the Model 59577 are shown at left.

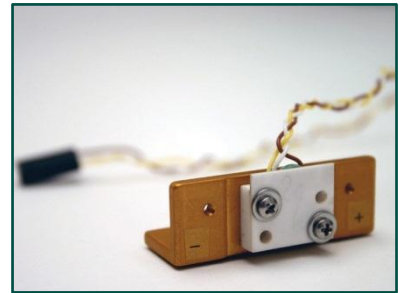


Specifications

Range	$\pm 75^\circ$ full, $\pm 60^\circ$ linear (uniaxial)
Resolution	0.001°
Power Requirement	Provided by signal conditioner
Temperature Range	-50 to +125°C
Dimensions	44.2 x 22.6 x 17 mm
Materials	Alumina sensor, anodized aluminum bracket

Model 84064-02 Wide-Angle Ceramic Sensor Assembly

The Model 84064-02 Ceramic Tilt Sensor Assembly has terrific linearity over a full ± 75 degrees of angular range. The alumina sensor has a fast warm-up and excellent thermal, mechanical and long-term stability. It is mounted on an anodized aluminum bracket for strength and easy installation. The small and lightweight assembly attaches directly to the elements you want to measure, without unbalancing them or altering their performance. Use any of our analog or digital signal conditioning units for operation of these sensors.

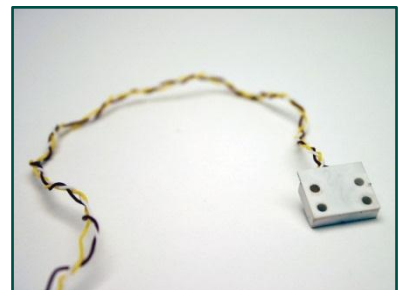


Specifications

Dimensions	17.8 x 4.6 x 15.2 mm
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Model 59579-02 Wide-Angle Ceramic Sensor

The Model 84064-02 Ceramic Sensor Assembly is available without the mounting bracket as our uniaxial Model 59579-02 Ceramic Sensor. Performance is the same. Dimensions of the Model 59579-02 are shown at left.



Models 59560 (Undamped) & 59562 (Damped) Biaxial Sensors, 5-Pin

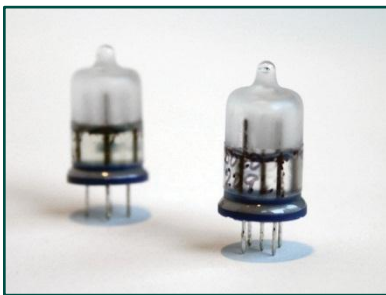


These 5-pin biaxial electrochemical sensors, used in our 900-Series Clinometers, are available as standalone units for your special applications. The design of these sensors, which have five internal electrodes instead of three, enables them to measure tilt in two orthogonal directions. Biaxial readings are obtained by using our Model 84828 or IRIS SC signal conditioners. Our other signal conditioners operate these sensors in uniaxial mode. The electrochemical fluid in sensor Model 59562 is slightly viscous to provide critical damping (please specify per order). This damping removes the effect of vibrations on the measurements.

Specifications

Range	±30° full, ±25° linear (biaxial)
Resolution	0.004°
Power Requirement	Provided by signal conditioner
Temperature Range	-50 to +125°C
Dimensions	12.7 dia. x 15.9 mm
Materials	High-strength glass

Models 59580 (Undamped) & 59585 (Damped) Biaxial Sensors, 5-Pin, Wide-Angle



These 5-pin biaxial sensors are the same as the Models 59560 and 59562, except they are taller, which enables them to measure angles up to 60 degrees from the vertical. Biaxial readings are obtained by using our Model 84828 or IRIS SC signal conditioners. Our other signal conditioners operate these sensors in uniaxial mode. The electrochemical fluid in sensor Model 59585 is slightly viscous to provide critical damping to remove vibrations (please specify per order).

Specifications

Range	±60° full, ±40° linear (biaxial)
Resolution	0.01°
Power Requirement	Provided by signal conditioner
Temperature Range	-50 to +125°C
Dimensions	12.7 dia. x 26.1 mm
Materials	High-strength glass

Signal Conditioning Units

Jewell Instruments manufactures a versatile selection of signal conditioning units for operating our Miniature Tilt Sensors. These include unboxed versions that are excellent for OEM applications and packaging in your own enclosures, along with fully boxed units that are ready for action in your laboratory or factory. Key features of these signal conditioners are summarized in the table below.

Signal Conditioner Selection Table

Model	Unboxed	Boxed	Analog Voltage Output	4-20 mA Output	RS232 and/or R485 Output	Display	No. of Channels
84828 Basic	•		•				1 or 2*
84800 Single Channel	•		•				1
83162 Dual Channel	•		•				2
Tulip SC	•			•			1
IRIS SC	•				•		2
781 Bench Top		•	•				2
786 Rack Mount		•	•				Up to 16

*2 channels when used with 5-pin sensors

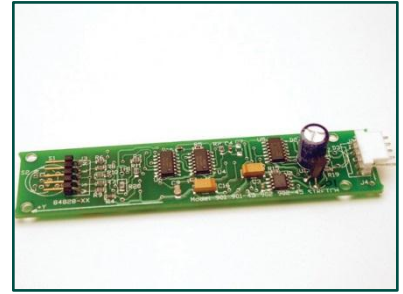
2

Specifications

Output	± 4 VDC/0-5 VDC
Resolution	$\ll 1$ mV
Power Requirement	8-24 VDC @ 7mA 10.5-26 VDC @ 7mA for 0-5 VDC output
Temperature Range	-40 to +85°C
Dimensions	103 x 23.4 x 7 mm

Model 84828 Basic Signal Conditioner

The Model 84828 Basic Signal Conditioner operates one 5-pin biaxial tilt sensor or one uniaxial sensor, and one LM-35 temperature sensor, which may be installed on the circuit board. The Model 84828 has one fixed gain and one RC low-pass filter, both of which can be factory-tuned to meet your requirements. The slim, low-profile design facilitates use in small spaces. This versatile and inexpensive signal conditioner has single-ended voltage output. The circuit is reverse polarity protected. It is an excellent choice for many of your OEM applications.

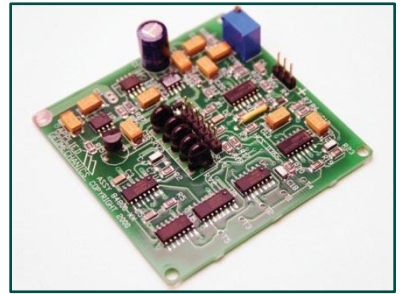


Specifications

Output	± 5 VDC single-ended and ± 10 VDC differential
Resolution	$\ll 1$ mV
Power Requirement	8-18 VDC @ 8mA
Temperature Range	-40 to +85°C
Dimensions	63 x 63 x 16 mm

Model 84800 Single-Channel Signal Conditioning Card

This single-channel signal conditioning card is a compact electronic circuit that provides excitation and signal conditioning for any electrolytic tilt sensor and for one LM-35 temperature sensor. A wide input voltage range, reverse polarity protection, and transient surge protection are advantages of this circuit. Its 2-pole Butterworth low-pass filter can be tuned to your special requirements. The Model 84800 will drive its analog voltage output signals over cable lengths longer than 300m. Four mounting holes allow easy packaging in OEM and end-user assemblies. This circuit is an excellent match for our high-precision 755- and 756-Series sensors and for all of our other Miniature Tilt Sensors.

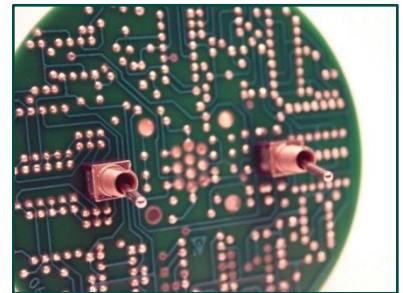


Specifications

Output	± 8 VDC single-ended and ± 16 VDC differential
Resolution	$\ll 1$ mV
Power Requirement	± 11 to ± 15 VDC @ 11 and -6 mA
Temperature Range	-25 to +70°C
Dimensions	98 mm dia. x 28 mm

Model 83162 Dual-Channel Signal Conditioning Card

The Model 83162 Signal Conditioning Card is a precision two-channel circuit for use with all electrolytic tilt sensors. It has switchable gain and low-pass filter settings, and will produce peak performance for the 755, 756, 84053 and 84064-02 Miniature Tilt Sensors. The Model 83162 generates a balanced AC sensor excitation, then amplifies, rectifies, and filters the sensor outputs to produce high-level DC signals proportional to the tilt angle. It includes an amplifier for an LM35 temperature sensor, and will drive output

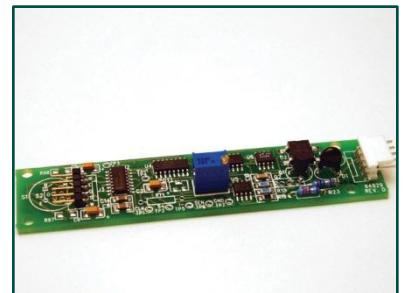


Specifications

Output	4-20mA
Resolution	< 0.001 mA
Power Requirement	-12 to 29 VDC
Temperature Range	-40 to +85°C
Dimensions	103 x 23.4 x 8 mm

Tulip SC 4-20mA Signal Conditioning Card

The Tulip SC is a 4-20mA signal conditioner for use with all of our Miniature Tilt Sensors. It operates one tilt channel and also measures temperature using a 2500 Ohm thermistor. The Tulip SC is current loop powered, so measurements can be made over long cable lengths using an economical 2-wire pair. You may operate this signal conditioner with normal or reverse polarity without affecting its performance. Its small size, easy setup and fast response time make the Tulip SC a great choice for OEM applications that require long cable runs or interfacing with control systems.



IRIS SC Digital Signal Conditioning Card



IRIS SC provides signal conditioning and serial data output for all of our Miniature Tilt Sensors. Use it with up to two uniaxial sensors, or any biaxial sensor. It has a 16-bit A/D converter, 540K of onboard FLASH memory and a real-time clock; it also measures temperature. Its powerful firmware commands include low-pass filtering, autozero, sampling frequency selection, RS232 or RS422 output selection, and onboard data storage. Other commands enable you to select among data formats, including formats compatible with popular GPS receivers. IRIS SC also operates as a tilt switch and controller. This product is a perfect choice for applications that require digital data streams or onboard recording of tilt measurements.

Specifications

Output	RS232 and RS422, full duplex
Resolution	16-bit A/D converter
Power Requirement	8-28 VDC at 27mA
Temperature Range	-40 to +85°C
Dimensions	67 x 67 x 8 mm max.

Model 781 Signal Conditioner (Bench Top)



The Model 781 is a precision, 2-channel signal conditioning unit for all electrolytic tilt sensors. It provides peak performance from your 755, 756, 84053 and 84064-02 Miniature Tilt Sensors. To build Model 781, we package an 83162 signal conditioning card in a rugged aluminum case with screw terminals on the rear panel for sensor connections, power input, and signal output. Three switches on the front panel control gain, and low-pass filter settings, and power (on-off). The Model 781 generates a balanced AC sensor excitation, then amplifies, rectifies and filters the sensor outputs to produce high-level DC signals proportional to the tilt angle. It also operates a LM35 temperature sensor and will drive tilt and temperature signals over 1000m cable lengths. This signal conditioner is excellent for laboratory and factory applications that require remote operation of one or two tilt sensors.

Specifications

Output	± 8 VDC single-ended and ± 16 VDC differential
Resolution	$<< 1$ mV
Power Requirement	± 11 to ± 15 VDC @ 11 and -6 mA
Temperature Range	-25 to +70°C
Dimensions	213 x 127 x 88 mm
Housing	Painted aluminum (indoor use only)

Model 786 Rack Mount Signal Conditioner



In Model 786 we have packaged the great performance of our Model 781 Signal Conditioning Unit in a multi-channel rack mount system. The Model 786 may be ordered with 2 to 16 tilt channels. For every pair of tilt channels there is one temperature channel. Temperature is measured using LM-35 temperature sensors. All sensor connections are made at quarter-turn connectors, located on the rear panel. Amplified DC outputs (tilt and temperature) are supplied at two DB25 connectors on the rear panel. The unit has two switchable gains and two filter setting for each pair of tilt channels. Gain, filter and on-off switches are located on the front panel. The Model 786 is AC-powered.

Specifications

Output	± 8 VDC single-ended and ± 16 VDC differential
Resolution	$<< 1$ mV
Temperature Range	-25 to +70°C
Power Requirement	110-240 VAC
Dimensions	483 x 381 x 123 mm
Housing	Painted aluminum (indoor use only)

3

Vibrating-Wire Sensors

We are proud to offer a full line of vibrating-wire (VW) sensors for geotechnical measurements. The output of these rugged and field proven sensors is a frequency, which is immune to noise under most conditions. These frequency signals can be transmitted through cables for distances of several thousand meters without signal loss—a big advantage in many

geotechnical projects. Our most popular sensors are described below. Readings from our vibrating-wire sensors are taken using the Advisor Vibrating-Wire Readout, our single-channel Handi-Logger Mini, or the multichannel Model 798-1000 Handi-Logger. Our VW sensors are manufactured by Geokon.

Specifications

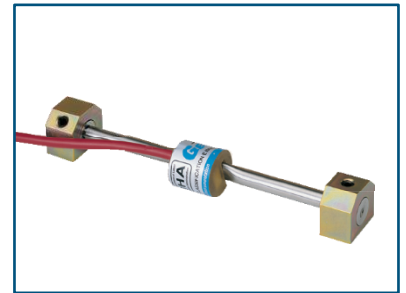
Standard Range	3000 μ strain
Resolution	1.0 μ strain
Accuracy ¹	$\pm 0.5\%$ F.S.
Nonlinearity	$< 0.5\%$ F.S.
Temperature Range	-20°C to $+80^{\circ}\text{C}$
Active Gage Length ²	150 mm

¹ Accuracy of $\pm 0.1\%$ F.S. available with optional, individual calibration.

² Other lengths available on request

Model 4000 Arc Weldable Strain Gage

The Model 4000 Strain Gage is designed primarily for arc welding to steel structures such as tunnel linings, excavation bracing, piles and bridges. The gage has a 150 mm gage length, a 3000 μ strain range, and a 1 μ strain sensitivity. This versatile gage can also be adapted for bonding to concrete or for bolting to steel surfaces by modification of the end blocks.



Specifications

Standard Range	3000 μ strain
Resolution	0.4 μ strain
Accuracy ¹	$\pm 0.5\%$ F.S.
Nonlinearity	$< 0.5\%$ F.S.
Temperature Range	-20°C to $+80^{\circ}\text{C}$
Active Gage Length ²	51 mm

¹ Accuracy of $\pm 0.1\%$ F.S. available with optional, individual calibration.

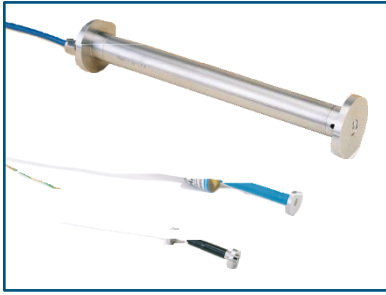
² Other lengths available on request.

Model 4100 › 4150 › 4151 Miniature Strain Gages

The Model 4100/4150 Strain Gage has a 51 mm gage length, and is designed to measure strains in steel structures (4100) and on reinforcement bars (4150) where space may be limited. The gage is installed quickly and easily by means of a capacitive discharge spot welder or, for short-term use, with special epoxy adhesives. The 4151 Strain Gage Series offers extended ranges, 5000 or 10,000 μ strain, for use in high strain regimes.



Model 4200 › 4202 › 4210 Concrete Embedment Strain Gages



These Strain Gages are designed for direct embedment in concrete. The 4200 (standard model) has a 153 mm gage length and 1 μ strain sensitivity, and is commonly used for strain measurements in foundations, piles, bridges, dams, tunnel linings, etc. The 4210 has a 250 mm gage length, making it particularly suitable for use in large-aggregate concrete. The 4202 is designed for laboratory use and other applications where there are space limitations. Low modulus versions, for measuring concrete curing strains, are also available (please contact Jewell for details).

Specifications

	4200	4202	4210
Standard Range	3000 μ strain	3000 μ strain	3000 μ strain
Resolution	1.0 μ strain	0.4 μ strain	0.4 μ strain
Accuracy ¹	$\pm 0.5\%$ F.S.	$\pm 0.5\%$ F.S.	$\pm 0.5\%$ F.S.
Nonlinearity	< 0.5% F.S.	< 0.5% F.S.	< 0.5% F.S.
Temperature Range	-20°C to +80°C	-20°C to +80°C	-20°C to +80°C
Active Gage Length	153 mm	51 mm	250 mm ²

¹ Accuracy of $\pm 0.1\%$ F.S. available with optional, individual calibration.
² Other lengths available on request.

Model 4420 Crackmeter



The Model 4420 Crackmeter is intended to measure movement across surface cracks and joints. It is installed by grouting, bolting, or bonding two threaded anchors (with ball joints) on opposite sides of the crack, and then attaching the ends of the gage to the anchors.

Specifications

Standard Ranges	12.5, 25, 50, 100, 150 mm
Resolution	0.025% F.S.
Accuracy	$\pm 0.1\%$ F.S.
Nonlinearity	< 0.5% F.S.
Temperature Range	-20°C to +80°C
Length x Diameter	318, 362, 527 mm x (shaft) 8 mm, (coil) 25 mm

Model 4500S › 4500SH › 4500AL(V) Standard Piezometers



The Model 4500 Standard Piezometer is designed for measuring fluid pressures, such as ground water elevations and pore pressures, when buried directly in embankments and fills. These piezometers can also be installed inside boreholes, observation wells and standard (>19 mm diameter) piezometer riser pipe. The Model 4500AL is designed for low-pressure ranges. The vented version, Model 4500AL(V), provides automatic compensation for barometric pressure changes. Internal thermistors are included to measure temperatures.

Specifications

	4500S	4500SH	4500AL(V)
Standard Ranges	350, 700 kPa 1, 2, 3 MPa	5, 7.5, 10, 20 MPa	70, 170 kPa
Over Range	2 x rated pressure	2 x rated pressure	2 x rated pressure
Resolution	0.025% F.S.	0.025% F.S.	0.025% F.S.
Accuracy	$\pm 0.1\%$ F.S.	$\pm 0.1\%$ F.S.	$\pm 0.1\%$ F.S.
Linearity ¹	< 0.5% F.S.	< 0.5% F.S.	< 0.5% F.S.
Length x Diameter	133 x 19.1 mm	194 x 25.4 mm	133 x 25.4 mm

¹ $\pm 0.1\%$ F.S. option available in some ranges.
² High temperature versions available on request.

3

Specifications

Standard Ranges	70, 170, 350, 700 kPa; 1, 2, 3, 5, 7.5 MPa
Over Range	2 × rated pressure
Resolution	0.025% F.S. (minimum)
Accuracy	±0.1% F.S.
Linearity	<0.5% F.S. (±0.1% F.S. optional)
Temperature Range ¹	-20°C to +80°C
Length × Diameter	187 × 33.3 mm

¹ High temperature versions available on request.

Specifications

Standard Ranges ¹	7, 17 m
Resolution	0.025% F.S.
Sensor Accuracy ²	±0.1% F.S.
Temperature Range	-20°C to +80°C
Length × Diameter	(reservoir) 152 × 51 mm (sensor) 191 × 35 mm

¹ Other ranges available on request.

² Laboratory accuracy. Total system accuracy is subject to site-specific variables.

Specifications

Standard Ranges	70, 170, 350, 700 kPa; 1, 2, 3, 5, 7.5, 20 MPa
Over Range	150% F.S. (maximum)
Resolution	0.025% F.S.
Accuracy ¹	±0.1% F.S.
Temperature Range	-20°C to +80°C
Height × Diameter ²	6 × 230 mm

Specifications

Rated Capacities ¹	100 to 10,000 kN
Over Range	150% F.S.
Resolution	0.025% F.S.
Accuracy ²	±0.5% F.S.
Temperature Range	-20°C to +80°C
Internal Diameters ¹	solid, 25, 50, 75, 100, 125, 150, 200, 250 mm

¹ Other capacities and diameters available on request. Calibrations that exceed Geokon's NIST traceable capacity of approximately 4500 kN are subcontracted to an accredited testing laboratory.

² Established under laboratory conditions. System accuracy depends on end loading conditions.

Model 4500DP Drive Point Piezometers

The Model 4500DP Drive Point Piezometer has the transducer located inside a housing with an EW drill rod thread and removable pointed nose cone. This model is ideally suited for use in peat and soft clays. Due to its convenient design, the piezometer may be recovered at the end of the job. Models are also available which use metric threads allowing for installation using conventional cone penetrometer or other drill rods with adapters.¹



Model 4650 Settlement System

The Model 4650 Settlement System uses a pressure transducer attached to a settlement plate located in the settling ground. The sensor is connected, via two fluid-filled tubes, to a reservoir located on firm ground, away from the area of anticipated movement. Fluid pressure within the tubes is detected by the transducer, which provides a measure of the elevation difference between the sensor and the reservoir. The tubes are flushable to remove air and maintain peak performance. This unit's transducer/reservoir system is vented and not influenced by barometric pressure.



Model 4800 Earth Pressure Cell

The Model 4800 Earth Pressure Cell is designed to measure total pressure in earth fills and embankments. All cells consist of two circular stainless steel plates welded together around their periphery and separated by a narrow cavity filled with de-aired oil. Changing earth pressure squeezes the two plates together causing a corresponding increase of fluid pressure inside the cell. A vibrating wire pressure transducer converts this pressure into an electrical signal which is transmitted to the readout location.



Model 3000 > 4900 Load Cells

The Model 4900 Vibrating Wire Load Cell consists of a cylinder of high-strength steel with 3 or 6 vibrating wire strain gages located around the circumference of the cell. Loads applied to the cell are measured by the vibrating wire strain gages. The effects of uneven and eccentric loading are minimized by averaging the output of all 3 or 6 individual readings. The Model 3000 Load Cell has the same design as the Model 4900 but uses electrical resistance strain gages in a Wheatstone Bridge configuration. The Model 3000 is also offered in aluminum.



Model A-1 Single Point Mechanical Extensometer

The Model A-1 Single Position Rod Extensometer is a very simple, rugged and reliable instrument, easily installed and

completely recessed within the borehole for optimum protection. The Model A-1 is a natural first choice for monitoring safety in and around tunnels and mine openings.

Model A-3 Multiple Point Groutable Anchor Extensometer

The Model A-3 Multiple Point Rod Extensometer is the preferred design for installation in downward directed boreholes which are easily filled with cement grout. Up to eight anchors can be installed, at various depths, in a 76 mm diameter borehole, providing the capability to locate multiple failure planes and zones of movement.

Model A-4 Multiple Point Snap-Ring Anchor Extensometer

The Model A-4 Multiple Point Rod Extensometer with Snap-Ring Anchors is quickly and easily installed in boreholes in hard or competent rock. Anchors are pushed to the required depth on the end of setting rods and then a cord is pulled to remove the locking pin, which allows two retaining rings on each anchor to snap outward and grip the borehole. Up to eight anchors can be installed, at various depths, in a 76 mm diameter borehole. The model A-4 is particularly useful in upward directed boreholes.

Model A-5 Multiple Point Hydraulic Anchor Extensometer

The Model A-5 Multiple Point Rod Extensometer with Hydraulic Anchors is recommended for use in soft ground and soils, or in rock prone to borehole deterioration. This anchor is very versatile and can be used in boreholes with varying diameter and roughness oriented in any direction.

Specifications

Standard Range	up to 100 mm
Least Reading	0.025 mm

Borehole Diameter	35, 44, 51, 64 mm
Maximum Length	10 m

Specifications

Standard Range	up to 300 mm nominal
Least Reading	0.025 mm
Borehole Diameter ¹	up to 76 mm
Maximum Length	100 m

¹ Any borehole diameter up to 76 mm may be specified. Note that the size of the borehole required increases with the addition of more measuring points.

Specifications

Standard Range	up to 300 mm nominal
Least Reading	0.025 mm
Borehole Diameter ¹	38 to 76 mm
Maximum Length	50 m

¹ Any borehole diameter up to 76 mm may be specified. Note that the size of the borehole required increases with the addition of more measuring points.

Specifications

Standard Range	up to 300 mm nominal
Least Reading	0.025 mm
Borehole Diameter ¹	38 to 102 mm
Maximum Length	100 m

¹ Note that the size of the borehole required increases with the addition of more measuring points.



4

Pavement Strain Sensors

Specifications

Bridge Circuit Four active 350-ohm strain gages

Range ±2000 microstrain

Sensitivity at 1000 $\mu\epsilon$ ~ 1.3 mV/Vexc

Excitation up to 10 Volts

Temperature Range -34°C to 100°C

Lead Wire 24 AWG, twisted four-wire with shielding

Specifications

Bridge Circuit Four active 350-ohm strain gages

Range ±3000 microstrain

Sensitivity at 1000 $\mu\epsilon$ ~ 1.3 mV/Vexc

Excitation up to 5 Volts

Temperature Range -34°C to 200°C

Lead Wire 30 AWG, twisted four-wire with shielding

Dynamic CSG

These rugged Concrete Strain Gages (CSG) are ideal for infrastructure and structural health monitoring applications that require dynamic strain measurements. The CSG uses a Wheatstone full-bridge circuit, which compensates for temperature and lead wire resistance, while the twisted and shielded lead wires provide protection from electrical noise. These devices are offered in either bending strain or axial strain configurations and are easily operated using conventional strain gage signal conditioners. The CSG is an excellent choice for measuring strains in pavement, columns, bridge components and other concrete structures.



Dynamic ASG

Our Asphalt Strain Gage (ASG) is an embeddable strain gage built to withstand high temperatures and vibratory roller compaction. These gages match the stiffness of typical asphalt, making them ideal for dynamic strain measurements in flexible pavement. The ASG uses a Wheatstone full-bridge circuit, which compensates for temperature and lead wire resistance. The twisted and shielded lead wires provide protection from electrical noise. The ASG is offered in either bending strain or axial strain configurations and is easily operated using conventional strain gage signal conditioners.



5

Traversing Inclinometer and Inclinometer Casing

Specifications

Probe Specifications:

Range ±38° (calibrated to ±30°)

Resolution 0.005 mm per 500 mm (0.00002 ft per 2 ft)

Repeatability ±0.003°

Temperature Limits -40° to 70°C

Readout Specifications:

Battery Life 6 to 8 Hours of readings

Temperature Limits 0° to 40°C

Digital Inclinometer System

Our Digital Inclinometer System is the most advanced traversing inclinometer on the market. Use it to measure lateral displacement of inclinometer casings in boreholes, soil, and rock. Monitor movement of landslides, embankments, excavations, retaining walls, roadways, dams and tunnels. The system combines an iPAC Pocket PC as the readout unit, a waterproof stainless steel probe, and a low-stretch graduated cable. The Pocket PC reads the probe over a Bluetooth™ wireless digital connection, and is protected in a water-resistant case. The system includes a probe carrying case, cable reel with case, Pocket PC docking station, data collection software, battery charger, 12V automobile charging adapter, and spare battery. Also included are adaptors for use with 70mm (2.75 in) and 85 mm (3.34 in) inclinometer casing. Please specify cable length and wheel spacing, English (2 ft, Model 98067) or metric (500 mm, Model 98068), when ordering.



GEO-LOK Inclinometer Casing



GEO-LOK Inclinometer Casing is preferred by drillers, geologists and geotechnical engineers because of its high strength and easy installation. Cumbersome couplings, glue, pop rivets, shear wires and tape are replaced with a threaded twist connection that is built onto each casing section. Sections are sealed with an O-ring. GEO-LOK's fully detachable threaded couplings are stronger than non-reversible snap-together designs. The casing can be retrieved and disassembled if necessary. Install GEO-LOK casing vertically or horizontally, and then use our Little Dipper in-place inclinometer or Digital Inclinometer System to monitor ground movement. Common applications include landslides, dam embankments, excavations, retaining walls, sheet piles, tunnels, landfills and tank foundations.

Specifications

Standard Sections:

Outside Diameter	70 mm (2.75 in) and 85 mm (3.34 in)
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Lengths	1.5 m and 3 m
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Telescoping Sections:

Outside Diameter	73 mm (2.87 in) and 89 mm (3.50 in)
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Length (fully extended)	791 mm
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Length (fully compressed)	639 mm
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Digital Readout Units

Advisor Tiltmeter Readout



The Advisor Tiltmeter Readout is a hand-held, weather-resistant display device designed for taking manual instrument readings. A crisp, high contrast OLED display shows instrument outputs in direct sun or low-visibility conditions. When used with Jewell's digital tiltmeters, the Advisor can also issue firmware commands through an intuitive push-button interface. The Advisor can be powered with either three D-cell batteries or an external power supply when long-term monitoring is necessary. Analog and digital bare wire adapters (BWA's, order separately) enable the Advisor to be used without connectors. Rugged, portable, and versatile, this device is a valuable tool for any monitoring project.

Specifications

Display	High-contrast organic LED
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Input	Analog voltage (bipolar) 4-20 mA RS232, RS422 Thermistor
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Power Requirement	3 D cell batteries
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Temperature Range	-25 to 60°C
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Materials	Unbreakable ABS plastic case
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Dimensions	220 x 190 x 95 mm
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VW Advisor Readout



The Advisor vibrating-wire readout unit displays and logs vibrating-wire and thermistor outputs from your geotechnical sensors. The Advisor has a large backlit LCD display, built-in multiplexer, and quick-connect cable terminals. The multiplexer enables the reading of load cells equipped with up to six vibrating-wire transducers. Protected in an unbreakable, weatherproof field case and powered by three AA batteries, this rugged unit is a must-have for any project that requires manual reading of vibrating-wire instruments. Model 98069.

Specifications

Excitation Range	400-6000 Hz, 5-Volt square wave
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Time Base Accuracy	+/- 50ppm
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Resolution	<0.01 µsecond
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Memory	11,400 data records, up to 256 sensors
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Power Requirement	3 AA batteries
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Temperature Range	-20 to 80°C
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Dimensions	220 x 190 x 95 mm
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7

Data Acquisition

Specifications

Excitation Range	400 - 6000Hz, 5-Voltsquare wave
Time Base Accuracy	+/- 50ppm
Resolution	<0.01 µsecond
Memory	30,000 data records
Sample Interval	2 seconds to 1 day
Power Requirement	2 AA batteries
Temperature Range	-40° to 60°C
Dimensions	150 x 65 x 40 m

Specifications

Input Channels	16 single-ended or 8 differential, 2 pulse counters
Input Voltage Range	Up to ±5 VDC, user selectable
A/D Resolution	13 bits
Memory	4 megabytes
Power Requirement	9.6 to 16 VDC, includes AC adaptor
Temperature Range	-25° to +50°C operation
Dimensions	383 x 333 x 193 mm plus cable entry
Housing	Fiberglass with locking hasp, NEMA 4X (IP65)

Specifications

Connections	Screw terminals
Power Requirement	10.5-16 VDC @ 5.6 mA quiescent, 140 mA active
Temperature Range	-25° to +50°C
Dimensions	356 x 267 x 191 mm
Housing	Fiberglass with locking hasp, NEMA 4X (IP65)

Specifications

Connections	Screw terminals
Power Requirement	11.3 to 16 VDC (under load), unregulated @ <0.21 mA quiescent, 6 mA active
Temperature Range	-25° to +50°C
Dimensions	239 x 102 x 46 mm
Housing	Anodized aluminum, not sealed

Handi-Logger Mini Single-Channel VW Logger

The Handi-Logger Mini automatically reads and records the output from a single vibrating-wire sensor. The NEMA 4X aluminum enclosure is designed for harsh environments. Power is provided by two AA batteries. It stores over 30,000 records including time, frequency and temperature. Use this logger with our vibrating-wire piezometers, crackmeters, strain gages and any other vibrating-wire sensor in projects that require dispersed automated monitoring. Model 98070.



Model 798 Handi-Logger

The Handi-Logger is a complete data logging system that automates the monitoring of all of your field instrumentation. Housed in a weatherproof NEMA 4X enclosure, it uses a Campbell Scientific CR1000 as its central processing unit. It includes an uninterruptible power supply with AC charger and solar panel connections, plus custom data collection software with features such as alarm checking, auto-zero and user-selectable sampling frequency. Download your data by direct connection to a PC, or automatically transfer data to an Atlas database over the Internet. By adding our Model 797 and AM16/32B multiplexers, you can collect data from up to 30 biaxial (40 uniaxial) tiltmeters and 256 vibrating-wire sensors.



Model 797 Multiplexer

The Model 797 Multiplexer allows the Model 798 Handi-Logger to log more tiltmeters. Model 797 routes power to the tiltmeters and sequentially multiplexes their signals into common input terminals, which are connected to analog inputs in the Handi-Logger. Tiltmeter connections are made at clearly labeled screw terminal strips on the front panel. The Handi-Logger controls the multiplexer using two control ports. Each Model 797 multiplexes up to either 10 biaxial, 20 uniaxial tiltmeters, or 30 two-wire signals from other devices. Up to two Model 797 units can be connected to one Handi-Logger.



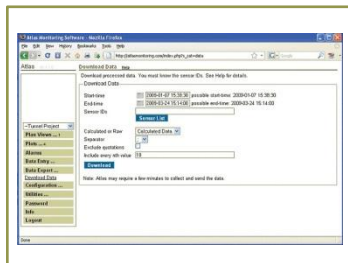
Model AM16/32B Multiplexer

Use the Campbell Scientific AM16/32B multiplexer to monitor more sensors with your Model 798 Handi-Logger. Model AM16/32B sequentially multiplexes sensor leads into common terminals, which are connected to the Handi-Logger's analog inputs, excitation channels, or ground. The Handi-Logger controls the operation of the multiplexer using its control ports. Model AM16/32B multiplexes up to 16 four-wire sensors or up to 32 two-wire sensors. It supports vibrating-wire sensors, thermistors, potentiometers, load cells, strain gages, soil moisture sensors, etc.



Software

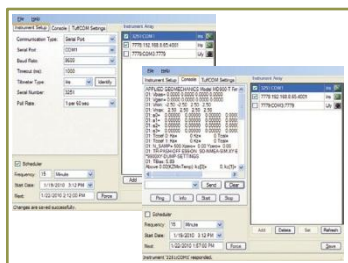
Altas



Atlas Web-based Monitoring software provides a fast, reliable, and cost-effective way to process and distribute data from your projects. Atlas automatically collects field data, generates reports and graphs, processes readings, and checks for alarms. Using AGI's secure web server, your data are available 24/7 through a web browser. An intuitive graphical user interface offers Atlas users comprehensive plan views, PDF reports, time series plots, correlations, and deformation profiles for clear and

easy analysis. Atlas also scans all incoming data for alarm conditions, and allows for immediate notification via email, text message, or phone line depending on user preference. Three tiers of administration assure limitless data accessibility while maintaining security. Atlas is offered as a monthly service package; monthly fees are dependent on number of sensors. Each service plan includes unlimited field reports, data plots, and log-in domains.

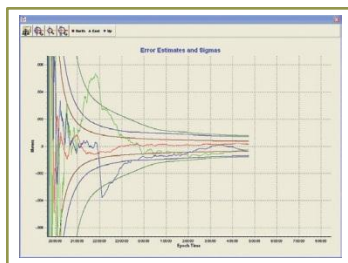
TuffCOM



Our TuffCOM Data Acquisition Software is a fast and easy way to manage and collect data for all of your Applied Geomechanics digital instruments. This powerful program can interface up to hundreds of units via radio modem, TCP or IP serial bridge, or direct serial connection. TuffCOM identifies instruments automatically, streamlining communication over even the largest data networks. Software runs on your PC or SBC as a Windows-based background service for hassle-free data acquisition 24/7.

Comma-separated data file storage ensures program compatibility, and graphs can be plotted with Excel or our Atlas web-based monitoring service. Additionally, TuffCOM's point and click user interface makes issuing firmware commands simple and intuitive. Users can also use TuffCOM to adjust sample rates, autozero instruments, and download data at automated intervals. System requirements: Windows XP or later – Windows 7 compatible.

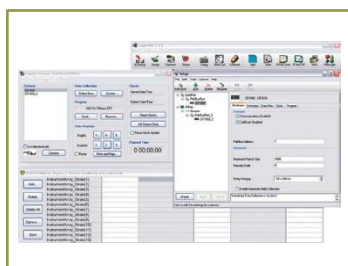
3D Tracker™



3D Tracker™ software uses Global Positioning System (GPS) technology to accurately compute 3-dimensional positions in real time. It was specifically designed for monitoring the movement of fixed structures such as bridges, dams, oil platforms, and large buildings. It also can be deployed on natural features including volcanoes, landslides, and subsiding ground. 3D Tracker is the first software product to simultaneously compute positions to millimeter accuracy in real time for dozens of GPS receivers. The software implements a custom-tuned Kalman filter with triple differencing, then sends

results to a graphical user interface that provides up-to-the-minute information about each site being monitored. The 3D Tracker graphical screens are user-configurable and clearly display information such as the current 3D displacement vector, the current rate of change, and the displacement history for each site. Alarms and notifications can be set to make users aware of excessive movement. 3D Tracker is available for sale, lease or as a service provided by Jewell Instruments System requirements: Windows 2000 or later, 1 GB RAM.

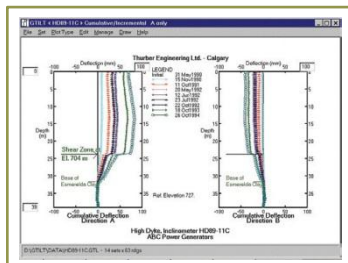
LoggerNet



Manage remote data collection using our LoggerNet software by Campbell Scientific. LoggerNet supports programming, communication, and data retrieval between a PC and the Model 798 Handi-Logger or Campbell Scientific dataloggers. It will support a single datalogger, but is especially adept in projects that require telecommunications or scheduled data retrieval in large datalogger networks. The software runs on a PC, using serial ports, telephony drivers, and Ethernet hardware to communicate with dataloggers via

phone modems, RF devices, and other peripherals. With LoggerNet you can create custom datalogger programs, display or graph real-time or historic data, and build custom display screens to view data or control flags/ports. You also can collect data on demand or on a schedule, and retrieve data using any of our telecommunications options. Windows® XP/2000/Vista/7.

GTILT / GTILT Plus



GTILT is a Windows program that helps you handle any amount of traversing inclinometer data with a minimum of effort. It has powerful data plotting, archiving and manipulation features that enable you to extract the most information from your inclinometer surveys. Use GTILT to plot cumulative displacement, incremental displacement, and absolute position against depth or elevation.

You also can plot displacement, shear strain, rate of displacement, and rate of shear strain against time. Make plots in the inclinometer groove directions or at a skew angle, in English or metric units. Correct for casing spiral using GTILT Plus. And you can view checksums in histogram form, allowing an immediate quantitative assessment of data quality. GTILT exports Windows graphics metafiles (.WMF) for use with other applications. System requirements: Windows 98® or later.

9

Fiber Optics: Bragg Grating Instruments

Specifications

	sm125-200	sm125-500	sm125-700
# Optical Channels	1	4	4
Scan Frequency	1 Hz	2 Hz	5 Hz
Wavelength Accuracy (picometers)	10	1	2.5
Wavelength Repeatability (picometers)	0.5 pm at 1 Hz, .02 pm at .01 Hz		
Dimensions	117 x 234 x 135 mm		
Temperature Range	0° to 50° C		
Input Voltage	7-36 VDC (100-240 VAC, 47-63 Hz) AC/DC Converter included		

sm125 Optical Sensing Interrogator

The sm125 Optical Sensing Interrogator is a compact, industrial grade static sensor interrogation module with field proven longevity and reliability. Its x25 optical interrogator core employs full spectral scanning and data acquisition to give measurements high absolute accuracy, high dynamic range, and flexible software post-processing. The sm125 has a high-power swept-wavelength laser, supporting higher sensor counts per channel than conventional interrogators. The unit's on-board NIST-traceable wavelength reference capabilities also allow for multifaceted sensor use with fiber Bragg gratings (FBGs), long period gratings, extrinsic Fabry-Perot sensors, and more. The sm125 platform provides signal and data output via Ethernet port and custom protocol, and is controlled with an external PC or sensor processor module. Units come standard with sensor analysis software.



Specifications

	sm130-200	sm130-500	sm130-700
# Optical Channels	1	4	4
Scan Frequency	100 Hz	500 Hz	1 KHz
Wavelength Repeatability (picometers)	1, 0.05 with 1,000 averages		
Dimensions	122 x 267 x 135 mm		
Temperature Range	0° to 50° C		
Input Voltage	7-36 VDC (100-240 VAC, 47-63 Hz) AC/DC Converter included		

sm130 Optical Sensing Interrogator

The sm130 Optical Sensing Interrogator is built upon a x30 interrogator core and provides measurements for FBG type sensors. This robust and field proven unit allows for high-speed hardware peak detection, optimizing data acquisition from multiple sensors. Fiber Fabry-Perot Tunable Filter technology and a high-power swept-wavelength laser support higher sensor counts per channel. Other capabilities include spectral diagnostic viewing, automated sensor distance measurement, and multiple-interrogator measurement synchronization. The sm130 platform provides signal and data output via Ethernet port and custom protocol, and is controlled with an external PC or sensor processor module. Units come standard with sensor analysis software.



Specifications

	sm041-008	sm041-016	sm041-408	sm041-416
Number of Channels	4 In/8 Out	4 In/16 Out	4 In/8 Out	4 In/16 Out
Multiplexer Type	Coupler	Coupler	Switch	Switch
Scan Frequency	25Hz to 2 KHz			
Dimensions/Weight	114 x 234 x 132 mm, 1.4 kg (3lbs)			

sm041 Channel Multiplexer

The sm041 Sensor Multiplexer is a reliable, industrial grade multiplexer that adds fiber-optic measurement channels and connections to an sm125 or sm130 interrogator. Solid state optical switches redirect optical signals without moving parts, giving the sm041 low insertion loss, fast response time, high extinction ratio and high repeatability. The sm041 is also offered as a wide band fiber-optic coupler-type unit. The sm041 can expand 4 parallel channels to 8 or 16 sub-channels, and can be cascaded with other units to process up to 64 fiber connections at once. Units are vibration and shock resistant for continuous operation in high abuse environments. The sm041 also comes with easy-setup sensor analysis software.



os3100 Optical Strain Gage



The os3100 Optical Strain Gage is a versatile FBG sensor commonly used for structural health monitoring. This robust sensor is engineered for fast and repeatable installation with either epoxy or weld attachment packaging. Additionally, the os3100's double-ended configuration allows for extensive multiplexing capabilities. The os3100 can also be arranged with other sensors in close proximity at 0°, 45°, and 90° angles for taking strain rosette measurements. These sensors form the core of any fiber-optic monitoring system, and should be considered for the monitoring of bridges, dams, tunnels, and large vehicles, or for experimental mechanics projects.

Specifications

	os3110	os3120
Fastening Methods	Spot Weldable	Epoxy Mount
Strain Sensitivity	-1.4 picometer / $\mu\epsilon$	
Gage Length	22mm	
Temperature Range	-40 to 120°C (150°C short-term)	
Strain Limits	$\pm 2500 \mu\epsilon$	
Fatigue Life	100 x 10 ⁶ cycles,	$\pm 2000 \mu\epsilon$

os3150 Optical Strain Gage



The os3150 is a rugged strain gage optimized for outdoor installations on steel structures including dams, tunnels, bridges, large vehicles, and more. Units are engineered for fast and repeatable installation, and provide long term stability through a FBG tension applying design. The os3150 allows for greater strain range and 100 times more fatigue life than conventional foil gages. Double ended configuration also provides extensive multiplexing capabilities. Sensors can also be arranged with other sensors in close proximity at 0°, 45°, and 90° angles for taking strain rosette measurements. Typical applications include continuous lifetime health monitoring of complex structures, and experimental mechanics evaluations.

Specifications

Fastening Methods	Spot Weldable
Strain Sensitivity	-1.4 picometers/ $\mu\epsilon$
Gage Length	75mm
Temperature Range	-40 to 80°C
Strain Limits	$\pm 2500 \mu\epsilon$
Fatigue Life	100 x 10 ⁶ cycles $\pm 2000 \mu\epsilon$

os3200 Optical Strain Gage



The os3200 Non-metallic Optical Strain Gage provides user's with accurate, repeatable static or dynamic strain measurements. The os3200's non-metallic carrier has a self-adhesive backing that holds the sensor body in place, and protects the FBG during installation. Units are epoxy mountable and support fast and easy installation. The os3200 Non-metallic Strain Gage is qualified for use in mild environments and delivers the many advantages inherent to all FBG based sensors.

Specifications

Fastening Methods	Epoxy
Strain Sensitivity	~ 1.2 picometers
/ $\mu\epsilon$ Gage Length	10 mm
Temperature Range	-40 to 60°C (80°C Max)
Strain Limits	$\pm 5000 \mu\epsilon$
Maximum Drift	< 50 $\mu\epsilon$

9

Specifications

Fastening Methods	Bolt-on, Grout-in, Weldable, Embeddable
Accuracy	$\pm .05$ % F.S.
Strain Sensitivity	~ 1.2 picometers / $\mu\epsilon$
Temperature Sensitivity	23.8 picometers / $^{\circ}\text{C}$
Gage Length	25.4 cm and 100 cm standard
Temperature Range	-40 to 80 $^{\circ}\text{C}$
Strain Limits	± 2500 $\mu\epsilon$

os3600 Long-Baseline Strain Gage

The os3600 Long-Baseline Strain Gage is a fiber Bragg grating (FBG) unit designed for long-term structural health monitoring in harsh environments. This rugged sensor contains two FBG sensors, which respectively measure strain and temperature for temperature-compensated strain measurements. The os3600 is bolt-on, grout-in, or weld mountable, and is also concrete embeddable (specify when ordering). Like our other FBG based sensors, the os3600 supports multiplexing capabilities, and can be configured with other sensors at 0°, 45°, and 90° angles for taking strain rosette measurements. Each sensor includes FC/APC connectors on either end. Typical applications include lifetime health monitoring of bridges, dams, buildings, tunnels, large vehicles, and other complex structures.



Specifications

Fastening	Epoxy
Operating Temperature Range	-40 to 120 $^{\circ}\text{C}$ (-40 to 250 $^{\circ}\text{C}$ for Single Ended version)
Temperature Sensitivity	~ 10 picometers / $^{\circ}\text{C}$ ($\pm 1.7\text{pm}/^{\circ}\text{C}$)
Response Time	4.6 seconds
Dimensions	31.8 x 7.6 x 7.6 mm
Housing Material	Alumina

os4300 Temperature Sensor

The os4300 Temperature Sensor utilizes fiber Bragg grating (FBG) technology for structural health monitoring and laboratory applications. These versatile sensors are qualified for use in harsh environments; common uses include absolute surface temperature measurement and temperature compensation calculation. The os4300 maintains the accuracy of conventional thermocouples while sustaining a wider operating range, faster response times, and less noise. The os4300's double ended design also allows for multi-sensor signal multiplexing. Housing consists of a sealed alumina ceramic tube: available in epoxy and flange mount packaging. Typical applications include lifetime health monitoring of bridges, dams, tunnels, large vehicles, and other complex structures.



Specifications

Operating Temperature	-40 to 80 $^{\circ}\text{C}$
Reference Sensitivity	~ 16 picometers /g
Frequency Range	DC to 300Hz
Mounted Resonance Frequency	~ 700 Hz
Maximum Operational Shock	100g Peak
Dimensions	38 x 9 x 19 mm
Weight	28g
Mounting	10-32 Tapped Hole

os7100 Optical Accelerometer

The os7100 is a fiber Bragg grating (FBG) based accelerometer optimized for monitoring large structures over extended periods of time. The rugged, corrosion resistant, sensor packaging and cable integrated design of these units makes them ideal for outdoor installation on exposed structures. The os7100 also offers EMI immunity and lightning resistance. Sensors measure accelerations from DC to low frequencies, and are available in one, two, and three axis configurations. The os7100 can also be integrated with other FBG sensors for comprehensive monitoring. The os7100's single-ended design is ideally deployed in couple-star sensor network architectures maximizing per-channel sensor capacity. Use the os7100 for the continuous lifetime health monitoring of bridges, dams, buildings, tunnels, large vehicles, and other complex structures.



Monitoring Services

Risk Management



Risk is a natural byproduct of engineering creativity. It is present during construction, and various levels of risk remain after a building, tunnel, or machine has been placed in service. Experienced engineers seek to minimize risk by using the best design, construction, maintenance and monitoring practices. Monitoring the performance of slopes and manmade structures is a powerful and effective alternative to risk reduction by costly overdesign. Monitoring during construction identifies hazardous conditions early, so they can be corrected before damage occurs. After construction, automated monitoring is your most efficient tool for maintaining the health of the finished structure.

Jewell Instruments specializes in the design, fabrication, and application of effective monitoring systems. We specify the best sensors and measurements for your project conditions, and couple them with automated, highly reliable data acquisition technology. Measurements are transmitted over the Internet so you can view them from any computer with a web browser. No matter where you are, you can verify that stable conditions are being maintained, or identify trends that warrant further attention.

GPS



Global Positioning Systems (GPS) compute three-dimensional position and movement, and can be operated remotely anywhere in the world. As a satellite based system, GPS is ideal for monitoring large structures such as bridges, dams, oil platforms, landslides, volcanoes, land subsidence, and mines. Jewell Instruments GPS systems use our powerful 3D Tracker software to provide real-time monitoring with millimeter accuracy. Jewell's web-based Atlas reporting services conveniently manage data for easy access to 3-D displacement vectors, real-time

rates of movement, 3-D displacement history, and more. Our Atlas software also allows you to enter programmable alarm thresholds for emergency notification via e-mail, text message, or phone, and for on-site audible and visual alarms. GPS can be paired with conventional instrumentation to provide especially comprehensive site monitoring. Contact us today for your customized GPS monitoring solution.

Tilt Mapping



Jewell Instruments tilt monitoring and mapping services provide clients with displacement profiles and other visualizations for a better understanding of site behavior. Tilt mapping refers to the derivation of displacement profiles and contours from tilt measurements made by surface and sub-surface instruments. Plotted as deformations over time, tilt maps can be combined to obtain animated images of displacement field development. Tilt measurements can also be incorporated with GPS stations for

absolute three-dimensional position accuracy. Our tilt mapping services provide clients with precise and comprehensible data, are quick and easy to implement, and provide high value. Atlas software allows for on-site data access or remote data access via the worldwide web. Jewell's tilt monitoring services should be considered for groundwater remediation projects involving hydraulic fracturing or dewatering, as well as all civil and mining engineering projects that produce ground deformation.

Fiber Optics



Jewell Instruments fiber-optic monitoring services offer powerful and economical solutions for projects with large-scale monitoring needs. Typical applications include structural health monitoring and geotechnical monitoring of levees, dams, bridges and pipelines. Our fiber-optic services employ a combination of distributed strain, distributed temperature and FBG sensors. Jewell's fiber-optic systems make multiple measurements on a single fiber, resulting in efficiencies over long measure-

ment distances that are unavailable from conventional monitoring instrumentation. Sensors operate without electrical current, minimizing fire hazards the risk of damage from electrical transients caused by lightning and other sources. Service packages are custom tailored to your project specifications to provide the most cost effective results for your anticipated operating conditions. Data can be collected and stored on-site or through our Atlas Web-based monitoring service.



ANGLE CONVERSION TABLE		degrees	arc minutes	arc seconds	μradians	mm/meter*	in/ft*
	1 degree =	1	60	3600	17453	17.453	0.20944
	1 arc minute =	0.016667	1	60	290.89	0.29089	3.4907x10 ⁻³
	1 arc second =	2.7778x10 ⁻⁴	0.016667	1	4.8481	4.8481x10 ⁻³	5.8178x10 ⁻⁵
	1 μradian =	5.7296x10 ⁻⁵	3.4378x10 ⁻³	0.20627	1	0.001	1.20x10 ⁻⁵
	1 mm/meter =	0.057296	3.4378	206.27	1000	1	0.0120
	1 in/ft =	4.7746	286.48	17189	83333	83.333	1

* Accuracy of conversion better than 0.1 percent for angles up to 2.5 degrees

PRESSURE CONVERSION TABLE		Bar	Millibar	MPa	kPa	atm	psi	m H ₂ O [†]	ft H ₂ O [†]	inch Hg
	1 bar =	1	1000	0.1	100	0.98692	14.504	10.197	33.455	29.533
	1 millibar =	0.001	1	0.0001	0.1	0.00098692	0.014504	0.010197	0.033455	0.029533
	1 MPa =	10	10000	1	1000	9.8692	145.04	101.97	334.55	295.33
	1 kPa =	0.01	10	0.001	1	0.0098692	0.14504	0.10197	0.33455	0.29533
	1 atm =	1.0133	1013.3	0.10133	101.33	1	14.696	10.332	33.898	29.924
	1 psi =	0.068948	68.948	0.0068948	6.8948	0.068046	1	0.70309	2.3067	2.0363
	1 m H₂O =	0.098068	98.068	0.0098068	9.8068	0.096785	1.4223	1	3.2808	2.8962
	1 ft H₂O =	0.029891	29.891	0.0029891	2.9891	0.029500	0.43352	0.30480	1	0.88274
1 in Hg =	0.033860	33.860	0.0033860	3.3860	0.033417	0.49110	0.34527	1.1328	1	

[†] Values for head of water (meters and ft) are for water at 4°C, the temperature at which water has the highest density