

# Inclinometer Probes

## Applications

The 6000 and 6100 Series Portable Inclinometer Systems are used to determine and measure the lateral movements in and around...

- Landslides
- Unstable Slopes
- Dam Embankments
- Landfills
- Slurry walls
- Caissons
- Piles
- Sheet Piling
- Tunnels



• Model 6000/6100 Inclinometer Probe (probe appearance is essentially identical).

## Operating Principle

Inclinometer probes are designed for use with standard, grooved inclinometer casing. Spring-loaded wheels on the probe engage the grooves in the casing thus maintaining the probe in a known orientation. Casing is grouted inside near-vertical boreholes (boreholes at other angles can be accommodated with some loss of resolution), cast inside concrete piles or slurry walls, or attached to steel pilings.

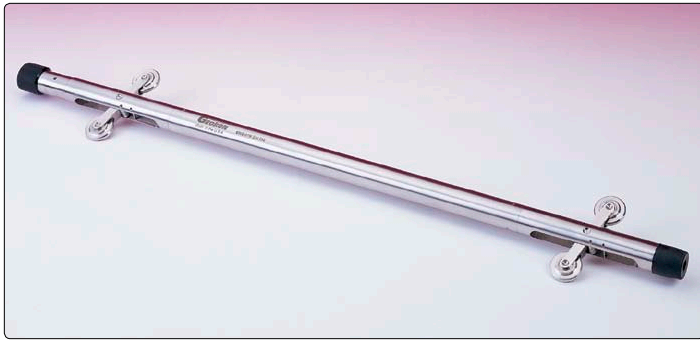
In use, the inclinometer probe is connected to a cable and lowered to the bottom of the casing and then raised in increments equal to the wheel spacing. At each increment the probe is read by a readout box connected to the upper end of the cable. The readout gives a measurement of the tilt of the casing to the vertical, at each depth increment. Repeat surveys of the casing reveal changes in these tilts, which can be analyzed to provide plots of lateral deflections of the casing, in orthogonal directions, at every depth increment.

## Advantages and Limitations

The connector on the end of the probe is of extra-high quality (hermetically sealed, with gold plated pins) which helps improve signal accuracy. It's design is such that the connector can be easily removed and replaced if it suffers from damage or excessive wear. A protective cap is supplied to cover the cable connector when not in use.

Wheels are self lubricated for longer life. In addition, the wheels are designed to be replaceable with minimal effort and expense, should wear become excessive.

## Model 6000 Inclinometer Probe



• Model 6000 Inclinometer Probe.

The Model 6000 Inclinometer Probe is designed to measure the tilt of vertical inclinometer casing at selected depth increments, consists of a waterproof, stainless steel housing, and contains two force-balanced accelerometers, one with its axis in the plane of the spring-loaded wheels, the other at 90 degrees.

At the base of the probe there is a rubber cushion designed to reduce shock loading on the accelerometer should the probe be dropped on to a solid surface. The accelerometers are capable of withstanding a certain amount of rough handling (shocks < 1000 g) but allowing the probe to fall against hard surfaces can permanently damage the accelerometer requiring expensive factory repairs. Therefore, it is very important to handle the probe with care at all times.

### Technical Specifications

Standard Range <sup>1</sup>	±53°
Sensors	2 force-balanced accelerometers
Output @ 30°	±5 VDC
Resolution <sup>2</sup>	±0.025 mm/500 mm (±0.0001 ft/2 ft) (±10 arc seconds)
Linearity	0.02% F.S.
Repeatability	±2 mm/30 m
Total System Accuracy <sup>3</sup>	±6 mm/30 m (±0.25 in/100 ft)
Temperature Range	0°C to +50°C (32°F to 122°F)
Temperature Coefficient	0.002% F.S./°C (0.001% F.S./°F)
Wheel Base	0.5 m, 1 m or 2 ft
Length × Diameter <sup>4</sup>	700 × 25 mm, 1200 × 25 mm or 32 × 1 in
Casing Size I.D. <sup>5</sup>	51 to 89 mm (2 to 3.5 in)
Weight (with case)	7.5 kg (16 lb)
Shock Survival <sup>6</sup>	1000 g (2.2 lb)

<sup>1</sup>The calibrated range of the inclinometer is ±30 degrees from vertical, but the inclinometer can be used at greater inclinations with a lessening in performance.

<sup>2</sup>±10 arc seconds. The resolution shown is only true in the range of ±5 degrees from vertical. Beyond this, the resolution is diminished (by the cosine of the angle from vertical). Resolution also depends on readout instrument used.

<sup>3</sup>Within 3° of vertical. This takes into account the accumulation of the error inherent with each reading, and normal placement errors in positioning the probe inside the casing; also the effect of debris in the casing, or casing damage.

<sup>4</sup>The cable connector adds 150 mm to the length of the probe.

<sup>5</sup>The probe is designed for use in all standard inclinometer casing up to a maximum diameter of 89 mm (3.5 inches).

<sup>6</sup>The Inclinometer Probe is a highly sensitive device and should be treated with great care at all times in order to maintain calibration. Particular attention should be given to preventing the probe from hitting the bottom of the casing with any impact.

## Model 6100 MEMS Inclinometer Probe



• Model 6100 MEMS Inclinometer Probe.

The Model 6100 MEMS Inclinometer Probe is identical to the Model 6000, except that it uses two MEMS (Micro Electro Mechanical Sensors) in place of the two force-balanced accelerometers.

At the base of the probe is a rubber cushion designed to reduce shock loading on the accelerometer, should the probe be dropped on to a solid surface. The accelerometers are capable of withstanding a certain amount of rough handling (shocks < 2000 g), but allowing the probe to fall against hard surfaces can permanently damage the accelerometer requiring factory repairs. Therefore, it is very important to handle the probe with care at all times.

The 6100 MEMS Inclinometer Probe has a restricted range of ±30°. This is more than ample for all nominally vertical boreholes. Custom-built 6100 MEMS probes can be made to accommodate special applications, such as casings installed on the sloping face of a dam embankment.\* Horizontal versions can also be supplied.

\*Special sensors for inclined slopes are not reversible.

### Technical Specifications

Standard Range	±30°
Sensors	2 MEMS sensors
Output @ 30°	±4 VDC
Resolution <sup>1</sup>	±0.025 mm/500 mm (±0.0001 ft/2 ft)
Linearity	0.02% F.S.
Repeatability	±1 mm/30 m
Total System Accuracy <sup>2</sup>	±3 mm/30 m (±0.125 in/100 ft)
Temperature Range	0°C to +85°C
Temperature Coefficient	0.002% F.S./°C
Wheel Base	0.5 m, 1 m or 2 ft
Length × Diameter <sup>3</sup>	700 × 25 mm, 1200 × 25 mm or 32 × 1 in
Casing Size I.D. <sup>4</sup>	51 to 89 mm (2 to 3.5 in)
Weight (with case)	7.5 kg (16 lb)
Shock Survival <sup>5</sup>	2000 g

<sup>1</sup>±10 arc seconds. The resolution shown is only true in the range of ±5 degrees from vertical. Beyond this, the resolution is diminished (by the cosine of the angle from vertical). Resolution also depends on readout instrument used.

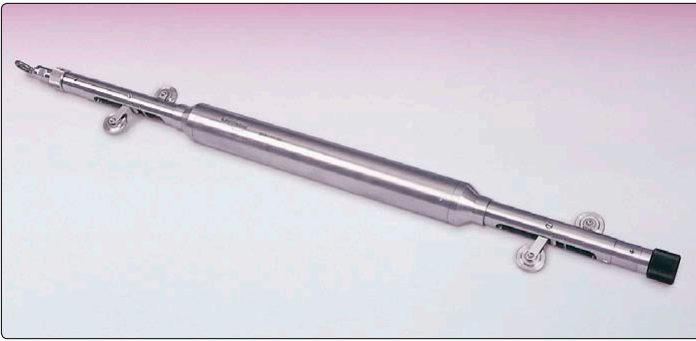
<sup>2</sup>Within 3° of vertical. This takes into account the accumulation of the error inherent with each reading, and normal placement errors in positioning the probe inside the casing; also the effect of debris in the casing, or casing damage.

<sup>3</sup>The cable connector adds 150 mm to the length of the probe.

<sup>4</sup>The probe is designed for use in all standard inclinometer casing up to a maximum diameter of 89 mm (3.5 inches).

<sup>5</sup>The Inclinometer Probe is a highly sensitive device and should be treated with great care at all times in order to maintain calibration. Particular attention should be given to preventing the probe from hitting the bottom of the casing with any impact.

## Model 6015 Horizontal Inclinometer Probe



● Model 6015 Horizontal Inclinometer Probe.

The Model 6015 Horizontal Inclinometer Probe is designed to make high resolution measurements of settlement or heave in tank foundations, dams, highway embankments, landfills, etc.

The system consists of the probe and cable, inclinometer casing, pull cable and the readout unit. The casing is installed in a horizontal trench or borehole passing below or through the fill material. When the casing cannot extend completely through the fill, a return pulley and cable arrangement is required.

An initial, baseline survey is taken to which all subsequent surveys are compared. The instrument yields the sine of the angle of inclination of the probe in the casing. Knowing the gage length and this angle, the vertical deflection can be calculated for each gage increment read. By summing these segments a change profile can be constructed which is a direct measurement of the casing and soil settlement or heave. The readings are repeated in reverse probe orientation to eliminate probe offset errors.

### Technical Specifications

Standard Range <sup>1</sup>	±53°
Sensors	2 force-balanced accelerometers
Output @ 30°	±5 VDC
Resolution <sup>2</sup>	±0.025 mm/500 mm (±10 arc seconds)
Linearity	0.02% F.S.
Repeatability	±2 mm/30 m
Total System Accuracy <sup>3</sup>	±6 mm/30 m
Temperature Range	0°C to +50°C
Temperature Coefficient	0.002% F.S./°C
Wheel Base	0.5 m
Length × Diameter <sup>4</sup>	671 × 45 mm
Casing Size I.D. <sup>5</sup>	61 to 89 mm
Weight (with case)	8 kg
Shock Survival <sup>6</sup>	1000 g

<sup>1</sup>The calibrated range of the inclinometer is ±30 degrees from horizontal, but the inclinometer can be used at greater inclinations with a lessening in performance.

<sup>2</sup>±10 arc seconds. The resolution shown is only true in the range of ±5 degrees from horizontal. Beyond this, the resolution is diminished (by the cosine of the angle from horizontal). Resolution also depends on readout instrument used.

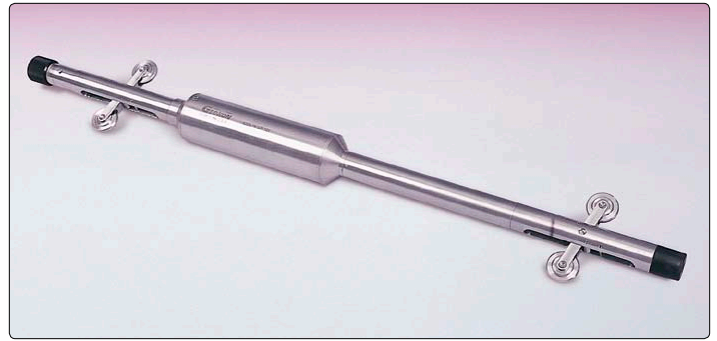
<sup>3</sup>Within 3° of horizontal. This takes into account the accumulation of the error inherent with each reading, and normal placement errors in positioning the probe inside the casing; also the effect of debris in the casing, or casing damage.

<sup>4</sup>The cable connector adds 150 mm to the length of the probe.

<sup>5</sup>The probe is designed for use in all standard inclinometer casing up to a maximum diameter of 89 mm.

<sup>6</sup>The Inclinometer Probe is a highly sensitive device and should be treated with great care at all times in order to maintain calibration. Particular attention should be given to preventing the probe from hitting the bottom of the casing with any impact.

## Model 6005 Spiral Indicator



● Model 6005 Spiral Indicator.

The Model 6005 Spiral Indicator is designed to measure the orientation of the grooves in inclinometer casing at any depth. Twisting or spiraling of the casing can occur during installation, especially if the casing is long; also the grooves in inferior extruded casing can become twisted during manufacture.

In use the probe is lowered down the casing with its wheels engaging the casing grooves, pausing at any depth to take a reading. A flux-gate magnetometer inside the probe measures the compass bearing of the wheel assemblies. The compass bearing is displayed on the Model GK-604 and can be stored for later analysis.

Note that, unlike some spiral indicators, where the orientation of the grooves requires a complete survey of the entire borehole, so that incremental values of twist can be summated, the Model 6005 Spiral indicator can measure the orientation directly at any depth and thus gives the required information much more quickly and accurately.

Due to the magnetic influences caused by steel, the Model 6005 is not suitable for use inside steel casing or near heavy rebar cages.

### Technical Specifications

Standard Range	360°
Sensor	Flux gate compass
Output	0.1 to 1.9 VDC
Resolution	0.1°
Repeatability	±0.5°
Total System Accuracy	±1.0°
Temperature Range	-20°C to +80°C
Wheel Base	610 mm
Length × Diameter <sup>1</sup>	686 × 51 mm
Casing Size I.D. <sup>2</sup>	61 to 89 mm
Weight (with case)	8 kg
Shock Survival	MIL-STD-810

<sup>1</sup>The cable connector adds 150 mm to the length of the probe.

<sup>2</sup>The probe is designed for use in all standard inclinometer casing up to a maximum diameter of 89 mm.

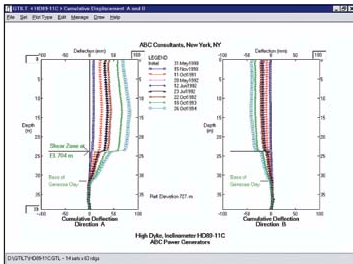
## Model GK-604 Inclinometer Readout



● Model GK-604-6 Field PC showing an inclinometer data reading screen shot.



● Model GK-604-4 Interface.



● GTILT® Plus Inclinometer Software (please see the GTILT® data sheet).

The Model GK-604 Inclinometer Readout is a rugged, hand-held, easy-to-use instrument designed to read MEMS and force balance type inclinometer probes, which have voltage outputs. In use, the probe is connected by its control cable to the **Model GK-604-4 Interface**, which may be stand-alone or located inside a reel. The interface converts its signal and transmits the data, via Bluetooth® radio, to the hand-held **Model GK-604-6 Field PC**.

Readings are stored by tapping "Record," or pressing the "Enter" button on the Field PC display. An audible beep indicates the completion of the reading storage. During the running of a deflection survey the Field PC has the

capability of displaying the check sum on the LCD screen, a useful tool for checking the survey data in the field so that reading errors are minimized.

When the survey is complete, the readings are saved in the solid state memory for transfer to a host computer, via USB and Microsoft® ActiveSync®, for data reduction using GTILT® Software (please see the GTILT® data sheet).

The Field PC comes complete with a hand strap, stylus, USB sync cable, Lithium-Ion battery, AC wall charger (with international plug kit), screen protector, CD-ROM (with license and manuals) and Quick Start Guide.

### Technical Specifications (GK-604-6 Field PC)

Processor	520 MHz PXA270
Operating System	Windows® Mobile® 6.1 Classic
Included Software	Microsoft® Office® Mobile; multiple languages
Memory	128 MB RAM
Data Storage	512 MB internal data storage; compact Flash slot (Type I or Type II); SD/SDHC slot, SDIO supported; user accessible CF and SD slots
Color Display	89 mm QVGA (240 × 320) active viewing area; high visibility active matrix TFT transreflective backlit LCD
Keyboard	Four-way directional button; discrete keys for Start, Applications, Manager, Home, Context Menu, Return and Power/Suspend; key functions can be user-defined; LED backlit keys
Ports	COM 1, RS-232C 9-pin D connector with 5 VDC power on DTR pin; USB Host (Mini A); USB Client (Mini B); 12VDC@800 mA power in, 10-18 V unregulated; communications module is user replaceable

Case	Magnesium with scratch resistant powder coat; easy to grip, impact absorbing overmold; IP67 waterproof and dust-proof
Environmental	Tested to MIL-STD-810F for water, humidity, sand, dust, vibration, altitude, shock and temperature
Power	Intelligent 3900 mAh Li-Ion battery; operates for up to 20 hours on one charge; charges in 4 to 6 hours; battery easily changed in the field without tools
Wireless Connectivity	Internal Bluetooth® wireless technology option, 2.0 +EDR, Class 1, range 20 m
Wi-Fi Support	SDIO or CF Wi-Fi card required
Certifications and Standards	FCC Class B; CE Mark; EN60950; RoHS compliant; FM approved Class 1, Div 2
Operating Temp.	-30°C to 55°C
Storage Temp.	-30°C to 60°C
Shockproof	Multiple drops from 1.5 m onto concrete
Dimensions	(L × W × H): 165 × 89 × 43 mm
Weight	482 g, with battery

### Technical Specifications (GK-604-4 Interface)

Standard Range	±8 V
Resolution	16 bit
Accuracy	±0.1% F.S.
Battery	>16 hours continuous operation, per charge
Temperature Range	-30°C to +50°C
Dimensions	(L × W × H): 160 × 75 × 75 mm

### Ordering Information

**Model GK-604-2:** Inclinometer Readout with hand-held Field PC, Software and Probe Interface.

**Model GK-604-3:** Inclinometer Software and Probe Interface, installed.

**Model GK-604-4:** Inclinometer Software and Probe Interface, installed in enclosure.

**Model GK-604-5:** Inclinometer Readout Software for hand-held Field PC.

**Model GK-604-6:** Hand-held Field PC and accessories only.



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