

# Digital Inclinerometer System

## Applications

The Model GK-604D Digital Inclinerometer System is 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 GK-604D Digital Inclinerometer System.

## Introduction

The Model GK-604D Digital Inclinerometer System is delivered in its entirety and includes a Model 6100D digital inclinometer probe (containing electronics to convert the analog voltage into a digital signal), a reel-mounted cable and a Field PC. The signal from the probe is transmitted by the control cable to the cable reel containing the Interface, which communicates via Bluetooth® to the Model FPC-1 Field PC.

## Operating Principle

Inclinerometer surveys are conducted in the conventional way using grooved inclinometer casing to engage and hold the spring-loaded wheels of the probe in a known orientation. The probe is connected to the cable and lowered to the bottom of the casing whereupon it is raised in increments to the top of the hole. At each increment a reading is taken of the amount of tilt of the probe away from the vertical. The spacing of the increments is determined by the metal markers crimped to the control cable at either

half-meter or two-foot intervals to match the spacing of the probe's spring-loaded wheels. At each increment the metal cable marker is rested inside a Cable Hold, positioned over the top of the grooved casing, and a reading is taken by tapping "Record," or pressing the "Enter" button on the FPC-1 Field PC display. The probe is then pulled out of the casing, turned through 180° and lowered to the bottom of the casing to repeat the procedure.

The difference of the two sets of tilt readings is then used to calculate the vertical profile of the inclinometer casing, which, when compared to profiles taken on different dates, will reveal the magnitude and location of any deflections occurring along the length of the casing.

## System Components



• Model 6100D Digital Inclinometer Probe.

### Inclinometer Probe

The Model 6100D Digital Inclinometer Probe has two MEMS tilt sensors oriented to measure tilt in two orthogonal axes over a range of  $\pm 30$  degrees. The probe contains a 24-bit A/D converter, which outputs a digital signal proportional to the sine of the angle of tilt. MEMS tilt sensors are capable of withstanding shocks as large as 2000 g. Nevertheless a rubber cushion fixed to the bottom of the probe helps to soften the blow of a probe inadvertently allowed to hit the bottom of the grooved casing—and care must still be exercised when handling the probe.

Wheels are self lubricated for longer life and the wheel assemblies are designed to be replaceable should wear become excessive.

The cable connector at the top of the probe is hermetically sealed with gold plated pins. It is designed to be replaceable if it suffers damage or excessive wear. A protective cap is supplied to cover the connector when not in use.

### Technical Specifications

Standard Range	$\pm 30^\circ$
Sensors	2 MEMS sensors
MEMS Sensor Output	Differential $\pm 4$ V
6100D Probe Output	Digital Data Stream
Resolution (Probe)	24-bit
Resolution (System) <sup>1</sup>	$\pm 0.025$ mm/500 mm ( $\pm 0.0001$ ft/2 ft)
Accuracy	$\pm 0.05\%$ F.S.
Linearity	0.02% F.S., up to $\pm 10^\circ$
Repeatability	$\pm 1$ mm/30 m
Total System Accuracy <sup>2</sup>	$\pm 3$ mm/30 m ( $\pm 0.125$ in/100 ft)
Temperature Range	0°C to +50°C
Temperature Coefficient	0.002% F.S./°C
Wheel Base	0.5 m, 1 m or 2 ft
Length $\times$ Diameter <sup>3</sup>	700 $\times$ 25 mm, 1200 $\times$ 25 mm or 32 $\times$ 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> $\pm 10$  arc seconds. The resolution shown is only true in the range of  $\pm 5^\circ$  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  $3^\circ$  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.

## System Components



- Model 6000-17 Cordura® carry case, with padded interior, is used to protect the probe, FPC-1 Field PC and accessories from shock during transportation. Case contents (top; left to right): Incliner Probe, power cord, USB cable, Field PC, Field PC charger, Cable Holds.



### Control Cable

The Model 6000-2 Control Cable is a lightweight, Polyurethane-jacketed cable and is less than 7 mm in diameter. A central Kevlar® strand, with a breaking strength of 330 lbs, is firmly

attached to the probe cable connector, which effectively prevents the cable from stretching and allows for a heavy pull in the event the probe becomes jammed in the casing. Non-slip metal depth markers are crimped onto the cable at intervals equal to the wheel base of the inclinometer probe (0.5 m or 2 ft). These markers engage the cable hold at the top of the casing while the probe is being read.



### Cable Reel and Case

The Model 6000-5-2 reel (150 m storage capacity) contains the GK-604D-5 Interface, external battery charger and Bluetooth® indicator light. The Interface converts the digital signal from the probe into a radio signal,

which is transmitted to the FPC-1 Field PC. The reel is supplied with the Model 6000-18 Carry Case.

### Technical Specifications (GK-604D-5 Interface)

Battery	>40 hours continuous operation, per charge
Temperature Range	-30°C to +50°C



### Carrying Case

The Model 6000-17 is a custom Cordura® carry case with padded interior designed to hold an inclinometer probe, the FPC-1 Field PC, battery chargers, USB cable and cable holds.



### Cable Holds

The Cable Holds are anodized aluminum plugs that fit into the top of either a 2.75" (Model 6000-13) or 3.34" inclinometer casing (Model 6000-14), with a "V" slot to allow

the cable and markers to be pulled through it during the survey. The center of the Cable Hold is tapered to a smaller diameter than the metal markers, which allows the cable to be held in place, via its markers, during readings. For cables > 100 m (328 ft), the Model 6000-6 Inclinometer Cable Pulley should be used (please see photo on back page).



### Dummy Probe

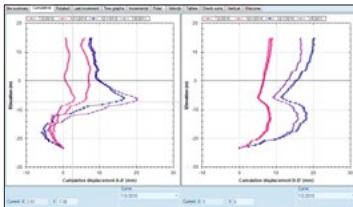
The Model 6000-10 Dummy Probe is geometrically identical to the Model 6100D Probe but does not contain any sensors. It is used to check that installed inclinometer

casings are free of obstructions or distortions that might prevent removal of the standard probe. The dummy probe is lowered and raised using coated stainless steel aircraft cable.

## Model FPC-1 Field PC



● Model FPC-1 Field PC showing an inclinometer data reading screen shot.



● SiteMaster Software graph showing cumulative inclinometer displacements.



● Model 6000-6 Inclinometer Cable Pulley, shown attached to Model 6400 Inclinometer Casing.

### Operating Principle

The Model FPC-1 Field PC is a rugged, handheld, easy-to-use instrument for reading inclinometer probes. The Field PC communicates with the Model GK-604D-5 Interface in the cable reel by means of Bluetooth®.

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.

### Technical Specifications (FPC-1 Field PC)

Operating Temperature	-30 °C to 60 °C
Storage Temperature	-40 °C to 70 °C
Processor	Marvell PXA310 806 MHz
Memory	128 MB SDRAM
Data Storage	4 GB iNAND Flash
Operating System	Microsoft® Windows® Mobile 6.1
Screen	480 × 640 pixel Anti-glare 3.5" VGA resolution, touchscreen, sunlight readable 262K colors (18 bit), with LED backlight
Keypad	Numeric keypad with backlighting, on-screen QWERTY keyboard
Battery	5600 mAh Li-ion battery pack

Once surveys are complete, readings saved to the internal SSD can be transferred to a host computer where data reduction, graphing and reporting can be accomplished using SiteMaster Software (sold separately—please see the SiteMaster data sheet for further details).

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.

Connections	1 × USB host and client (Mini AB USB OTG, 1.2 host, 2.0 client), Power jack, 1 × SDIO slot, 9-pin serial RS-232 connector
Communication	PAN: Bluetooth® 2.0 +EDR, WLAN: Integrated 802.11 b/g supports AES, TKIP, WEP, WPA and WPA2, GSM/UMTS (HSDPA/EDGE)
Navigation	Integrated GPS SiRF Star III chipset with WAAS/EGNOS support, Integrated E-Compass and G-Sensor, Integrated Altimeter
Camera	Integrated 3 megapixel camera with autofocus and LED Flash
Weight	490 g, including rechargeable battery
L × W × H	179 × 97 × 37 mm

### Ordering Information

**Model GK-604D-20M:** Inclinometer Readout System with Digital MEMS Biaxial Inclinometer Probe, FPC-1 Field PC, Software, Cable Reel, requisite Carry Cases and 20 m Cable marked every 0.5 m.

**Model GK-604D-30M:** As above, with 30 m Cable.

**Model GK-604D-50M:** As above, with 50 m Cable.

**Model GK-604D-70M:** As above, with 70 m Cable.

**Model GK-604D-100M:** As above, with 100 m Cable.

**Model GK-604D-130M:** As above, with 130 m Cable

**Model GK-604D-150M:** As above, with 150 m Cable

**Model GK-604D-170M:** As above, with 170 m Cable

**Model GK-604D-200M:** As above, with 200 m Cable

**Model GK-604D-100E:** Inclinometer Readout System with Digital MEMS Biaxial Inclinometer Probe, FPC-1 Field PC, Software, Cable Reel, requisite Carry Cases and 100 ft Cable marked every 2 ft.

**Model GK-604D-150E:** As above, with 150 ft Cable.

**Model GK-604D-200E:** As above, with 200 ft Cable.

**Model GK-604D-250E:** As above, with 250 ft Cable.

**Model GK-604D-300E:** As above, with 300 ft Cable.

**Model GK-604D-350E:** As above, with 350 ft Cable.

**Model GK-604D-400E:** As above, with 400 ft Cable.

**Model GK-604D-450E:** As above, with 450 ft Cable.

**Model GK-604D-500E:** As above, with 500 ft Cable.



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