

# Digital Inclinator System

## Applications

The Model GK-604D Digital Inclinator 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 Inclinator System.



• Model 6000-20 Cable Pulley, attached to Model 6400 Inclinator Casing.

## Introduction

The Model GK-604D Digital Inclinator 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®** wireless technology to the Model FPC-2 Field PC.

## Operating Principle

Inclinator 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 the Cable Hold or pulley assembly, positioned over the top of the grooved casing, and a reading is taken by tapping "Record," or pressing the "Enter" button on the handheld 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 cable pulley arrangement can be used with a casing extension in situations where the inclinometer casing is inside a protective tube.

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 designed to be replaceable if it suffers damage or excessive wear. A protective cap is supplied to cover the connector when not in use.

### Built-in Compass (for Spiral Survey)

A Digital Compass is built into the Inclinometer Probe body allowing spiral surveys to be made using the same probe. The surveys obtained can be used to correct the inclinometer data sets for any twist (or spiraling) that may be present in the installed inclinometer casings. The spiral survey data is presented on (and stored in) the same FPC-2 Field PC used for taking inclinometer readings (see page 4). The compass will not work in close proximity to ferrous metals such as steel pipes and rebar.

### Technical Specifications (Inclinometer Probe)

Standard Range	$\pm 30^\circ$
Sensors	2 MEMS sensors
MEMS Sensor Output	Differential $\pm 4$ V
6100D Probe Output	Digital Data Stream
Resolution (Probe)	0.0013°
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 × 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> $\pm 10$  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° 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.

### Technical Specifications (Compass)

Sensor	Anisotropic Magnetoresistive
Resolution	12 Bit
Accuracy	$\pm 2^\circ$
Operating Temperature	-30° to +85°C

## System Components



- Model 6000-17 **CORDURA®** Carry Case, with padded interior, is used to protect the probe, FPC-2 Field PC and accessories from shock during transportation. Case contents (top; left to right): Inclinator Probe, Casing Adaptor for the Cable Pulley, Universal Power Adapter, Wall Charger for the Field PC, Deoxit Spray and Waterproof Grease, Field PC, Spare Parts for the Inclinator Probe, Car Charger and USB cable for the Field PC, Cable Reel Charger.



### Control Cable

The Model 6000-2 Control Cable is lightweight, less than 7 mm in diameter and comprises a central **Kevlar®** core and a double pressure extruded Polyurethane jacket with an additional **Kevlar** braid between

the jacket layers. The minimum breaking strength is > 400 lbs. The conductors and **Kevlar** members are 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 wireless indicator light. The Interface converts the digital signal from the probe into a radio signal,

which is transmitted to the FPC-2 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



### Electric Cable Reel

The Model GK-604D-EW Electric Cable Reel System comprises a 12 volt electric winch, a cable reel with 300 m capacity, an automatic brake and a galvanized steel tripod. The winch features a speed control, direction control, precision slip rings and, along with the

cable reel, is mounted in a protective steel transport case. The brake is designed to stop the winch every 0.5 m and features a hand switch to trigger movement to the next 0.5 m interval; it fits on top of the steel tripod, which sits over the inclinometer casing to facilitate the inclinometer survey process.



### Cable Pulley

The Model 6000-20 Cable Pulley is designed to be placed inside the top of the inclinometer casing to allow the cable to be lowered and, using the built in cable clamps, conveniently held at each measurement increment.



### Dummy Probe

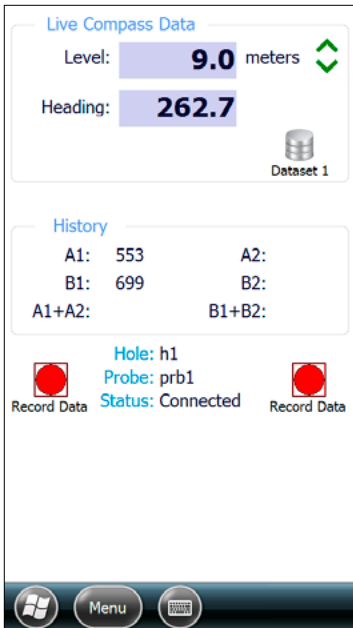
The Model 6000-10 Dummy Probe is geometrically identical to the Model 6100D Probe but does not contain any sensors. It is used to

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-2 Field PC



• Model FPC-2 Field PC showing a Live Inclinometer Data reading screen shot.



• Screen shot showing compass survey data from the digital inclinometer probe.

### Operating Principle

The Model FPC-2 Field PC is a rugged, handheld, easy-to-use instrument for reading inclinometer probes (and VW sensors when used with the GK-405 Readout). The Field PC communicates with the Model GK-604D-5 Interface in the cable reel by means of Bluetooth wireless technology.

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. The FPC-2 will also perform a spiral survey at the same time as the normal inclinometer survey, the results of which are stored in a

separate data file with the suffix "\_COMPASS." The "View" function on the Field PC can be used to display or save the spiral table or it can be exported along with the standard survey data. Tapping the "compass" icon during a survey, allows the current compass heading to viewed at any time.

Once surveys are complete, readings saved to the internal Solid State Drive 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.

### Technical Specifications (FPC-2 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 x 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

Connections	1 x USB host and client (Mini AB USB OTG, 1.2 host, 2.0 client), Power jack, 1 x SDIO slot, 9-pin serial RS-232 connector
Communication	PAN: Bluetooth version 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 x W x H	179 x 97 x 37 mm

### Ordering Information

**Model GK-604D-20M:** Inclinometer Readout System with Digital MEMS Biaxial Inclinometer Probe, FPC-2 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-2 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.

