VERTICAL IPI STRING

GEOKON®

MODEL 6140



Model 6140 Vertical IPI String

APPLICATIONS

The remote, continuous, and automatic monitoring of:

- Lateral deformation in dams and tailings
- The stability of natural slopes, landslides, embankments, and subsea marine sediments
- The stability of slurry walls, sheet piling and tieback walls
- Lateral movements in, around and above tunnels and underground openings



Model 6140-HOIST: Assists in the installation and removal of IPI strings.

OPERATING PRINCIPLE

The basic principle of operation is the utilization of MEMS (Micro-Electro-Mechanical Systems) tilt sensors to make accurate measurements of inclination over segments of an inclinometer casing.

The Model 6140 Vertical IPI String consists of a string of Biaxial MEMS tilt sensors, installed in rugged engineered polymer housings. One spring-loaded wheel and two fixed wheels, allow the string to positively engage the grooves of conventional inclinometer casing[1] maintaining azimuth with depth. The string suspended at the top of the casing using a suspension cable and support bracket. Depending on string length and site conditions, strings may require additional tension via suspension weight(s) attached to the bottom sensor. The Model 6140-HOIST, with sturdy frame, pulley system, support cable, and cable reel, is available to help facilitate installation and removal. (The hoist system is required for strings greater than 50 sensors.)

Sensors in the inclinometer string are mechanically connected with high-strength aircraft cable assemblies, which are free to pivot about the connection point. Sensors are electrically connected via a common bus cable, while the top-most sensor includes a waterproof connector that allows for easy assembly to the chosen readout device (PC, datalogger, SCADA system, etc.) through a customer-specified readout cable.

Each sensor outputs calibrated tilt (angular degrees) and temperature (degree Celsius) readings, which can be easily imported into MS Excel, or any inclinometer visualization software, without the need to convert raw data into engineering units.

[1]Fits into 70 mm and 85 mm casing

ADVANTAGES

The Model 6140 Vertical IPI String takes the benefits of MEMS technology (wide angular range, high sensitivity, excellent long-term stability) and integrates it into a robust system that requires minimal assembly and is easy to install.

With high spatial resolution (0.5 m or 2 ft), the device is capable of measuring extreme lateral movements. Additionally, the flexible nature of the product allows for installations into deformed casings where traditional IPI systems could not be deployed.

The Vertical IPI String is light and compact, making it the ideal choice for remote and difficult to access monitoring locations.

DATA ACQUISITION

The Model 6140 Vertical IPI String uses industry standard Modbus® Remote Terminal Unit (RTU) protocol to communicate. It employs an RS-485 (half duplex) electrical interface, recognized for its prevalence, simplicity, and success as a robust, industrial physical layer.

Monitoring can be accomplished using GeoNet Digital Data Loggers, the Model 8020-38 Addressable Bus Converter, Model 8600 Series Dataloggers, or any other device capable of operating as a Modbus RTU client and having an RS-485 port.

TECHNICAL SPECIFICATIONS

Range[1]	±90°	Standard Sensor Length	0.5 m, 2 ft
Resolution[2]	0.00025° (0.004 mm/m)	Weight, Sensor	0.39 kg (0.86 lb.)
Precision[3]	±0.0075° (±0.13 mm/m)	Weight, Suspension	2.27 kg (5 lb.)
Nonlinearity	±0.005° across ±30° range (±0.09 mm/m)	Materials	316 Stainless Steel, Engineered Polymer
Temperature Dependent Uncertainty	±0.001°/°C across ±5° angular range (±0.016 mm/m) ±0.0016°/°C across ±15° angular range (±0.026 mm/m) ±0.0026°/°C across ±30° angular range (±0.042 mm/m)	Interface	RS-485
Operating Temperature	–40 °C to 65 °C (–40 °F to 149 °F)	Protocol	MODBUS
Power Supply Voltage	12 VDC (+0%/–10%)	Baud Rate	115,200 bps
Peak Operating Current[4]	20 mA ±1 mA	Acquisition Cycle Time	350 ms
Average Operating Current[4]	5 mA	Temperature Accuracy	±0.5 °C
Standby Current[4]	2.2 mA ±0.1 mA	Ingress Protection	IP68 to 3 MPa (300 m head water)
Datalogger Sensor Limits	Refer to the applicable data logger manual	Electrical Cable	Four Conductor, Foil shield, Polyurethane jacket, nominal OD = 7.9 mm

[1] Calibrated Range: ±30°
[2] 99% confidence interval (i.e. 99 out of 100 individual readings fall within this tolerance).
[3] Includes random walk (changes between consecutive readings that have no discernible cause) and seismic noise during testing.
[4] Operating and standby current are for each individual sensor in a string.
[5] Dependant on datalogger used. Consult datalogger manufacturer.

ORDERING INFORMATION

6140-1: Vertical IPI String Top, with Readout Cable connector
6140-0.5M: Vertical IPI String Middle, 0.5 m spacing
6140-2FT: Vertical IPI String Middle, 2 ft. spacing
6140-2: Vertical IPI String Bottom, with Suspension Weight connector
6140-3-1: Suspension Cable, <5 m length
6140-3-2: Suspension Cable, 5 m to 10 m length
6140-3-3: Suspension Cable, 10 m to 20 m length
6140-4: Suspension Weight
6140-5-1: Vertical IPI String Connector Bottom, 0.5 m spacing, for strings with >100 sensors, 1 required per 100 sensors
6140-5-2: Vertical IPI String Connector Bottom, 2 ft spacing, for strings with >100 sensors, 1 required per 100 sensors
6140-6: Sensor Hold
6140-HOIST: Installation/Removal Hoist
6180-2: Suspension Bracket
6180-3-1: Readout Cable, bare leads, <15 m length
6180-3-2: Readout Cable, bare leads, 15 m to 30 m length
6180-3V: Readout Cable, bare leads, >30 m length

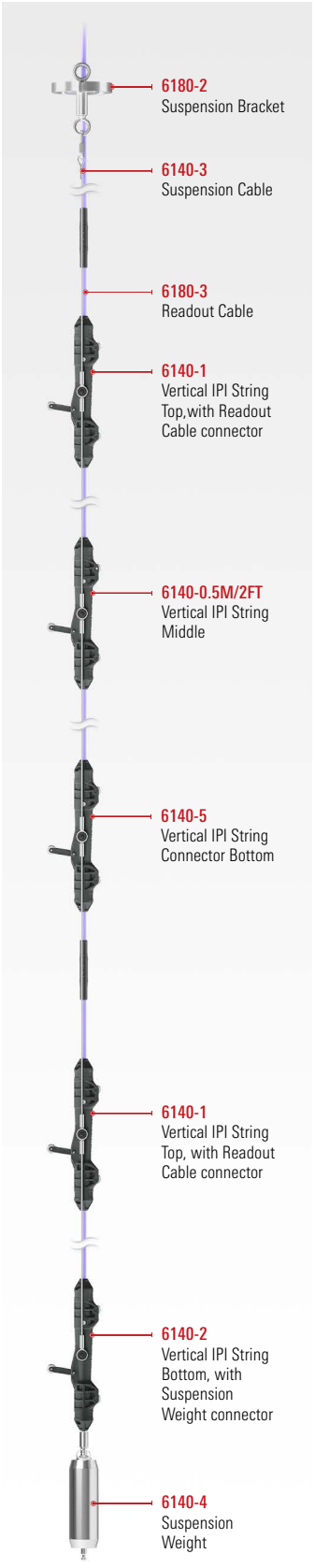
**Each string comprises a customer-specified number of 6140 middle sensors and one of each of the following: 6140-1, 6140-2, 6140-3, 6140-4, 6180-2, 6180-3. Strings over 100 sensors require one 6140-5 for every 100 sensors*



GeoNet Addressable Data Logger.

COMPATIBLE READOUTS AND DATA LOGGERS

8800 and 8900 Series: GeoNet Wireless Mesh Data Acquisition System
8910 Series: GeoNet Wireless LoRa® Data Acquisition System
8920 and 8921 Series: GeoNet Cellular Data Loggers
8930 Series: GeoNet Wi-Fi Data Loggers
8940 Series: GeoNet Local Data Loggers
8600 Series: Data Loggers



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Please note: *The Model 6140 is currently Patent Pending.*

GEOKON | TRUSTED MEASUREMENTS.
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