MEMS Tilt Sensors

Applications

The Model 6160 and 6161 MEMS Tilt Sensors are designed to measure tilt in structures including…

- **Buildings**
- **Dams**
- **Embankments**
- **Slopes**
- **Excavation walls**
- **Open pits**

Model 6160A-2 Biaxial MEMS Tilt Sensor.

Model 6161A-1 Uniaxial MEMS Tilt Sensor with cover removed.

Model 6161A-1 Uniaxial MEMS Tilt Sensor in NEMA 4 enclosure.

Operating Principle

The Model 6160 and 6161 MEMS Tilt Sensors are designed for attachment to structures, on either a vertical or horizontal surface, and for the subsequent measurement of any tilting that may occur. The sensor itself is a MEMS (Micro-Electro-Mechanical Systems) sensor which offers a high range, with high sensitivity and accuracy. The included associated signal conditioning yields an output of ±4 V at ±15° and is designed to drive long cables without degradation.

Advantages and Limitations

MEMS tilt sensors are low-cost, robust, virtually immune to shock loading and exhibit very good long-term stability. Biaxial tilt sensors contain two MEMS sensors oriented at 90° to one another to allow perpendicular tilt measurement. They are readily adaptable for automated data acquisition, which allows a series of sensors to be continuously monitored for profiling purposes. (On projects that consist solely of vibrating wire instruments for monitoring purposes, the Model 6350 Vibrating Wire Tiltmeter may be a more suitable option to help simplify the design of any required data acquisition system)

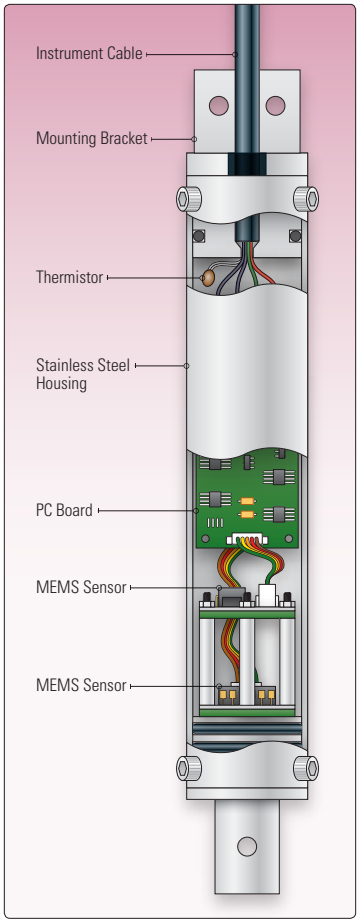
System Components

The basic transducer for the Model 6160 MEMS Tilt Sensor is mounted inside a stainless steel housing equipped with a lug for mounting the sensor to an adjustable bracket. The bracket is bolted to the structure using the supplied hardware, which includes a ⅜" drop-in anchor.

The Model 6160 is also used in the 6150 Series MEMS In-Place Inclinometers, where a string of sensors are connected together and spaced apart by means of rigid rods to generate a continuous profile of tilt and deflection inside an inclinometer casing.

In the Model 6161, the sensor is mounted inside a protective Nema 4 enclosure which is, in turn, attached to a plate for ease of attachment to masonry, steel, wood and concrete structures.

Both types of tilt sensors are available in uniaxial and biaxial versions and include a thermistor, mounted inside the sensor housing, to permit the measurement of temperatures.



● *Model 6160A-2 Biaxial MEMS Tilt Sensor.*

● *Closeup of Model 6160A-2 Biaxial MEMS Tilt Sensor mounting bracket assembly.*

Available Versions

Several versions are available allowing for optimal configuration based on application and site specifics:

6160A · 6161A | Analog Tilt Sensor

This is the standard, classic configuration in which uniaxial or biaxial MEMS tilt sensors are mounted in short lengths of stainless steel tubing (6160) or in protective Nema 4 enclosures. Output is ±4 V at ±15° and each sensor uses its own cable (up to 305 m (1000 ft) in length). Readout is achieved using the Model RB-500 (manual readings) or with the Micro-1000 or Micro-800 Dataloggers.

6160B · 6161B | Analog Tilt Sensor, Addressable

Similar to the above but with the ability for many tilt sensors to be connected together on a single 6-pair cable as part of a string. Each string is custom made with requisite cables according to customer specifics. The maximum number of sensors that can be used in this configuration is 16 and the maximum cable length is 305 m. This assembly operates in much the same way as a multiplexer and is read using the Micro-1000 or Micro-800 Dataloggers.

6160C · 6161C | Digital Tilt Sensor, Addressable

Similar to the above but with the tilt sensors connected to a 2-conductor Frequency Shift Keying (FSK) trunk line made according to customer specifics. Readout is accomplished using the Micro-1000 or Micro-800 Dataloggers via a modem interface (each modem is capable of supporting up to 6 IPI sensor strings). The maximum number of sensors that can be used in this configuration is 16. Digital systems offer greater noise immunity than analog types, and are capable of signal transmission over cables up to 305 m in length.

6160E · 6161E | RS-485 Version*

Similar to the 6160C/6161C described above, but with a 4-conductor cable and RS-485 output allowing for direct connection to a variety of dataloggers and the Model 8800 Series GeoNet Wireless Network.

**Available Fall 2015.*

Technical Specifications

	6160A-1/2 · 6161A-1/2	6160B-1/2 · 6161B-1/2	6160C-1 · 6161C-1	6160E-1 · 6161E-1
Standard Range[1]	±15°	±15°	±15°	±15°
Resolution	±0.02 mm/m (±4 arc seconds)	±0.02 mm/m (±4 arc seconds)	±0.02 mm/m (±4 arc seconds)	±0.02 mm/m (±4 arc seconds)
Sensor Accuracy[2]	±0.05 mm/m (±10 arc seconds)	±0.05 mm/m (±10 arc seconds)	±0.05 mm/m (±10 arc seconds)	±0.05 mm/m (±10 arc seconds)
Sensor Voltage (Nom)	12 V DC	12 V DC	12 V DC	12 V DC
Sensor Output	±4 V @ ±15°	±4 V @ ±15°	Digital	Digital
Cable (Uniaxial)	3 pair	6 pair	n/a	n/a
Cable (Biaxial)	6 pair	6 pair	1 pair	2 pair
Shock Survival	2000 g	2000 g	2000 g	2000 g
Thermal Zero Shift	0.0003 Volt/°C rise	0.0003 Volt/°C rise	0.0003 Volt/°C rise	0.0003 Volt/°C rise
Temperature Range[1]	–20° to +80°C	–20° to +80°C	–20° to +80°C	–20° to +80°C
Thermistor Accuracy	±0.5°C	±0.5°C	±0.5°C	±0.5°C
Dimensions (6160A/B/C/E)	219 × 32 mm (sensor L × ø)	362 × 32 mm (sensor L × ø)	362 × 32 mm (sensor L × ø)	362 × 32 mm (sensor L × ø)
Dimensions (6161A/B/C/E)	122 × 81 × 61 mm (L × W × H)	122 × 81 × 61 mm (L × W × H)	122 × 81 × 61 mm (L × W × H)	122 × 81 × 61 mm (L × W × H)
Max Cable Length	305 m	305 m	305 m	TBD
Max Sensors per String	N/A	16	16	TBD

[1]Other ranges available on request. | [2]Established under laboratory conditions.

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