The Fredericks Company

Tilt measurement solutions

November 11th, 2015

For tilt and Inclination sensors –

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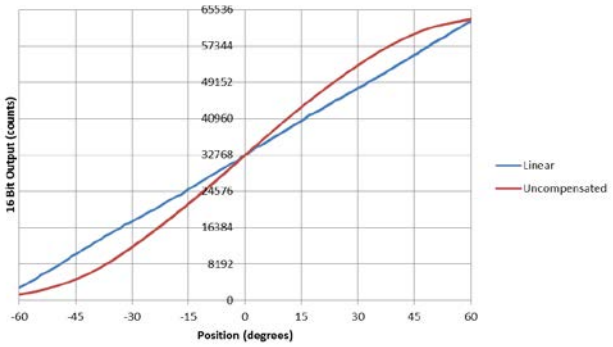
Definition of Terms

- **Sensor**
  - Passive component that measures tilt when combined with electronics.
- **Inclinometer**
  - Provides a continuous output of tilt position, includes a sensor and electronics.
- **Tilt Switch**
  - Provides a discrete on/off output indicating whether the unit is tilted past a specific angular position. Includes a sensor and electronics.

Accuracy

- **Repeatability**
  - The maximum deviation in output when the sensor is tilted and then returned to its original position
- **Resolution**
  - The minimum incremental position change that generates a monotonic output
- **Linearity**
  - The maximum deviation from a linear output as a percentage of the measured range. This can be compensated in software.



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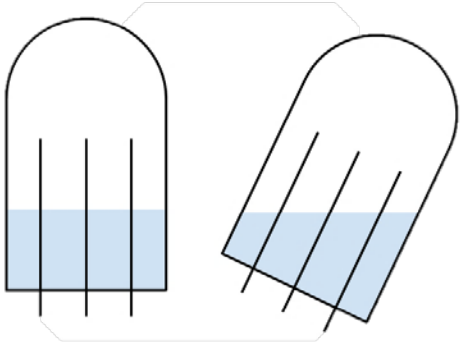
Electrolytic Sensors Theory of Operation

- Cavity filled with conductive electrolytic fluid
- Electrodes extend into fluid
- As the sensor moves, fluid depth at each electrode varies
- Conductivity between electrodes changes
- This can be translated into tilt position



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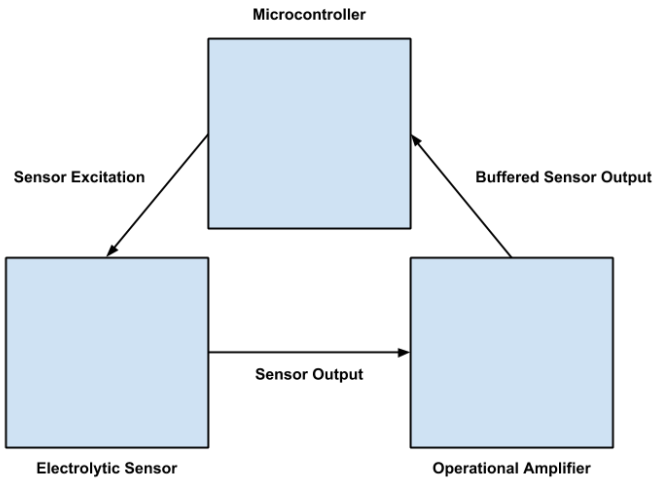
Integrating Electrolytic Tilt Sensors

- **Necessary components**
  - Microcontroller
  - High impedance op-amp
  - Sensor

- **We provide**
  - Drawings
  - Schematics
  - Gerber files
  - Firmware source files

- All of this hardware/software is included in our signal conditioners



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Fredericks Company Benefits to our Electrolytic tilt sensors

- Very low power consumption
- Extremely long life and exposure to Shock
- Minimal drift over lifetime compared to MEMS devices
- Excellent resolution and repeatability
- Superior performance in extreme temperatures and environments
- Excellent customer support – we will provide engineering resources to develop or evaluate your design to incorporate our sensors into your new design projects
- Manufactured in house at our facility
- Lifetime support of our products for your applications
- Can offer solution and customer designed sensors to meet your specific needs
- Design and manufacturing tilt sensors for over 45 years for use in rugged and robust applications.

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Typical applications for our sensors –some examples

- Dam, building, and bridge construction and monitoring
- Geophysical tilt metering and monitoring
- Gyroscopes
- Laser leveling systems
- Mining machinery and equipment
- Zero point and position adjustment

- View a full list of applications on The Fredericks Company website at www.fredericks company.com.

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Electrolytic Tilt Sensors - TrueTilt™ Metal

0717 Wide Range

- Dual axis
- Up to ±60° range
- ±0.1° repeatability or better
- ▼▼▼ Lowest cost

0703 Mid-range

- Single axis
- Up to ±25° range
- ±0.005° repeatability or better
- ▲ High accuracy

0703 Narrow Range

- Single axis
- Up to ±3° range
- ±0.001° repeatability or better
- ▲▲ Very high accuracy

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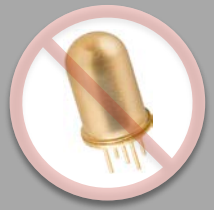
0717 Series Wide Range Sensors

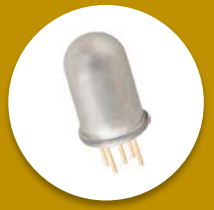


Standard Gold Plated

- Original design
- More expensive than un-plated
- Not recommended for new designs
- ±0.1° repeatability

Un-plated

- Newest design
- ▼▼▼ Lowest cost
- Recommended for new designs
- ±0.1° repeatability
- Highest volume part we sell



HSA Gold Plated

- ▲ Highest accuracy option
- Recommended for new designs
- ±0.05° repeatability

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Electrolytic Tilt Sensors - Glass

Wide Range

- Single or Dual axis
- Up to ±70° range
- ±12 arc seconds repeatability or better
- ▲ High accuracy

Mid-range

- Single axis
- Up to ±10° range
- ±2 arc seconds repeatability or better
- ▲▲ Very high accuracy

Narrow Range

- Single axis
- Up to ±3° range
- Down to ±0.5 arc second repeatability
- ▲▲▲ Extremely high accuracy

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MidRange
Single Axis
Linear Output
Electrolytic Tilt Sensor

- The **0703-1601-99** TrueTilt™ sensor is designed for applications requiring highly repeatable mid-range angle measurement and a linear output. Long-term stability over its angle and temperature range is a distinctive characteristic of this sensor. The 0703-1601-99 uses patented technology and construction to provide an accurate and robust angle sensor at an attractive price with excellent sensor-to-sensor repeatability and reliability. Unparalleled performance and features compared to any other commercially available product.

- The data sheet with full specifications is avail at:
- http://fredericks company.com/tilt-sensors-electronics/truetilt-mid-range/0703-1602-99

Operating Range (max.)(Fig. 1)	± 25°
Linear Range (Fig. 2)	± 10°
Max deviation from Linearity	≤0,01° from 0 ° to 3°
	1% (FROM 3° TO 10°)
Null Current(max.)	0.2 mA (continuous)
Null Impedance (nom)	50k 0hms (25°C)
(measured left to right electrode)	
Null Repeatability	≤ 18 arc seconds
Resolution	< 1 arc second
Symmetry	≤ 20 %
Mounting Offset [1]	≤ 1°
Cross Axis error at null	0.03% / Degree
Operating Temperature	-40° C to +85° C
Storage Temperature	-50° C to +100° C
Time Constant (@66%) [1]	≤ 1 second
Materials	magnetic
Temperature coefficient (null)	≤ 6 arc seconds / ° C
Temperature coefficient (scale)	0.075% / °C
Stability 24 Hrs	±0.01°
[1] Difference between electrical and mechanical null	

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TrueTilt™ Single Axis Narrow Range Electrolytic Tilt Sensor

Part Number: 0703-0711-99

- The **0703-0711-99** TrueTILT™ single axis, narrow range electrolytic tilt sensor has a robust, all metal construction providing durability while maintaining superior tolerances and sensor to sensor performance. It is economical with a high level of linearity and repeatability making it ideal for a versatile range of applications in all sectors.

Applications

- Dam, building, and bridge construction and monitoring
- Geophysical tilt metering and monitoring
- Gyroscopes
- Laser leveling systems
- Mining machinery and equipment
- Zero point and position adjustment

Operating Specifications	
Operating range	±3°
Linear Range	±1°
Axes of Measurement	1
Linearity (±1°)	≤3%
Symmetry (±1°)	≤0.05°
Repeatability	≤5 arc seconds
Resolution	≤1 arc second
Null Offset	≤0.25°
Cross Axis Roll Sensitivity	≤20 arc seconds (±3° roll)
Long Term Stability/Drift	≤5 arc seconds
Null Temperature Coefficient (max.)	±1 arc second per °C
Operating Temperature	-20° to +50° C
Storage Temperature	-50° to +100° C
Null Impedance (typ.)	50 kΩ
Time Constant (63.2% of final output)	≤1 second
Materials	Magnetic metals
Maximum Current at Null	0.2 mA (continuous)

http://fredericks company.com/tilt-sensors-electronics/truetilt-narrow-range/0703-0711-99

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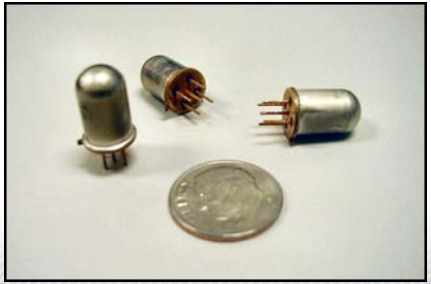
Dual Axis Wide Angle Electrolytic Tilt Sensor

http://fredericks company.com/tilt-sensors-electronics/truetilt-wide-range/0717-4313-99

Full data sheet and avail at the above website:

- The **0717-4313-99** TrueTilt™ Sensor" represents a new advancement in electrolytic tilt sensor technology. Robust all metal construction provides durability as well as superior dimensional tolerances, which equates to excellent sensor-to-sensor electrical performance. This sensor is ideal for economical, commercial market applications requiring high production quantities and first-rate accuracy.

- *Angle Range* *± 50°*
- *Resolution* .2 arc minutes
- *Repeatability* *± 0.05°*



Operating Range (max.)	± 50°
Linear Range	± 20°
Null Voltage	≤0.015 Volts
Null Current(max.)	0.2 mA (continuous)
Null Impedance (nom)	50 K Ohms (25°C)
(measured left to right electrode)see fig. 2	
Repeatability	0.05°
Resolution	< 0.2 arc minutes
Symmetry (typ)	5 %
Null Offset (max)	4.0°
Mech. Crosstalk/Deg. (to 20°)	0.025°
Temperature coefficient	
Null	20 arc sec /°C
Scale	0.1% /°C
Stability @24 Hrs.	0.05°
Operating Temperature	-40° C to +85° C
Storage Temperature	-55° C to +100° C
Time Constant (1)	≤ 100 msec
Materials	magnetic

NOTE: Output sensitivity's scale factor may be modified to individual requirements upon special order.

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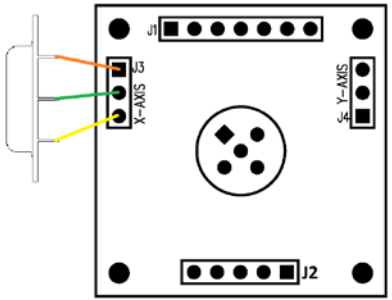
Signal Conditioners

- **Can control any TFC electrolytic sensor**
- **0717 series sensors can be mounted directly on board**
- **Output options**
  - Analog 0 to 5 V DC
  - PWM
  - RS-232
  - RS-485
  - SPI



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