Geo Tech Note:

The Role of Signal Conditioning

Our first electrolytic tiltmeters were built in 1982; and today, Jewell Instruments offers dozens of products incorporating electrolytic tilt sensors. Jewell Instruments also has gained years of experience supplying thousands of electrolytic tiltmeters to a variety of demanding markets, including civil engineering, geophysics, aerospace and oceanography.

Most of our Geo tilt meters have own built-in signal conditioning electronics. Building the electronics into the sensor module provides important benefits for the user:

1. The instruments are immune from power supply variations since the electronics precisely regulate the excitation signal sent to the sensor. Any external supply voltage in the specified range provides stable readings.
2. Each sensor is calibrated together with its signal conditioning electronics. The calibration is not dependent on the data logger used and stays the same no matter how you take your readings.
3. The instrument output does not depend on cable type or length. This results in significant cost savings because you can lengthen or shorten cables to fit your needs. You can even buy your cables locally, saving on shipping costs and reducing lead times.
4. Temperature induced changes in cable resistance do not affect the readings.
5. The output of the instrument can be read by anything that can read DC volts.

Role of Signal Conditioning Electronics

All electronic sensors require some amount of signal conditioning between the sensor and the display or data acquisition equipment. Signal conditioning circuitry performs some or all of the following functions: (1) it excites the sensor, (2) it receives the signal returned by the sensor and amplifies it, and (3) it converts the signal into a format that can be displayed and recorded by the available equipment (volts, RS232, etc.). Essentially, signal conditioning transforms a weak signal into a robust signal that lends itself to display and recording. Signal conditioning details are functions of the sensor and the recording equipment but typically include signal amplification, AC to DC rectification, pulse counting, filtering, and analog to digital (A/D) conversion, among other possible functions. Because the raw signals from most sensors are of low amplitude, some degree of amplification is almost always involved.

The signal conditioning electronics play a major role in producing accurate and stable measurements over long cable lengths. Excitation signals (voltage, frequency, etc.) must be stable to prevent drift in the sensor output. Signal processing circuits must similarly be stable over the specified operating range to produce stable, low-noise measurements. Noise is defined as any unwanted signal that appears in the data and drift as a gradual change in the data unrelated to the measured parameter. Signal conditioning - used in combination with predictable, repeatable sensors - is the means by which we achieve stable, low-noise measurements over long cable lengths.

Geo Tech Note:

The Role of Signal Conditioning

Remote vs. On-Board Signal Conditioning

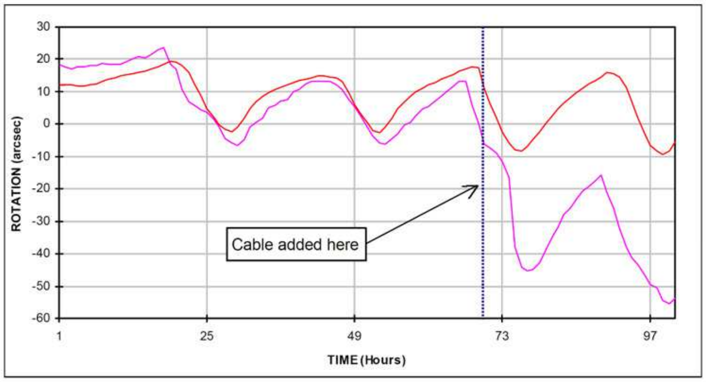
The logic behind packaging the signal conditioning electronics with the sensor is simple: The stronger and more noise immune the signal sent down the cable, the more noise-free and drift-free the signal recorded by the data acquisition system. If the amplifiers are at the recorder end of the cable, cable noise will first be amplified, then recorded. If the sensor's output is first amplified, then sent down the cable, cable noise will be a much smaller fraction of the final recorded signal.

Although its importance is often overlooked, the length of cable between the sensor and the display or recording system is part of the signal conditioning circuit. An inescapable fact is that cables pick up noise from a variety of sources. They pick up radio frequency noise, cable resistance changes caused by temperature fluctuations that modify the signal received at the recorder, and single-ended (ground referenced) recordings are subject to ground loops if the cable is grounded in more than one location (this can occur accidentally, unbeknownst to the operator).

Example of Changing Cable Resistance

We installed two instruments on the concrete wall of our factory so that they would measure rotations in the plane of the wall. One instrument is a Model 801-S "Tuff-Tilt" which contains on-board signal conditioning, and the second is a third-party beam sensor that uses a datalogger at the opposite end of its cable for signal conditioning. The instruments were installed inside the building. The wall is south facing so that it heats up in the direct sun during the day. The instruments were installed one above the other, each separated by about 30 cm. The beam sensor is 6 ft long. The tiltmeter (10 x 13 cm) was anchored to the wall by three epoxy-grouted studs. All data were recorded with the same data logger.

The figure below shows the effect of adding 200 ft of cable to the Jewell model 801 tiltmeter and 170 ft to the third-party beam sensor. The Model 801 data were not affected. The third party beam sensor data show a permanent shift of about 25 arc seconds. The daily oscillations are the thermoelastic expansion and contraction of the wall, plus the temperature coefficients of the instruments themselves (undifferentiated in this test).



The results of these tests illustrate the relative impact that cable length has on "electrolevels" without internal signal conditioning versus Jewell tiltmeters with built-in signal conditioning.

Changing cable length symbolizes changing cable resistance, which occurs as a result of temperature and age.

Jewell Instruments

Phone :
+1 (603) 669-6400

Email :
info@jewellinstruments.com

Web :
jewellinstruments.com