FOUR COMMON SOURCES OF INACCURACY IN SENSOR MEASUREMENTS

How to Improve Your Data Acquisition System's Measurement Accuracy

Connecting a sensor such as a thermocouple to a data acquisition system to obtain accurate measurements involves some forethought. For example, electromagnetic signal interference (aka 'signal noise') and many other factors can combine to negatively affect measurement accuracy, or possibly even damage the equipment! Understanding these factors is crucial to obtaining meaningful measurements.

This White Paper from CAS DataLoggers addresses four measurement accuracy issues in the order of most to least common. These issues regularly occur when a data acquisition system collects data in typical industrial process applications.

1. **Signal Noise:**

A leading cause of measurement errors, **Signal Noise** is caused by multiplexers in PC-based data acquisition systems, allowing cross-channel interference due to their capacitance. Multiplexer inputs store a charge proportional to their measurement system's sample rate (i.e. the data collection rate). This is why high sample rate and the resultant data exchange can dramatically increase signal noise. To lessen the effects of signal noise:

- Connect an isolation amplifier's output to the data acquisition system's multiplexer input, especially when using high sampling rates. Some measurement systems have built-in isolation amplifiers for every channel.
- Using cable shielding is a simple way to reduce signal noise.
- Using twisted wire pairs further reduces signal interference.
- A signal conditioning amplifier presents a low resistance and small, uniform capacitance to the system multiplexer. This can decrease inaccuracy.

2. **Damaging Voltage:**

High voltage can cause serious damage to data loggers and PC-based data acquisition systems. Equipment housed in an enclosure isn't necessarily safe either—the culprit could be faulty wiring or another installation mistake. Even a small amount of excessive voltage can cause your system's channels to produce data errors.

- To help prevent the likelihood of system damage, choose an instrument with galvanic isolation. This precaution ensures that the vulnerable parts of your system will be protected from high-voltage hazards. The system's I/Os, channels, power sources, and sensors can all be isolated.
- Likewise, an intrinsically-safe isolation barrier and/or an insulated enclosure can add further protection.
- Be sure to check your given system's max input voltage specification. This is the manufacturer's rating for the safest voltage level the device can be exposed to without a risk of damage.
- Signal conditioning modules use varying amounts of isolation to eliminate ground loop problems and induced field noise.
- As with signal noise above, using a signal conditioning amplifier will protect your system from damage due to voltage outside its specified tolerance.

3. **Common Mode Voltage (CMV) Inaccuracy:**

When a data acquisition system takes measurements in the presence of a **Common-Mode Voltage (CMV)**, its measurement accuracy will suffer. Users can learn the extent of this inaccuracy by checking their system's **Common Mode Rejection (CMR)** specification as listed by the manufacturer.

In contrast, CMR is a noise-reducing phenomenon that occurs when a signal common to two lines which are opposed in polarity gets cancelled at the receiving end. CMR is usually listed as a ratio (CMRR) expressed in decibels, with higher ratings being more effective. This CMRR rating shows you how much of the common-mode signal will adversely affect your system's measurement accuracy.

A measurement system featuring a differential input can reject CMV to a degree determined by its CMRR.

If your measurements are being affected by AC or DC common-mode voltage, you can use a signal conditioning amplifier to reduce noise. The amplifier's isolation barrier will reject the CMV. However, the amplifier's own CMRR may be affected in the case of AC applications, which

often give you greater difficulty in obtaining accurate measurements. A common example is when you have to deal with electromagnetic noise in the area.

4. Wide Measurement Ranges Pose a Risk to Inputs:

If you're working in an industrial application or another wide-range task, your measurement system may be at risk from inadequate input protection. For example, occasionally users try to measure high voltages while their system is still set for lower ranges, which causes the system to exceed its own max range value. Without input protection, this can cause inaccuracies or even permanently damage the system.

There are many different devices available which can protect your system's inputs. While none of them are perfect, they can help ensure that your system will more safely handle higher-input signals. Depending on your application, you may also want to select products rated to protect against high common-mode voltages and/or transient events.

For more information on Data Acquisition Systems, or to find the ideal solution for your application-specific needs, contact a CAS DataLoggers Application Specialist at (800) 956-4437 or visit our website at www.DataLoggerInc.com.