Why You Should Consider Using Isolated Measurement Systems

The Benefits of System Isolation

In today's data-driven world, the integrity and reliability of electrical measurement systems are critical. Electrical isolation, a protective design feature, plays a crucial role in ensuring the accuracy and safety of data acquisition systems. By separating measurement signals from different sensors from each other and from the data processing circuitry, isolation prevents electrical interference and protects both the system's components and the collected data.

This white paper explores the concept of electrical isolation, its benefits, and the potential risks associated with non-isolated systems. We'll delve into specific applications where isolation is essential and provide insights into why you should consider using isolated data acquisition systems and data loggers in your process-critical applications.

What is Electrical Isolation:

Electrical isolation is a protective design feature of many data loggers and data acquisition systems. Isolation is implemented to separate measurement signals from each other in order to keep them from interacting and causing electrical issues. The essential design feature is to keep each section of the circuit independent such that there is no current path between different sections of the measurement system including the signal conditioning, measurement, and data communication circuitry. Isolation can be implemented by several different techniques such as using optical isolation, transformer isolation, or

specialized isolated circuits (ICs) that decouple the inputs and outputs to break any grounds or other current paths.

For example, a specific type of isolation, galvanic isolation, can be used to separate the analog signal processing and measurement circuits from the digital data processing and communications circuits to cut off the flow of current among them. This protects the system's electrical components by eliminating the potential for issues such as ground loops while still allowing for communication and data exchange per usual between electric circuits. For example, you can use opto-isolators which are ICs that use light to transfer data between system components. By allowing no ground or DC paths, galvanic isolation keeps unintended current from flowing between the system segments.

Your existing data acquisition equipment may already have isolation; if you're unsure, check the device's specification sheet. If your system is multiplexed (combining several signals into one), it may already feature a level of isolation between channels. This will normally be called out in the specifications as channel-to-channel isolation resistance or maximum common mode voltage. Devices with greater communication capability often have (or require) galvanic isolation owing to their greater need to safeguard data.

Why Isolate Your Systems?

Isolation is often required in real-time data acquisition applications such as:

- Automotive manufacturing
- Machine monitoring (turbines, motors, etc.)
- Food processing operations
- Materials Engineering (alloys, etc.)
- Many other heavy industrial uses
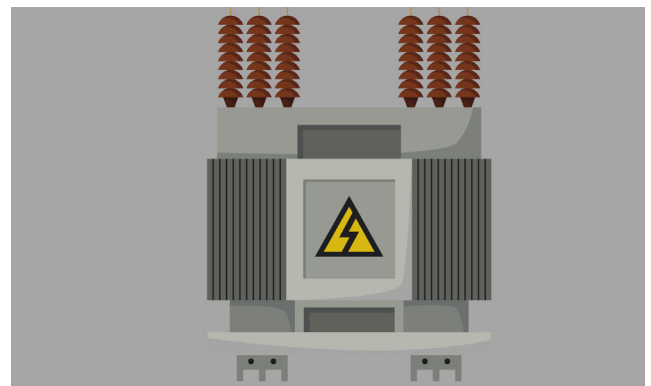
One excellent reason to use isolated data acquisition systems is to protect yourself or your personnel from electrical accidents. In particular, galvanically isolated systems protect operators from being exposed to unintended current paths or high voltage in the case of a fault. Another good reason to use isolated measurement systems is to ensure that your measurements are free (as much as possible) from signal noise. In electronic equipment, signal noise is a very common wiring issue that corrupts your devices' program signals, leading to data distortion or drops. Signal noise is caused by unintended current carried by a ground loop, which is in turn formed when two or more connected electrical systems are accessing more than one path to the ground. Resistance changes these currents into voltage fluctuations, causing the problem.

As mentioned in our earlier White Paper, '5 Ways Signal Noise Can Impact Your Electrical Equipment,' applications with high signal noise and electromagnetic interference can greatly benefit from system isolation. Many manufacturers of data acquisition systems offer several different models of their basic product, featuring different levels of isolation such as channel-to-channel, galvanic, etc.)

While it's true that all measurements have a certain amount of inaccuracy, if you're working in a high-accuracy application then you'll need to reduce errors and interference for external sources as much as possible. An isolated design helps to prevent signal noise by eliminating potential ground loops caused by different ground points for different sections of the measurement systems. Galvanic isolation offers an additional benefit in the form of common-mode voltage rejection, which reduces signal noise by ignoring those signals (voltages) that are common to both the + and − input connections. This is especially useful if you're trying to record accurate measurements in areas where the output voltage of a sensor may be floating with respect to the earth's ground.

What Risks are Posed by Non-Isolated Systems?

While isolated measurement systems are fractionally more costly than non-isolated

products, you may find that the cost of repairing or replacing your system is much higher! For the average user of a data acquisition system, the most likely risk is that the analog/digital signals will be corrupted or that the system will be damaged as a result of unintended ground current flow. For example, your system's circuits can be damaged in an instant by currents caused by a fault if this threat is not mitigated beforehand by isolation. For all practical purposes, non-isolated systems also restrict your choice of input signal types.

However, Ground loops pose one of the greatest threats, both to measurement signals and to users themselves:

- **Data Loss**: Networked data systems lacking isolation are at great risk of losing data through signal degradation. Isolation safeguards data from signal degradation while also helping to protect your initial investment in your data acquisition system. A very common example is noise inducted in a USB-connected measurement system that does not provide isolation between the USB interface and the analog measurement circuits

- **Physical harm**: Users of non-isolated systems face a real risk of harm caused by high current or voltage

Isolation prevents these ground loops from forming, thereby protecting the system and measurement signals. If you need to take additional precautions, galvanic isolation prevents ground loops by preventing the current paths that cause current to flow between units in the first place (i.e. by breaking the loop).If you're working on a process application, you'll want isolation as an extra precaution against measurement and control system failures, which can cause a costly process delay or shutdown.

If you're a systems integrator or contracted purchaser, you should consider isolating your data acquisition systems to avoid complaints or even lawsuits from customers whose

systems were damaged from ground loops and other electrical issues. By supplying systems with built-in isolation, you can also gain a reputation for quality products in the heavy industrial market.

SUMMARY

No matter what application you're considering sourcing a data acquisition system or data logger for, we highly recommend you first consider whether or not you'll need a system with built-in isolation. If so, the marginally higher cost is well worth it considering the potential for lost data, damaged components, and physical risk to the operator. If you're not sure whether or not your application requires isolation, be sure to address this with a trusted solutions provider.

For more info on Data Acquisition Systems, or to find the ideal solution for your application-specific needs, contact a CAS Data Logger Applications Specialist at **(800) 956-4437** or visit us at https://www.dataloggerinc.com.