



Data Acquisition

The Complete Guide to
Better Measurements



What is the value of a sensor? For leading companies in the automotive, military, aerospace and medical markets, a handful of sensors could be worth millions of dollars. That may seem like a stretch until you think about how important data acquisition is when validating your designs.



Testing out a missile or a new jet engine can easily cost millions of dollars per test. Add in all of the engineering and design hours it takes just to come up with a prototype, and you can see how the difference between a good sensor and a bad one can make or break your business.

That is why design engineers need better sensors and data acquisition systems. Only with the best data acquisition equipment can you properly test and validate your products, enabling:

- **Quicker product development/production**
- **Higher test accuracy and reliability**
- **Enhanced cost savings from fewer expensive tests**
- **Easy regulatory compliance**

This guide will cover why data acquisition is so important, how signal integrity and enhanced synchronization lead to higher-quality data, and what kinds of equipment you can use to improve your data acquisition.



The Need for Better Data Acquisition

The only way to ensure that your products work is through high-quality testing and data acquisition equipment. If you want to validate your design Finite Element Model with what is actually built in the shop, then testing is required.

The entire data acquisition process revolves around sensors. Sensors essentially monitor a physical property associated with your device, converting that property into a corresponding electrical signal. Different parameters that engineers often measure include:



Putting a sensor on an engine, for instance, can help you measure the response of the engine given specific stimuli. Is the engine getting too hot at certain speeds? How does the engine handle certain environmental conditions such as rain or hail? Does the engine start breaking down when facing operational-levels of vibration or other forces? All of these questions can be answered with sensors.



The Importance of Signal Integrity

When using sensors to gain insight into how your products function, signal integrity is key. Signal integrity is essentially the quality of an electrical signal. In the context of data acquisition, this means the accuracy of your test results.

Since the real world is not a perfect system, some level of signal degradation is bound to occur with every test. Especially when dealing with lengthy cables and longer ranges, signals can be affected and degraded by the instruments that they pass through. This is particularly true at connection points.

While you cannot expect perfect signal integrity, if enough degradation happens, you will end up with false test results, completely ruining the validity of your data acquisition system. With how expensive and time-intensive functional tests are, you need to secure the signal integrity of your data acquisition systems as much as possible.

A data acquisition system with high signal integrity is a system that you can trust. Having good signal integrity also means that your results will be repeatable. That is important, because you need to have repeatable results to help prove that the results are indeed accurate. Non-repeatable results are not results at all.

So how do you ensure that your data acquisition system has high signal integrity? The first step is to make sure that there is not any leakage or sources of error throughout your data acquisition system. The second step lies with signal conditioning.

Signal conditioning is where you manipulate a signal to prepare it for the next stage of processing. Think of it in similar terms to translating a language or converting energy. Sensors require signal conditioning before your data acquisition system can accurately measure the signal – i.e., the results of the test. Types of signal conditioning can include:



- Amplification
- Excitation
- Linearization
- Filtering
- Isolation

While signal integrity can degrade as the signal moves from one instrument to another, you essentially have the same effect if you have improper signal conditioning. Either will give you false results and/or cause your test to fail.

The best way to maintain accurate test results is to have built-in signal conditioning. Not only does this lead to more efficient data acquisition systems, but it can also help to mitigate signal degradation from the conditioner.



The Demand for Rugged Data Acquisition Systems

We know that signal integrity and proper signal conditioning are important. However, actually achieving accurate and reliable results with a functional or a black box test is different than performing in a lab setting.

To withstand the rigors of something like missile testing or jet engine testing, your data acquisition system must be able to perform reliability within the test cell. This means that your sensors must be rugged and durable.

But it is about more than just the sensors. The old method of testing in these types of demanding scenarios was to put all of the sensors on the product within the test cell, then use long cables to connect the sensors to the other data acquisition instruments that could not handle the extreme conditions. This was a time-intensive process and highly prone to errors. Not only could those long cables break, but they made your signals vulnerable to noise and interference from the high temperatures, shock and vibrations from the test itself.

Instead, ruggedized data acquisition equipment allows engineers to place the rest of their measuring instruments directly in the test chamber along with the sensors. Able to withstand hazardous conditions such as extreme temperatures and vibration, rugged equipment could be close to an engine or thruster – sometimes directly on the machine itself. This increases testing accuracy and reliability while reducing the time necessary for setup, ultimately leading to better functional tests in demanding applications.

How to Obtain High-Speed Synchronized Data Acquisition

One good sensor is not enough. In order to maintain accurate and reliable data acquisition, you often need multiple high-quality sensors placed all over the product you are testing.

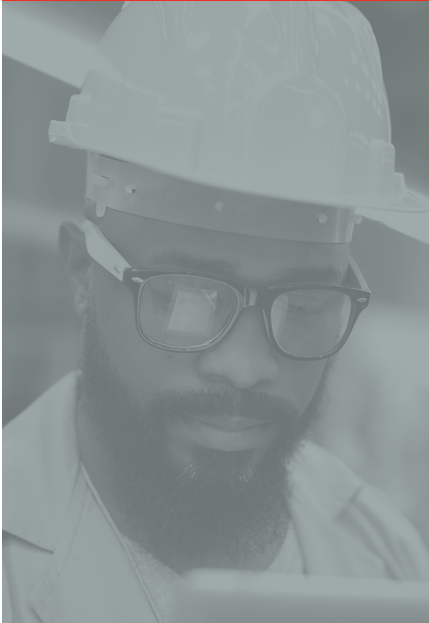
For instance, when testing out a new fighter jet, you will probably need to place hundreds or thousands of little sensors all over the aircraft. Remember, you are not just testing for one thing when you perform a functional test. A single fighter jet – which will likely be destroyed in the test – can easily cost 10 or 15 million dollars. You need to test out as many capabilities and properties as possible, using as many sensors as possible, in order to not waste the test.

How you distribute those sensors and allow them to work together as part of a full data acquisition system is important. This is where synchronization and scalability come into play.

Synchronization is all about making sure that your sensors, controllers and every other testing instrument are integrated properly. The right data acquisition system will provide box-to-box synchronization to help precisely correlate all acquired data. The more unified and integrated your system is, the faster and more efficient your data acquisition will be.

When you can easily integrate and synchronize multiple devices, it also makes your data acquisition system very scalable. This is important when you require large data sets or when your testing and data acquisition needs change. Properly synchronized and scalable systems will have the architecture to handle anywhere from tens to thousands of channels.





A Note on Testing Confidence

With the dynamic, high-stakes nature of modern manufacturing, many engineers are often up against tight deadlines due to ever-increasing product throughput demands. These demands dictate having minimal test system downtime while simultaneously placing a high level of importance on accuracy so that tests do not have to be repeated. That is why ensuring reliable test data and fast instrument calibration are key to the success of any production team.

In order to move quickly, while also confidently, data acquisition systems can be integrated with added intelligence to facilitate maximum system uptime while increasing manufacturing efficiency. Added intelligence such as Built-In-Self-Tests (BISTs), self-calibration, lead-wire calibration, and shunt calibration can be utilized prior to a critical test to ensure confidence that your data acquisition system is ready to go.

Key Applications

Quality data acquisition is important for any test. However, there are certain industries and applications that have a high demand for better data acquisition systems. These include:



Aircraft Structural Tests

Where you need to accurately measure and synchronize thousands of channels of strain gauge inputs distributed across the vessel.



Solid Rocket Motor Reliability Testing

Where you must maintain accuracy and stability in a hazardous environment located 1000+ meters away from the safety of a bunker.



Healthcare and Pharmaceutical Temperature Monitoring

Where temperatures of coolers and freezers must be accurately measured to ensure the safety of blood products and medicines.



Wind Turbine Health Monitoring

Where run-time electrical and mechanical characteristics of wind turbines must be measured in remote locations.

VTI Instruments: Equipment for Better Data Acquisition

As part of the AMETEK Programmable Power team, VTI Instruments specializes in precision modular instrumentation and systems for electronic signal distribution, acquisition and monitoring. Known for putting signal integrity at the forefront, VTI Instruments creates data acquisition systems that produce reliable data the first time, every time.

To help you achieve better data acquisition in the world's most demanding applications, AMETEK Programmable Power and VTI Instruments offer several data acquisition systems. Products include both hardware and software solutions, such as:



EX1403A

The EX1403A Precision Bridge and Strain Gauge Instrument sets a new industry standard for strain and bridge measurements. Based on a flexible data acquisition platform, the EX1403A offers superior signal integrity for the highest performance measurements possible while controlling overall test hardware costs. With sixteen channels of strain or voltage, independent 24-bit ADCs per channel, extensive software-selectable filtering and independent signal conditioning paths, you can expect next-level accuracy and reliability. Built-in signal conditioning, programmable excitation, and selectable bridge completion – all integrated into the instrument and configurable on a per-channel basis – greatly simplify setup and configuration for optimal system efficiency.

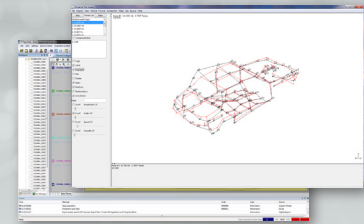


RX0424

Built to handle the most demanding testing environments, the RX0424 brings laboratory-grade measurements to the field. The rugged IP66-rated design of the RX0424 makes it an ideal solution for measuring acceleration forces, such as sensing static and dynamic movement or vibrations. With independent 24-bit analog-to-digital converters, the RX0424 delivers repeatable, high-resolution measurements without compromising on accuracy.

Data Acquisition Software

In addition to hardware models, VTI specializes in data acquisition software designed for sensor-based measurements such as temperature, pressure, strain, voltage, and digital states. Turnkey, full-featured software solutions include EXLab and X-Modal III. EXLab-based systems combine robust, turnkey software and precision instrumentation to verify designs of electro-mechanical products. X-Modal III offers a comprehensive modal analysis package featuring an intuitive user interface, extensive modal parameter estimation algorithms, parallel display capabilities, flexible data management, and embedded data acquisition capabilities.



Beyond offering innovative data acquisition equipment, AMETEK Programmable Power and VTI Instruments have the expertise to ensure that you get the right testing solution. With years of data acquisition experience across a variety of demanding applications, we know what works and what does not. That means that we can help you find a better solution, faster, without having to waste countless hours and capital on failed tests.

With the right data acquisition system from VTI Instruments, you can get the data that you need to validate your designs and ensure that your products work.



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