Effective Monitoring and Streamline Testing Using a DAQ

Introduction

Manufacturing and field operations generate a high volume of data, and they are also fueling growth in the use of smart remote sensing and the Industrial Internet of Things (IIoT). The data that is generated gives users visibility into their operations in real time or near real time to help them make decisions quickly. Time is a critical factor when high-volume production lines go down, electrical distribution stations trip causing massive blackouts, and traffic bottlenecks trigger accidents along frequently traveled roads.

Smart remote sensing and the IIoT have spurred the use of data acquisition (DAQ) systems worldwide. A DAQ system consists of sensors, hardware, and software that collect, store, and, to some extent, pre-process data that becomes useful for analysis. The DAQ market reached $1.63 billion in 2018 and is expected to grow at a cumulative average rate of 5.1% from 2018 to 2025, according to Frost & Sullivan’s 2018 global DAQ market report.

This white paper discusses how to effectively monitor and streamline testing using a DAQ. First, we will address using a DAQ to monitor your process or product.

Key factors to streamline test processes:
- Test asset optimization
- Easy-to-configure test station setup
- Test time optimization

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Use a DAQ for Effective Monitoring

A DAQ system is an effective tool for monitoring your operation due to its versatility in measuring multiple signal types, data logging capability over long periods, and multichannel measurement input scalability. Let’s look at a manufacturing environment with multiple work cells. Each manufacturing work cell is a complete end-to-end manufacturing process that can be arranged as a circular cell or as a single-line process. In the case of three separate circular work cells, the test process engineer needs to monitor the temperature of the oven, the voltages of the power supplies, and the radio-frequency output of the devices.

Now, let’s look at two types of DAQ measurement systems.

Centralized DAQ System

The most common DAQ setup solution is a single centralized DAQ system. This setup is ideal for R&D product designers who are working on standalone projects or gathering data points from a small footprint of a single point physical location.

However, this does not mean that you can use a centralized DAQ system only for small projects. Centralized DAQ systems are scalable to measure or scan hundreds of, and up to 1,000, channels per second. Here are the advantages of using centralized DAQ systems:

1. All the sensor inputs go into one system, and it is much easier to manage and process raw data, present data visualizations, analyze data, and trigger actions.
2. Data synchronization is easily achieved because it is synchronized by a single DAQ system.
3. Centralized DAQ systems are easier to configure for standalone projects or for single point locations.

However, there are some disadvantages to using a centralized DAQ system. Figure 1 shows sensors wired from manufacturing work cells in multiple locations. These three work cells may be far apart from each other, making the wiring of the sensors to the centralized DAQ quite long. And long wires can potentially decrease measurement accuracy.
Let’s use the same example of a manufacturing environment with three separate work cells; see Figure 2. This time each work cell has a dedicated DAQ system, albeit a small DAQ mainframe, but each cell connects via Ethernet or LAN to DAQ software running on a central control location. This is an example of a distributed DAQ system.

There are advantages to using a distributed DAQ system:

1. Since each DAQ is located close to the work cell, sensor wirings are very short. This will ensure optimal measurement accuracy.

2. There is also some flexibility if any of the distributed DAQ systems become faulty; exposure to the overall manufacturing test environment is limited to a localized work cell.

3. A smaller, and localized number of sensors for each work cell will reduce the cost of wiring and setup complexity.

4. Each of the smaller distributed DAQ systems can help perform signal conditioning and raw data processing prior to sending the information to centralized DAQ software for data consolidation and visualization.
The biggest challenge for a distributed DAQ system setup is the time synchronization of all the data collected. However, this may not be an issue for many applications. Only a small fraction of the data logging process requires time synchronization to the highest precision of microseconds. In this example, most of the time manufacturing work cells may not require interaction of activities between them. Hence, it may not need the highest time precision synchronization. There are, however, some work cells or distributed DAQ systems that need to interact with each other — automotive robotic work cells, for example. This will require DAQ systems that have precise IEEE 1588 clock synchronization.

Ultimately, you must choose the DAQ configuration setup that will serve your project or environment best.

Figure 2: Distributed DAQ system
Use Your DAQ to Streamline Testing

Dedicated test instruments tend to have limited measurement inputs and can measure one or two devices at a time. High-volume manufacturing companies test their products by the hundreds or thousands of units per hour (UPH). How can test equipment managers or test engineers meet the order fulfillment demands?

If you are a test equipment manager or engineer setting up a production line, these are likely your main goals:

1. Maximize your test asset return on investment. You want to ensure that for every test instrument you have, you will be able to test as many products as possible. Generally, you want to have the highest UPH possible.

2. Simplify your test setup for easy configuration and setup processes

3. Ensure you have some flexibility to scale the test station up or down to test multiple products simultaneously or in batches. Scaling up does not mean a heavy investment in capital equipment. You want to invest a fraction of your initial setup cost and easily double or triple the quantity of your test output.

4. When testing requires a complex set of instruments, such as a power supply, a digital multimeter, an oscilloscope, an electronic load, and a spectrum analyzer, you do not want to replicate exactly the same complex set of instruments to increase test throughput or UPH. Testing in batches using the DAQ switching control system can save test time without a large capital investment in replicating this complex set of instruments.

Why not use a DAQ? One of the most powerful features in a DAQ system is the switching control system. Using the switching control system, you can simplify your test setup, reduce the number of test instruments, and test multiple devices.
Figure 3 is an example of using a DAQ switching matrix module to streamline your testing. The switch matrix module is fitted into the mainframe. For example, if a module consists of four rows by eight columns (4x8) of switch matrices, some DAQs can concatenate the rows or the columns. You will then be able to make matrices such as 8x8 and 4x16, limited by the number of module slots of the DAQ mainframe.

In this test setup example, three instruments connect in three columns via the two-wire connectors. There are four devices under test (DUTs) connected in four rows via the two-wire connectors. The precision meter measures voltage or current from the DUTs — the DC power supply is used to DC bias the DUTs, and the electronic load simulates resistive load for testing on the output of the DUTs.

This DAQ with switching modules improves test asset optimization by using a set of test instruments to test multiple DUTs. This switch matrix setup helps reduce cost and space in terms of the number of instruments. It also simplifies your test setup because it is less messy, and you can implement setup configurations on the DAQ mainframe or remotely via a DAQ software application. It also enables you to perform switching and measuring processes automatically, which helps you save total test time for every DUT.
Important Factors to Consider When Purchasing a DAQ

Choosing the right DAQ system is as important a decision as choosing a centralized or distributed DAQ system for your monitoring and testing operations.

Measurement hardware

DAQ measurement hardware consists of various types of plug-in modules, such as analog-to-digital converters, digital inputs, and counters. Some DAQs have built-in digital multimeters and signal conditioners to provide universal measurement inputs. Every input can measure multiple types of signals, such as voltage, current, resistance, temperature, strain, and vibration. The built-in signal conditioners help convert the signal to a form that the system can better measure.

Control hardware

Besides making measurements, a DAQ can output analog or digital signals to control your test system or bias your product for testing. By using control hardware, you can provide a close loop monitoring and test system.

Switching hardware

The switch matrix configuration, shown in Figure 3, is a great example of streamlining your test process. The multiplexer configuration is another type of switch configuration in a DAQ system. It is commonly used to scan multiple input channels into a single measuring instrument in sequential mode. Depending on the types of physical switches being used, for example, reed and armature relays, are common in low-speed applications but have high power handling. Solid-state switches can scan extremely fast, and up to 1,000 channels per second.

Sensors or transducers

A DAQ system is typically versatile; it can work with sensors that measure temperature, voltage, current, resistance, strain, and more.

For more information about DAQ systems, please read our white paper Getting Started with Data Acquisition Systems.
Conclusion

A DAQ system is the best instrument for monitoring your operation effectively because of its versatility in measuring multiple types of signals, data logging capability over long periods, and multichannel measurement input scalability. Choose the DAQ system that will work best for your project or environment, either a centralized or distributed DAQ configuration setup.

A DAQ system has a powerful switching control system that can help you streamline your test process. Using a DAQ will help you maximize your test asset return on investment and offers you the flexibility to scale up or down the test station to test multiple products. In addition, the DAQ switching control system saves test time and does not require a major capital investment to replicate many complex instruments.

Keysight high-performance bench and modular DAQ systems offer best-in-class features needed to meet the increasing demand for effective monitoring and the streamlining of test operations.

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