Understanding Portable Data Acquisition Systems

Portable data acquisition applications have to meet a number of stringent requirements not present in traditional laboratory systems. Environmental conditions such as extremes in temperature, humidity, shock and vibration, are all factors that must be considered when selecting portable data acquisition equipment. Other concerns include whether the data acquisition equipment is capable of supporting the mix of particular sensors that will be used as well as if there is adequate memory/storage to support the test.

Before selecting a particular data acquisition solution or vendor, users should have a clear idea of the desired results required of the device or system. For example, sampling rates can vary greatly from as low as once per day or more than 1,000,000 samples per second. Data can also be acquired and submitted in a variety of different formats. Anticipating future needs today can save precious time and money down the road. Data acquisition systems can be very simple or quite complex, and offer a wide range of performance, functionality, and price tags. However, there are some basic criteria that one should consider before deciding to purchase a portable data acquisition system.

Environmental Considerations

Given the susceptibility of portable data acquisition equipment to harsh environments i.e. those with extreme temperatures, humidity, dust, etc., ruggedized packaging of the unit itself as well as the electrical components that comprise it are imperative in order to maintain the unit's integrity and that of the data being acquired. For example, portable data acquisition equipment used in mil/aero applications need to withstand a temperature range of at least -55°C to +125°C and beyond. In oil and gas exploration applications, temperatures involved in exploring downhole well formations can reach upwards of 200°C.

In addition to withstanding extreme temperatures, portable data acquisition units need to be able to survive in high shock and vibration environments such as the trunk of a car or on-board an airplane, or simply as a result of human mishaps such as being dropped by its user. Also inherent in environments such as these, is the requirement for the portable data acquisition system to be as compact and lightweight as possible.

Further packaging constraints, such as watertight housing, need to be considered for applications such as seismic exploration in which data acquisition systems are required to make deep underwater measurements at levels ranging from 300 m to 1500 m below sea-level. Sealed data acquisition systems used for oceanographic research need to be capable of continuous recording of low-frequency seismic signals and storage of the data in a mass memory while being reliable, effective, and economical.

Accuracy and Sampling Speed

An obvious characteristic of any data acquisition system is the need to accurately capture recorded data. While most would assume that this is a given, the degrees of accuracy attainable by portable data acquisition units available on the market today can vary considerably. Invariably, the accuracy of field measurements is highly dependent upon the sensors being used. For most sensors that have been calibrated in the laboratory and installed in the field, accuracies in the range of 0.01 % to 1 % of full scale are typical. Some sensors are significantly less accurate. For example, strain gauges commonly used for strain and stress measurements depend on the installation material for their accuracy and can have field accuracies ranging from 3% to 5% of full scale.

Data acquisition sampling speed must be taken into account when determining the accuracy of the system. A given signal must be acquired fast enough so that any important information is not lost while the signal is being acquired. The required rate of data acquisition can be determined by using Nyquist's Sampling Theorem. Simply put, the Nyquist theorem states that a signal must be sampled at twice the frequency of the spectral signal components which are of interest in order to accurately reconstruct the waveform.

Power Supply

For remote data acquisition systems, where access to a standard 120 V AC power outlet is not possible, the electric power to the system can be supplied in two ways. The first is using an internal battery pack while the other is to run an external wire to a DC power supply.

In order to conserve power, users with minimal processing requirements can select a lower range CPU and pair it with a high-end storage system in order not to load up the processor any more than necessary.

Sensors and Signal Conditioning

Selecting a portable data acquisition system with internal signal conditioning equipment can improve the quality and performance of the system. Types of signal conditioning include amplification, attenuation, and filtering. The type of signal conditioning required is very dependent upon the application and the types of sensors used to make the measurements.

For example, an application that requires temperature measurements will most likely use thermocouples. In a thermocouple, the sensing junction produces a voltage that depends upon temperature. However, connecting a thermocouple to a data acquisition system creates a cold junction point at the terminals that acts as a thermocouple itself, and signal conditioning is required to compensate for it. Otherwise the measured temperature which is derived from the total voltage will be skewed by the added voltage of the cold junction point.

Since thermocouple outputs may be very low-level, signal conditioning can also be used to amplify the signal and offset any undesirable distortion due to noise. Signal conditioning is equally useful when portable data acquisition equipment is connected to other types of transducers such as strain gauges, accelerometers, etc.

Built-in Features for Remote Systems

Often portable data acquisition equipment, such as data loggers, are left to operate unattended for days or possibly years at a time. Data loggers are typically stand-alone instruments that once set up can measure, record and display data without operator or computer intervention. They are able to receive data from multiple inputs, even data from more than 100 channels simultaneously. Most data loggers feature built-in signal conditioning and can simultaneously record data from a variety of different sensors.

Portable data acquisition equipment selected for permanent unattended systems typically have communications capabilities using telephone connections or wireless systems for downloading data to remote computers, large amounts of built-in storage, and user interfaces for remote setup and control of the device. Sophisticated solutions offer built-in testing capabilities so that, once setup, a user simply needs to react to data acquired.

Summary

There are numerous portable data acquisition systems available on the market today, and each has its own feature set that make some units more suitable than others for certain applications. Portable data acquisition systems face unique requirements given that they are used in harsh environments or on a moving platform such as automobiles, airplanes, etc.

Ideal portable data acquisition systems are compact, light-weight units that run off of either a self-contained battery or a single DC power source, and require no other connection to function except the connection to the sensors under monitor. In remote areas, a user interface and means of communication with the device become important. Signal conditioning, such as gain and filtering, and high-capacity non-volatile data storage are other important considerations.

Whether we realize it or not, portable data acquisition systems are used to acquire data and perform testing of everyday utilities that we take for granted as being safe and reliable – i.e. automobiles, airplanes, bridges, tunnels, ships, etc. These powerful, yet compact data acquisition devices play an important role in the verification testing and monitoring of these critical systems, and selecting the right one for a given application requires careful consideration.

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