FROM MOTION TO DATA TO KNOWLEDGE

Application Note

DAQ Theory for MiDAS DA

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Abstract

This application note discusses Data Acquisition Theory in conjunction with Xcitex's MiDAS DA software. Discussed are such factors as the hardware configuration involved with data acquisition, a basic introduction to the various sensor types, understanding the multiplexing process and how it relates to data acquisition.

Overview

Data Acquisition is the process of capturing real-world physical conditions via high-speed synchronized video and converting these conditions into digital numeric values (data). This data can then be manipulated by MiDAS DA in order for in-depth scientific understandings and interpretations.

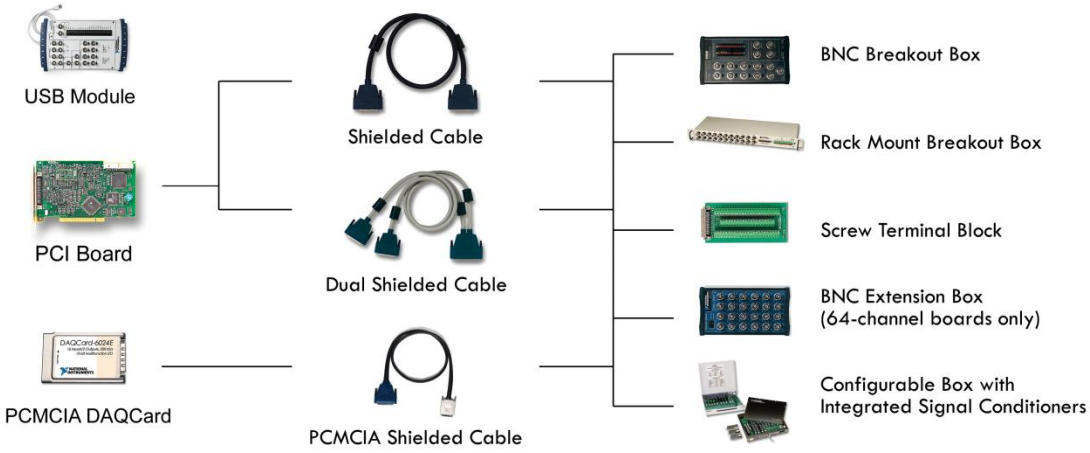
Hardware

Before getting into details about theory, it is important to know about the main hardware components involved in data acquisition.

In a data collection system there is hardware responsible for measuring and storing data. Called the Data Card, it is installed in your computer. Attached to the data card through a cable, is a Breakout Box. On the breakout box are Terminals, which are connection points. There are terminals that connect signals from the data card to the camera(s) and terminals used to connect incoming data sources. The terminals can be BNC Connectors for attaching coaxial cable, or screw terminals into which wires are attached directly. There are even a rack of signal conditioners.

One important exception in terms of separating the data card and breakout box is, USB Breakout Boxes are now available from National Instruments. USB breakout boxes incorporate both the data card and breakout box in one device that attaches to the computer through a USB cable.

The supported configurations of data hardware are shown in the following diagram:



Sensors

Data Acquisition hardware configurations work with a large number of different types of Transducers. These “sensors” convert force, rate of flow, pressure, temperature, etc. into a voltage (volts) that is proportional to the physical parameters being monitored. Typical sensors that can be used are:

- Accelerometers
- Microphones
- Strain Gauges
- Flow Sensors
- Pressure Sensors
- Thermistors
- Hydrophones
- Dynamometers
- Speedometers
- Tachometers

Note: Often, these sensors must be amplified, filtered, biased or converted from current to voltage, or processed in a similar fashion. Therefore, each sensor type typically uses a signal conditioner, designed specifically for that type of sensor in order to produce signals recognized by your specific hardware configuration. MiDAS DA uses voltage variations on the data lines to determine correct data values, so any signal conditioner that outputs voltage can be used.

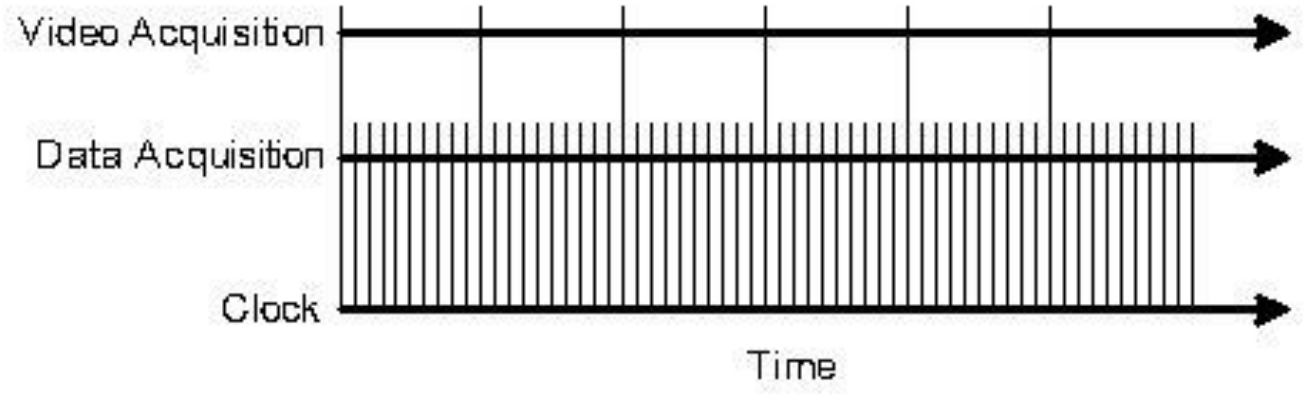
Multiplexing

Data Acquisition gathers its signal (and data) through a process called Multiplexing. This is the common technique for sampling multiple channels with one data acquisition device. The incoming signals are wired to a multiplexer switch (mux switch) that rapidly switches the inputs to the instrumentation amplifier. MiDAS DA automatically configures the data acquisition hardware you've chosen to enable this switching and keeps track of which channel is configured on which connector.

How MiDAS DA Data Acquisition Works: The Master Clock

The Master Clock used by the MiDAS DA data acquisition system comes from the data acquisition board installed in your computer, or from the USB data acquisition breakout box if applicable. The master clock controls pulses both for data acquisition and for video camera frame capture, so the two pulses are coordinated with precise timing to allow for accurate measurements and subsequent data. The data acquisition hardware and the camera are connected via a synchronization cable - a BNC coaxial cable from the sync out terminal on the BNC breakout box to a sync in input on your camera. The camera operates as a slave device to the data hardware. Specifically, a frame is acquired by the camera when a pulse is received across the sync in line. The same master clock drives the data collection pulse, assuring the two signals do not differ.

The ability to have synchronized yet different clock rates, and thus different acquisition frequency for video and data, is the basis for MiDAS DA data acquisition. For example, if the operator chooses to acquire ten data points per single frame of video, the pulse sequence includes one pulse to the video camera for every ten data pulses, as shown below:



Multiplexing and Data Acquisition

If multiple analog channels are selected, the various inputs are multiplexed, sampled sequentially through individual analog inputs. The input is switched between the enabled channels. The switching time between acquisitions is dependent on the type of data acquisition card you are using. If your data acquisition hardware can acquire 200,000 samples per second, and if you enable two analog input channels, then each channel can acquire a maximum of 100,000 samples/second. If four channels are enabled, then each channel can acquire 50,000 samples/second. If eight channels are enabled, then each channel can acquire 25,000 samples/second. In the above figure, we left out the concept of multiplexed acquisition for simplicity. In fact, if the operator chooses to acquire ten (10) data points per frame and to enable eight (8) analog channels, the ten (10) data sample pulses shown per video frame pulse each represent eight (8) slightly offset pulses, one for each of the analog input channels.

Note: Camera images are streamed directly to the local memory on the camera board. Data is streamed directly to the computer RAM.

Note: For more detailed instructions concerning MiDAS DA and data acquisition please refer to your MiDAS DA User Guide - Chapter 5: Data Acquisition Theory.

For further information on Xcitex products, visit www.xcitex.com or send an email to info@xcitex.com.

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