Data Acquisition System Part (1)

Digital inputs output and counter

You can think of a data acquisition system as a collection of software and hardware that connects you to the physical world. A typical data acquisition system consists of these components.

![Data acquisition system](image)

**Figure 1 Data acquisition system**

**Components Description**

**Data acquisition hardware**: At the heart of any data acquisition system lies the data acquisition hardware. The main function of this hardware is to convert analog signals to digital signals, and to convert digital signals to analog signals.
Sensors and actuators (transducers)
Sensors and actuators can both be transducers. A transducer is a device that converts input energy of one form into output energy of another form. For example, a microphone is a sensor that converts sound energy (in the form of pressure) into electrical energy, while a loudspeaker is an actuator that converts electrical energy into sound energy.

Signal conditioning hardware
Sensor signals are often incompatible with data acquisition hardware. To overcome this incompatibility, the signal must be conditioned. For example, you might need to condition an input signal by amplifying it or by removing unwanted frequency components. Output signals might need conditioning as well. However, only input signal conditioning is discussed in this chapter.

Computer
The computer provides a processor, a system clock, a bus to transfer data, and memory and disk space to store data.

Software
Data acquisition software allows you to exchange information between the computer and the hardware. For example, typical software allows you to configure the sampling rate of your board, and acquire a predefined amount of data. The data acquisition components, and their relationship to each other, are shown below.
The figure depicts the two important features of a data acquisition system:

- Signals are input to a sensor, conditioned, converted into bits that a computer can read, and analyzed to extract meaningful information.
- Data from a computer is converted into an analog signal and output to an actuator.

**Data Acquisition Hardware**

Data acquisition hardware is either internal or installed directly into an expansion slot inside your computer, or external and connected to your computer through an external cable, which is typically a USB cable. At the simplest level, data acquisition hardware is characterized by the *subsystems* it possesses. A subsystem is a component of your data acquisition hardware that performs a specialized task. Common subsystems include:

- Analog input
- Analog output
- Digital input/output
- Counter/timer

*Figure 3 Data Acquisition Hardware*
**Analog Input Subsystems**

Analog input subsystems convert real-world analog input signals from a sensor into bits that can be read by your computer. Perhaps the most important of all the subsystems commonly available, they are typically multichannel devices offering 12 or 16 bits of resolution. Analog input subsystems are also referred to as AI subsystems, A/D converters, or ADCs.

**Analog Output Subsystems**

Analog output subsystems convert digital data stored on your computer to a real-world analog signal. These subsystems perform the inverse conversion of analog input subsystems. Typical acquisition boards offer two output channels with 12 bits of resolution, with special hardware available to support multiple channel analog output operations.

**Digital Input/output Subsystems**

Digital input/output (DIO) subsystems are designed to input and output digital values (logic levels) to and from hardware. These values are typically handled either as single bits or *lines*, or as a *port*, which typically consists of eight lines. While most popular data acquisition cards include some digital I/O capability, it is usually limited to simple operations, and special dedicated hardware is often necessary for performing advanced digital I/O operations.

**Counter/Timer Subsystems**

Counter/timer (C/T) subsystems are used for event counting, frequency and period measurement, and pulse train generation.

**Lab work:**

In our lab data acquisition hardware that we will use is a data acquisitions card USB6009 from national instrument, and Labview is our software. The NI USB-6008/6009 provides connection to eight analog input (AI) channels, two analog output (AO) channels, 12 digital input/output (DIO) channels, and a 32-bit counter with a Full Speed USB interface.
Digital I/O
The NI USB-6008/6009 has 12 digital lines, P0.<0..7> and P1.<0..3>, which comprise the DIO port. GND is the ground-reference signal for the DIO port. You can individually program all lines as inputs or outputs.

Digital I/O Circuitry
Figure below shows P0.<0..7> connected to example signals configured as digital inputs and digital outputs. You can configure P1.<0..3> similarly.

Event Counter
You can configure PFI 0 as a source for a gated inverter counter input edge count task. In this mode, falling-edge events are counted using a 32-bit counter.

Figure 4 digital input output circuit

1 P0.0 configured as an open collector digital output driving an LED
2 P0.2 configured as an active drive digital output driving an LED
3 P0.4 configured as a digital input receiving a TTL signal from a gated inverter
4 P0.7 configured as a digital input receiving a 0 V or 5 V signal from a switch
I/O Protection
To protect the NI USB-6008/6009 against overvoltage, under voltage, and over current Conditions, as well as ESD events, you should avoid these fault conditions by using the following guidelines:

• If you configure a DIO line as an output, do not connect it to any external signal source, ground signal, or power supply.

• If you configure a DIO line as an output, understand the current requirements of the load connected to these signals. Do not exceed the specified current output limits of the DAQ device. National Instruments has several signal conditioning solutions for digital applications requiring high current drive.

• If you configure a DIO line as an input, do not drive the line with voltages outside of its normal operating range. The DIO lines have a smaller operating range than the AI signals.

• Treat the DAQ device as you would treat any static sensitive device. Always properly ground yourself and the equipment when handling the DAQ device or connecting to it.

Exercise 1:
Connect led as a digital output on DAQ and control a led from your front panel on Labview.

Exercise 2:
Connect switch as digital input for DAQ indicate switch status by led on your front panel.

Exercise 3:
Implement event counter using DAQ.

Exercise 4:
 Implement flasher using DAQ>
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Figure 5 Digital Terminals