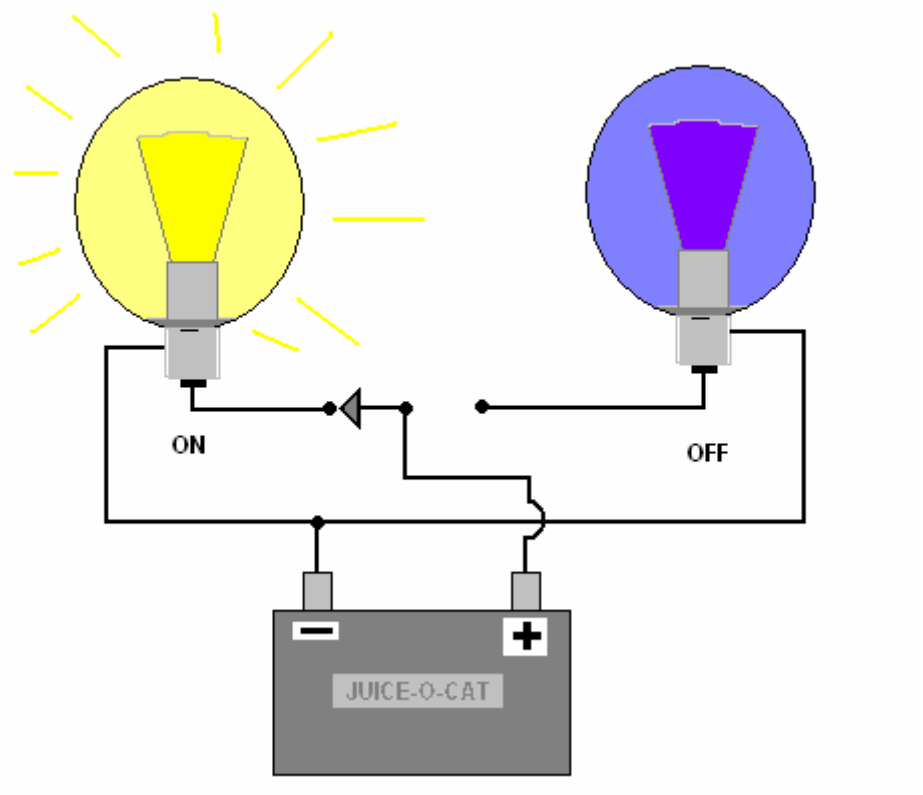
Data Acquisition Basics

Data Acquisition devices provide an interface between electrical signals a computer can read or write to control things in the real world.

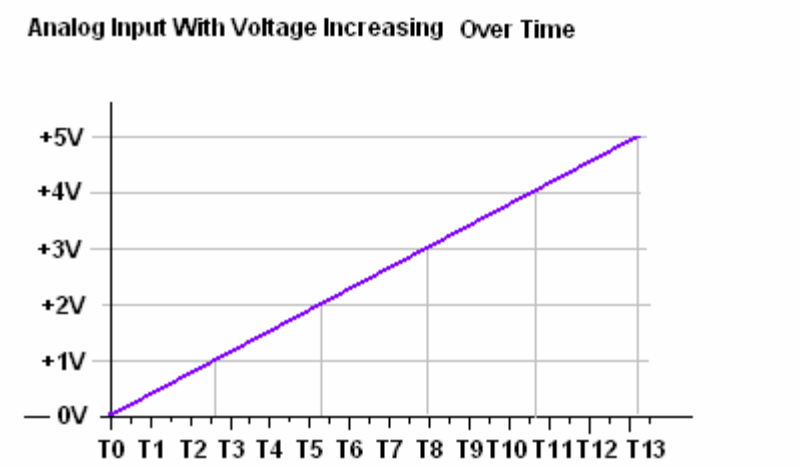
A computer is equipped with various communication ports to access the outside world, but it needs software to read and write to them, as well as display data or accept user input.

In the early days of PC's a user could use a simple programming language to write a program that would access the ports using direct port-in and port-out commands and read or set the value. Examples of digital inputs or outputs could be found in computers with joystick and trigger inputs, and in the parallel port control line outputs such as strobe, and control line inputs for busy, paper error, ack, and the 8 bits of data output. With a joystick port, there were digital inputs for trigger and analog inputs for joystick position.

With a digital input we can read two states, a high or low. A switch can be open or closed.



With a digital output, we can turn a light on or off, control a relay or turn a motor on or off. If we can turn a digital output on/off rapidly enough, we can vary the on/off time for PWM (Pulse Width Modulation) and effectively develop a average DC voltage anywhere between full on, full off, or with a 50% duty cycle, half the source voltage.



Many more real world inputs are not simply on or off, but can be a range of values. These are called analog signals. Data acquisition hardware commonly accepts analog inputs such as voltages from 0 to 5VDC, or currents from 4-20mA or 0-20mA. Some analog inputs are designed to handle very low voltages in the milli-volt range such as thermocouples, RTD's, strain gauges or other sensors. Analog outputs are commonly DC voltages, such as 0 to 10VDC or currents such as 4-20mA.

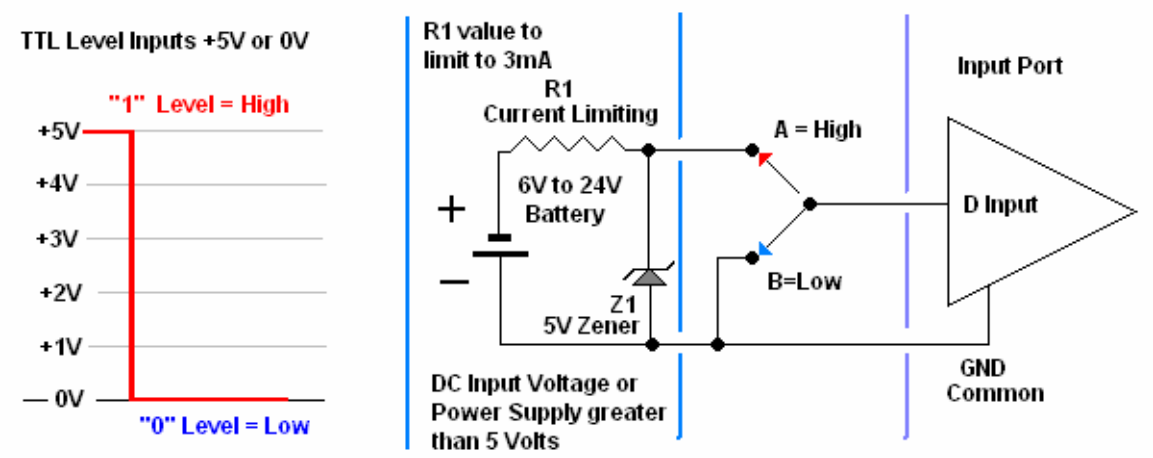
Data Acquisition devices can be a range of equipment such as industrial PLCs, single board computers, internal PC hardware such as PCI cards, USB connected devices, serial connected devices such as RS232, RS422 or RS485, Ethernet devices, and wireless devices connected using Wi-Fi or proprietary RF 900MHz or 2.4GHz radios.

Digital input modules may include pulse or frequency counters to measure duration or intervals.

Other key point to consider are how many data points you want to monitor, the sampling rate (how often you can read each input), and the allowable latency (time between when the sample was obtained and when you get it and can do something with it).

Digital Input Levels

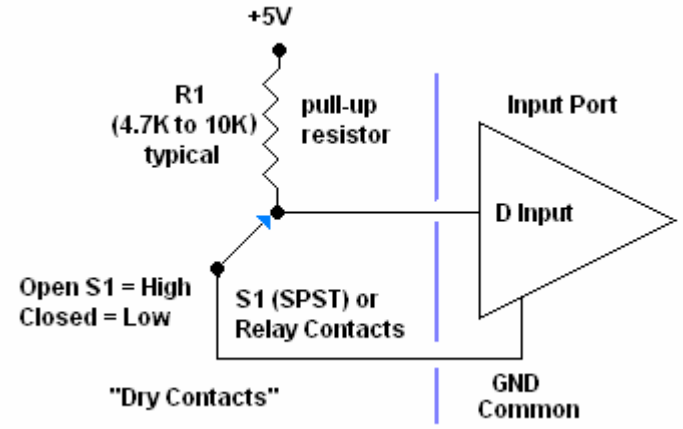
A digital interface is used to sense a high or low, such as a switch closure. Connect one side of the switch to an input along with a resistor connected to a voltage source to pull the input high. Connect the other side of the switch to ground. Periodically read the port to see when the input is high or low. When the device must be read repeatedly, it is said to be "polled" – this is the most common type of application. Other types of devices may periodically transmit their status automatically, or only report on exception (when the status changes from one state to another). These devices are less common, often designed for use in pairs, such as B&B Electronics 232IOEXT or Zlinx I/O where inputs on one unit are automatically transferred to outputs on the paired device.



To properly connect a real world output to the digital input of your data acquisition equipment, you need to know whether the output is “sinking” or “sourcing.” A sinking device acts simply as a switch to ground and may be referred to as a dry contact. To connect a sinking device to a digital input a pullup resistor may be needed to provide the high voltage condition when the contact is open.

A “sourcing” input supplies the voltage itself. When connecting a sourcing input, a pulldown resistor between the digital input and ground may be required to provide the low voltage condition when the output is turned off.

Typical Circuitry for “Dry Contact” Digital Inputs



Always check the documentation for your data acquisition device to see what its input configuration is. In some cases you may need to add an external resistor to get the best results.

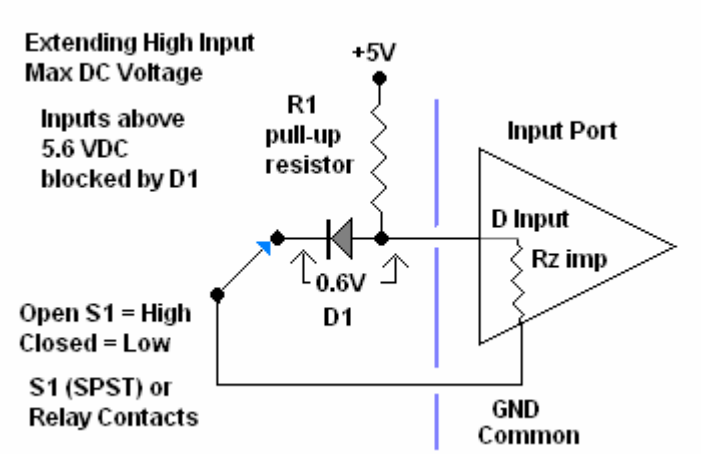
Extending the Input Range

Important specifications for digital inputs are:

1. Maximum voltage input rating (+5 TTL level inputs are typically 0 and 5 volts)
2. Voltage range for Low reading (TTL level low is usually less than 0.8 volts)

3. Voltage range for High reading (TTL level high is usually more than 2 volts)

4. Rated input impedance (ohms) (Higher ratings have less loading effect on the connected sensor)



Often the device you need to connect to an input is rated at a higher voltage than the rating of the digital input of the DAQ module. One simple method of connecting a higher voltage device is shown above.

Application Tip

Digital inputs can be affected by electrical noise if left disconnected. Unused inputs should be connected to ground to avoid unwanted switching that could disrupt other parts of the circuitry.

Series Circuit Calculations