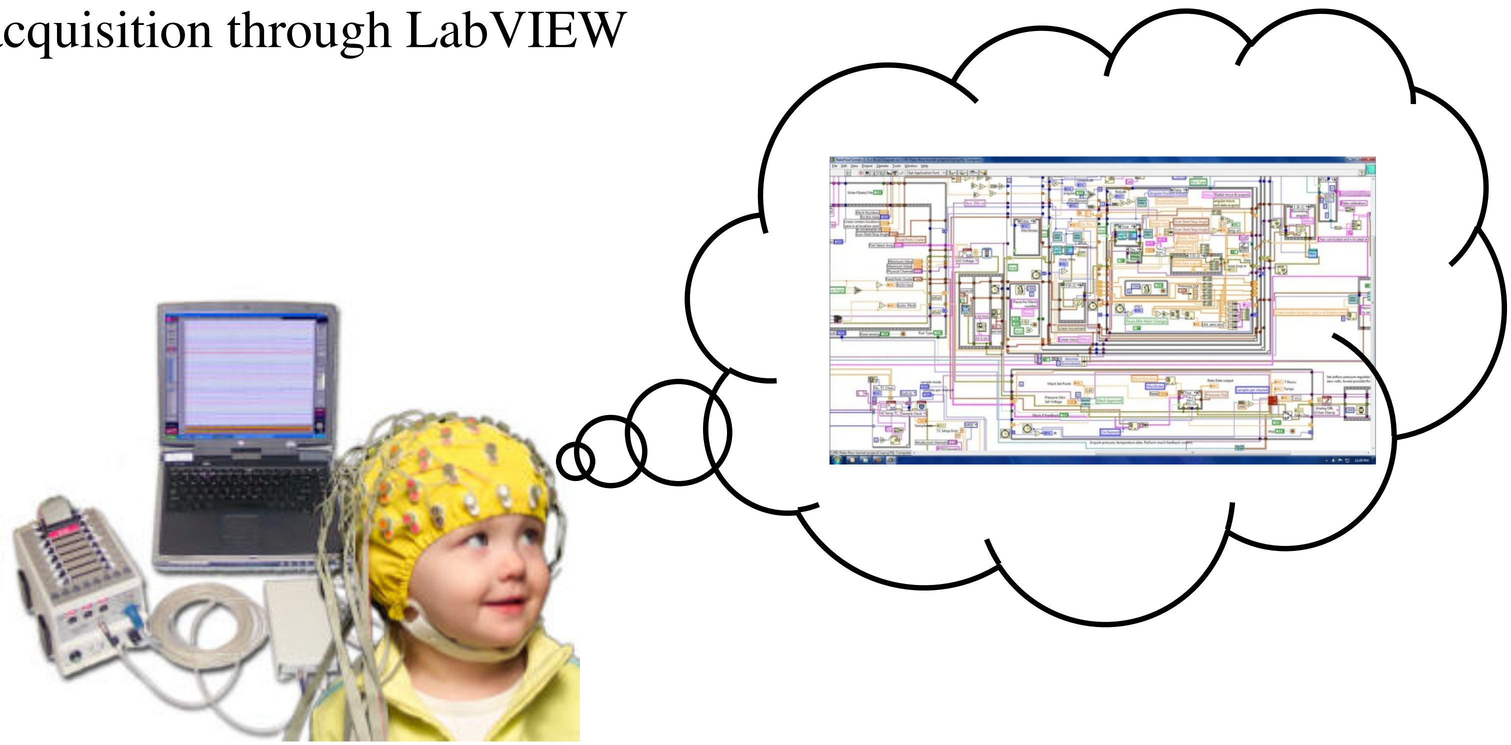
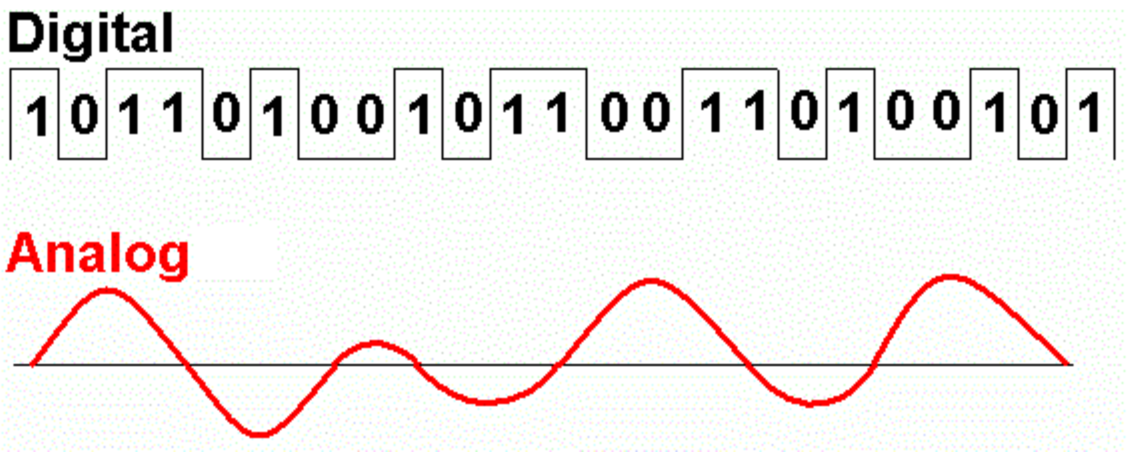
LabView
Lecture II: Data Acquisition

- As mentioned previously, LabVIEW:
  - Is made to allow people with limited coding experience to write programs for automated experiments much faster than with conventional programming environments
  - Has extensive support for accessing instrumentation hardware
- In this lecture, I will introduce basic data acquisition concepts and data acquisition through LabVIEW



Signals

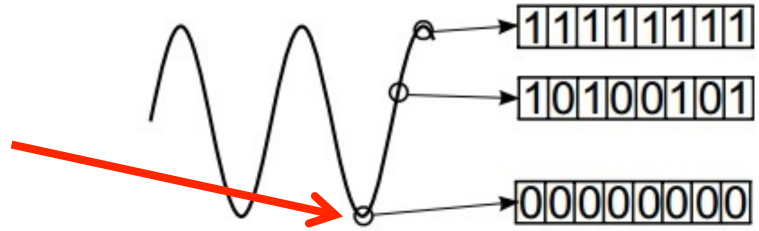
- Data containing information about the physical world and control signals sent to interact with the physical world are typically **analog** or continuously varying quantities
- In order to use the power of digital electronics it is necessary to convert these analog signals into **digital** signals for measurement and processing and conversely from digital to analog to control physical objects



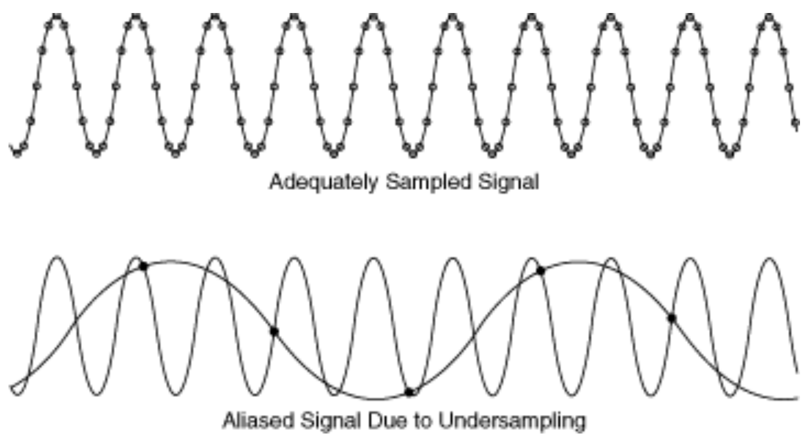
Analog to Digital Conversion 1

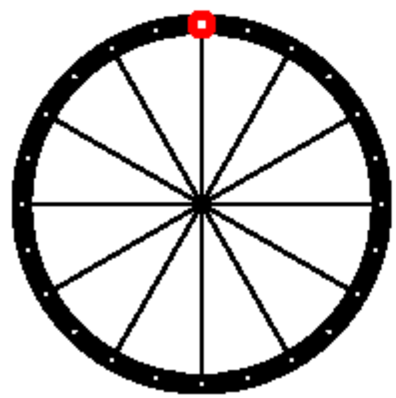
- Converting from an analog to digital signal is based on sampling the analog signal over time and converting the measured analog signal into discrete digital values

Sampling point



- If the sampling rate is too low, aliasing occurs
  - Nyquist rate is the minimum sampling rate required to avoid aliasing, equal to twice the highest frequency contained within the signal
  - The wheel is only going forward but our brain samples our eyes at 10-12 images per second…





Analog to Digital Conversion 2

- Another key to converting analog to digital is the resolution of the converter
  - The converter resolution is the number of bits in the converted digital value (precision)
  - Sets the smallest change in the input signal that can be detected

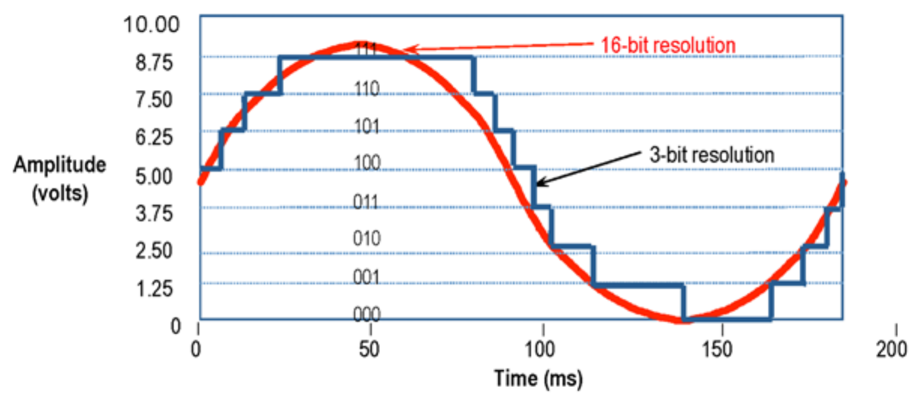
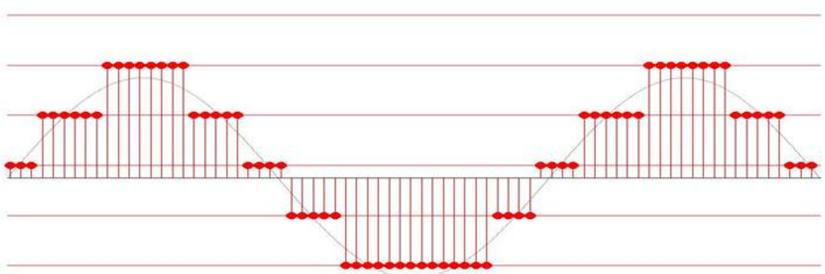
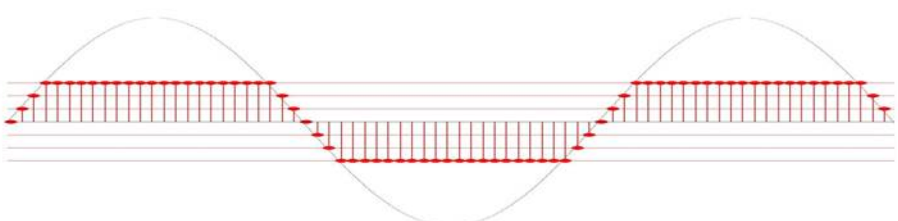


Figure 2. 16-Bit resolution versus 3-Bit resolution chart of a sine wave

- The ADC dynamic range determines the maximum value that can be digitized



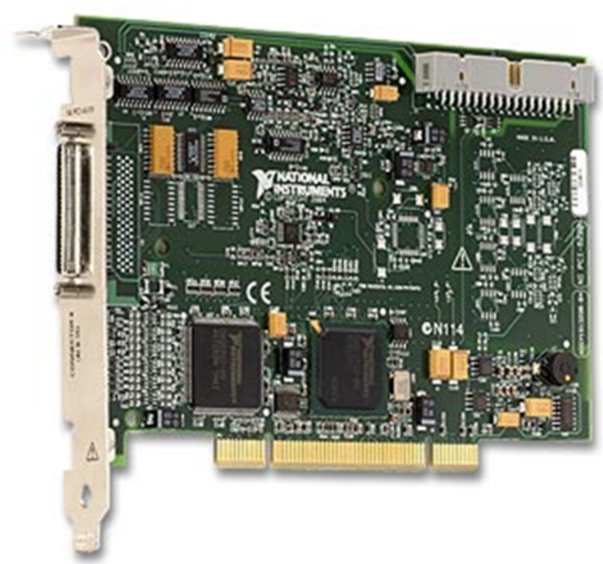
enough dynamic range



not enough dynamic range

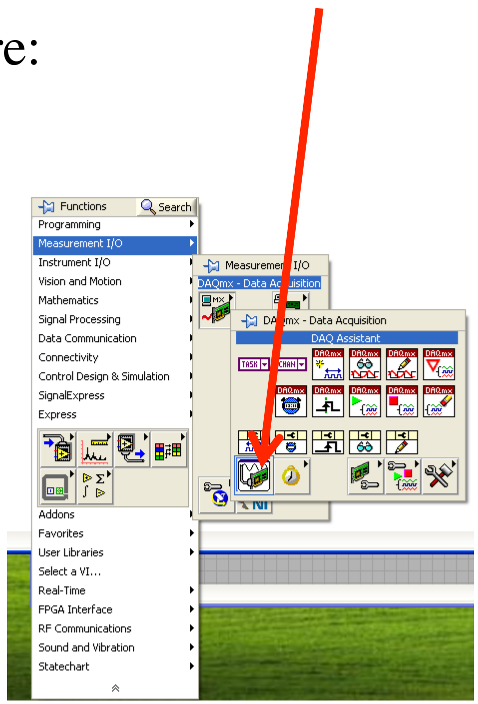
Data Acquisition in P3700

- In data acquisition systems, analog signals are digitized, operated on, and stored in a computer
- With LabVIEW and LabVIEW specific DAQ devices this process becomes simple
  - *In the next lab you will develop your own LabVIEW based data acquisition software for demonstrating propagation of errors*
- NI-6220 - the DAQ card used in P3700 - $519 each
  - 24 digital IO lines
    - Used for spitting out and receiving purely digital signals
  - 16 analog inputs
    - 16 bit resolution
    - 240 K samples per second (max)



Configuring/Using The NI-6220 in LabVIEW

- LabVIEW contains a special software suite called NI-DAQmx which contains a function called the "DAQ Assistant" that can be used to generate LabVIEW code for configuration and use of the NI-6220
- To access the DAQ Assistant:
  - Right click anywhere in the block diagram and the functions pallet will appear, mouse over the Measurement I/O section then the DAQmx section and left click on the DAQ Assistant
- A tutorial on using the DAQ Assistant can be found here:
  - http://www.ni.com/white-paper/2744/en



Propagation of Errors

- In the lab, you write the LabView program to measure 160 pairs of resistors

$$R_0 = R_1 + R_2$$

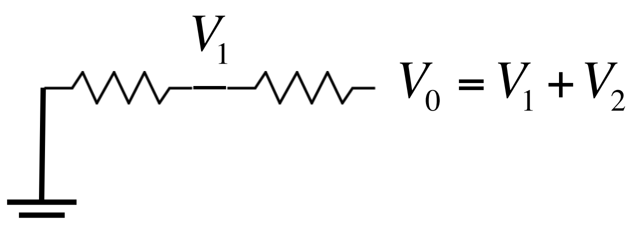
- In practice, you supply a constant current through the resistors and measure

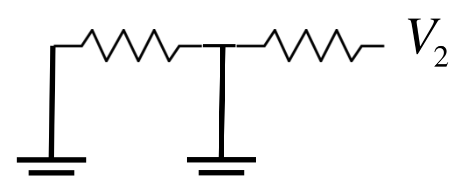
$$V_0 = V_1 + V_2$$

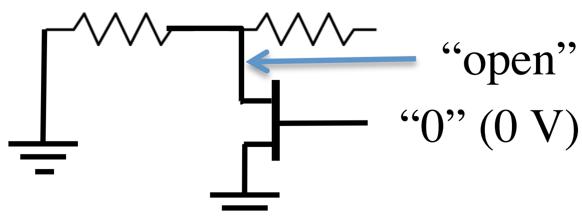
- By propagation of errors

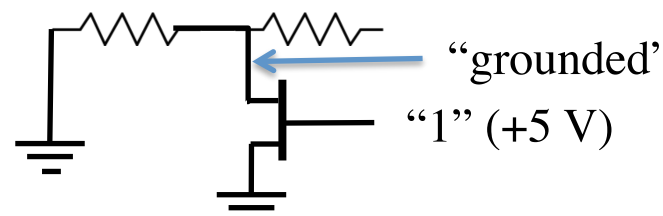
$$\sigma_0^2 = \sigma_1^2 + \sigma_2^2$$

- The voltages are measured by grounding the circuit at the appropriate locations:









Your Task - Demonstrating Propagation of Errors

- We have built a simple interface to the NI-6220 that will allow you to measure the value of many resistors and demonstrate propagation of errors
- The measurement will be done using PCB cards housing 32 SMD resistors that may be plugged and unplugged into a test card containing a precision temperature compensated current source, a multiplexer, and a transistor
  - Simplified schematic on next slide
- Your job is to use the NI-6220 and LabVIEW to control the ADG726 and NTA4001N to measure and save to disk the measurement of the resistances on many resistor cards
- FYI, the LabVIEW documentation is extensive both on the web and in the help suite installed with the software!

Schematic of the Measurement Setup