Data acquisition

- Physical quantities measured are conditioned and interpreted by computer.
- Measured quantities are available as electrical signals.
- Signals are processed by a digitizer and sent to a computer.
- The digitizer and computer "talk" to each other using a programming language (LABVIEW, MATLAB, C etc)
Digitizers

• Real world information is analog (i.e. continuous functions of time)

• Computer signals are digital (i.e. discrete “packets” of information)

• Digitizers convert analog signals to digital signals.
Features of a good digitizer

- Must be capable of reading signals precisely.
- Must reject suspicious signals.
- Must read strong and weak signals (while not picking up noise)

Non-exhaustive list...
Resolution

• Resolution of an A/D converter is the number of steps into which the input range is divided. Resolution is usually expressed as bits (N) and the number of steps is $2^N$.

• Sometimes expressed in digits.
  – Number of digits = $\log_{10}(2^N)$

• Why are we concerned?

• Example: A converter with a 12-bit resolution divides the range into $2^{12}$, or 4096 steps.
  – A 0-10 Volt range will be resolved to 10V/4096 or 0.25 mV.
Throughput

- Throughput is the maximum rate at which the A/D converter can output data values.
- A converter that takes 10 microseconds to acquire and convert will generate 100,000 samples per second.
- Why is this important?
Integration time

• Signal acquired is integrated over time, to eliminate noise.
• Normally specified in Power Line Cycles (PLC) or Number of Power Line Cycles (NPLC)
• 1 PLC = 1/60 seconds.
• Higher PLC = Better noise elimination, but slower rate of signal acquisition
Accuracy

• Accuracy refers to “exactness” of the measured value.
• In reality, accuracy tells us how close a measured value is to a standard reference (“true value”)

Gain

• Weak signals are amplified by built in amplifiers.
• A good amplifier will have high gain.
• Gain = Output signal/Input signal
GPIB (General Purpose Interface Bus)

- Also known as IEEE-488
- Started by HP (HPIB)
  - 16 line parallel connection

- Advantages
  - Fast data transfer rates
    - Up to 1 MB/s
  - Multiple devices (15) on each GPIB

- Disadvantages
  - Limited transmission lengths (2 m to 4 m) between devices
  - Need GPIB adapter in PC
Digitizer in our lab – Agilent 34970A

- Upto 6 and $\frac{1}{2}$ digits resolution (22 bits)
- Upto 200 PLCs.
- Throughput is small. Upto 600 samples/second.
Accuracy of the Agilent 34970A

• Calculated as:
  • Total error in measurement = % error in reading + % reading in range.

• Take a look at the handout for these percentages. They depend on external conditions.
How does the Agilent “talk” to the computer

- Linux PC
- Program templates in C code.