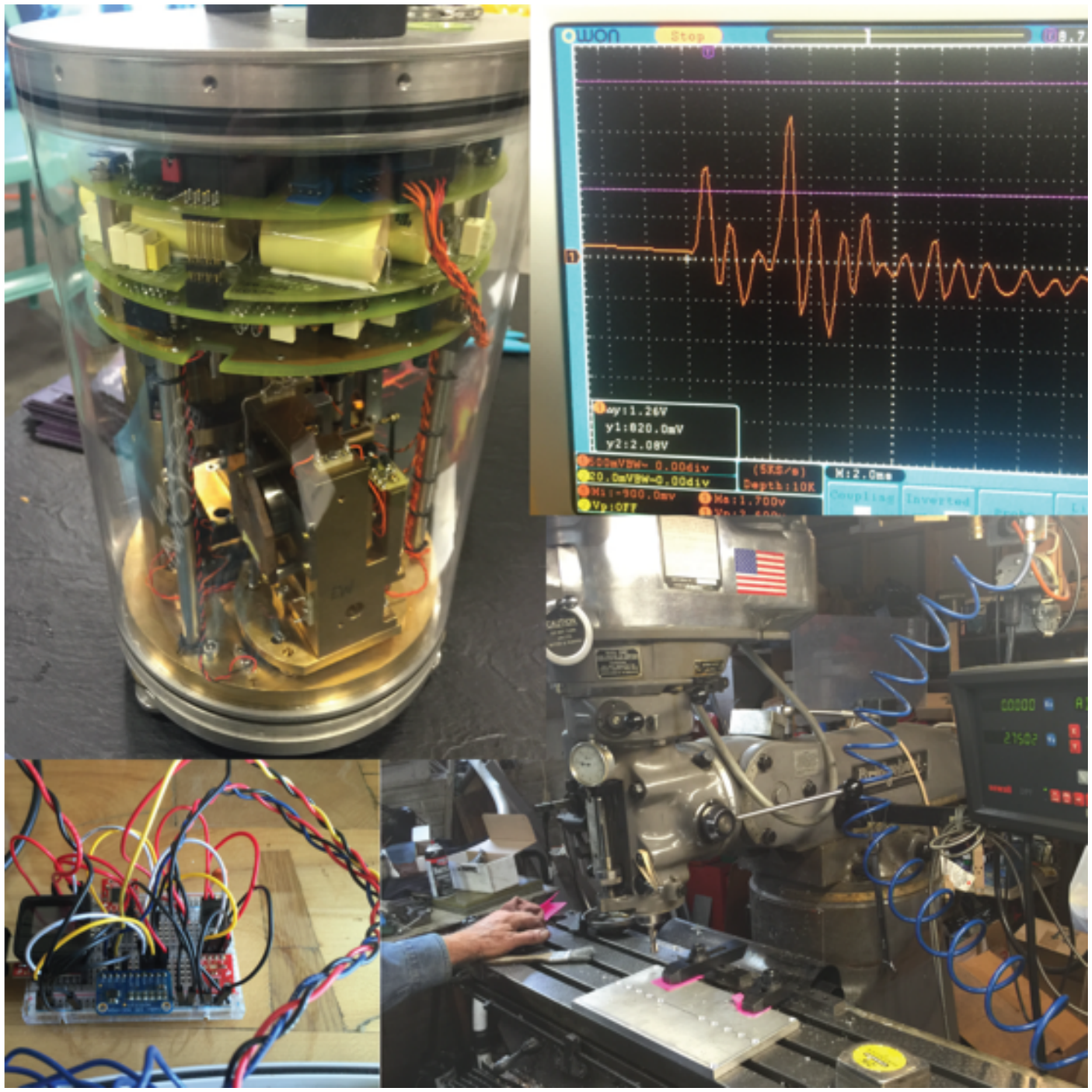
Data Acquisition

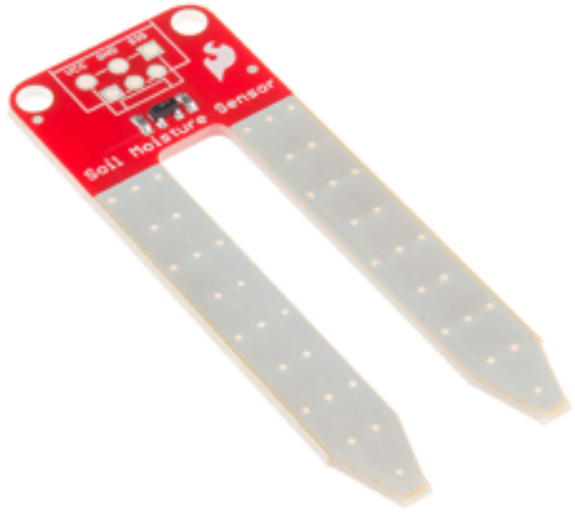
J.R. Leeman and C. Marone

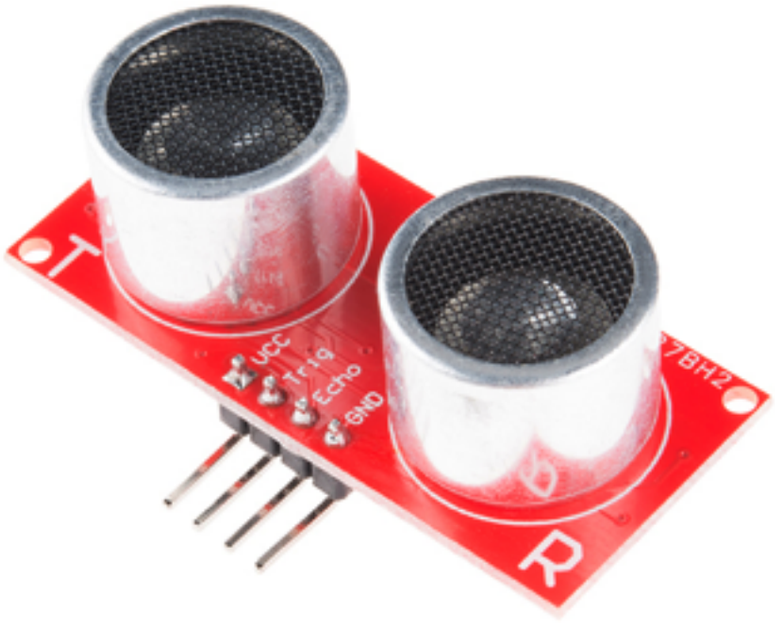
Techniques of Geoscientific Experimentation

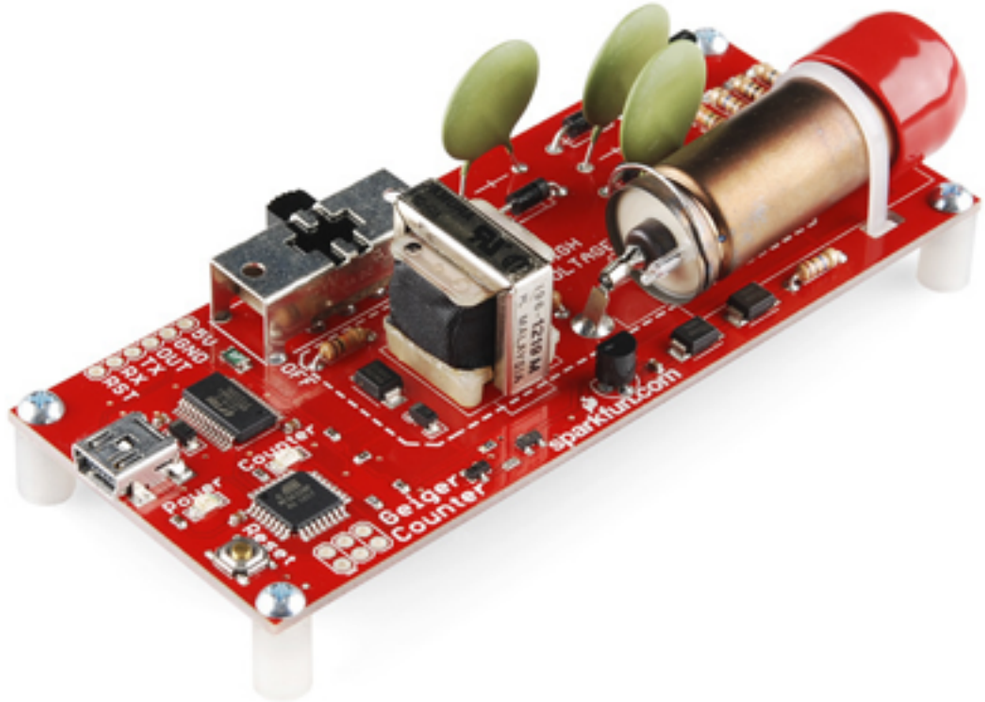
September 13, 2016



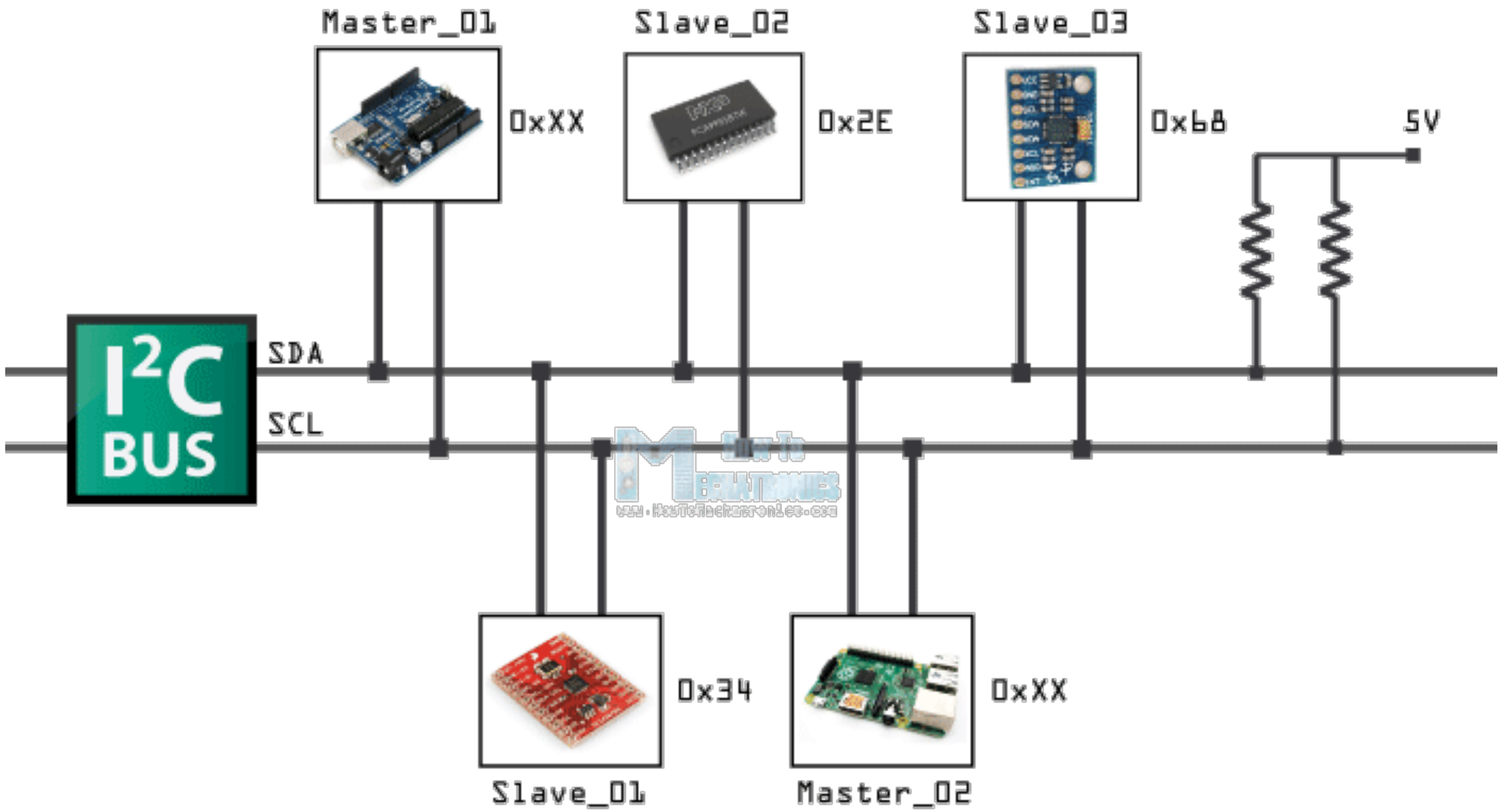
We measure the real world with transducers





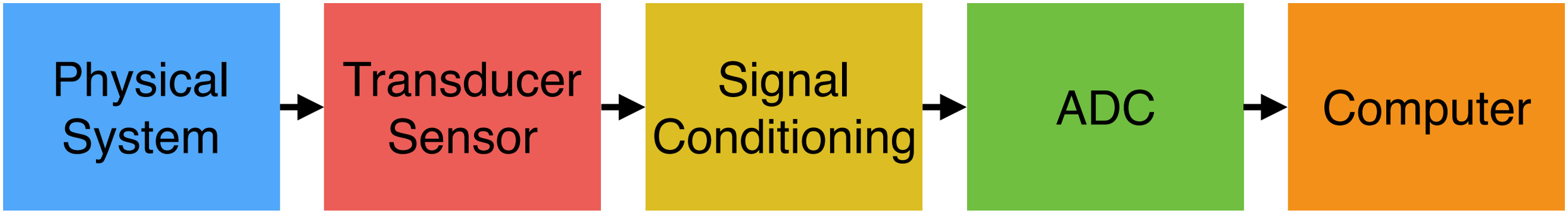


There are a number of digital to digital communications protocols



I2C, SPI, CAN…..

The process of collecting and storing data is called data acquisition or DAQ



Let’s say we want to measure the air temperature

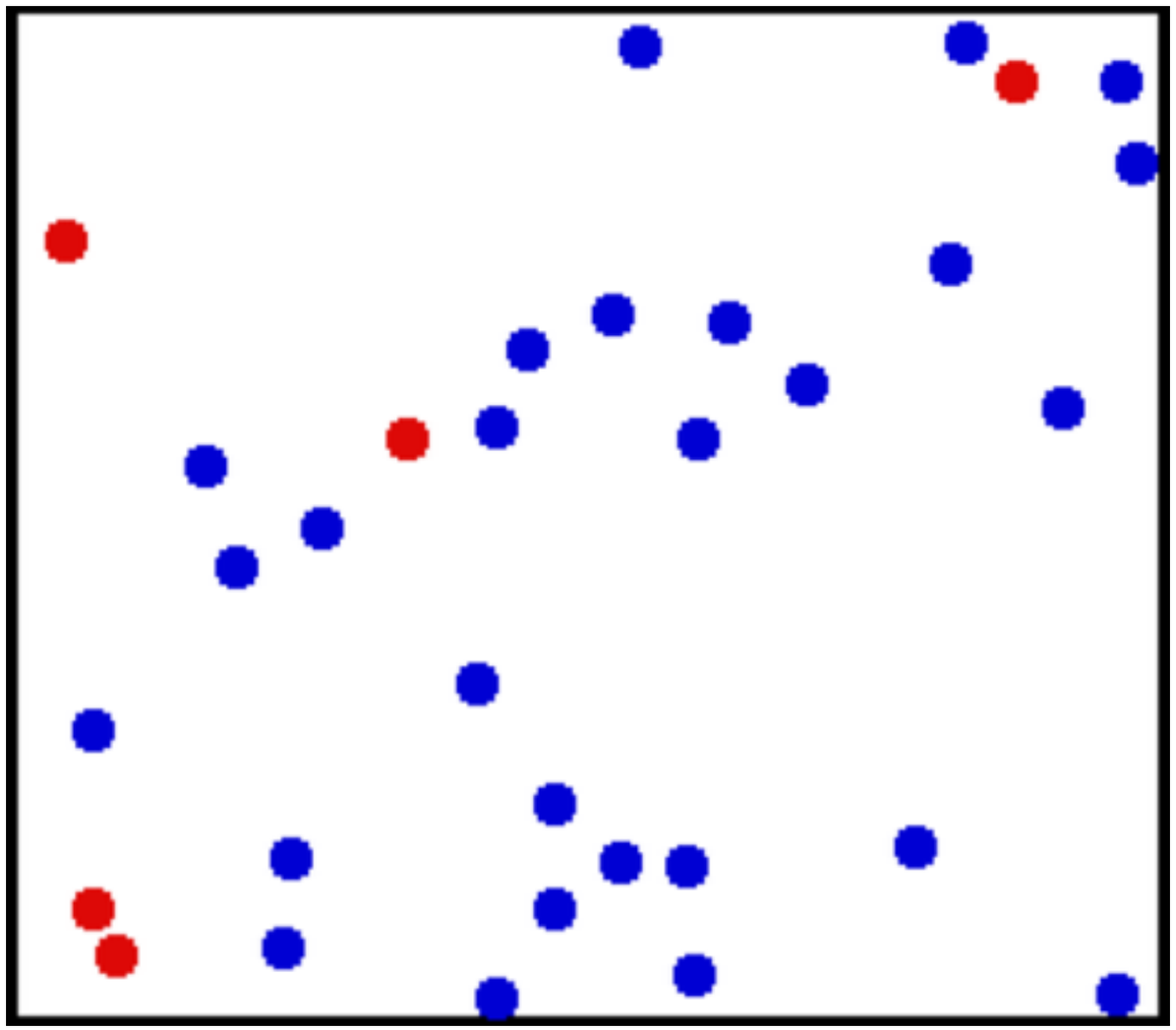


Image: wikipedia.com

Physical System: Hoth

Image: starwars.com

A transducer/sensor turns the physical signal into an electrical one

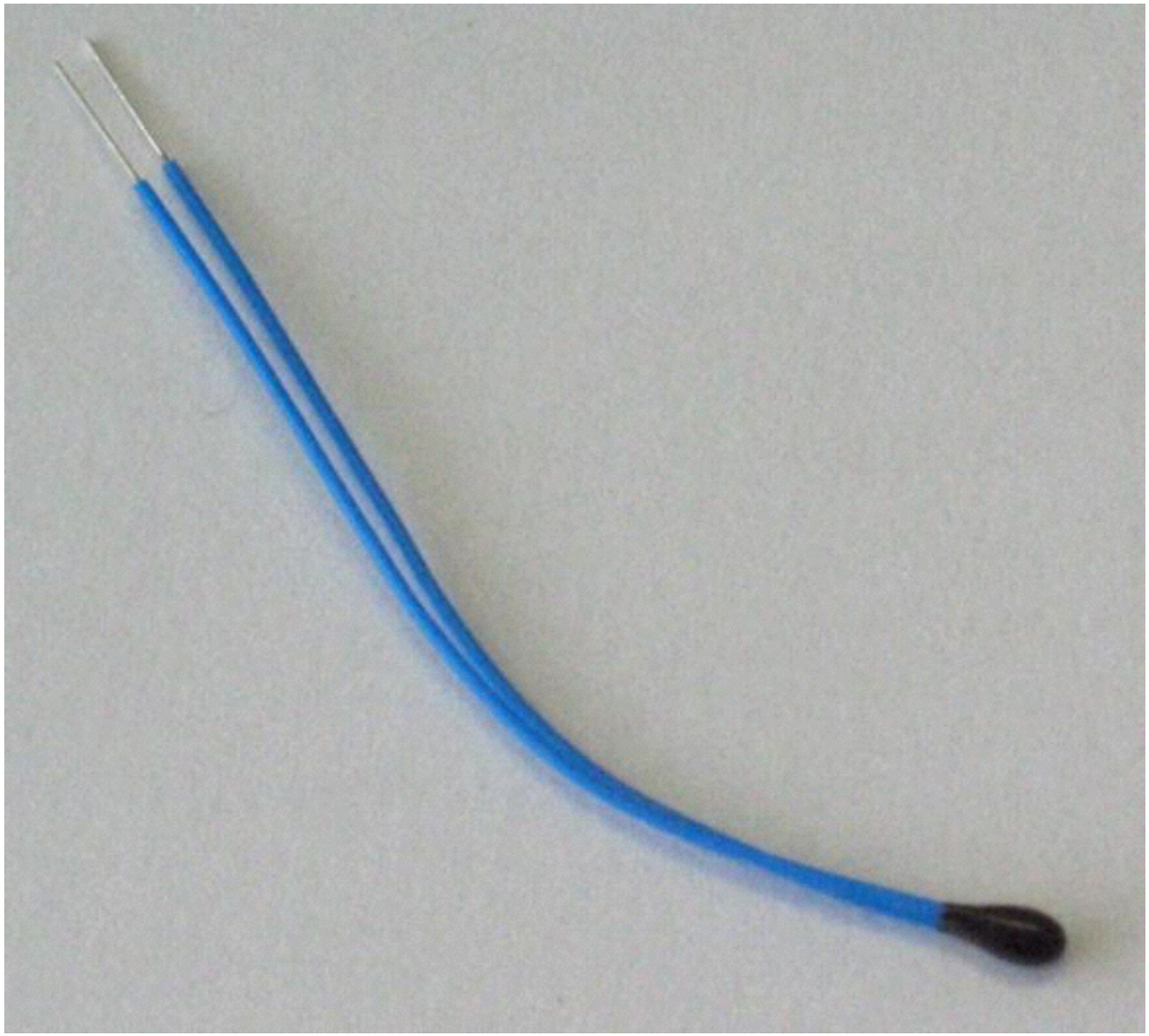


Image: wikipedia.com

We need to condition the signal to make it useable

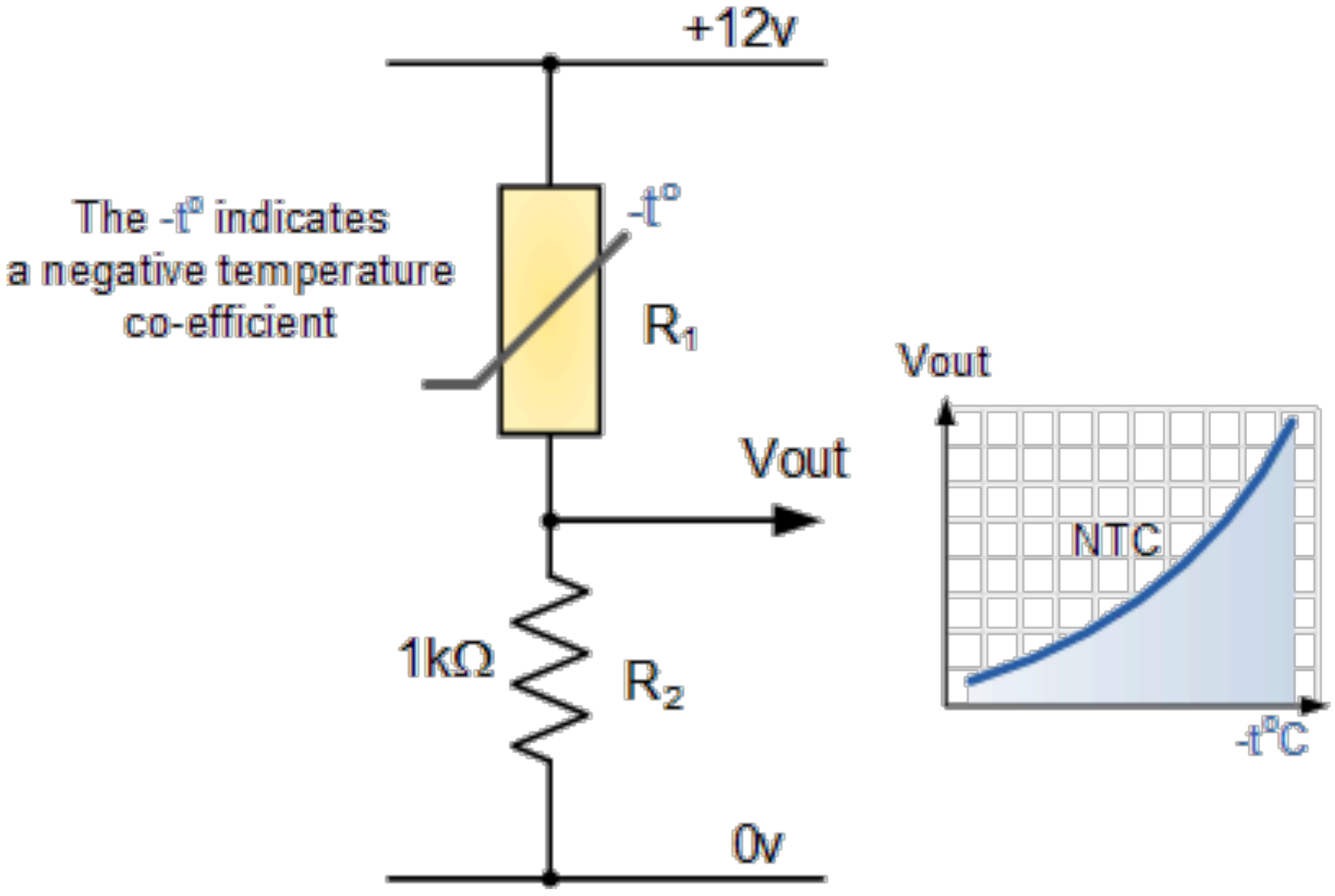
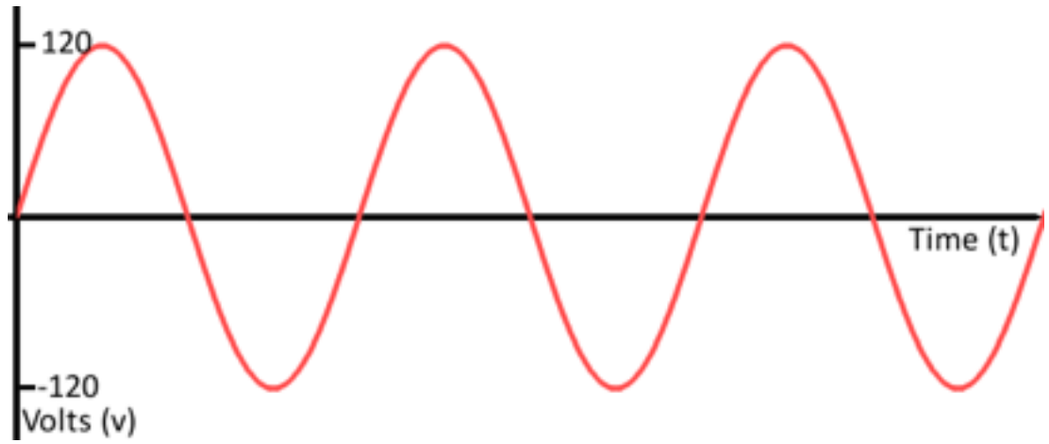
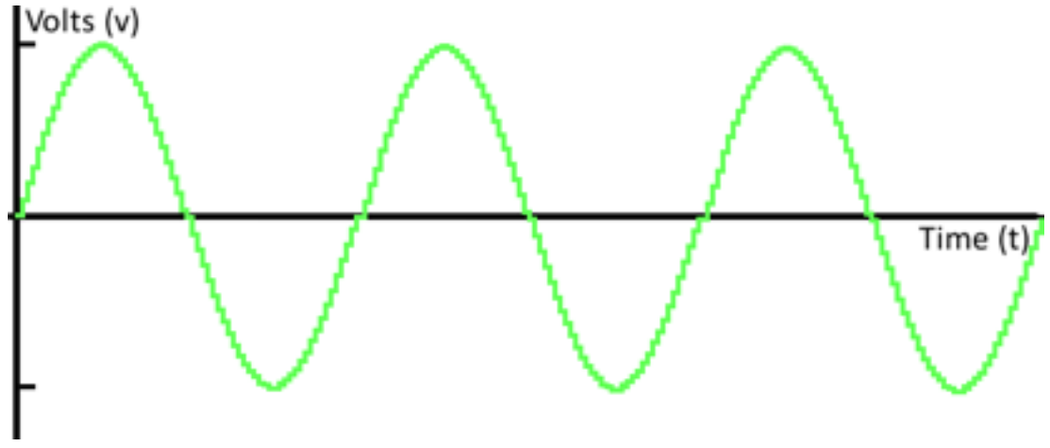


Image: electronics-tutorials.ws

The signal is then converted to a digital representation with an analog to digital converter



ADC



Images: sparkfun.com

ADC resolution is specified by the number of bits used

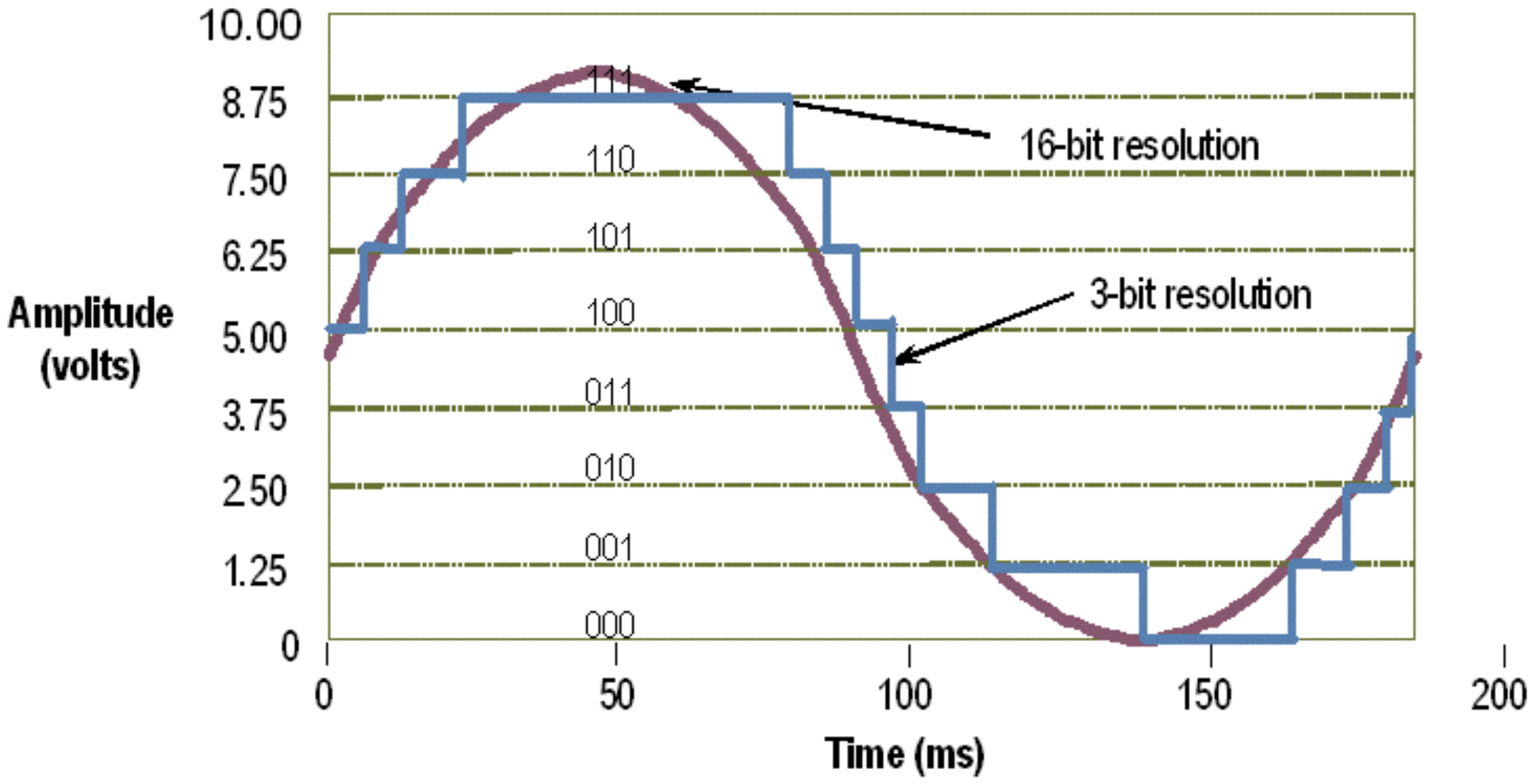
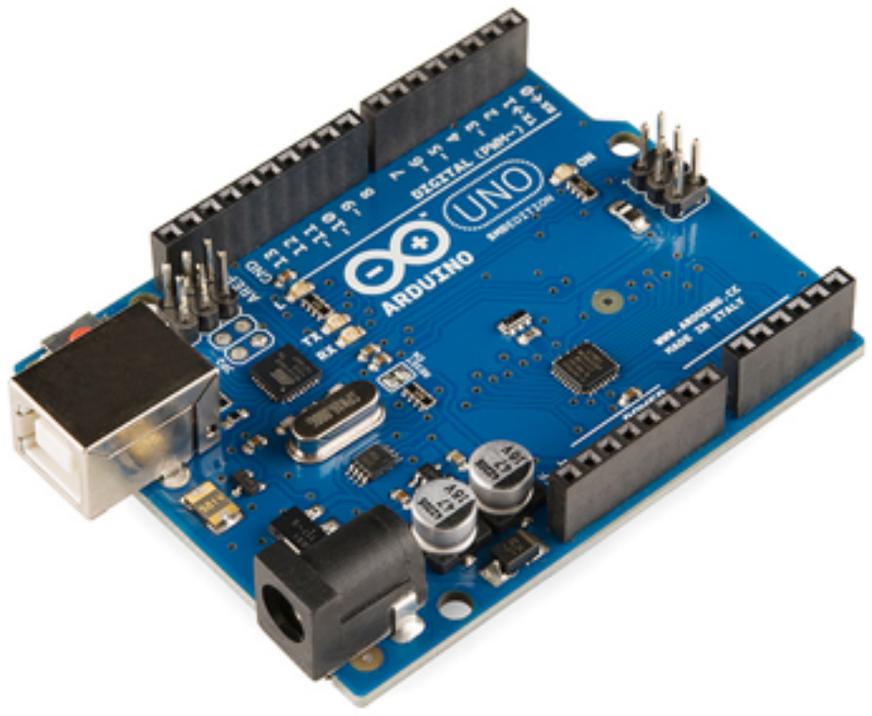


Image: ni.com

Let’s calculate the resolution of our Arduino ADC

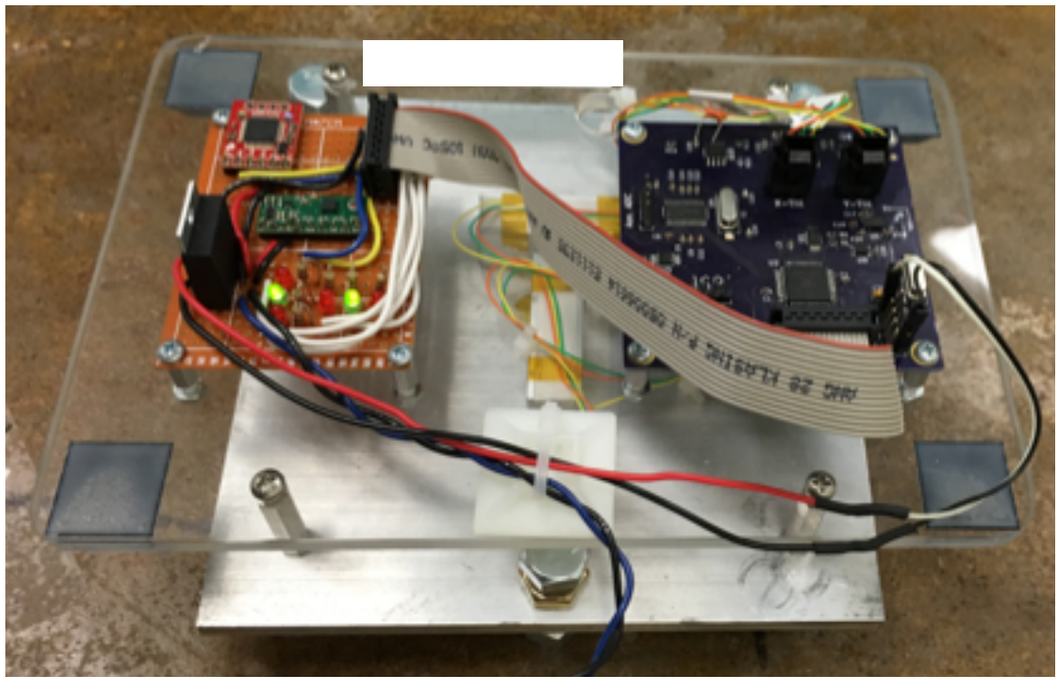
$$\frac{Resolution\ of\ the\ ADC}{System\ Voltage} = \frac{ADC\ Reading}{Analog\ Voltage\ Measured}$$

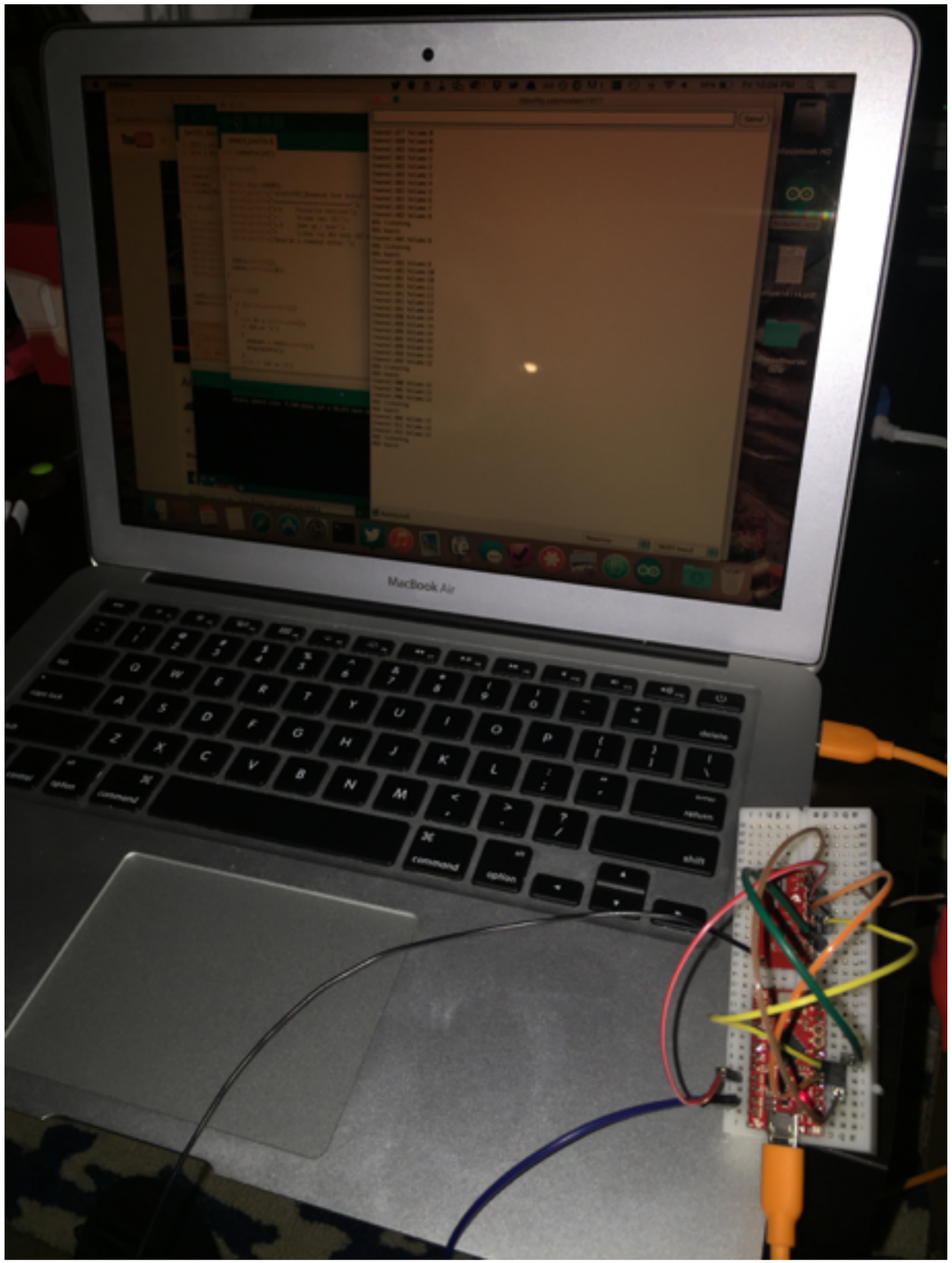


$$\frac{1023}{5} = \frac{ADC\ Reading}{Analog\ Voltage\ Measured}$$

Image: wikipedia.com

Finally the data is stored or processed by a computer or micro controller





Images: J.R. Leeman

We apply calibrations to convert the digital back to the physical units we actually wanted

2.45 Volts

0.01483 Volts/lbs
67.4 lbs/Volt

165.2 lbs

Back on Hoth, we need the Steinhart-Hart equation

$$\frac{1}{T} = A + B\ln(R) + C[\ln(R)]$$

where:

- T is the temperature (in Kelvins)
- R is the resistance at T (in ohms)
- A, B, and C are the **Steinhart–Hart coefficients**

wikipedia.com

There are continuous and triggered DAQ systems

Image: S. Anandakrishnan

A continuous system records things that are constantly changing with time in an unknown way

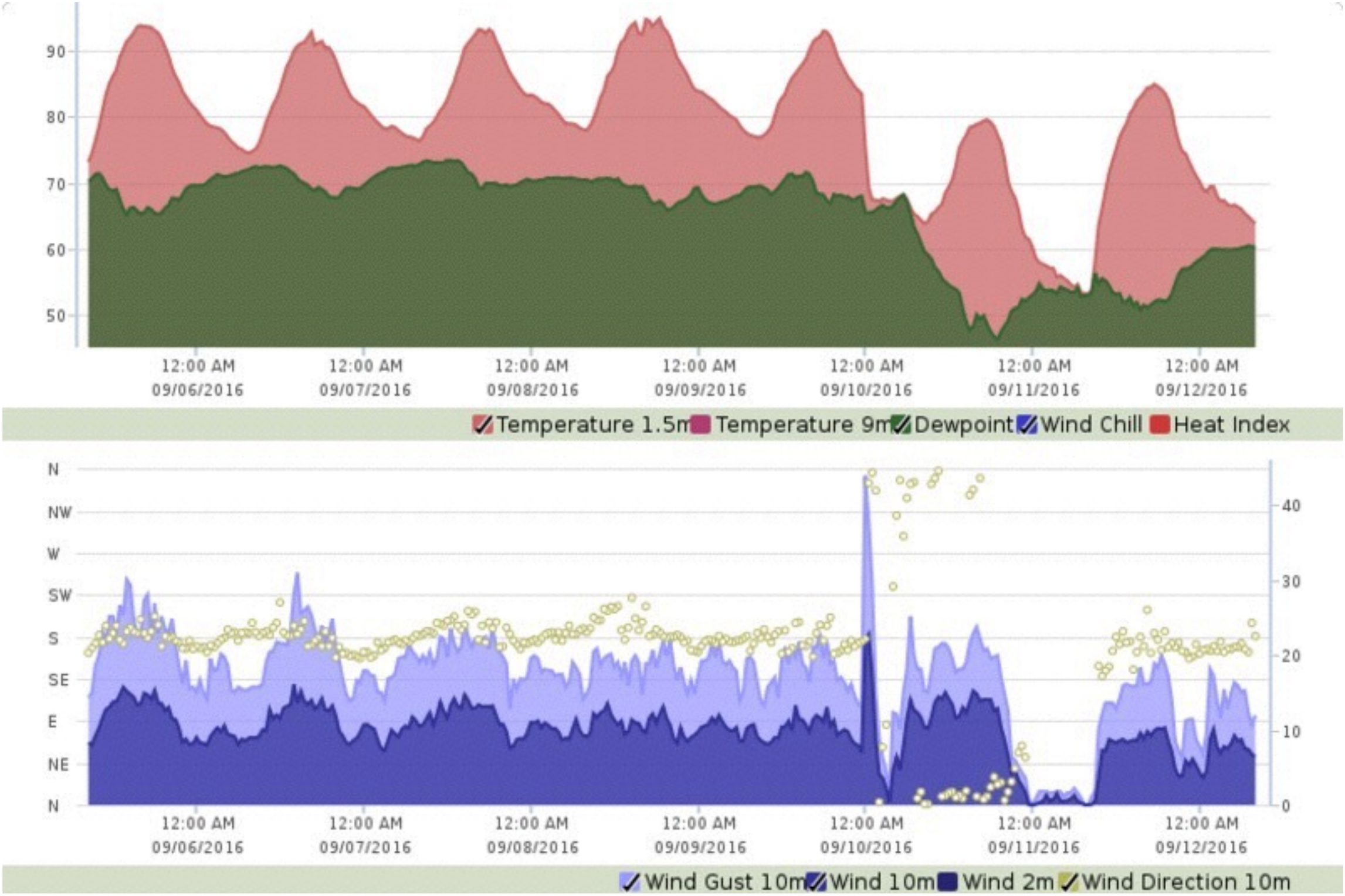
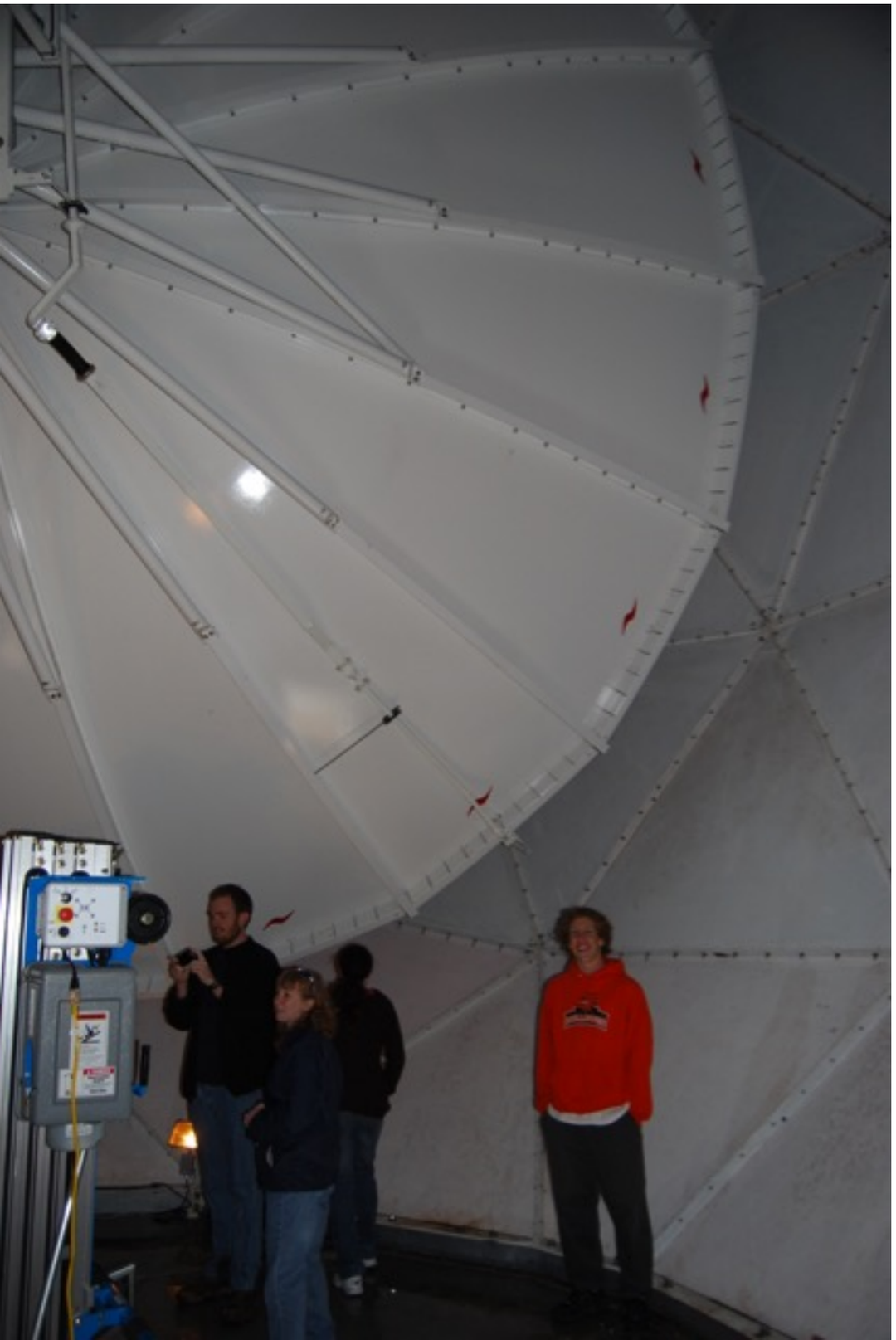


Image: mesonet.org

A triggered system records changes when we know when the interesting parts of the signal will occur or can detect them



Images: J.R. Leeman

Make sure that you are sampling at an adequate frequency

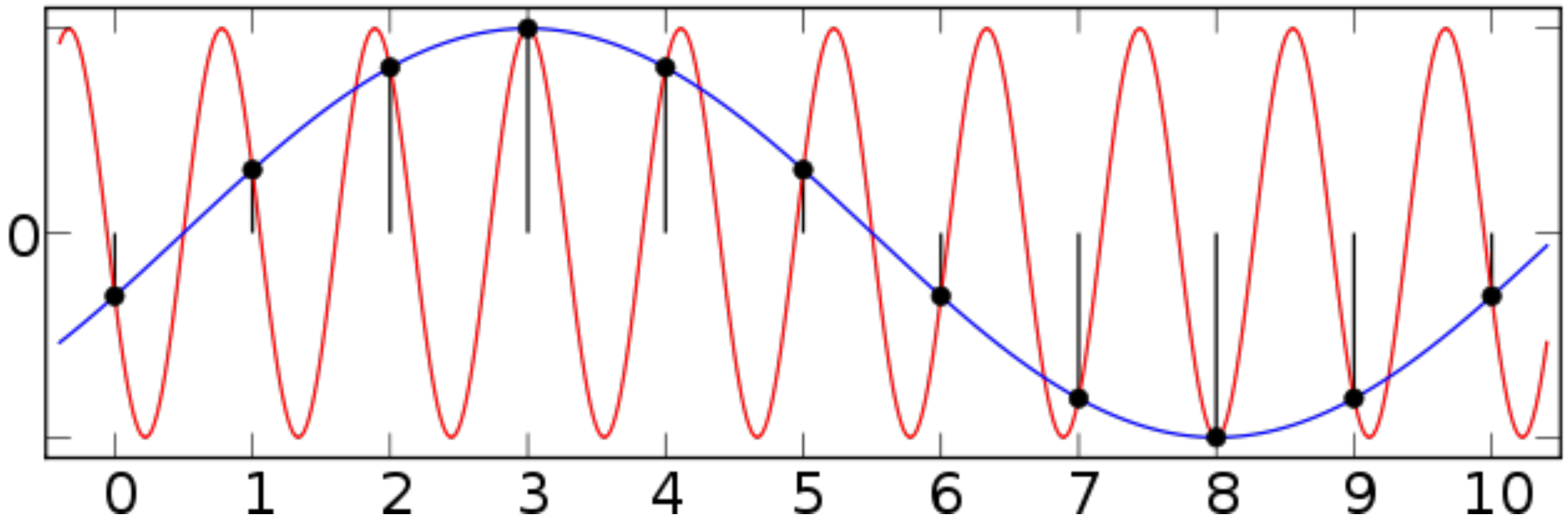
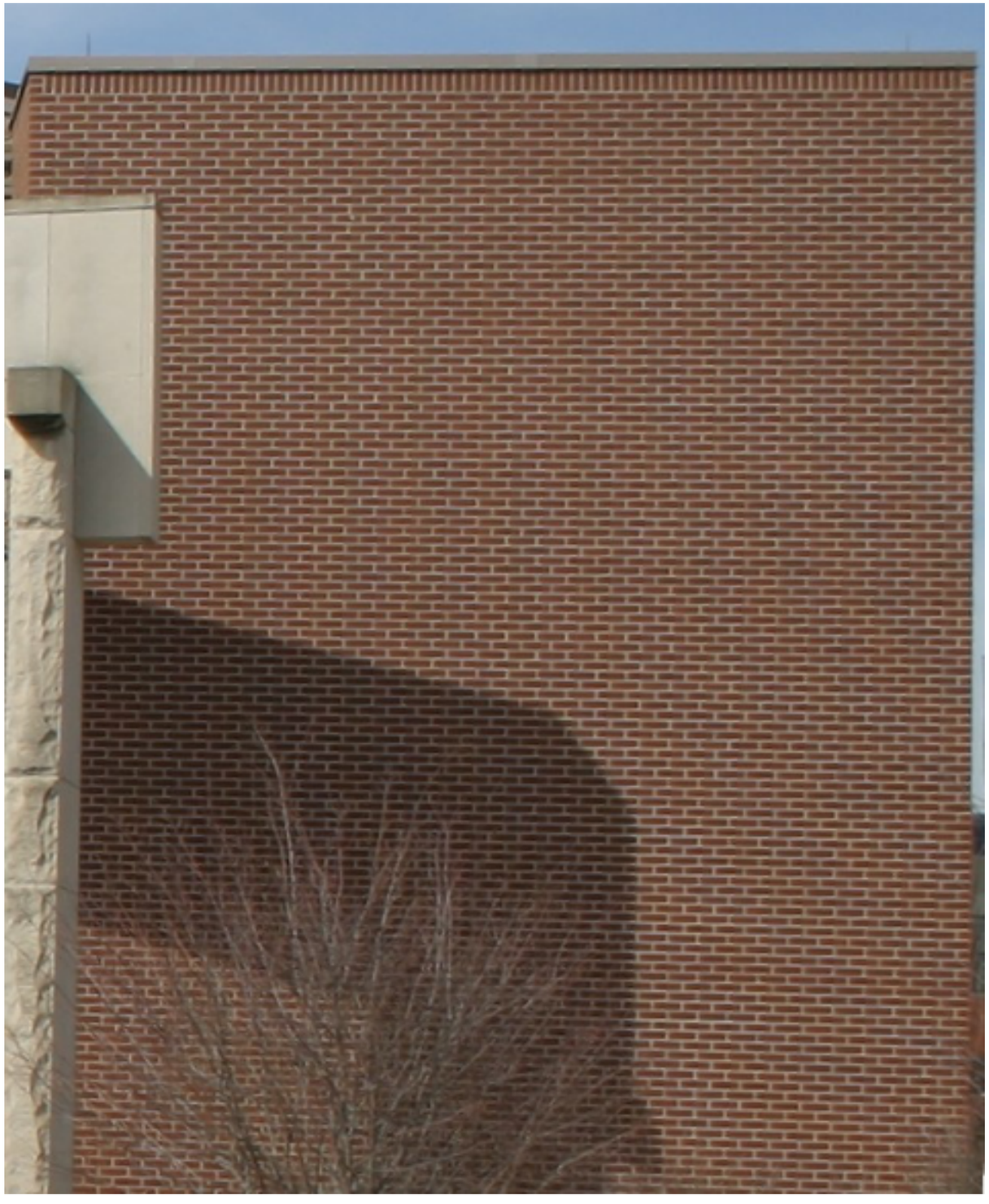


Image: wikipedia.com

Make sure that you are sampling at an adequate resolution



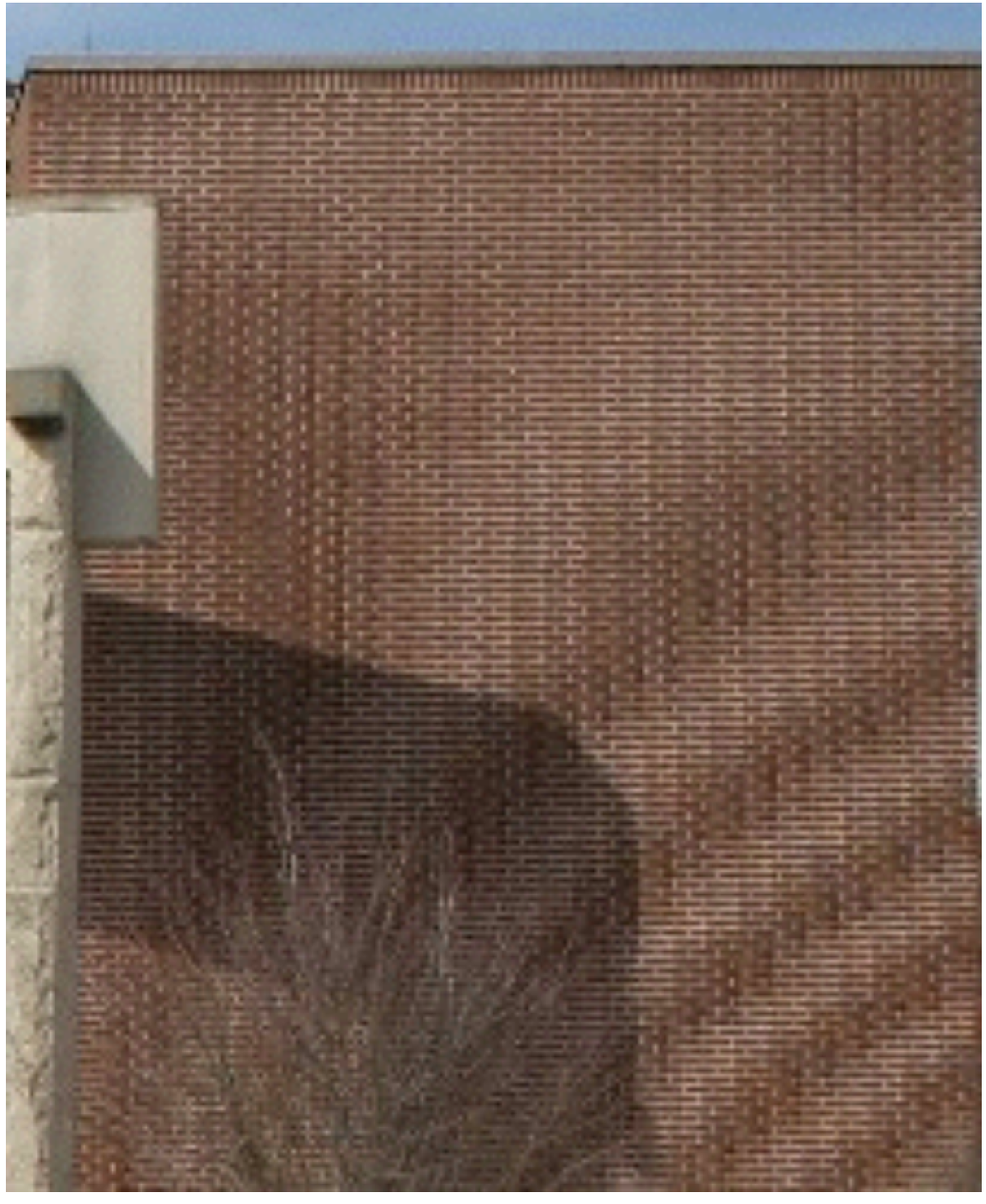


Image: wikipedia.com

Your sampling should be guided by Nyquist-Shannon theory

Harry Nyquist (1889–1976)

Claude Shannon (1916-2001)

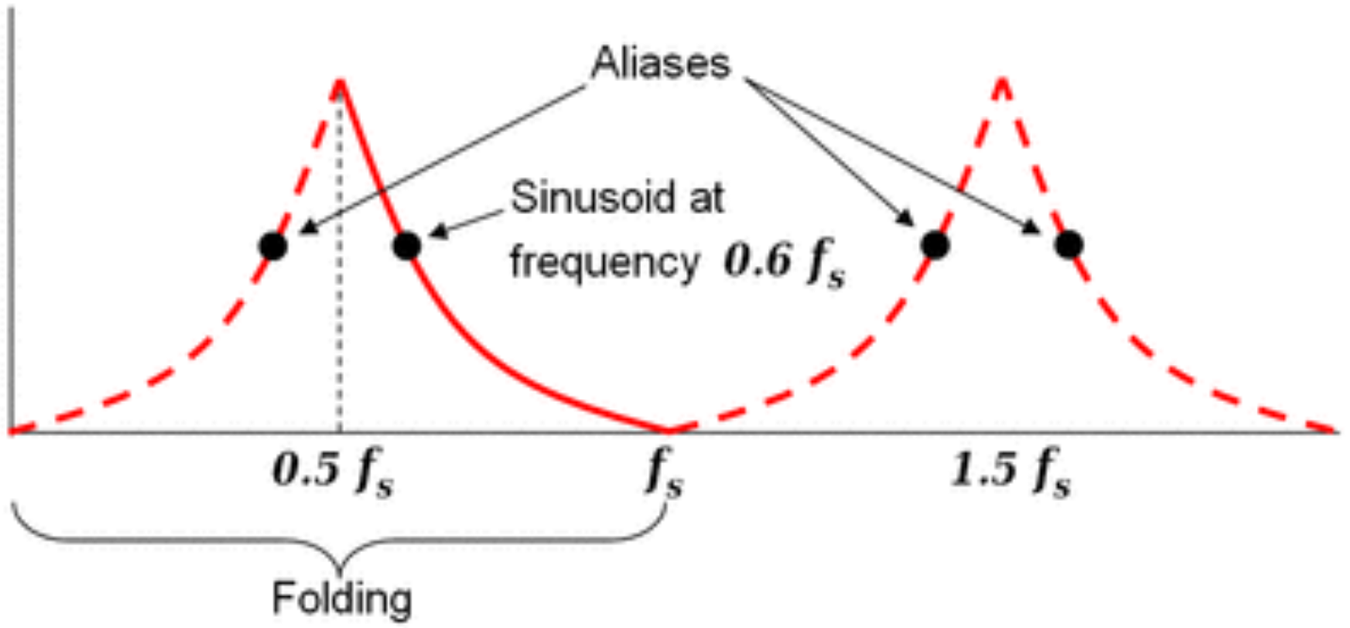
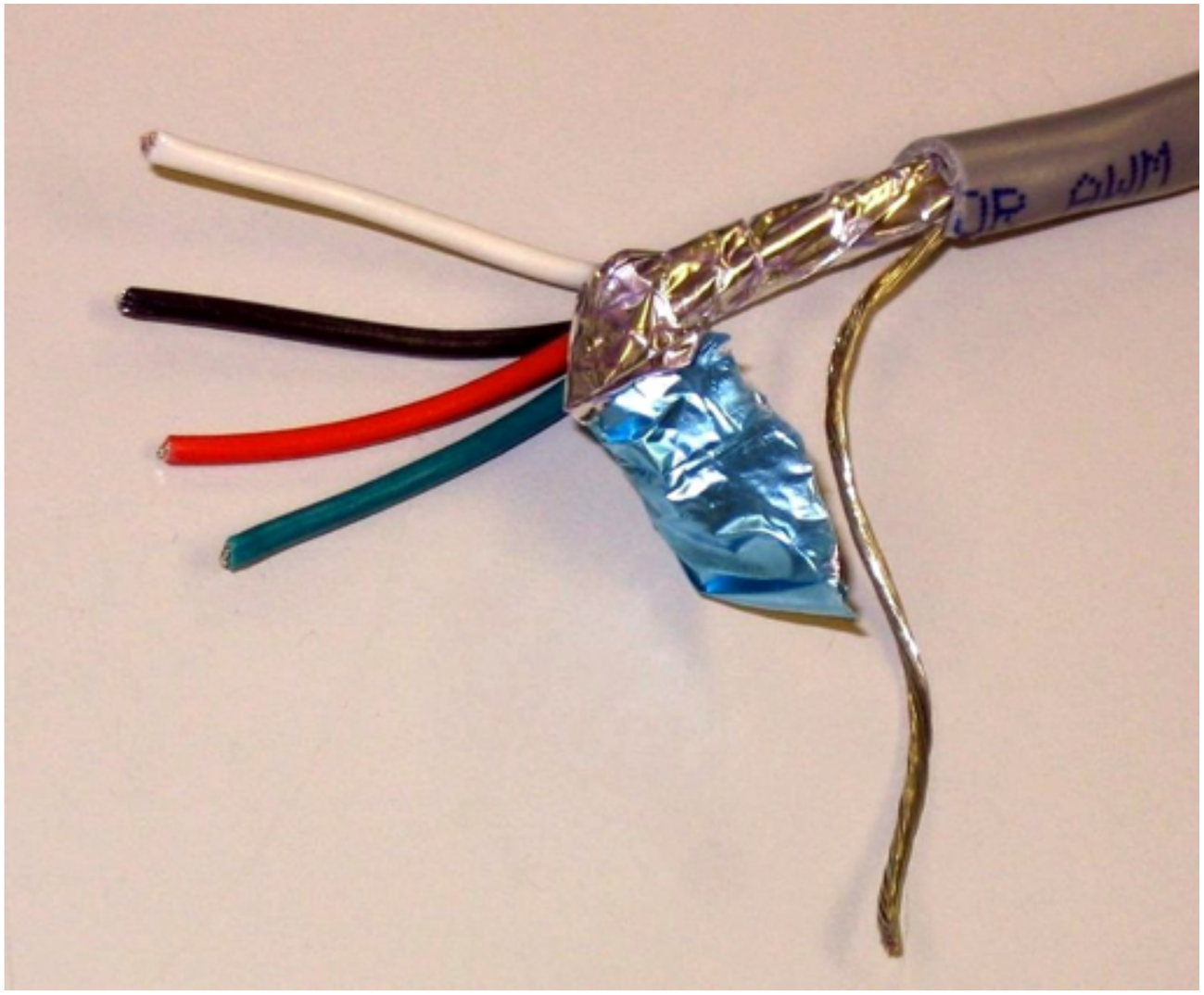
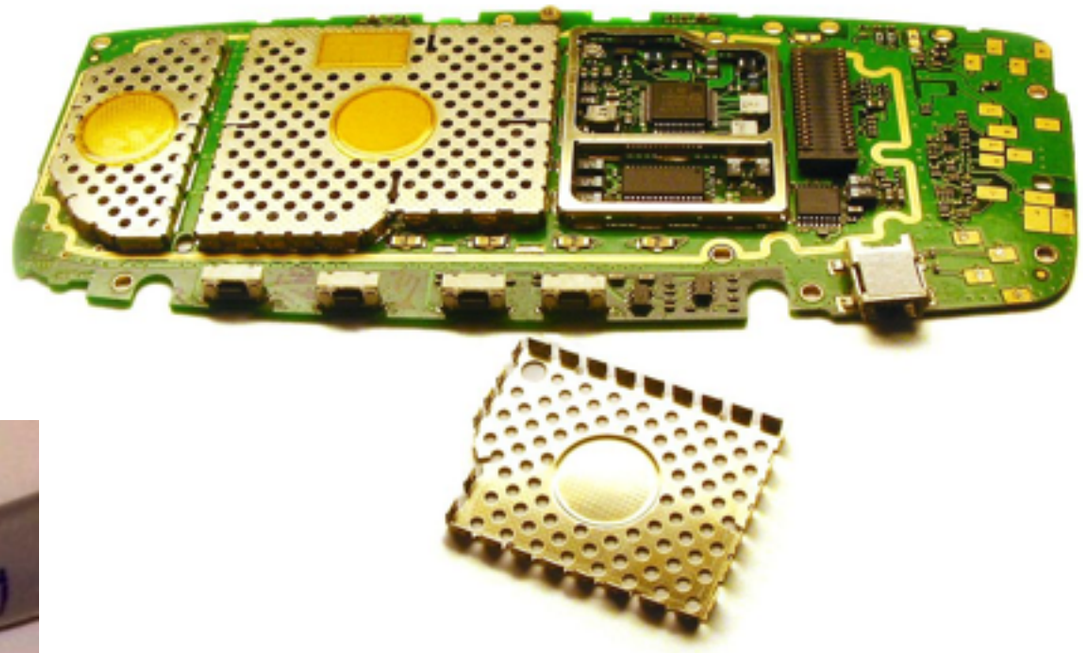


Image: wikipedia.com

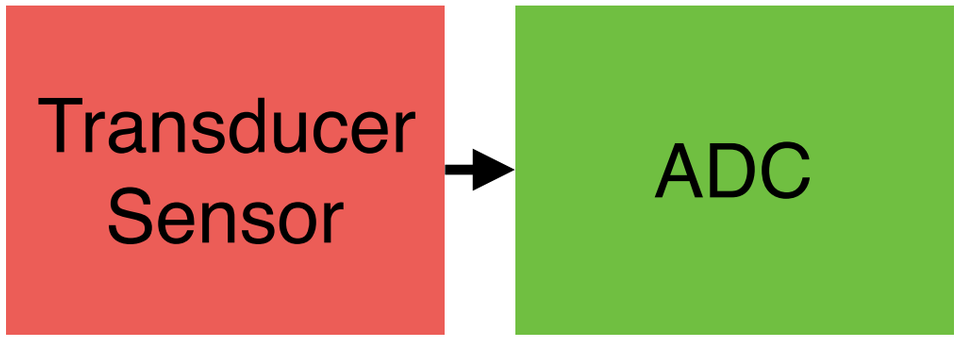
Make sure signals have a clean path through the system





Images: wikipedia.com

Watch out for loading of the transducer/system by the measurement system



National Instruments produces some of the leading DAQ hardware around

Images: ni.com

It is programmed through the graphical LabView language

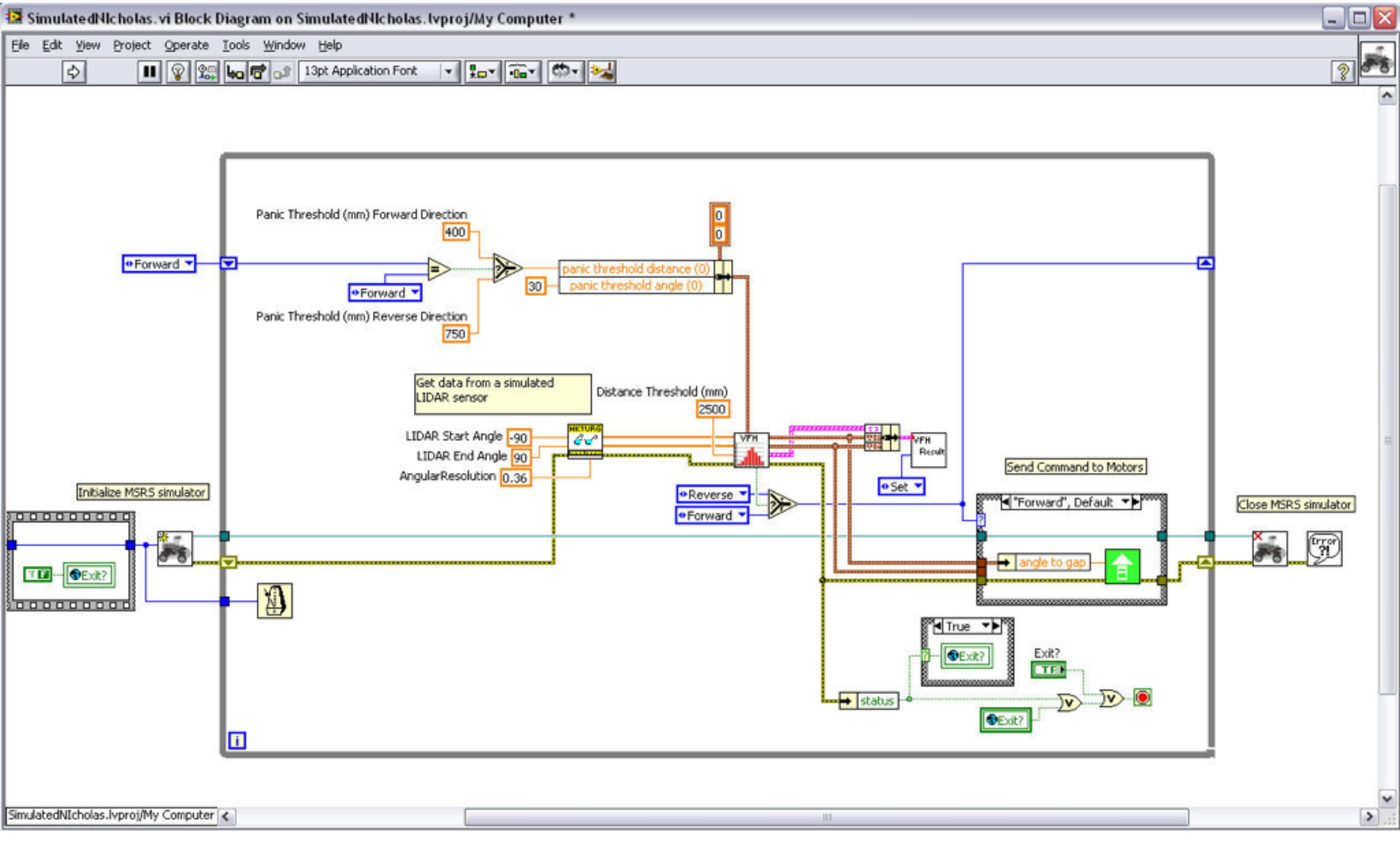


Image: labviewrobotics.wordpress.com

You'll need training and/or professional help

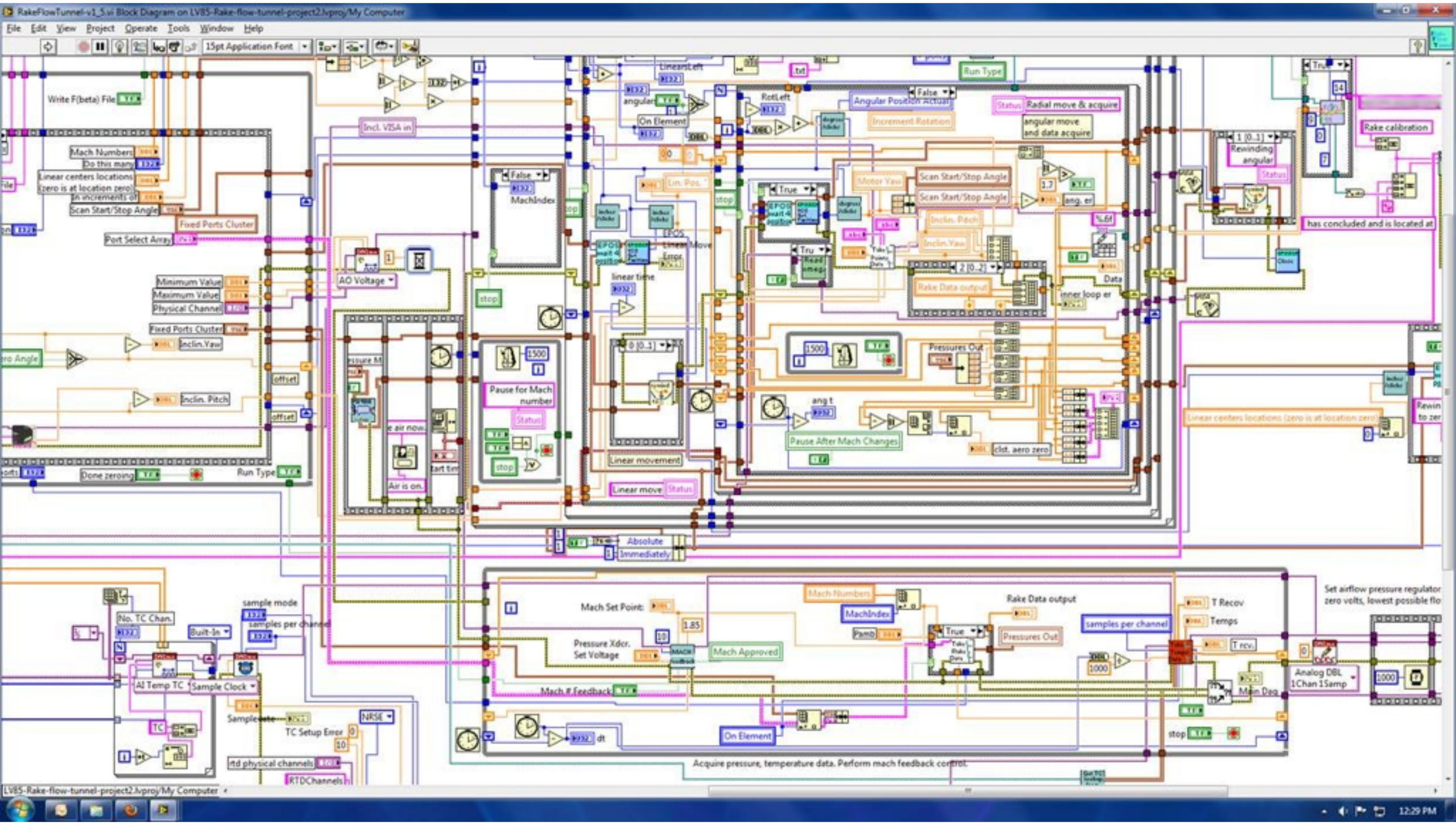


Image: ni.com

LabJack is another handy device that has many interfaces and DAQ tools

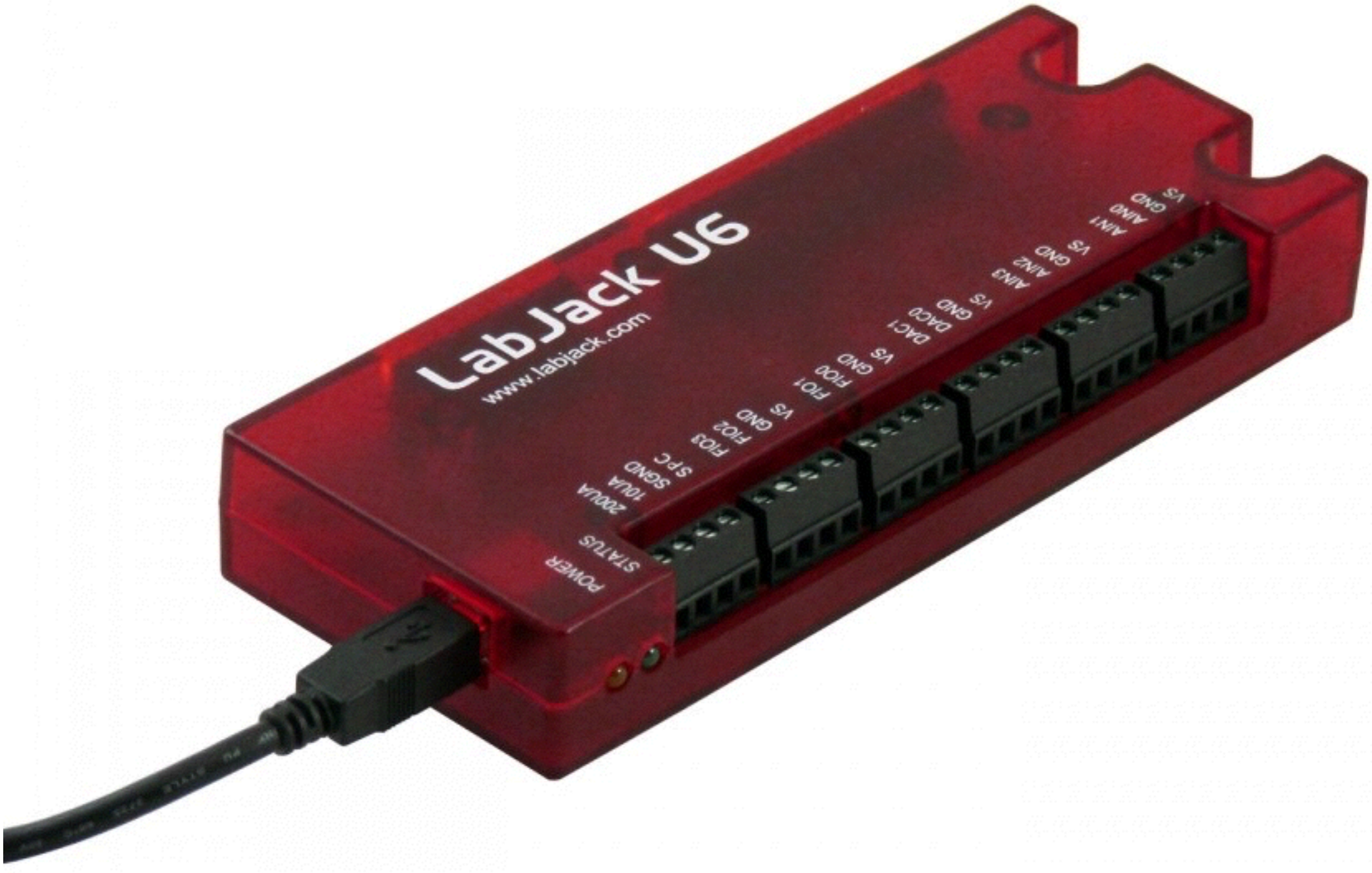


Image: labjack.com

DATAQ, Omega, and many others create similar devices

Image: dataq.com

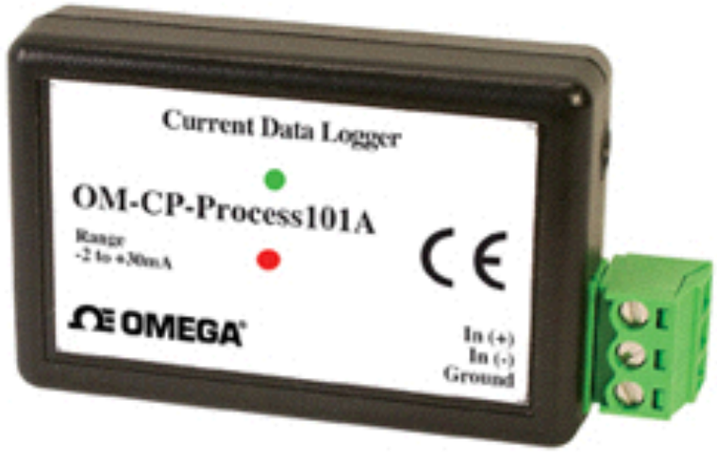


Image: omega.com

Image: onsetcomp.com

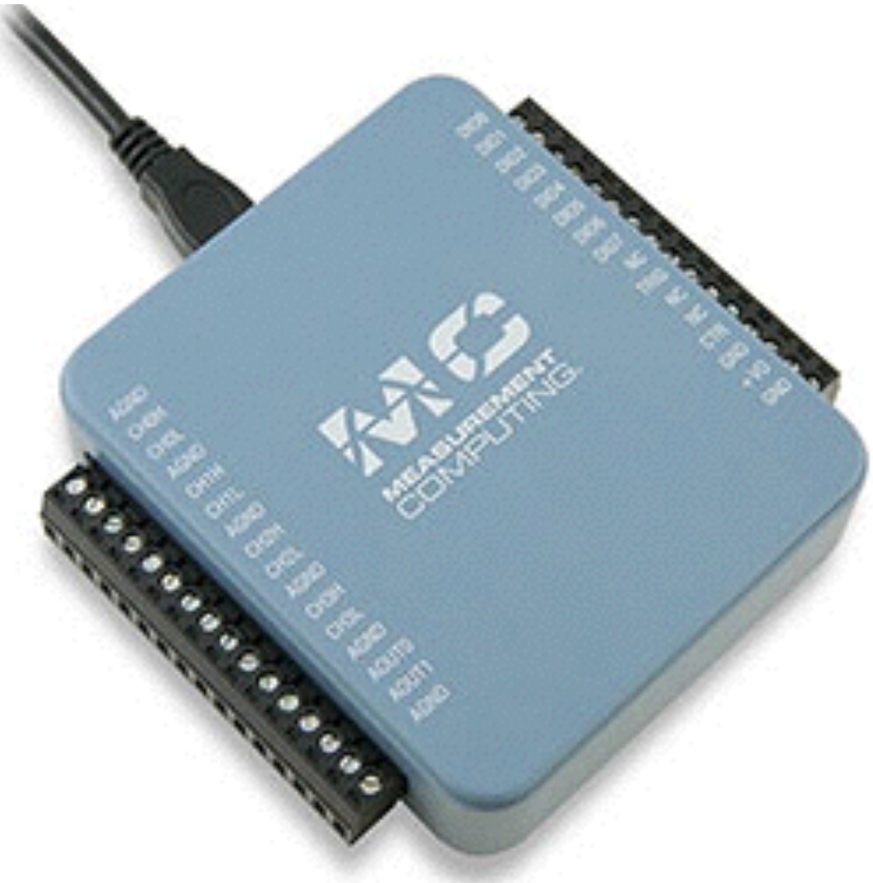


Image: mccdaq.com

There are also field/equipment specific DAQ devices

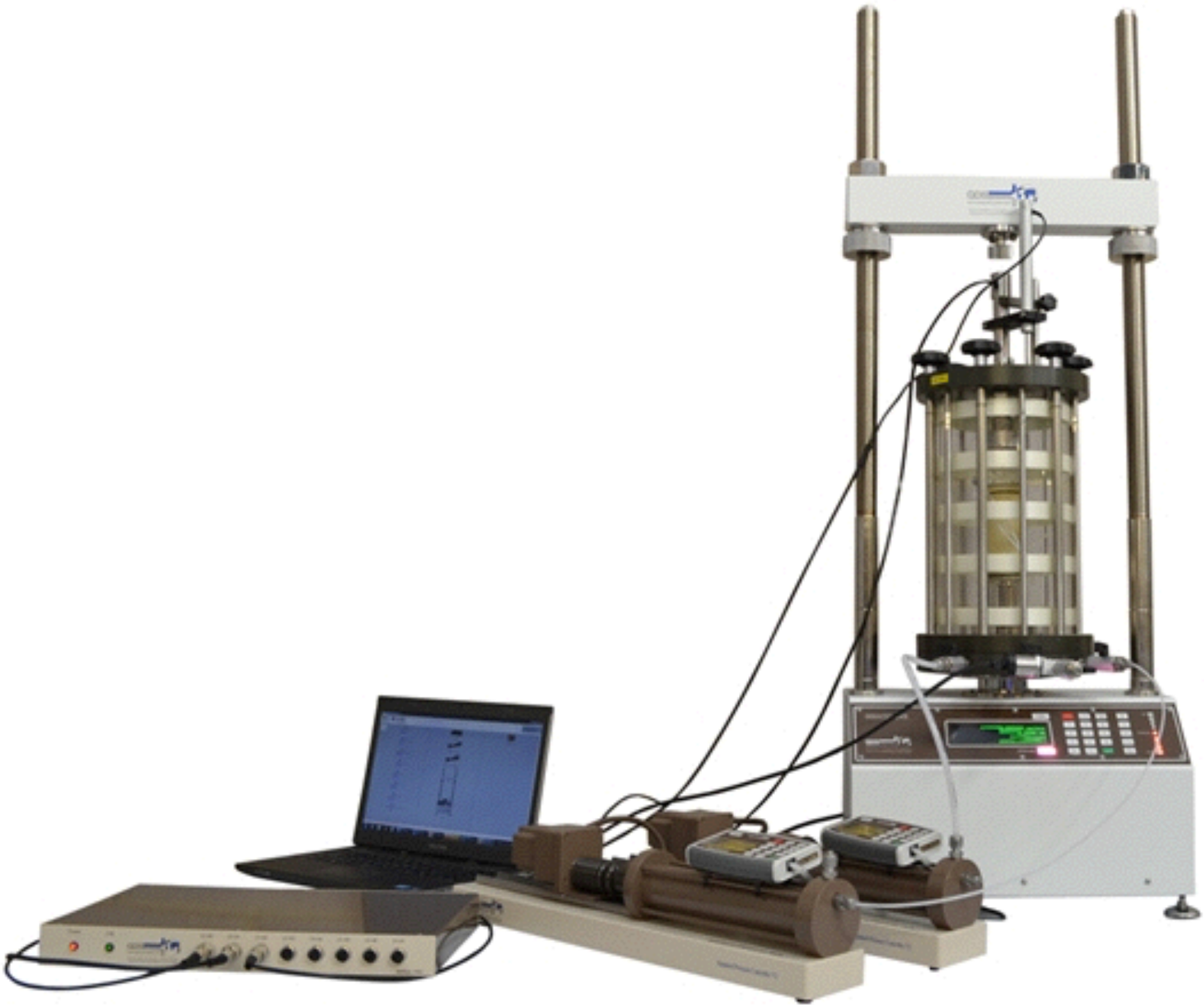
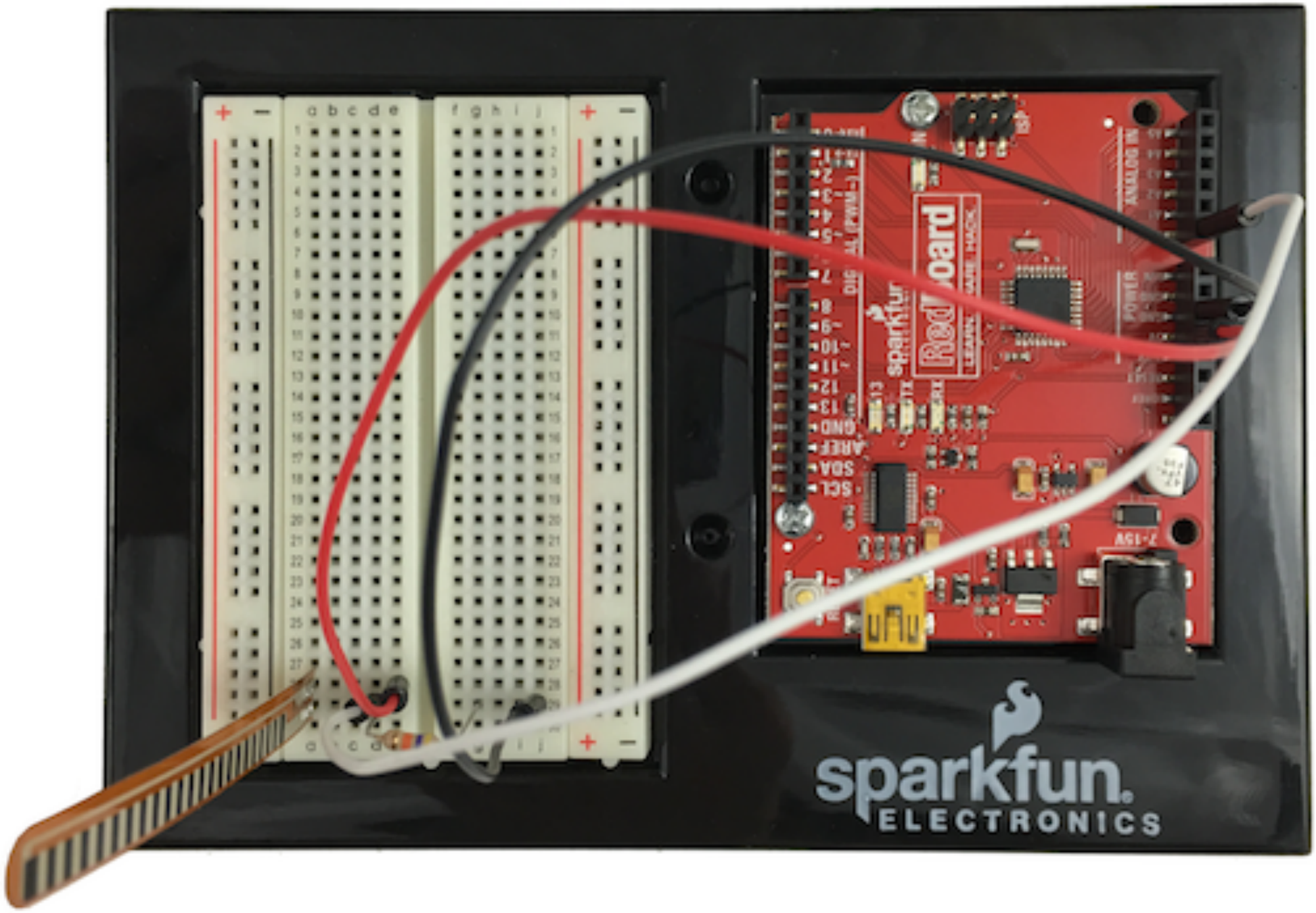
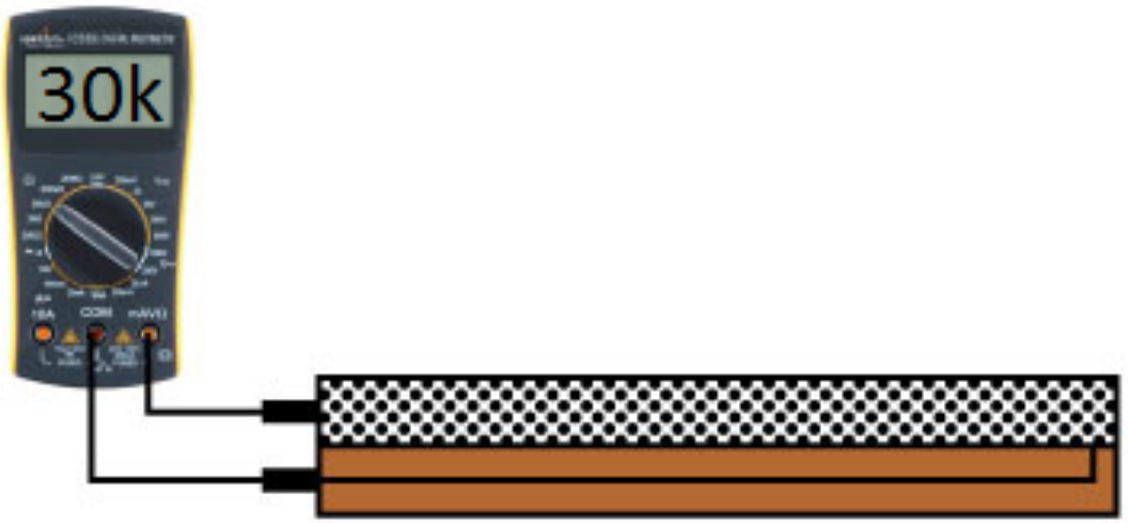


Image: gdsinstruments.com

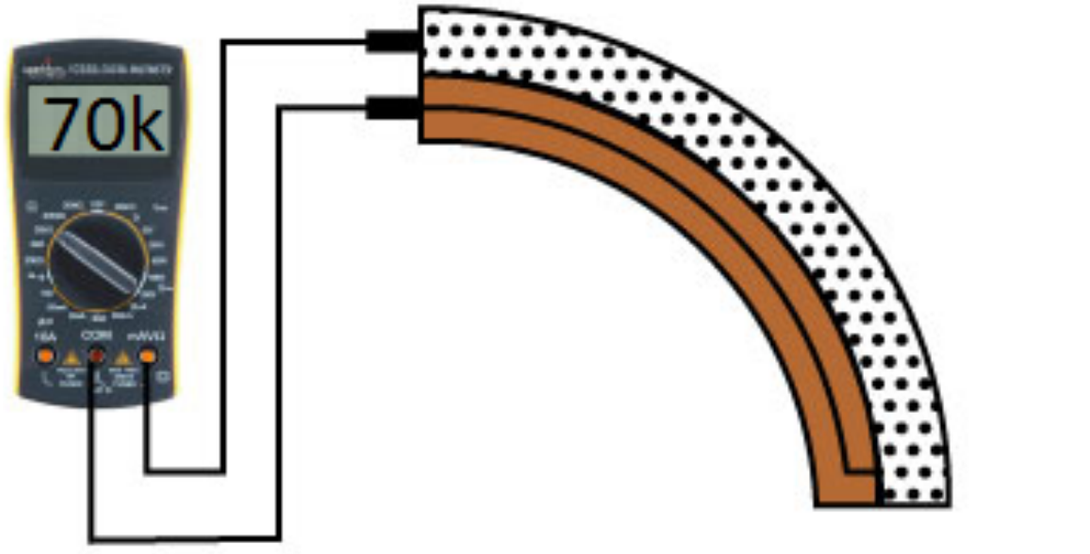
Activity: Flex Sensor Data Acquisition



The flex sensor changes resistance with the amount of bend



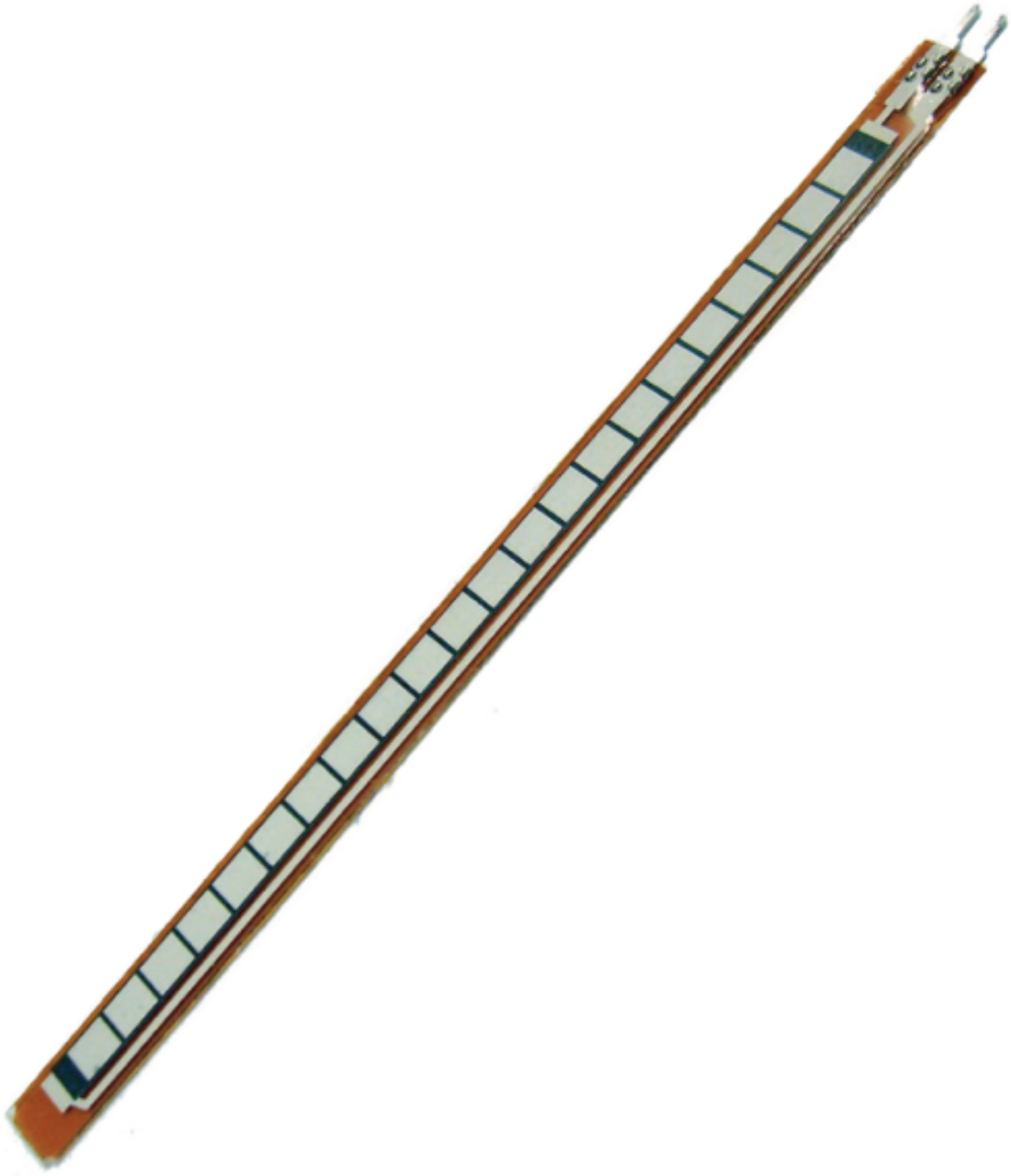
Conductive particles close together - 30kΩ.



Conductive particles further apart - 70kΩ.

Image: sparkfun.com

Only bend the flex sensor in this direction!



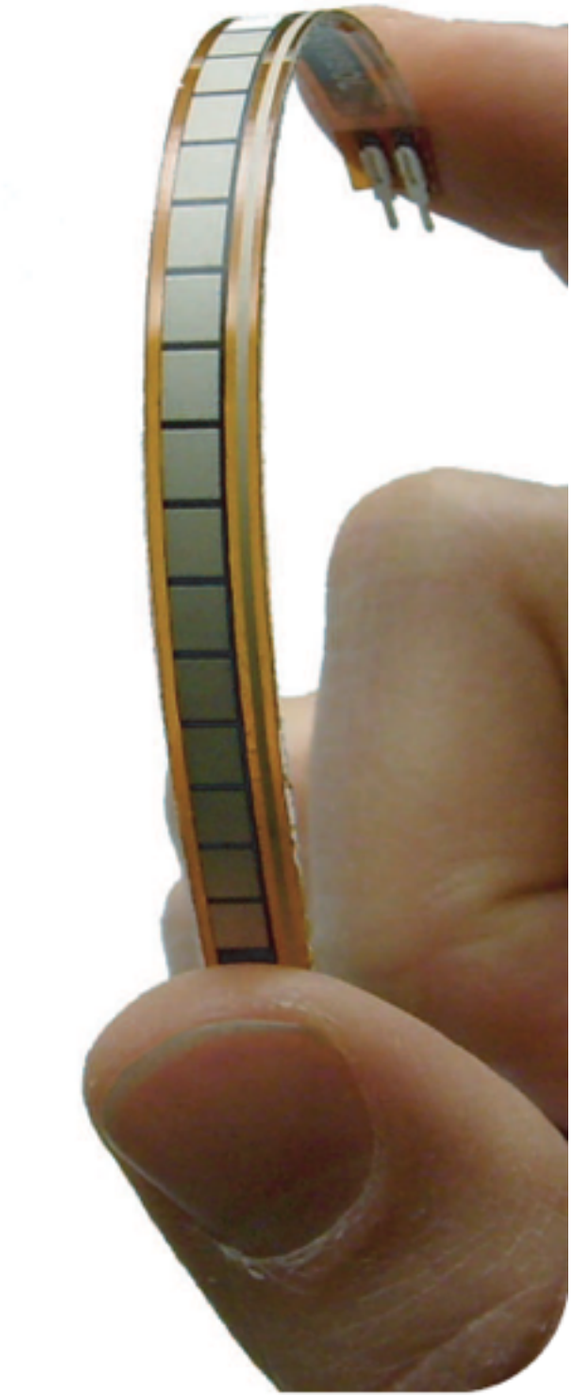
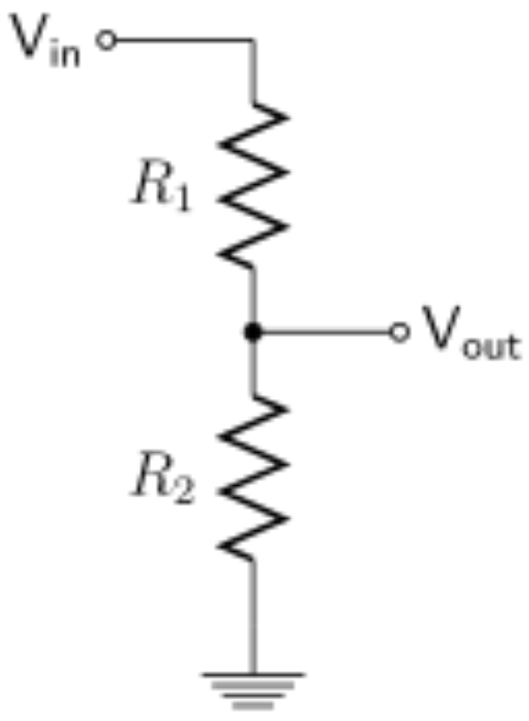


Image: sparkfun.com

We need to make the resistance change into something that we can measure with the Arduino



$$V_{\text{out}} = V_{\text{in}} \frac{R_2}{R_1 + R_2}$$

Image: wikipedia.com

Assignment: Flex Sensor Plot

Email us a plot (from the Arduino IDE, or one that you made externally) of your flex sensor flexing. Use the proper physical unit (degrees).

DUE: 9/15/16