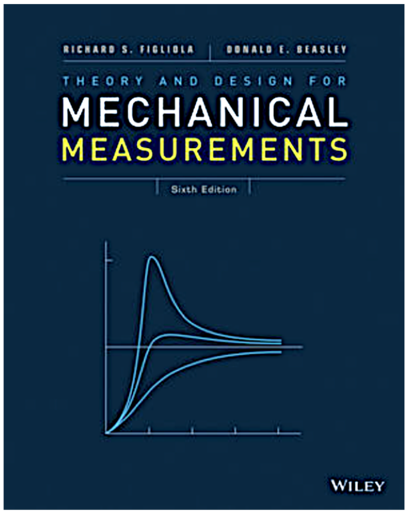


Lab #1 Introduction

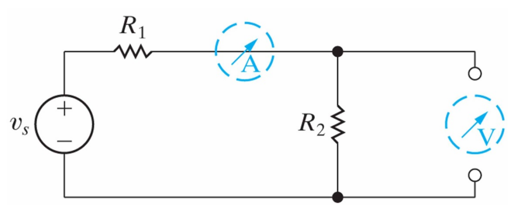
Engr325

Instrumentation

Dr Curtis Nelson

Instrument Loading Review

- An ideal meter has no effect on the circuit variable being measured.
- That means when an ideal *ammeter is placed in series* to measure the current through an element, it should have an equivalent resistance of 0 Ω.
- That means when an ideal *voltmeter is placed in parallel* to measure the voltage across an element, it should have an equivalent resistance of ∞ Ω.
- Choose your instrumentation carefully knowing something about what it is you are measuring – output impedance from sensors may not be known.



RMS Measurements

- RMS is described as a measure of equivalent heating value, with a relationship to the amount of power dissipated by a resistive load driven by the equivalent DC value. For example, a 1Vpk sine wave will deliver the same power to a resistive load as a 0.707Vdc signal. A reliable RMS reading on a signal will give you a better idea of the effect the signal will have in your circuit.

$$X_{rms} = \sqrt{\frac{1}{T}\int_0^T x^2 dt}$$

AC Measurements

- V_{AVG} vs. V_{RMS}
- Why V_{AVG}?
  - Because V_{RMS} is hard to do.

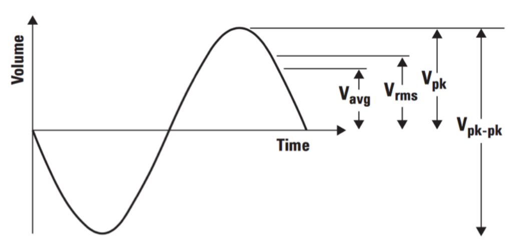


Figure 1. Common voltage parameters

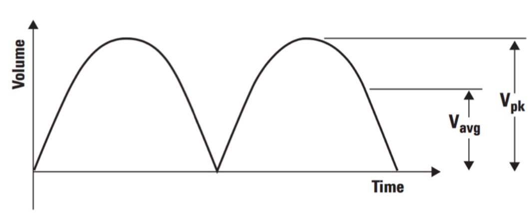


Figure 2. V_{avg} is calculated based on the absolute value of the waveform.

AC Measurements

- For sine waves, the negative half of the waveform cancels out the positive half and averages to zero over one cycle. This type of average would be useless so most meters compute V_{avg} based on the absolute value of the waveform. For a sine wave, this works out to V_{pk} x 0.637.
- This scaling factor applies only to pure sine waves. For every other type of signal, **using this approach produces misleading answers**. If you are using a meter that is not really designed for the task, you easily can end up with significant error depending on the meter and the signal.

RMS Measurements

- You can derive V_{RMS} by squaring every point in the waveform, finding the average (mean) value of the squares, then finding the square root of the average. With pure sine waves, you can take a couple of shortcuts: just multiply V_{pk} x 0.707 or V_{avg} x 1.11. Inexpensive peak-responding or average-responding meters rely on these scaling factors.

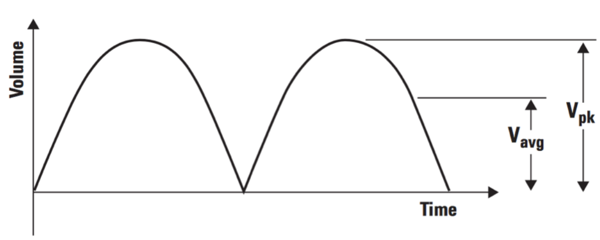
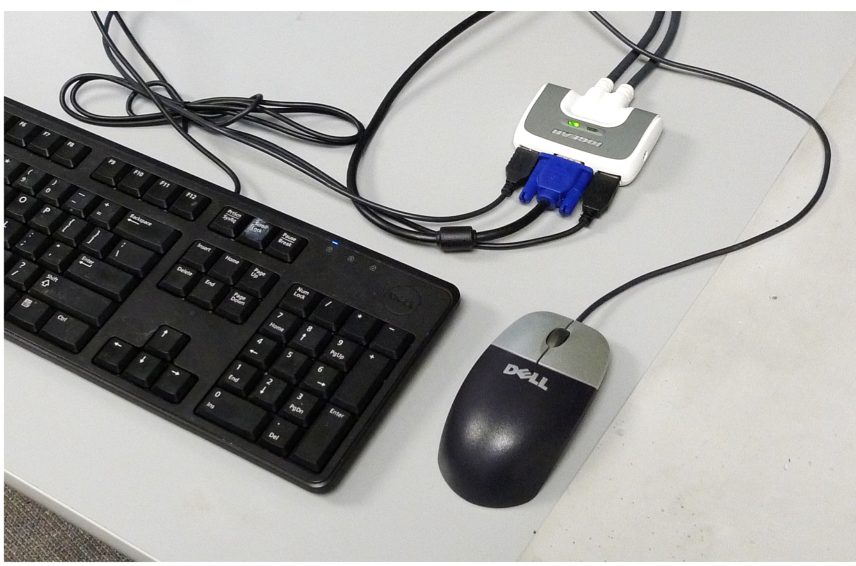


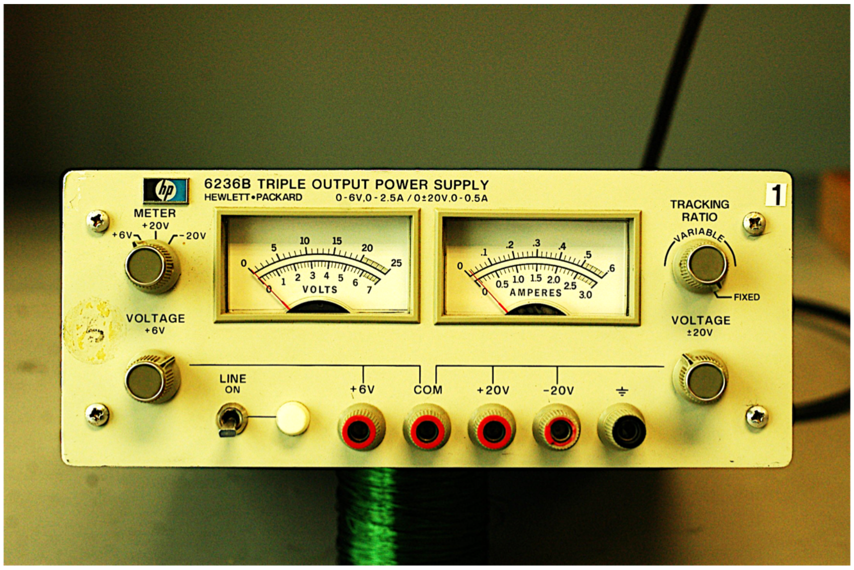
Figure 2. V_{avg} is calculated based on the absolute value of the waveform.

Station Tool Set

Computer and Switch



Triple Output DC Power Supply

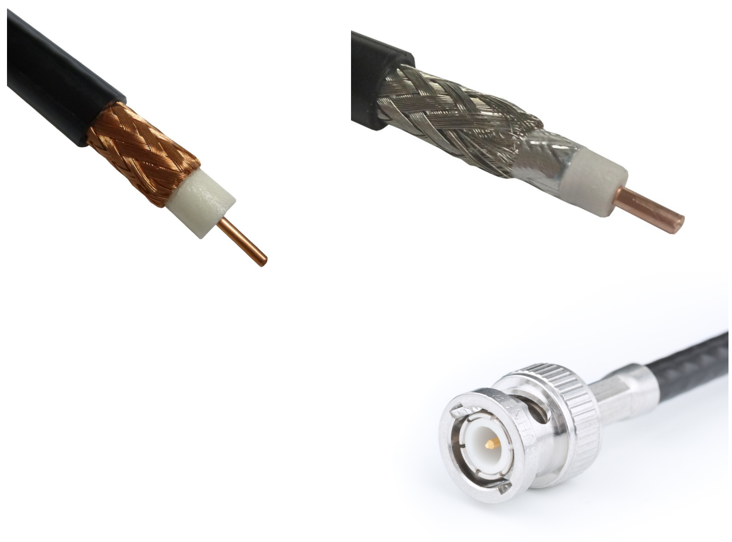


Waveform Generator - Frequency

Waveform Generator - Amplitude

Waveform Generator - Offset

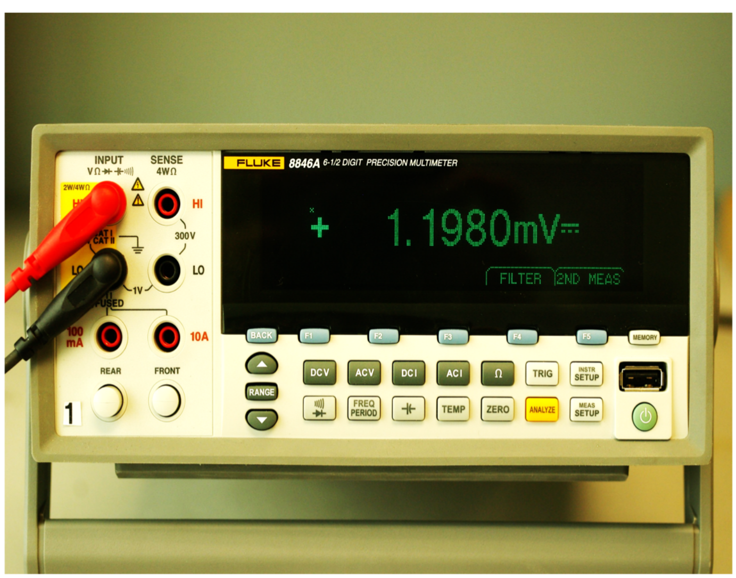
BNC Cables



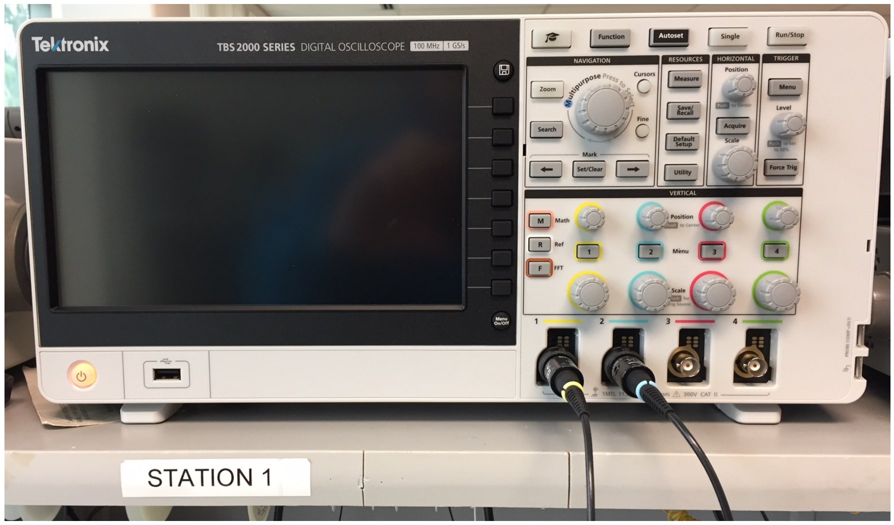
Banana Jack Connections

Banana Jack Connections

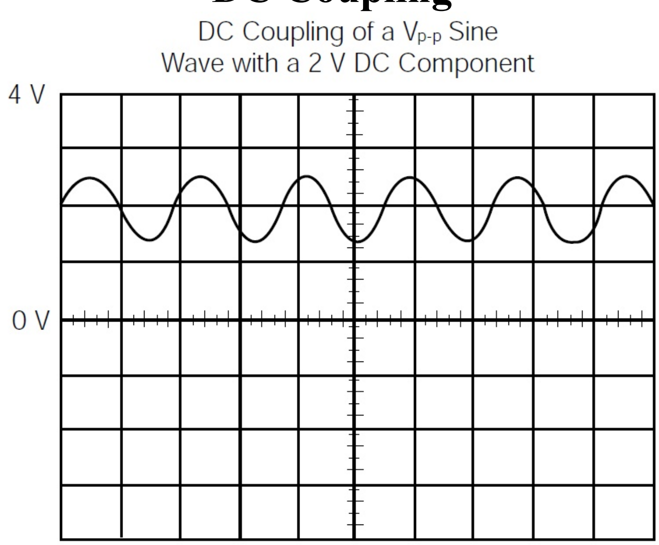
Fluke Benchtop Multi-meter



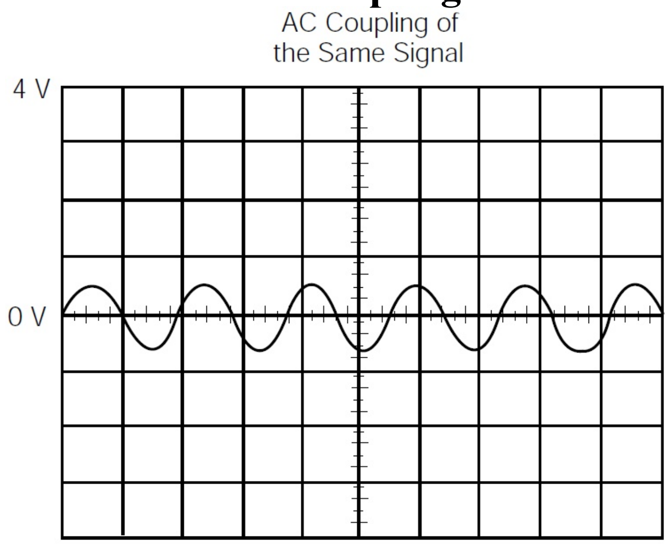
Textronix TBS2000 Oscilloscope



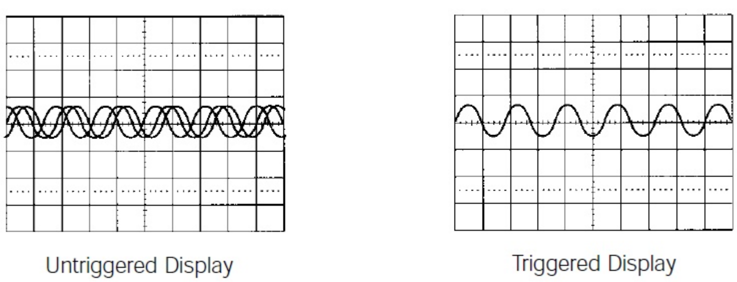
DC Coupling



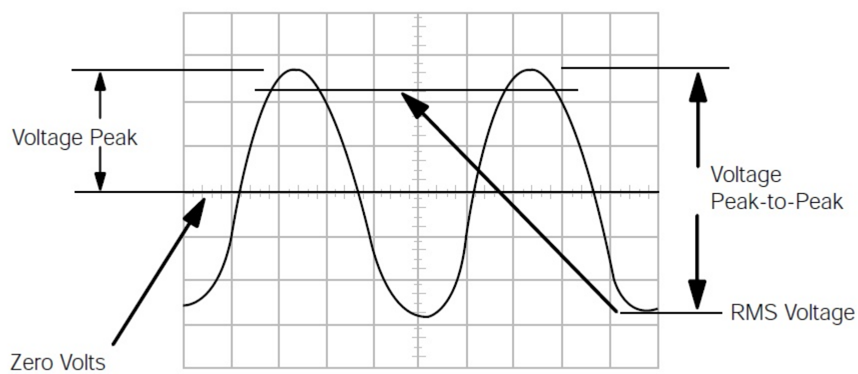
AC Coupling



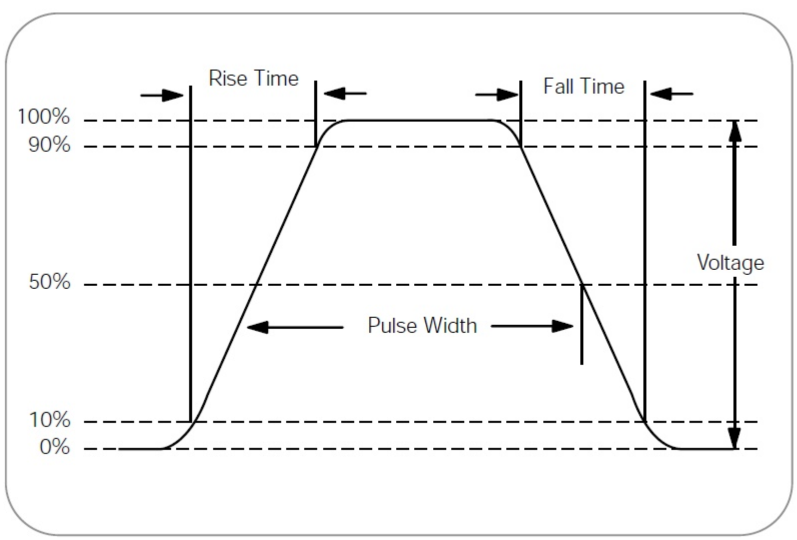
Scope Triggering



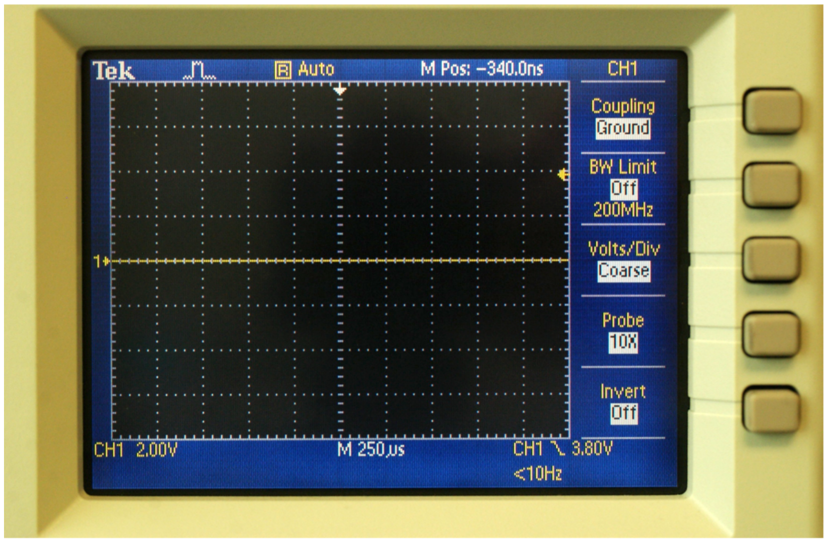
AC Voltage Measurements



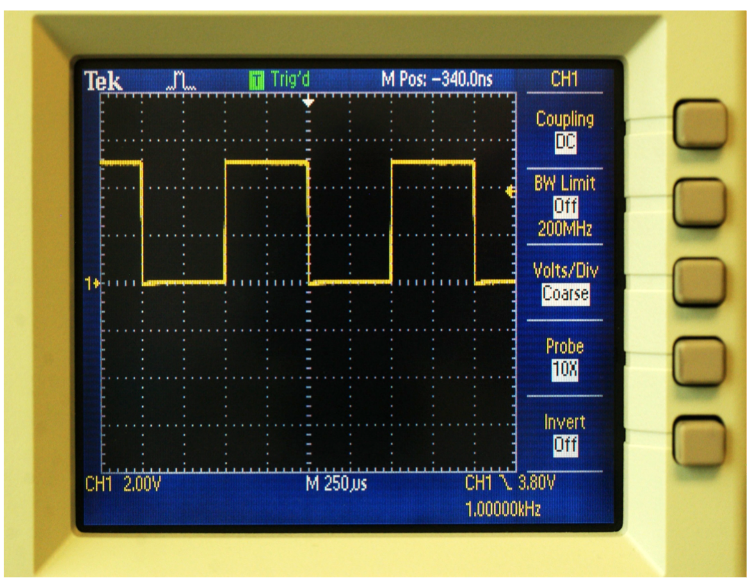
Measuring Rise and Fall Times



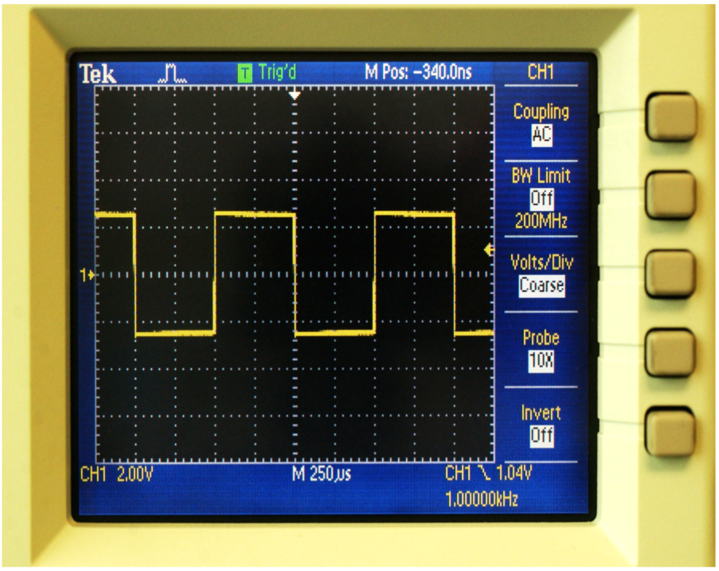
Ground Display



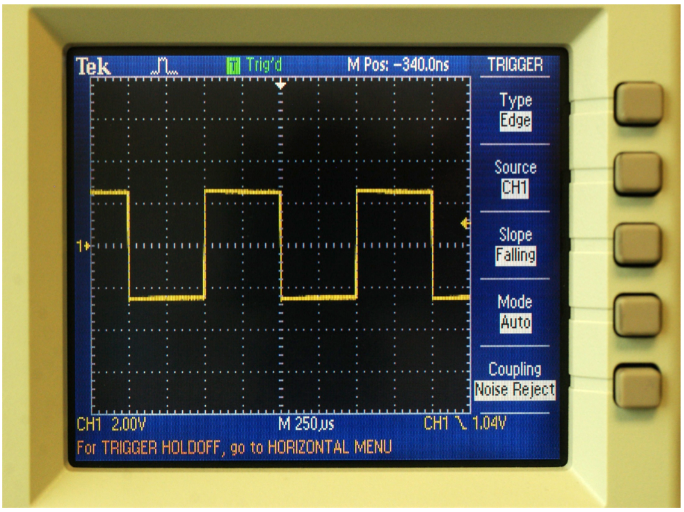
DC Coupling



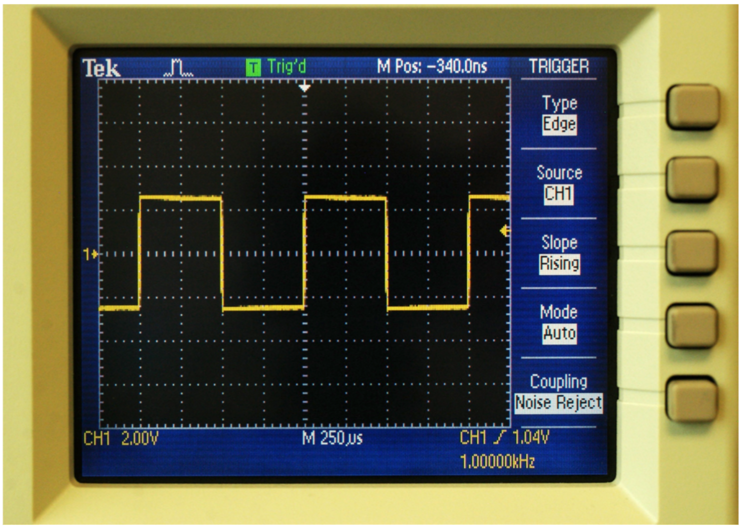
AC Coupling



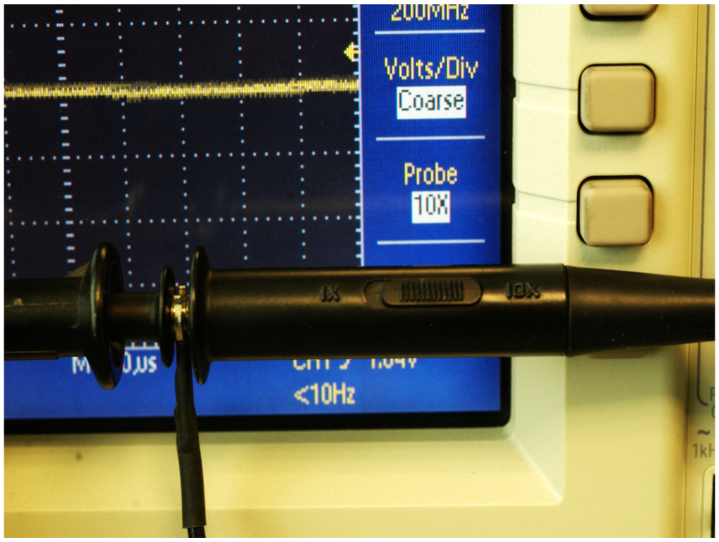
Falling Edge Triggering



Rising Edge Triggering

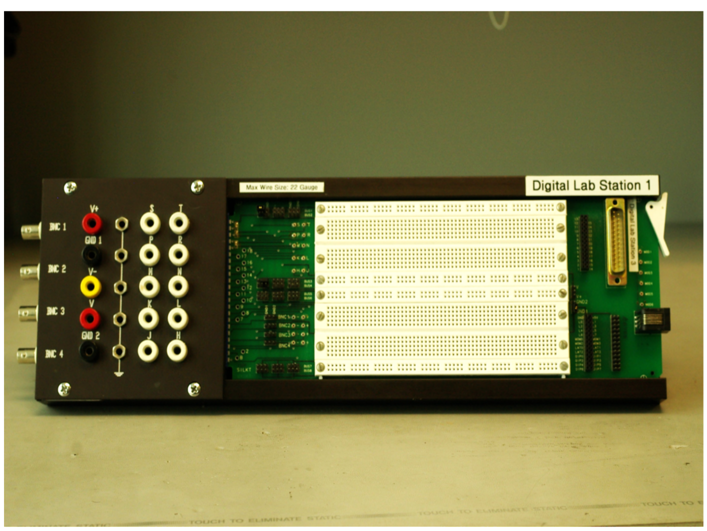


Probe Calibration



Probe Calibration

Lab Breadboards



Lab Breadboards