UMass ECE 210 – Fall 2023

Lab 1: AC signals (Intro to lab equipment)

GOALS:

- Learn about lab equipment:
  - Signal Generator – alternating current (AC) signals
  - Oscilloscope – measure and save signals

- Learn about AC signals:
  - Root Mean Square (RMS) voltage
  - Average voltage

DATA required for Lab report:

PLOT – Sine wave	
PLOT – Square wave	
PLOT – Triangle wave	
PLOT – Sine wave with offset	

Lab report (Due in 1 week):

1. Introduce concepts and justification for experiment.
   a. Voltage, current, AC signals, RMS etc.
2. Describe your experimental setup in a diagram for each plot
   a. Label all equipment, voltages, currents (with direction).
3. Present measurements with plots that are clearly labeled
4. Analysis for each plot – How well does data match prediction?
5. Conclusion – Summary of concepts and data and ways to improve measurements (See template for more details)

You will need to RECORD all of your data independently.

Failure to record your data properly or take notes about your procedures will leave you **unable** to write your lab report.

TAKE CAREFUL NOTES and RECORD everything!

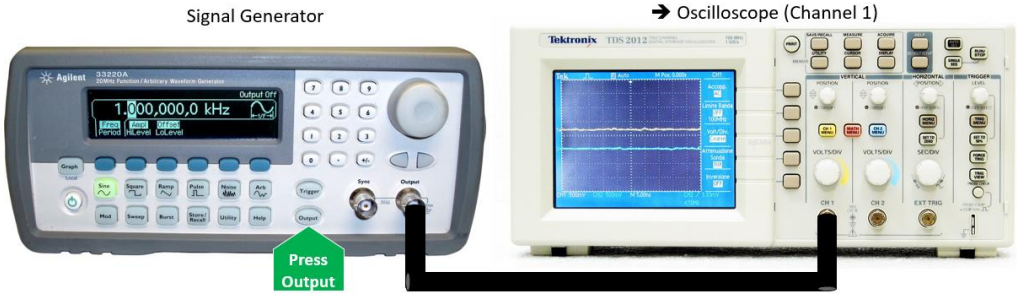
Measuring RMS voltage with Oscilloscope

To begin we will start by learning how a signal generator and oscilloscope work through an example of measuring the RMS voltage of the signal generator on the oscilloscope.

If you haven't already installed UltraSigma and UltraScope on your laptop, see appendix.

1. **Signal Generator:**
   i. Turn on the power to the signal generator
   ii. Change waveform type to **SINE WAVE**
   iii. Set the frequency to **1 kHz**
   iv. Set the maximum Voltage to +**1.0 V**
   v. Set the minimum Voltage to **-1.0 V**
   vi. **Turn on the 'output'**

2. **Oscilloscope**:
   i. Turn on the power to the oscilloscope
   ii. Connect the signal generator to the oscilloscope (Ch 1) with a **BNC cable**
   iii. Press the "AUTO" button on the oscilloscope to automatically range the axes.
   iv. Try adjusting the **vertical** 'SCALE' by rotating the knob
   v. Try adjusting the **horizontal** 'SCALE' by rotating the knob



3. Press the 'MEASURE' button on the oscilloscope:
   i. Measure and RECORD the peak-to-peak voltage ('vertical' measurement)
   ii. Measure and RECORD the RMS voltage ('vertical' measurement)
   iii. Measure and RECORD the time period ('horizontal' measurement)

4. Calculate the RMS voltage of your signal. (It should match your measurements exactly)

5. **Save the oscilloscope data of the signal:**
   i. Open UltraSigma (see instructions in appendix)
      i. Right Click to launch UltraScope from within UltraSigma
      ii. Save raw data or screen captures with cursors and measurements.

6. Record details about how your data was taken:
   i. Sketch a diagram of all equipment used in your notes
   ii. Sketch the final plot (roughly draw the wave and label the axes)

Square Wave:

1. **Signal Generator:** Change the waveform type to **Square Wave**
2. Measure and RECORD the peak-to-peak amplitude (‘vertical’ measurement)
3. Calculate and RECORD the RMS voltage from the pk-pk voltage.
4. Measure and RECORD the RMS voltage (‘vertical’ measurement)
5. Measure and RECORD the period of the signal (‘horizontal measurement)
6. **Save the oscilloscope data of the signal**

Triangle Wave:

1. **Signal Generator:** Change the waveform type to **Triangle Wave**
2. Measure and RECORD the peak-to-peak amplitude (‘vertical’ measurement)
3. Calculate and RECORD the RMS voltage from the pk-pk voltage.
4. Measure and RECORD the RMS voltage (‘vertical’ measurement)
5. Measure and RECORD the period of the signal (‘horizontal measurement)
6. **Save the oscilloscope data of the signal**

Sine Wave with offset:

1. **Signal Generator:**
   i. Change waveform type to **Sine WAVE**
   ii. Set the maximum Voltage to +**2.0 V**
   iii. Set the minimum Voltage to **0.0 V**

TRIGGER: You may notice that now that the sine wave has an offset voltage that the sine wave doesn’t seem to cross through the center of the screen anymore. This is because the ‘trigger’ at which the oscilloscope aligns each wave is set to zero, but your signal isn’t expected to cross at zero anymore.

2. **Find the Trigger adjustment and center it at the offset of your wave so it is symmetric again. (Raise trigger level from 0V to +1V)**
3. Measure and RECORD the peak-to-peak amplitude (‘vertical’ measurement)
4. Calculate and RECORD the RMS voltage from the pk-pk voltage.
5. Measure and RECORD the RMS voltage (‘vertical’ measurement)
6. Measure and RECORD the period of the signal (‘horizontal measurement)
7. **Save the oscilloscope data of the signal**

LAB REPORT DUE NEXT WEEK

Start outlining report. Do you have all the data you need?

Do you need to take pictures of your setup?

DETAILED RUBRIC ON NEXT PAGE

Lab Report 1 – Rubric

To practice your technical writing skills, you will write a concise (short) lab report which is a self-contained document, introducing important concepts with citations to a few sources, motivating your experiment, presenting your experimental setup and your experimental results (PLOTS, TABLES etc.) and analyzing your results to verify the concepts you introduced were confirmed within the precision of your measurements.

Lab reports should focus on proving to the reader that you made the measurements accurately and precisely. Meaning you will need to take pictures of your circuit and setup and present data in well labeled figures that are easy to interpret towards your conclusions.

2,000-word limit 1 report/group

Focus on presenting your data clearly with well labeled plots. You can use any plotting software.

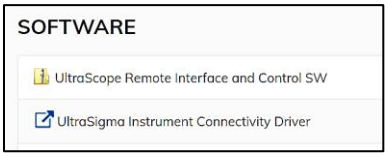
		Points	**Grade**
	Introduce and define concepts (with citations)	5	
	Motivation for experiment	5	
1	Experimental Diagram (with labels)	5	
	PLOTS – AC signals from signal generator on oscilloscope	10	
	Analysis (RMS voltage: calculation vs. measurement)	10	
2	**PLOT – AC signal with offset on oscilloscope**	5	
	Analysis (RMS voltage: calculation vs. measurement)	5	
	Conclusion	5	
		50	

1. Introduce concepts and justification for experiment.
    a. RMS voltage
2. Describe your experimental setup in a diagram for each plot
    a. Label all equipment, voltages, currents (with direction).
3. Present measurements with plots that are clearly labeled.
4. Analysis for each plot – How well does data match prediction?
5. Conclusion – Summary of concepts and data and ways to improve measurements.

Oscilloscope software

Downloads: https://www.rigolna.com/products/digital-oscilloscopes/1000z/

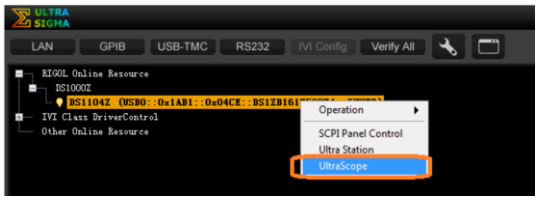
1. Download and install – "UltraSigma Instrument Connectivity Driver" (>500MB!!)
2. Download and install – "UltraScope Remote interface and Control SW"



3. Plug in USB in the back left of the oscilloscope and your laptop

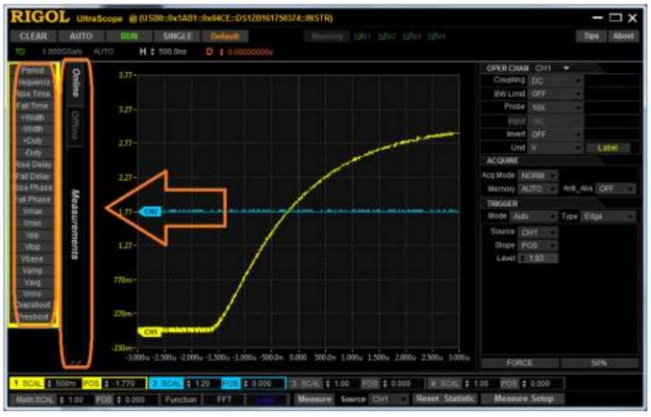
UltraSigma:

4. Launch UltraSigma (not UltraScope). Verify connection.
5. In UltraSigma: Right click on oscilloscope
   a. Choose >> 'UltraScope'



UltraScope:

6. **Configure measurements:** Measurements tab on LEFT side of screen (click 'ONLINE')



7. **Save DATA:** Right click >> Print Instrument Screen'