University of California, Davis
College of Engineering
Department of Electrical and Computer Engineering

Experiment No. 1
Electronic Test Equipment and Measurements

Objectives

1) To become familiar with commonly encountered laboratory equipment including, function generators, oscilloscopes, and multimeters.

2) To develop proficiency in laboratory techniques for the measurement of circuit parameters such as resistance and signal parameters such as rise and fall times.

Required Equipment

1) Oscilloscope
2) Power Supply
3) Digital Multimeter (DMM)
4) Function Generator

Prelab

Reading: 1) "Analog Circuits Laboratory Instrumentation and Measurement Techniques"
2) "The XYZ's of Oscilloscopes" by Tektronix

Procedure:

Use of the Oscilloscope

1) After letting the oscilloscope warm up for 1 minute, check the vertical amplifier calibration. Use the scope to apply a calibration signal (a square wave) to one of the vertical inputs. Verify that the scope is calibrated.

2) Next, set the external trigger control to "LINE" and one vertical input to the DC mode. Short the vertical input to ground and set the vertical position control so that the trace is at a convenient reference point. Now

connect a DC power supply to the vertical input and vary the supply voltage. For three significantly different supply-voltage settings (e.g., 1V, 5V, 10V), check the accuracy of the meter on the power supply by also using the scope to measure the DC voltage.

3) Now connect the sine wave generator to the vertical input. Set the frequency to about 1 kHz. Move the trigger control to "coupling DC". Determine the frequency by measuring the period of the sinusoid with the scope. How closely does it agree with the generator setting? Vary the "TRIGGER LEVEL" control and note the effect on the waveform.

4) Using a function generator from an adjacent bench, apply another sine wave to the second channel of the oscilloscope. Place the scope in X-Y (or A-B) mode and generate Lissajous patterns. Set one function generator for a frequency of 100 Hz and the other for 200 Hz, then 300 Hz and finally 400 Hz. Determine what happens to the vertical or horizontal lobes as the frequency on one channel is swept through multiples of the frequency on the other channel.

5) Return the scope to its normal operating mode. Using one function generator, send a 1-MHz 5-Volt square wave to the oscilloscope. Note the shape of the waveform.

6) Using the markings on the oscilloscope screen, measure the rise and fall times of the signal (the “10% to 90%” rise and fall times).

7) Using the delayed sweep, make another measurement of the rise and fall times of the signal.

Resistance Measurements

8) Obtain a small resistor (< 100Ω). Measure and record the exact resistance using the multimeter. Compare this value to the ideal value of the resistor.

AC Voltage Measurement with the Digital Multimeter (DMM):

Background: RMS amplitude (rms = root-mean-square) is a way of describing a signal’s amplitude. If we **square** a periodic signal, take its average over one time period, and then take the **square root** of that, we get the rms value of the signal.

If a sinusoid has a peak amplitude of A Vp (which corresponds to a peak-to-peak amplitude of 2A Vpp), it has an rms value of 0.7071A Vrms. Note that this is a relation for sinusoids only; the ratio of peak amplitude to rms amplitude is different for different wave shapes.

9) With the function generator connected to the scope, set the generator for a 1-kHz sine wave with 0 V offset. Then, set the amplitude as high as the function generator will allow. Measure and record the peak amplitude of the sinusoid using the scope.

10) Disconnect the function generator output from the scope and connect the generator output to the appropriate inputs of the DMM. Set the DMM to measure AC Voltage and choose the lowest voltage range (200 mV). Select the DMM range until the correct voltage is displayed with the most significant figures. Record the displayed (rms) voltage.

    Recalling that the rms amplitude is 0.7071 times the peak amplitude (A Vrms = 0.7071A Vp), convert the rms voltage just measured to peak voltage. If this value is not close to the value measured in (b), then there is some error. Note that the DMM is more accurate than the scope.

11) Set the function generator, with frequency at 1 kHz, to an amplitude of exactly 1.00 Vrms amplitude as **shown on the DMM**. Now increase the generator frequency (do it in big steps: 10 kHz, then 100 kHz, then 1 MHz) until the DMM reading falls by a least 2%; now search downwards in frequency until you find and record the frequency (above 1 kHz) where the DMM reads 0.980 Vrms (a 2% decrease).

    Now adjust the frequency below 1 kHz to find where the DMM reading falls by 2% and record that frequency, too.

    Since the function generator amplitude varies little over the whole frequency range, the roll-off of the displayed rms voltage is due to the limited capabilities of the DMM. (You can verify, using the scope, that the function generator output amplitude is remaining constant as you change frequency.) Therefore, you should note that you can use the DMM reliably only between the above frequencies for AC measurements.

DC Voltage Measurement with the DMM

Now set the DMM to measure DC volts (not AC volts). For each measurement, set the DMM scale to the range that gives you the most significant figures. The scope can measure DC voltage, but not as accurately as the DMM.

12) Connect the largest available positive DC voltage supply to the DMM. Turn the power supply's DC voltage amplitude knob to its maximum, and measure the voltage. Turn the DC voltage amplitude knob to its minimum; measure the voltage.

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CHECKLIST for LAB. #1

ITEM	**TA REMARKS**
Part 4	
Part 9	

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