

LAB 2. Instrumentation

Objectives

A brief description of the equipment (Oscilloscope, Function Generator, Power Supply, and Digital Multimeter) and its operational principles are discussed. The students are urged to read the operational manuals of the equipment and do all the pre-lab problems before coming to perform the experiment designed to familiarize to the equipment.

In this experiment the students will learn how to use :

- i) Oscilloscope
- ii) Function Generator
- iii) Digital Multimeter
- iv) Power Supply

Ground

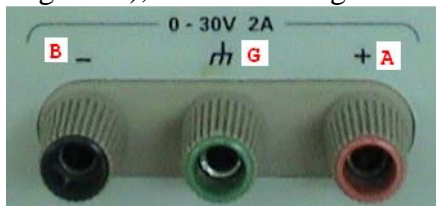
The issue of ground connections is a concern in the lab. Lab instruments have terminals so that we connect them to circuits. For example, in the Tek PS 280 Dual Power Supply, we see plus(+) and minus(-) terminals.



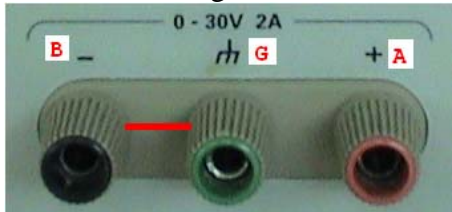
The voltage between the two terminals is well defined by your setting. Also, we see the third terminal (called "ground") between plus and minus terminals. The ground terminal may be connected to the internal chassis of the power supply ("chassis ground") and to the ground lead of the power cord's plug.

When you plug in the power supply, the ground lead of the power cord comes in contact with the ground terminal of the power outlets on your bench, which is connected to earth potential for safety. In fact, other instruments on your bench, on other benches, or even elsewhere in the building may have their grounds connected to that same point, through the third wire of their power cords.

When we use a power supply with output floating (i.e., neither plus or minus terminal connected to ground), then the voltage between A and B, V_{AB} , is well defined as V .

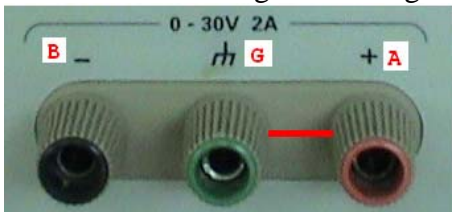


However, V_{AG} and V_{BG} are not defined. To avoid this, we should strap one of the two output terminals to the ground, as shown below.



Then, all the voltages are well defined: $V_{AB}=V$, $V_{BG}=0$, $V_{AG}=V_{AB}+V_{BG}=V$. By this we develop a positive voltage at terminal A.

When we need a negative voltage with respect to ground, we use the following connection.



Here terminal B has $-V$ with respect to ground.

Generation of Signal Using Function Generator

Tek CFG280 Function Generator can generate Outputs of Square wave, sine wave, triangle wave, TTL pulse, positive and negative ramp, pulse and skewed sine wave, AM, and sweep functions in the Frequency Ranges 0.1 Hz to 11 MHz. Main output amplitudes are:
 200 mV to 20 V p-p (open circuit)
 100 mV to 10 V p-p (50 Ω load)



Supplying DC power using DC Power Supply

See the Ground section we discussed above.

Measurement of the Signal using Oscilloscope and Multimeter

The oscilloscope (or simply "scope") is to display and measure time-varying signals (waveforms). We connect the generated signal from the function generator to a scope or a multimeter.

*NOTE: Read the manuals of Tek 2235 scope, Tek CFG280 Function Generator, and Tek PS280 power supply. They are available from the class note web site.

PRELAB - lab 2:

DATE: _____

NAME: _____

ID#: _____

1. Describe the functions of each of the following oscilloscope controls.

- a) Focus
- b) Vertical position
- c) A and B SEC/DIV Switches
- d) Input Coupling (AC-GND-DC) Switches

2. Calculate the time elapsed between two points on a waveform separated by 4 cm., if the sweep time of the scope is :

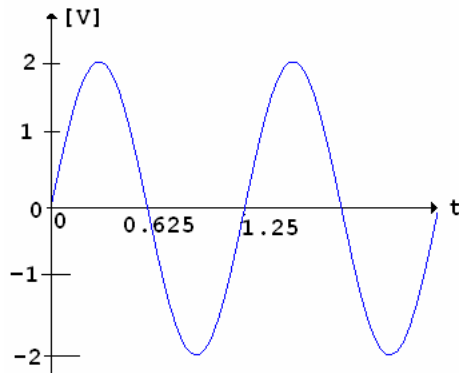
- a) 1 ms/cm
- b) 2 s/cm
- c) 50 μ s/cm

3. Sketch a 1 Volt peak to peak, 1 KHz. Square wave as it would appear on a scope with a horizontal sweep of 1 ms/div. and a vertical deflection of 1 Volt/div. A graph sheet must be used for this sketch and the units on each axis must be clearly indicated.

4. For the given Sine wave pattern on the scope, calculate

- a) V_{pp}
- b) T(period)
- c) Frequency

*note that the time in x-axis is in milli-second.



5. Explain and draw a connection diagram of terminals, using the Tek PS280 dual power supply, how to generate dual voltage of +5Vdc and -9V dc.

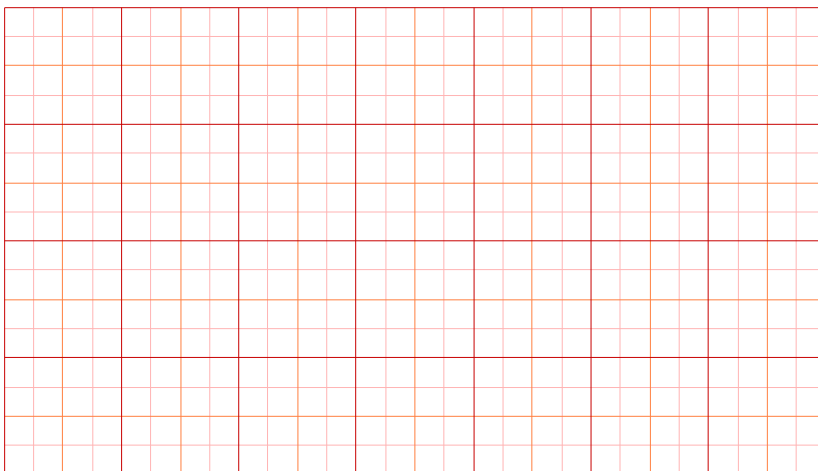
LAB PROCEDURE - lab 2:

(A) DC and AC measurements Using Scope and Digital Multimeter (DMM):

1. Using channel 1, obtain a horizontal sweep on the scope. Using the GROUND switch (#12), center the sweep on the scope. This is your Zero voltage reference line. Set the sensitivity switch (#9) at 2V/div. and turn switch #12 to dc.
2. Using a **DC power supply**, apply +4 volts to channel 1 input terminal. Observe the deflection (up or down) of the sweep on the scope. Adjust the power supply until you get exactly +4 volts on the scope. Check the zero reference to make sure that it is not disturbed and go back to see that you have +4 volts.
3. Change the sensitivity to 1V/div. Using the vertical control switch (#15), bring back the sweep on the scope. How can you measure the +4V (which is what you have) with this setting? (you must have a zero volt reference somewhere on the scope). If necessary, you may have to adjust the DC power supply to get exactly +4 V on the scope.
4. Observe the same +4 Volts using 5 V/div.
5. Now, measure the voltage from the function generator, using the Digital Multimeter, with DC and AC reading sets.
6. Now, supply -4 V DC and repeat the above steps. If one of the settings cannot be used for this measurement, state this in the appropriate column.
7. Enter all your readings in the following Table.

	SCOPE			DMM	
	1 v/div	2 v/div	5 v/div	AC set	DC set
+4V dc					
-4V dc					

(B) Using the **Function Generator**, apply a sine wave (any convenient magnitude and any frequency) to Ch. 1 of the SCOPE. Make certain that the waveform is stable by using proper controls. Now, adjust the sine wave to $8V_{pp}$ at some frequency so that you can see at least 2 cycles of the waveform on the scope. Sketch the waveform here. Indicate V_{pp} and the time period (T) of the wave.



Also, measure the sine wave using the DMM with AC and DC sets.

Record the readings of DMM here.

DC: _____
 AC: _____

(C) Frequency Measurements Using the Time Base on the Scope

Use only one channel (eg. Ch. 1) of SCOPE.

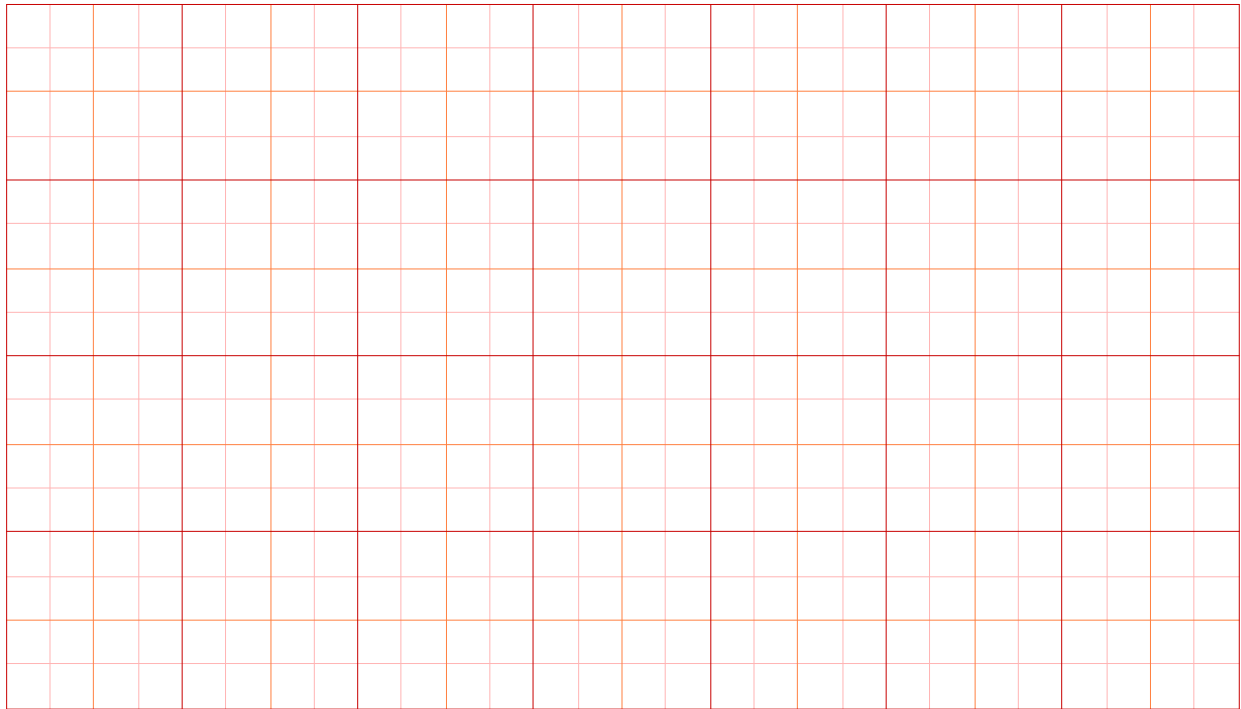
Using the function generator (FG.), apply a $4V_{pp}$, 750 Hz. sine wave to the scope. Note that the reading of f of the signal on the FG is only approximate. The accurate value is calculated by measuring the period of the wave accurately on the scope, or by the use of a frequency counter.

Display the largest possible wave on the scope so as to get the best possible readings for the amplitude as well as the time period.

Measure the time period and calculate $f = \frac{1}{T}$. $T =$ _____ $f =$ _____

Use DMM with AC set to read the voltage of the waveform. _____

Sketch the waveform and indicate V_{pp} and T.



DISCUSSION POINTS

What to submit:

1. The two page lab measurement (with my signature)
2. 1 or 2 page long discussion

*Note: No cover sheet.

But on each page, your name clearly, and Group Number (or names of the students you worked together)

Submission must be done before lecture starts - Late submission is not accepted.

What to discuss?

This is some triggering idea and suggestion for you think about your discussion topic(s). Pick a few for your discussion which arose some interest and questions.

- (a) When there is discrepancy among suppliers and measuring instruments, which one do I believe would be correct? How do I know that? Is there any mechanism or function in instrument to solve this kind of problem?
- (b) When a function generator produces a sinusoid (sine waveform) of a frequency, how do I know it produces a pure sinusoid with the prescribed frequency? Or how do I know the waveform is not purely sinusoid, or the frequency is not actually the frequency the function generator indicates it produces?
- (c) When a sinusoid of peak-to-peak 8V is measured by a DMM with AC coupling, why the measured value is not 4V or 0V? When a sinusoid of peak-to-peak 4V is measured by a DMM with AC coupling, why the measured value is not 2V or 0V? What is the ratio of the magnitude (peak-to-zero, which is half the peak-to-peak) and the DMM measured value of a sinusoid of peak-to-peak 8V case? What is the ratio for a sinusoid of peak-to-peak 4V case? Any surprising coincidence or fact here?
- (d) What's the advantage of Scope over DMM in measurement?
What's the disadvantage of Scope compared with DMM in measurement?
- (e) Any other subject?

APPENDIX: SETTING UP OF THE SCOPE:

1. Turn ON the scope and do not turn it OFF until all your measurements are completed. The scope works better when it is warmed up.
2. Set the TRIGGER switch (# 25) to AUTO.
3. Set the SOURCE switch (# 29) to INTERNAL.
4. You may see a horizontal sweep on the scope. If not, press the BEAM FIND SWITCH (# 6) and adjust the horizontal and vertical positions to bring the bright spot to the center of the screen.
5. Apply a wave to Ch. 1 using the function generator. Adjust the INTENSITY (# 8) and FOCUS (# 4) switches to obtain the best trace. NOTE that the intensity must be as low as possible in order to **AVOID DAMAGE TO THE SCREEN** and to get accurate readings. Sometimes it may be necessary to adjust the TIME BASE switch (# 18) to obtain a stationary trace.
6. The TRIGGER LEVEL SWITCH (# 27) may be used to stabilize the display.
7. The red switches (# 10 and # 20) must be turned all the way to the right to the CAL. position (until a click is heard), otherwise the readings will not be accurate.
8. When using both channels, use switch # 14 on CHOP mode.