Laboratory 1.1	**DC Circuits**
Name	**Section**

PURPOSE

1. Become familiar with the operation of the oscilloscope, the breadboard, and the signal generators.
2. Measure voltage differences around a simple circuit.
3. Experiment with a voltage divider.
4. Experiment with a current divider.

COMMENTS

Somewhere on or near your breadboard you will have a power supply with connectors for plus and minus voltages and a common return. In some cases this common return will be connected to an actual ground within the supply. Although you cannot see it, the oscilloscope and signal generator instruments also have one lead connected to this ground. You will not need the plus and minus power supply voltages for this exercise, but we will visibly interconnect the grounds of all devices.

In this and future exercises, be particularly careful when placing wires near any power contacts. The power supplies, the signal generator, the push buttons, the potentiometers, and the speakers can be easily destroyed by incorrect connections. **Leave the breadboard power off unless needed!**

SPECIAL EQUIPMENT

A 10 kΩ or similar potentiometer is needed.

A. Oscilloscope

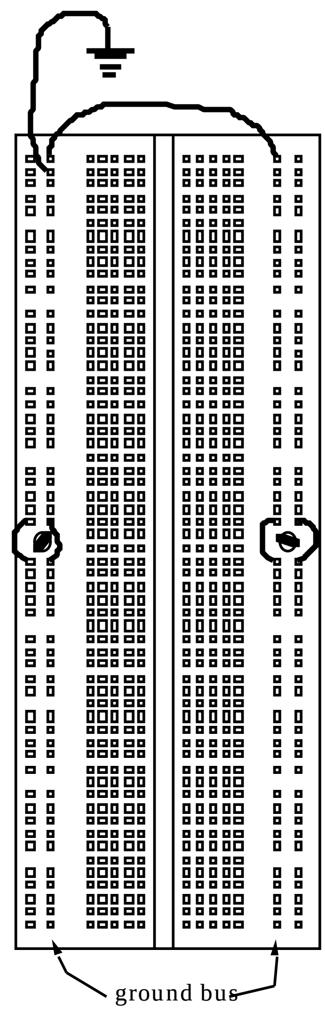
1. Oscilloscope preparation

a. Cut and strip the ends of three 3" lengths of wire. Connect one to each probe tip, and one to the ground clip of the probe leading to the A channel. The scope probes are heavy and direct connection leads to problems, so always use the probes with these wires in place.
b. If the probes on your oscilloscope have 1X and 10X switch positions, set them to the 10X position. This mode divides the input signal by ten, but has several advantages that will become more apparent later. Get in the habit of always using this mode.
c. Set the flip switch on channels A and B to the DC position, and move the MODE switch to the third position (DUAL, ALT, or CHOPPED depending on your scope brand.).
d. On both channels, set the volts/cm rotary switch to 0.1 V (With a 10X probe this position corresponds to 1 V/cm), and confirm that the smaller knob is fully clockwise (calibrated).
e. Set the sweep time to 1 ms/cm and verify that the smaller knob is again fully clockwise.

f. In the triggering section of your scope controls (usually outlined on right side of scope), adjust the controls for AUTO triggering on the A channel and center the TRIGGER LEVEL control. You will find a 5X sweep expansion switch somewhere in this area (perhaps on the HOROZONTAL POSITION knob); make sure that it and all other triggering features of your scope are disabled.
g. Verify that the HOROZONTAL POSITION knob is centered.
h. Switch on the scope, and in a few minutes you should have two horizontal lines on the scope face. Use the two VERTICAL POSITION controls to adjust the A sweep into the top half of the display and the B sweep into the bottom half.

2. Breadboard preparation and connection of the signal generator

a. If they are not present, insert the four short jumper wires shown on the figure. These produce four long "power" buses that run the length of the breadboard (50 holes each).
b. Cut a wire and connect the two inner strips near one end of the breadboard: these will become the common or ground bus for all of your circuits. In later experiments, you will need to use the two outer strips for power connections.
c. Connect the ground from your signal generator to one of these inner strips then connect the ground of your A channel scope probe to a nearby point on the same strip.
d. Set your signal generator to give a 1 kHz signal and connect your A scope probe to the signal generator signal lead and experiment or seek help until you obtain a stable sinusoidal display on your oscilloscope with a 1 volt amplitude. Be sure it is the amplitude that is 1 volt!
e. If you have a second signal generator, connect it to the B channel and adjust it for a 1 volt amplitude 2 kHz signal. You may need to power up the breadboard for this test. Turn it off when finished with this test. Note that if the two frequencies are equal (or an integer multiple) the A and B signals will show no relative drift?



3. Oscilloscope controls

Experiment with the controls on your oscilloscope, particularly the vertical sensitivity and the triggering. Seek help for features or results that you do not understand.

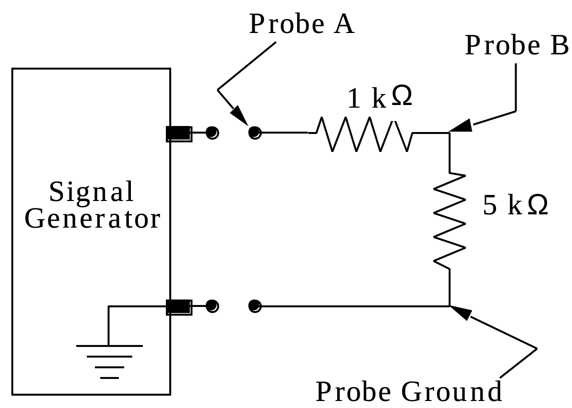
B. Measure Voltage Differences

Build the simple circuit shown, then measure the amplitude of the signals at A and B with respect to ground.

v_A = v_B =

If your oscilloscope has an ADD position on its MODE switch, select that position then find the control that inverts channel B signal and set it so that your display shows $v_A - v_B$. Measure the amplitude of this signal and verify that it is as you expect.

$v_A - v_B$ =

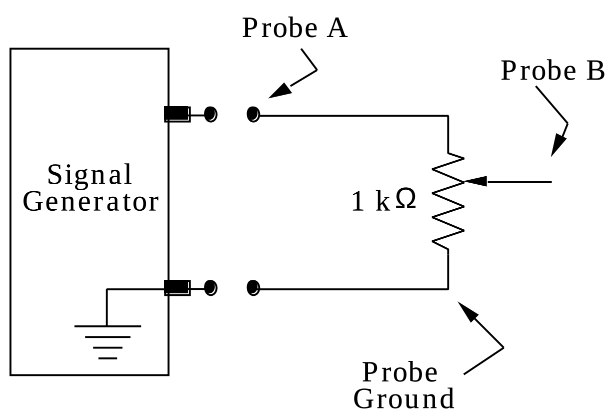


C. Voltage Divider

1. Display the signal generator output, note its amplitude, then connect the 1kΩ potentiometer as shown. Connect the B probe to the sliding output of the potentiometer.

   a. Why does the A signal become smaller when the potentiometer is connected?

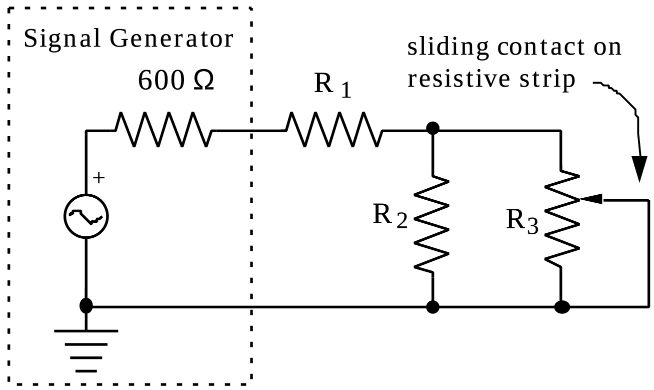
   b. Describe how the B signal amplitude varies with the potentiometer setting.



D. Investigate a Current Divider

1. Build the current divider shown below, using $R_1 = 10\ \text{k}\Omega$, $R_2 = 20\ \text{k}\Omega$, and a potentiometer $R_3 = 10\ \text{k}\Omega$ or a similar value.

   a. With the potentiometer set so that the maximum resistance is in the circuit, measure the voltages, v_A and v_B, and use Ohm's law to calculate the currents in R_1, R_2. and the in-circuit part of R_3. Write algebraic expressions for the currents before using the actual component values.



v_A = v_B =

i_1 = =

i_2 = =

i_3 = =

   b. Reduce the potentiometer to about one-quarter of its maximum setting (just estimate this from the knob rotation), and again measure the voltages and calculate i_3 with the assumption that R_3 is one-quarter of its maximum value

v_A = v_B =

i_3 =

   c. Draw the schematic when the potentiometer R_3 is set to zero Ohms in the circuit. Simplify your sketch by removing branches that carry no current, then calculate the current through sliding contact.

i_3 =