

Voltage and Current Division

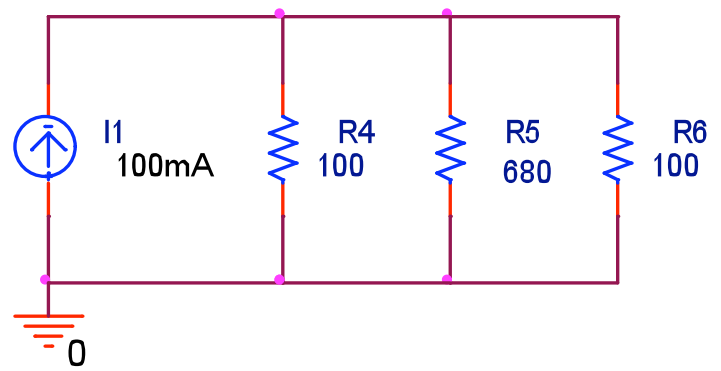
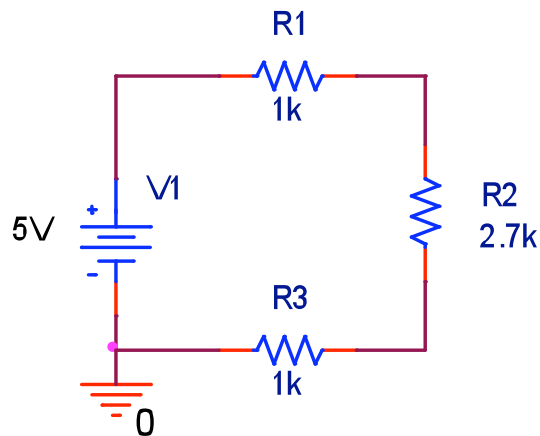
Purpose: Apply the theory of voltage and current division.

Equipment Required

- 1 - Digital Multimeter
- 1 - Triple Power Supply (with current limit)
- 1 - Protoboard
- 1 – 2.7k Ω 1/4W Resistor
- 2 – 1k Ω 1/4W Resistors
- 1 - 10k Ω potentiometer
- 2 – 100 Ω 1/4W Resistors
- 1 – 680 Ω 1/4W Resistors

Prelab

In your journal, find the voltages V_{R1} , V_{R2} and V_{R3} in the circuit of Fig. 1, and the currents I_{R4} , I_{R5} and I_{R6} in the circuit of Fig. 2. Show your work.



Procedure**1. Measure element values**

Measure and record the actual resistance of each resistor that will be used in constructing the circuits of Fig. 1 and Fig. 2. Label the two $1\text{k}\Omega$ resistors with their values so that you can keep track of their final locations in the circuits. Measure and record the output voltage of the power supply, V_S .

2. Prepare a data table

In your journal create a table — similar to the one below — for recording your data. Enter the data already collected into the appropriate cells. Redo the analysis using the actual measured values of your resistors, which will eliminate the calibration error of the components. In your lab journal draw a new schematic diagram similar to Fig. 1, except on this schematic label the elements with the actual (*measured*) resistance and the newly computed voltages

Voltage divider circuit data

A	B	C	D	E	F	G
Component label, or signal variable	Nominal R value (From color code)	Nominal voltage (from Prelab)	Actual meas. resistance of R's	Expected voltage drop (use meas'd Rs)	Actual meas'd volts	% error Voltage COL E to COL F
R_1, V_1	$1\text{k}\Omega$					
R_2, V_2	$2.7\text{k}\Omega$					
R_3, V_3	$1\text{k}\Omega$					

3. Collect voltage divider data

- a. Ensure that the power supply is off. On a protoboard, construct the circuit of Fig. 1. Remember to track the location of the resistors. Turn on the power supply and measure the voltages V_{R1} , V_{R2} , and V_{R3} . Record these values in the data table.
- b. Fill in the column labeled "% error". Compare the measured voltage (column F) to the voltage predicted using the actual measured resistance values (column E). The error listed in the last column should be less than 5%. If

your error is greater than 5%, try to find the reason. Explain the source of the error you do get. Does $V_{R1} + V_{R2} + V_{R3} = V_s$ for both the computed and measured values? Explain your answer.

4. Examine a current divider

Create a table in your journal similar to the one used for the circuit of Fig. 1, but which is modified to record the amperage data for the circuit of Fig. 2. Compute the currents I_{R4} , I_{R5} , and I_{R6} , and record them in your table. With the power off, construct the circuit of Fig. 2. Use the ammeter to measure I_{R4} , I_{R5} and I_{R6} . Always turn off the power before making changes in your circuit (such as moving the ammeter to measure current through a different resistor). Record these measured values in your table, compute the error and answer the questions as in Part 3.

5. The potentiometer

In this part of the exercise you will learn how to use a potentiometer, and why it works.

- a. Measure the resistance between the two outermost terminals. With the ohmmeter still connected, rotate the shaft of the device. Record in your lab journal what happens to the measured resistance. Move one of the probes to the center terminal. Rotate the shaft again. Explain what happens in your lab journal.
- b. With the power off, construct the circuit of Fig. 4. Turn on the power supply. Adjust the potentiometer so that the output, V_{out} , is one volt. Shut the power off and disconnect the supply. Carefully, without moving the arm on the potentiometer, measure the value of the resistance between the upper terminal and the center terminal, and again between the lower terminal and the center terminal.

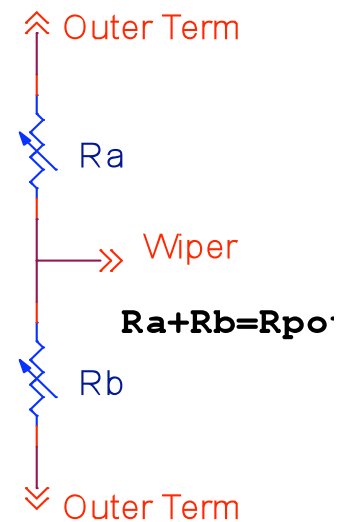


Figure 3

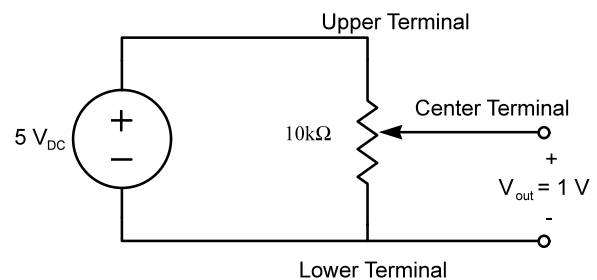


Figure 4

- c. Draw the equivalent voltage divider circuit in your journal, and label the resistances with their actual value. Use these measured values in the voltage divider equation to determine the expected output. Do these calculations support the contention that the potentiometer functions as a voltage divider?

6. Circuit design

You have gained some valuable experience with circuit analysis. Now you'll have an opportunity to apply what you've learned to a design problem.

Ask a lab instructor for a load resistor, R_{LOAD} . Your task is to design a circuit that will deliver $1.5V \pm 5\%$ across your particular load with the load connected. Figure 5 demonstrates the problem. The resistors available for use in the design are limited to those listed in Fig. 5.

As with most design problems there are constraints. (Since we don't have much money to spend on this problem your job will be to minimize parts count perhaps with a trade-off for accuracy.) In this case, your design must use no more than three resistors. A potentiometer would certainly work but costs way too much.

- Design and document in your journal a circuit that will meet the design criteria. Design often involves making informed guesses at a solution. For each of your proposed solutions record in your journal the schematic and other details. If the design is unworkable, explain why and then try another idea. Brainstorm until you have found a solution.
- Construct your proposed solution circuit. Verify that it meets the design criteria. When you have the circuit operational, demonstrate the design to your lab instructor. Have your instructor sign off on your design in your lab journal.

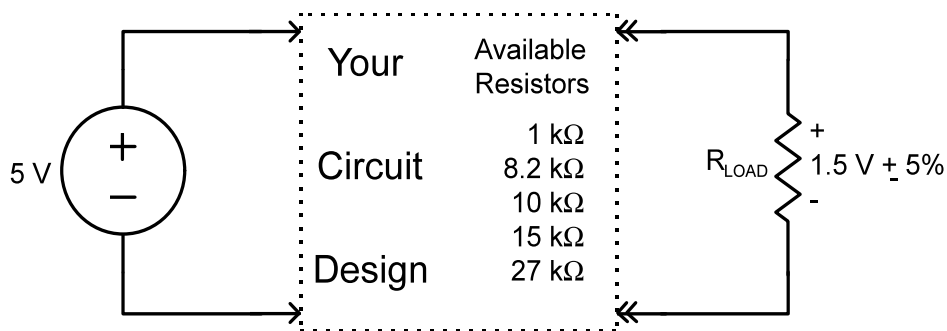


Figure 5