RESISTANCE, VOLTAGE AND CURRENT MEASUREMENTS

PURPOSE The purpose of this experiment is to study DC measurements of resistance, voltage and current. Voltage and current divisions as well as Kirchhoff's laws will be verified. The input resistance of X1 and X10 oscilloscope probes and their effect on circuit measurements will be considered. It is impossible to insert a meter in an electrical circuit without altering the circuit, thus the quantity being measured. This experiment will show that the addition of a digital multimeter changes the circuit very little, whereas the X1 oscilloscope probe makes a measurable change in the reading.

PART I. Resistance Measurements

Before making any voltage or current measurements the resistance of all of the resistors to be used in this experiment should be measured. In addition, the resistances seen looking into channel #1 of the oscilloscope with a X1 probe connected and when a X10 probe is used should be measured. The oscilloscope input resistances should be measured with the oscilloscope turned on, and with the oscilloscope turned off. This is a total of 9 resistance measurements. The Ohmmeter (and voltmeter) on the digital multimeter (DMM) uses the top two right-hand terminals on the DMM. (The two left-hand terminals are never used in this laboratory.) The two-wire resistance measurement should be used.

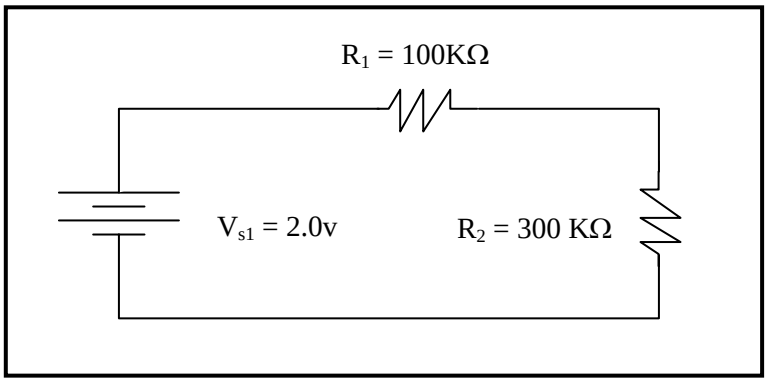

Figure 1. Voltage Divider

As part of the laboratory report the percent error (between measured and specified values) for each resistor should be calculated. Consider using a table to display the specified, measured and percent error values. Agilent Technologies specifies the resistances seen looking into the oscilloscope probes as 1MegΩ and 10MegΩ respectively. How close do your measured values come to the specification?

As a suggestion, the data sheet for this part could look like the following:

R_1 = _____ R_2 = _____ etc.

PART II Voltage Measurements

A. Unloaded Voltage Readings These measurements use Figure 1. The voltmeter in the DMM has an input resistance of over 10GΩ when the voltage is below 3 Volts. For this reason the voltmeter may be considered an open circuit for these readings. Three voltages (the input voltage and two resistor voltages) should be measured for the circuit. You should be able to show that the three voltages verify Kirchhoff's voltage law. In addition, voltage division may be used to verify the two resistor voltages. You may assume that the resistor values are as measured in Part I. The voltmeter uses the same terminals as the Ohmmeter in the DMM.

As a suggestion, the data sheet for this part could look like the following:

V_{s1} = _____ VR_1 = _____ VR_2 = _____.

B. Loaded Voltage Readings (X1 Probe) This part considers the change in voltage readings when a large resistor, such as an oscilloscope probe, is connected across one of the elements. (See Figure 2.) For this set of measurements the X1 oscilloscope probe should be added in parallel with R_2. (Note that the probe must also be connected to the oscilloscope and the oscilloscope turned on.) The three unloaded voltage readings of Part A above should be repeated. With the voltages on the two resistors you should be able to calculate the resistance seen looking into the oscilloscope probe. Again assume that the other resistors are as measured in Part I.

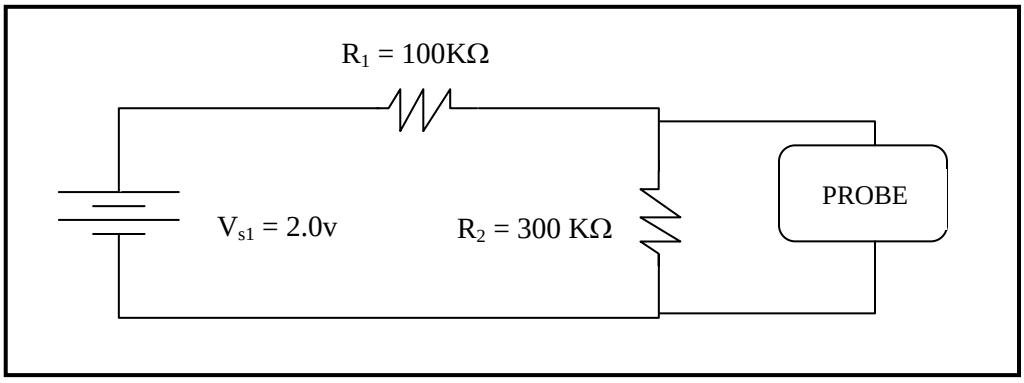

Figure 2. Probe Connection

As a suggestion, the data sheet for this part could look the same as the data sheet for Part A with a note saying that a X1 probe was added to R2.

C. Loaded Voltage Reading (X10 Probe) Repeat Part B for a X10 oscilloscope probe. You do not have to calculate the resistance looking into the X10 probe since it will be about 10MegΩ and therefore, will probably change the voltage very little.

PART III Current Measurements

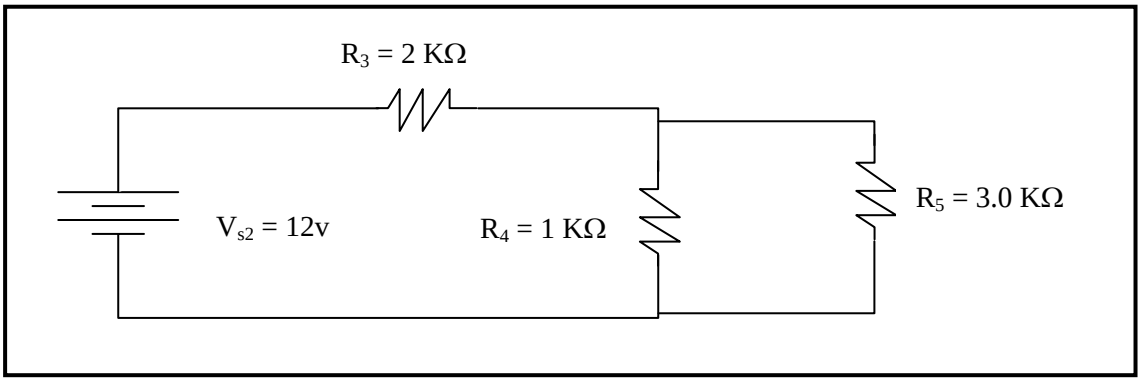

Figure 3. Current Divider

These measurements use Figure 3. Three currents (the three resistor currents) should be measured for this circuit. You should be able to show that the three currents verify Kirchhoff's current law. In addition, current division should be used to verify the currents in the two parallel resistors. You may assume that the resistor values are as measured in Part I. The ammeter uses the bottom two right-hand terminals on the DMM. (**Since current is a "through" (series connection) type variable, the circuit must be "broken" to insert the ammeter.**)

As a suggestion, the data sheet for this part could look like the following:

IR_3 = _____ IR_4 = _____ IR_5 = _____.

DISCUSSION TOPICS The following topics are suggested as things you possibly might want to discuss in the laboratory report. It is expected that most students will be able to provide additional insights, as well as connections between experimental and theoretical analysis. These topics are to be discussed in sentences and are not to be answered with one or two word answers.

1. Were Kirchhoff's laws verified?
2. Were current and voltage division verified?
3. Did the oscilloscope probes meet the advertised specifications?
4. Did the measured input voltage V_s match that shown on the source digital display?
5. How close to the color code values were the resistors. (Use a table. Give percentages)
6. Would you rather use a X1 or a X10 oscilloscope probe if you wanted to disturb the circuit as little as possible?

Pre-Lab (20 points) Prior to the laboratory meeting make a data sheet that can be used to record all of the data that will be taken during the experiment. The sheet must be computer generated. (Either a word processor or a spreadsheet should do the job.) The data sheet must have your name, your partner's name, and the date at the top. At the bottom there must be a line (with the appropriate name under it) for the instructor to sign. Be sure that you know your instructor's name.