Resistor Color Code, DMM and Proto Board

Lab Objectives

When this lab exercise is completed, the student should be able to:

1. Identify a resistor by type nominal value, and power rating.
2. Read the color code to identify the nominal value and tolerance.
3. Use the DMM to measure the resistance of a resistor.
4. Determine if the resistor is within the rated tolerance
5. Understand how the proto board is laid out
6. Identify which holes in a protoboard comprise a node.
7. Build a simple circuit on the proto board based on a circuit diagram.

Pre-Laboratory Preparation

Prior to your scheduled laboratory meeting time the following items need to be completed. (Note the prelab quiz will be based on this preparation.

1. **Research**
   a. On the internet, look up and print a Resistor Color Code Chart (in color). Use this for the quiz.
   b. Print out and read (in MyCourses) "Protoboard-DMM-Primer". Use this for the quiz.
2. **On Line Learning:**
   a. Click on this link and watch the video on Proto Boarding <u>before lab.</u> http://www.youtube.com/watch?v=oiqNaSPTI7w
   b. If the video doesn't load, search YouTube for a short introduction to the breadboard (protoboard) and see the "Proto Board and Digital Multi Meter" handout.
3. Preparation for the prelab quiz: The quiz for this lab will be on the following topics:

   a) Reading the resistor color code
   b) Calculating a resistor tolerance
   c) Measuring resistance
   d) Reading a data sheet
   e) Identifying the nodes in a protoboard

DC Circuits Lab Procedure- Part 1: Resistor Color Code and DMM

1. Pick up a box from your instructor with 8 resistors in it (or get 8 resistors from your instructor).
2. For each resistor determine the color bands that describe the nominal value, and record the color bands in the correct order in Data Table 1 below.
3. Decode the color bands, and determine the nominal resistor value and tolerance. Record this data in the data table with the band colors. (<u>**R_0 is shown as an example of how to record this data in the table**</u>.)
4. Using the DMM, measure each resistor, and record the actual value of resistance in the Data Table.
5. Calculate the percent error between the nominal value resistance as determined by the color code, and the value measured with the DMM. (<u>**See the lab notes at end of this handout for help on performing a % error calculation**</u>)
6. <u>Have your Lab Instructor or TA sign off on the completed Data Table 1.</u>
7. Discuss with your lab partners why a manufacturer's tolerance value is necessary, and why the resistors cannot be manufactured to 0 % tolerance.
8. Based on your discussion and lab work, answer the questions beneath Data Table 1 on the same page.
9. **Continue on to part 2.**

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	Data Table 1 Resistor Color Code									
	Color Bands (Color/Value)					Resistor Value				
	1	2	3	4	5	Nominal Value	Min Value	Max Value	Measured Value	Percent Error
R_0 (example)	Brown / 1	Red / 2	Orange / 3	Gold / 5%	None / n/a	12,000Ω	11,400Ω	12,600Ω	11,870Ω	-1.08%
R_1										
R_2										
R_3										
R_4										
R_5										
R_6										
R_7										
R_8										

Have your lab work signed off. Work not bearing a signoff from instructor or TA will not be accepted for grade.

Questions:

1. Why do resistors need a tolerance factor (like ±5 %) at all? Why not make all resistors ideal (0 % error)?

2. Is the DMM an ideal device (0 % error) or does it have a measurement tolerance as well as the resistor it measures?

Instructor: Sign-off for Part 1 on the grading sheet

Part 2: Circuit Construction and measuring resistances on a Proto Board

1. Refer to the "Protoboard and Digital Multi-meter" handout you printed and read for prelab. Read and discuss the sections on "**Measuring Resistance**," and **"The Protoboard."**
2. Using resistors from the lab supply drawers and reading the color codes (*Be Careful! sometimes the resistors are incorrectly replaced in the drawers*), build the circuit on the last page of the "Protoboard and Digital Multi-meter" handout using **R_1 = 1kΩ; R2 = 2.2kΩ; R3 = 4.7kΩ; and R4 = 6.8kΩ.** Make sure the physical circuit is built exactly as shown in the diagram. Note that resistors are connected to each other only at the protoboard nodes (Remember the video).
3. Measure and record in Table 2 the resistances between the 2 points identified by the lower case letters (i.e. R_{a-b} is the resistance between nodes a and b). When measuring resistance indicated by subscripts, the red lead is placed on the node indicated by the first letter (in this example point a), and the black lead is placed on the node indicated by second letter (in this example point b).
4. Discuss the results of your measurements with your lab partners, and based on your work and discussion, answer the question below table 2.
5. Obtain your instructor's sign off for Part 2

Data Table 2 – Resistance Between Nodes

Resistance Measurement	Measured Value	Resistance Measurement	Measured Value	Resistance Measurement	Measured Value
$R_{a-b\,(example)}$	1,000Ω	R_{c-d}		R_{a-c}	
R_{a-b}		R_{d-e}		R_{c-e}	
R_{b-a}		R_{a-e}		R_{b-d}	
R_{b-c}		R_{e-a}		R_{a-d}	

Questions:

3. When measuring the resistances above, did it matter in which direction you measured it (i.e. R_{a-e} and R_{e-a})? Why or why not? Explain in 2 or 3 sentences.

Post Lab Requirements and Lab Notes:

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After lab, **during a time specified by your instructor**, take the Post Lab Quiz on myCourses. You may work together with your teammates; use your prelab work, lab data and answers to the lab questions as reference material.

Turn in your completed documentation at the beginning of next week's lab before you take that week's prelab quiz, (remember, it's late 10 minutes after lab starts). Your submission package will be graded and returned with comments. Submit the following in order at the start of lab NEXT week:

1) The following cover sheet (completely filled in by all of your team members, one per team).

2) Data Table 1 and the completed questions (one per team)

3) Data Table 2 and the completed questions (one per team)

Submit NO ADDITIONAL PAPER or INFORMATION other than that requested. Extraneous Information such as the lab handout, resistor color codes, etc will result in reduced credit for this assignment.

If you have any questions about the lab submission, please ask your instructor for clarification.

Lab Note 1: The Percent Error Calculation

When engineers compare two numbers, they use a percent error calculation. This compares the two values relative to one another. The words "close" and "similar" do not *measure* the differences, and if you write "the results were very close", you are not measuring the difference; you are describing how you "feel" about the results.
To calculate a percent difference, you need a predicted, or nominal value (Nom_val) and a measured value (Meas_val).

The following expression is then used:

$$\%\text{error} = \frac{\text{Meas\_val} - \text{Nom\_val}}{\text{Nom\_val}} \times 100\%$$

Note that a negative result indicates that the measured value is lower than nominal value, and a positive result means the measured value is higher than nominal. This gives you, the engineer, a good tool to compare predictions to results.

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Team Name and Lab Section:… ....

Team Members Present (printed)

First Name, Last Name	Role This Lab	RIT Program

TEAM LABORATORY RESULTS GRADE

(all work done neatly, legible and organized, completed on time, all signoffs in place, no missing information and no extraneous information)

Instructor Signature, Part 1 ________	**/15**
Data Table 1, Q1/Q2	**/15**
Instructor Signature, Part 2 ________	**/15**
Data Table 2, Q3	**/15**
Final Team Grade	**/60**

Instructor comments: