

Laboratory Manual

EE-153L – Introduction to Electrical Engineering

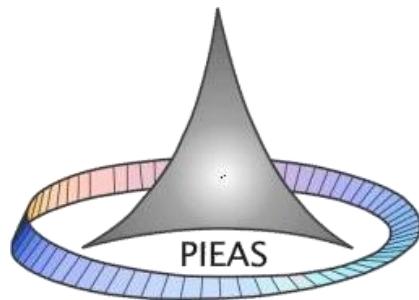
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Experiment 3

Resistor Color Code

3.1 Objective

The objective of this exercise is to become familiar with the measurement of resistance values using a digital multimeter (DMM). A second objective is to learn the resistor color code.

3.2 Theory Overview

The resistor is perhaps the most fundamental of all electrical devices. Its fundamental attribute is the restriction of electrical current flow: The greater the resistance, the greater the restriction of current. Resistance is measured in Ohms. The measurement of resistance in unpowered circuits may be performed with a digital multimeter. Like all components, resistors cannot be manufactured to perfection. That is, there will always be some variance of the true value of the component when compared to its nameplate or nominal value. For precision resistors, typically 1% tolerance or better, the nominal value is usually printed directly on the component. Normally, general purpose components, i.e. those worse than 1%, usually use a color code to indicate their value.

The resistor color code typically uses 4 color bands. The first two bands indicate the precision values (i.e. the mantissa) while the third band indicates the power of ten applied (i.e. the number of zeroes to add). The fourth band indicates the tolerance. It is possible to find resistors with five or six bands but they will not be examined in this exercise. Examples are shown below:

Color	Significant figures			Multiply	Tolerance (%)	Temp. Coeff. (ppm/K)	Fail Rate (%)
black	0	0	0	$\times 1$		250 (U)	
brown	1	1	1	$\times 10$	1 (F)	100 (S)	1
red	2	2	2	$\times 100$	2 (G)	50 (R)	0.1
orange	3	3	3	$\times 1K$		15 (P)	0.01
yellow	4	4	4	$\times 10K$		25 (Q)	0.001
green	5	5	5	$\times 100K$	0.5 (D)	20 (Z)	
blue	6	6	6	$\times 1M$	0.25 (C)	10 (Z)	
violet	7	7	7	$\times 10M$	0.1 (B)	5 (M)	
grey	8	8	8	$\times 100M$	0.05 (A)	1(K)	
white	9	9	9	$\times 1G$			
gold				$\times 0.1$	5 (J)		
silver				$\times 0.01$	10 (K)		
none					20 (M)		

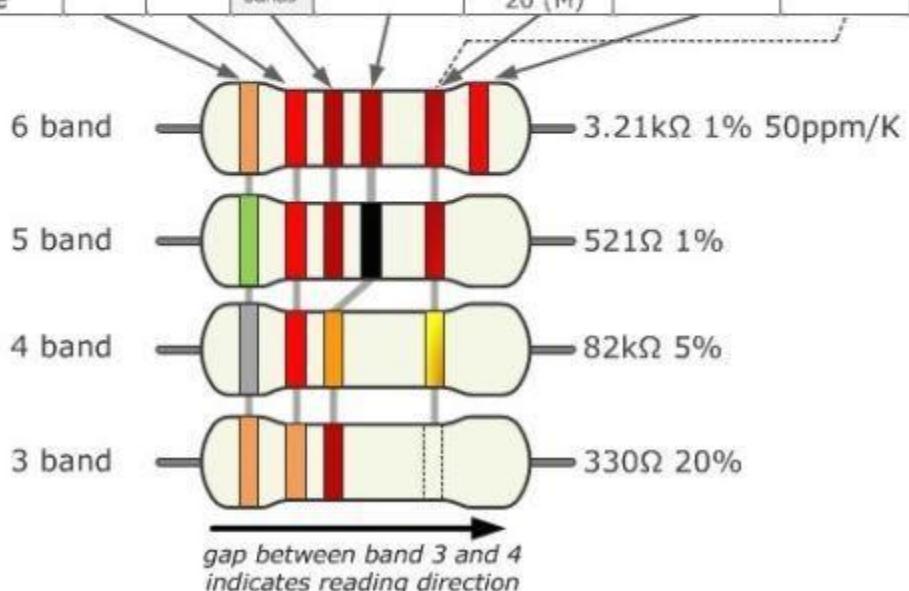


Fig 3.1 Resistors color code chart

It is important to note that the physical size of the resistor indicates its power dissipation rating, not its ohmic value.

Each color in the code represents a numeral. It starts with black and finishes with white, going through the rainbow in between:

0 Black	1 Brown	2 Red	3 Orange	4 Yellow	5 Green
6 Blue	7 Violet	8 Gray	9 White		

For the fourth, or tolerance, band:

5% Gold	10% Silver	20% None
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For example, a resistor with the color code brown-red-orange-silver would correspond to 1 2 followed by 3 zeroes, or 12,000 Ohms (more conveniently, 12 k Ohms). It would have a tolerance of 10%

of 12 k Ohms or 1200 Ohms. This means that the actual value of any particular resistor with this code could be anywhere between $12,000 - 1200 = 10,800$, to $12,000 + 1200 = 13,200$. That is, 10.8 k to 13.2 k Ohms. Note, the IEC standard replaces the decimal point with the engineering prefix, thus 1.2 k is alternately written 1k2.

Similarly, a 470 k 5% resistor would have the color code yellow-violet-yellow-gold. Measurement of resistors with a DMM is a very straight forward process. Simply set the DMM to the resistance function and choose the first scale that is higher than the expected value. Clip the leads to the resistor and record the resulting value.

3.3 Procedure

1. Given the nominal values and tolerances in Table 3.1, determine and record the corresponding color code bands.
2. Given the color codes in Table 3.2, determine and record the nominal value, tolerance and the minimum and maximum acceptable values.
3. Obtain random resistor of any value. Determine the minimum and maximum acceptable values based on the nominal value and tolerance using color coding. Record these values in Table 3.3. Using the DMM, measured the actual value of the resistor and record it in Table 3.3. Determine the deviation percentage of this component and record it in Table 3.3. The deviation percentage may be found via: Deviation = $100 * (\text{measured}-\text{nominal})/\text{nominal}$.

Circle the deviation if the resistor is out of tolerance.

4. Repeat Step 3 for the remaining 10 resistors.

3.4 Data Tables

Value	Band 1	Band 2	Band 3	Band 4
27 @ 10%				
56 @ 10%				
180 @ 5%				
390 @ 10%				
680 @ 5%				
1.5 k @ 20%				
3.6 k @ 10%				
7.5 k @ 5%				

10 k @ 5%				
47 k @ 10%				
820 k @ 10%				
2.2 M @ 20 %				

Table 3.1: Color of bands against various resistances

Colors	Nominal	Tolerance	Minimum	Maximum
red-red-black-silver				
blue-gray-black-gold				
brown-green-brown-gold				
orange-orange-brown-silver				
green-blue-brown –gold				
brown-red-red–silver				
red-violet-red–silver				
gray-red-red–gold				
brown-black-orange–gold				
orange-orange-orange–silver				
blue-gray-yellow–none				
green-black-green-silver				

Table 3.2: Resistances against various color of Bands

Table 3.3: Data table of various measured resistances and their deviation

3.5 Questions

1. What is the largest deviation in Table 3.3? Would it ever be possible to find a value that is outside the stated tolerance? Why or why not?
 2. If Steps 3 and 4 were to be repeated with another batch of resistors, would the final two columns be identical to the original Table 3.3? Why or why not?
 3. Do the measured values of Table 3.3 represent the exact values of the resistors tested? Why or why not?

3.6 Conclusion

3.7 Assessment

Sr. No.	Specific Course Learning Outcomes	Knowledge Domains	Performance indicator
Upon completion of this course, the students will be able to			
1	USE electronic lab instruments including the digital multi-meter, function generator, oscilloscope and electronic circuit trainer.	P1	<ul style="list-style-type: none">• Correct use of needed instruments (signal generator, oscilloscope, etc.)Study and complete pre-lab tasks
2	CONSTRUCT and ANALYZE basic circuits.	P2	<ul style="list-style-type: none">• Proper designing, wiring of the circuit as per requirement.• Analyzing the circuit and recording the data.• Relate experiment with theoretical concept discussed in class• Discuss discrepancies between theoretical, simulation and experimental results• Performing the necessary Calculation required in the lab and investigate effect of various changes.
3	COMMUNICATE clearly and effectively through presentation and/or report	A2	<ul style="list-style-type: none">• Report is structured properly Figures and Graphs annotated
4	DEMONSTRATE teamwork and show commitment to the group in achieving the objectives of laboratory	A2	<ul style="list-style-type: none">• Take his/her part in the group.
5	DEMONSTRATE punctuality, dress appropriately and comply with the standard safety procedures of the lab	A2	<ul style="list-style-type: none">• Wear proper dress to perform the tasks and Follow lab timing• Follow safety instructions for handling the Instruments.

