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Experiment No.1

Resistor Color Code

1. Introduction

1.1 Objective:

In the previous labs, you have learned how to build very simple resistive circuits and take basic measurements. In this lab, you will work with resistive circuits that are a little more complex to study the properties of series and parallel connection.

1.2 Components:

1. Carbon resistors.
2. Digital multimeter
3. Set of wires.

1.3 Theory:

There are many different types of resistors available which can be used in both electrical and electronic circuits not only as loads, but also for distributing the current or for producing a voltage drop in many different ways. But in order to do this, the actual resistor needs to have some form of "resistive" or "resistance" value.

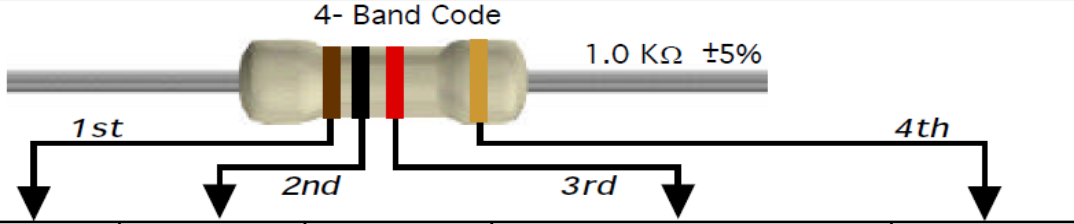
It is not possible to manufacture all value of resistors right from one Ohm (Ω) to millions of Ohms. So, only a set of preferred values of resistors is generally made with their resistance value printed onto their body in colored ink.

Also, in a manufacturing process, in which thousands of resistors are made in a day, it is not possible to adjust every ordinary resistor to an exact value. The term 'tolerance' denotes the acceptable deviation in the resistance value of a resistor and is expressed as a percentage of its “nominal” or preferred value.

The resistance value, tolerance, and wattage rating are the main specification of resistor which are generally printed onto its body as numbers or letters when the resistors body is big enough to read the print, such as large power resistors. But when the resistor is small such as a 1/4 watt carbon or film type, these specifications must be shown in some other manner as the print would be too small to read. So to overcome this, small resistors use colored painted bands to indicate both their resistive value and their tolerance with the physical size of the resistor indicating its wattage rating. These colored painted bands produce a system of identification generally known as a **Resistor Color Code**.

An international and universally accepted resistor color code scheme was developed many years ago as a simple and quick way of identifying a resistors ohmic value no matter what its size or condition. It consists of a set of individual colored rings or bands in spectral order representing each digit of the resistors value. It markings are always read one band at a time starting from the left to the right. So we need to understand how to apply these bands in order to get the correct value of the resistor.

There are two ways to find the resistance value of a resistor. As shown in Fig. 1, there are 4-band and 5-band resistors. For both 5- and 4-band resistors, the last band indicates the percentage of tolerance.



Color	1st Band	2nd Band	3rd Band	Decimal Multiplier		Tolerance
Black	0	0	0	1	1	
Brown	1	1	1	10	10	± 1 %
Red	2	2	2	100	100	± 2 %
Orange	3	3	3	1K	1,000	
Yellow	4	4	4	10K	10,000	
Green	5	5	5	100K	100,000	
Blue	6	6	6	1M	1,000,000	
Violet	7	7	7	10M	10,000,000	
Gray	8	8	8		100,000,000	
White	9	9	9		1,000,000,000	
Gold					0.1	± 5 %
Silver					0.01	± 10 %
None						± 20 %

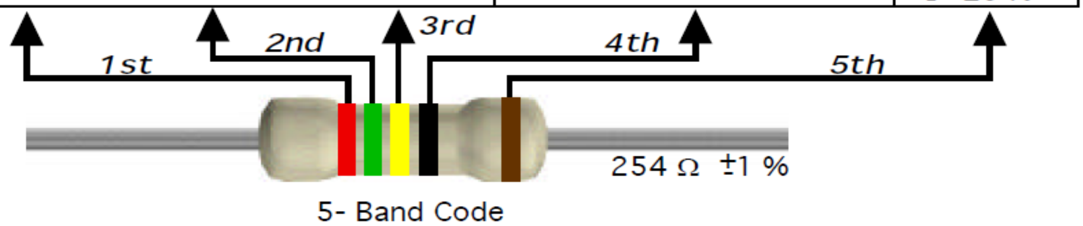


Fig. 1. Resistor color code chart.

By matching the color of the first band with its associated number in the digit column of the color chart, the first digit is identified and this represents the first digit of the resistance value. Again, by matching the color of the second band with its associated number in the digit column of the color chart we get the second digit of the resistance value and so on. The multiplier is the number of zeros that have to be added after the significant numbers.

- 4-Band: Reading the resistor from left to right, the first two color bands represent significant digits, the third band represents the decimal multiplier, and the fourth band represents the tolerance. Digit, Digit, Multiplier, Tolerance = (Color, Color × 10 color) ± Tolerance
- 5-Band: The first three color bands represent significant digits, the fourth band represents the decimal multiplier, and the fifth band represents the tolerance. Digit, Digit, Digit, Multiplier, Tolerance = (Color, Color, Color × 10 color) ± Tolerance

Typical resistor tolerances for film resistors range from 1% to 10% while carbon resistors have tolerances up to 20%. Resistors with tolerances lower than 2% are called precision resistors with the or lower tolerance resistors being more expensive. Most five band resistors are precision resistors with tolerances of either 1% or 2% while most of the four band resistors have tolerances of 5%, 10% and 20%. The color code used to denote the tolerance rating of a resistor is given as:

Brown = 1%, Red = 2%, Gold = 5%, Silver = 10%

If the tolerance color is not present, the resistor tolerance would be 20% above and below the nominal value. So to determine the range of the resistance (Rmin~Rmax) considering the tolerance percentage (T) we can apply:

$$R_{min} = R_{nominal} - (R_{nominal} \times T)$$

$$R_{max} = R_{nominal} + (R_{nominal} \times T)$$

2. Procedure

Measure and record in Table 1 the value of resistance for five different resistors by using a digital multimeter and compare it with the color code resistance range and calculate the deviation percentage as below:

$$\text{Deviation} = [(R\ \text{measured} - R\ \text{nominal}) / R\ \text{nominal}] \times 100\%$$

Table 1

Color Code Bands	Nominal	Tolerance	Minimum	Maximum	Measured	Deviation

3. Question

1. What are the uses and main specifications of resistors in electrical circuits?

2. What is meant by color codes and tolerance values of resistors?

3. Comment on your results in Table 1. Would it ever be possible to find a measured value of resistance out of the stated tolerance? Why or Why not?

4. Given the nominal values and tolerance in Table 2, determine and record the corresponding color code bands.

Table 2

Value	Four Band Resistor Color Codes
390 ± 10 %	
680 ± 5 %	
1.5k ± 20 %	
10k ± 5 %	
820k ± 10 %	
2.2M ± 10 %	

5. Given the color codes in Table 3, determine and record the nominal value, tolerance and the minimum and maximum acceptable values.

Table 3

Color Code Bands	Nominal	Tolerance	Minimum	Maximum
Red-Red-Black-Silver				
Blue-Gray-Black-Gold				
Brown-Green- Brown-Gold				
Green-Blue-Brown-Gold				
Gray-Red-Red-Gold				
Orange-Orange-Orange-Silver				