

Activity 2-2

RESISTOR COLOR CODE

Many of the components used in electronics employ various colors in the form of dots, circles, and bands to indicate values. This arrangement is most commonly used with fixed resistors and capacitors. Simply to print or letter the value of a component on its body is extremely impractical due to the small size of many of the components, the placement of the components in circuits, or the long numbers that would indicate the values of some components.

OBJECTIVE

1. To examine the color coding system used with fixed resistors.

EQUIPMENT

Fixed resistors (eight of any value)

PROCEDURE

1. The most significant things to learn when dealing with color-coded components are the meaning and placement of the colors on the body of the component. Figure 2-2A shows fixed resistors that employ the band system of color coding.

2. There are two widely used standards for color coding fixed resistors. These two standards are the Military and the Electronic Industries Association (EIA) standards of resistor color codes. Both standards use the same 12 basic colors to designate the value of a fixed resistor. In both systems the *first* color indicates the first digit in the value of the fixed resistor, which is measured in ohms. The *second* color indicates the second digit in the value of the resistor. The *third* color indicates the number by which the first two digits are to be multiplied, or the number of zeros to be added to the first two numbers. The *fourth* color, if there is a fourth color, indicates the *tolerance* of the value of the resistor. The tolerance is generally expressed as $\pm 5\%$, $\pm 10\%$, or $\pm 20\%$ of the value in ohms indicated by the first three colors. The *fifth* color, if used, indicates the percent of failure rate per 1000 h of use associated with the resistor. In addition to this method of color coding, a five-band system is also used and is explained in the text.

3. Figure 2-2B shows a resistor using a common band color-code system. Reading the colors from left to right, or from the end of the resistor closest to where the bands begin, and using the chart in your textbook you should be able to deter-

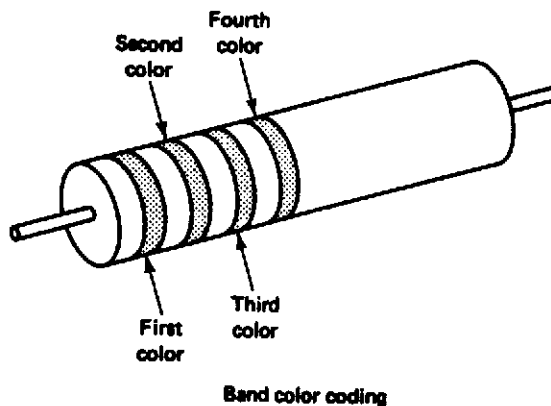


FIGURE 2-2A

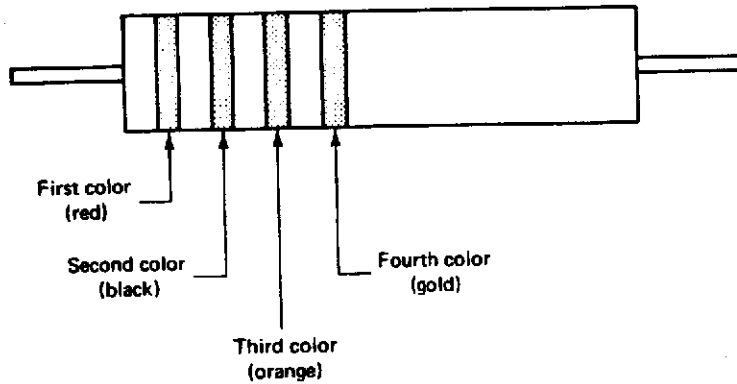


FIGURE 2-2B

mine the value of the resistor in ohms, its tolerance, and its failure rate.

The first color is *red*, which indicates the first digit in the value of the resistor is 2.

The second color is *black*, which indicates the second digit in the value of the resistor is 0. We now have the first two digits of the ohmic value of the resistor: 20.

The third color is *orange*, which indicates the number by which the first two digits are to be multiplied or the number of zeros to add to the first two digits. Since the color orange designates a multiplier of 1000, we can multiply 20×1000 to give us the value in ohms of the resistor ($20 \times 1000 = 20,000 \Omega$). Orange also indicates that we could add three zeros to our first two digits to determine the ohmic value of the resistor (20 with three 0s added gives 20,000 Ω). The two methods are equally effective.

The fourth color is *gold*, which indicates the tolerance of the resistor. The tolerance shows how close the measured value of the resistor is to the rated value and is normally expressed as a percent of the rated value. In this case, gold indicates a tolerance of $\pm 5\%$. This means this resistor will be within 5% of 20,000 Ω one way or the other. Thus the value of the illustrated resistor could be as low as 19,000 ohms ($20,000 \times 0.05 = 1000$ and $20,000 - 1000 = 19,000$) or as high as 21,000 ($20,000 \times 0.05 = 1000$ and $20,000 + 1000 = 21,000$).

4. In some instances, there is no fourth color indicated on the body of the resistor. When this condition occurs, you may automatically assume its tolerance to be 20%. Frequently no fifth color appears on the resistor. There is no accurate method of predicting failure rate without the manufacturer's specifications. In Fig. 2-2C, indicate the values of the illustrated resistors, listing the ohmic value, tolerance, and failure rate when applicable.

5. By now you should be able to determine the value and tolerance of any color-banded resistor by using the resistor table. Without the table, you might be helpless. Another way of determining the basic value of any color-coded resistor is to remember the following quote: "Big brown rabbits often yield great big vocal groans when gingerly slapped." The first letter of each word in this statement corresponds to the first letter of each of the 12 colors used in the color code. Also, the words of the statement may be counted, beginning with zero (0), to determine which word corresponds with each digit or the number of zeros to be added to complete the resistor's value. Using this quote, determine the values of eight resistors in your component package.

6. In the following spaces, list, in order, the color bands of each of the eight resistors. After listing the colors, in order, record the value and tolerance of each resistor. Example:

Brown , Black , Black , Gold
10 Ω , 5 $\%$

a. _____ , _____ , _____ , _____
 _____ Ω , _____ $\%$

b. _____ , _____ , _____ , _____
 _____ Ω , _____ $\%$

c. _____ , _____ , _____ , _____
 _____ Ω , _____ $\%$

d. _____ , _____ , _____ , _____
 _____ Ω , _____ $\%$

e. _____ , _____ , _____ , _____
 _____ Ω , _____ $\%$

Name: _____

Date: _____

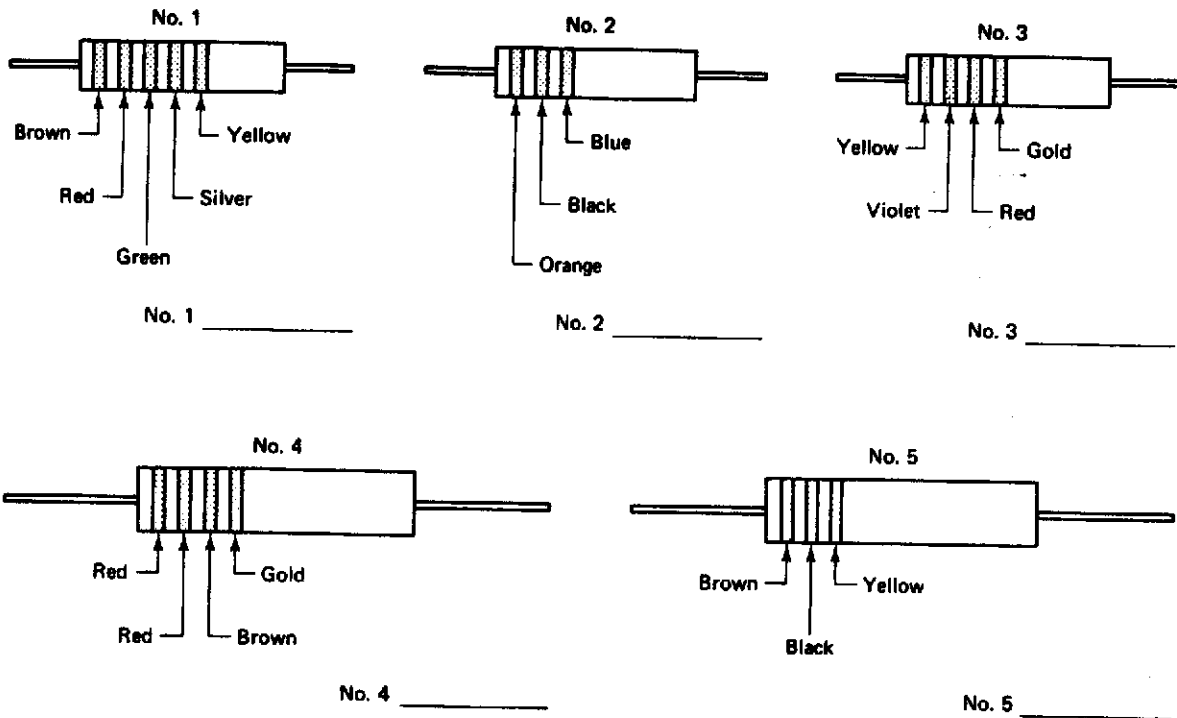


FIGURE 2-2C

- f. _____, _____, _____, _____
_____ Ω , _____ %
- g. _____, _____, _____, _____
_____ Ω , _____ %
- h. _____, _____, _____, _____
_____ Ω , _____ %

3. What is indicated by the third color of a color-banded resistor? _____
4. What unit of electrical measurement is used to indicate resistance? _____
5. What is indicated by the fourth and fifth colors of a five-color banded resistor? _____
6. If no fourth color is indicated on the body of a resistor, what is its tolerance value? _____

ANALYSIS

1. What are two systems of resistor color coding?

2. What is represented by the first and second colors of a color-banded resistor? _____

Activity 2-3

MEASURING RESISTANCE

Resistance is the term used to describe the opposition encountered by electrical current flow. Resistance is measured in ohms (Ω).

In Activity 2-2, you learned how to determine the value of a resistor by observing its color bands. However, the resistance of many components cannot be determined by observation and therefore must be measured.

OBJECTIVE

1. To learn how to measure resistance with the ohmmeter portion of a multimeter (VOM).
2. To learn to interpret an analog scale.

EQUIPMENT

Multimeter (VOM)

Potentiometer: 5 k Ω

Resistors: 10 Ω , 15 Ω , 220 Ω , 470 Ω , 1 k Ω , 5.1 k Ω , 68 k Ω , 100 k Ω , 220 k Ω , 1 M Ω

PROCEDURES

1. The multimeter (VOM) is used for basic electronic work. A VOM can be used as an ammeter, a voltmeter, or an ohmmeter. Simply adjust the function selection switch for the desired function. Fig. 2-3A shows the controls, including the function-select switch, of a common VOM.

You will notice that the function-select switch is in the center of some circular divisions and acts as a dial. You will also notice that a portion of the circular divisions is designated as the ohms function. Further, notice that the area of the divisions located within the ohms-function space is divided into four positions: $\times 1$, $\times 100$, $\times 1000$, and $\times 100,000$. The meter that you are using may be slightly different from the one illustrated. Nevertheless, it will exhibit the same basic characteristics as the VOM shown. Adjust the function-select switch on your meter to the ohms function. List below the different positions within the ohms-function area on your meter.

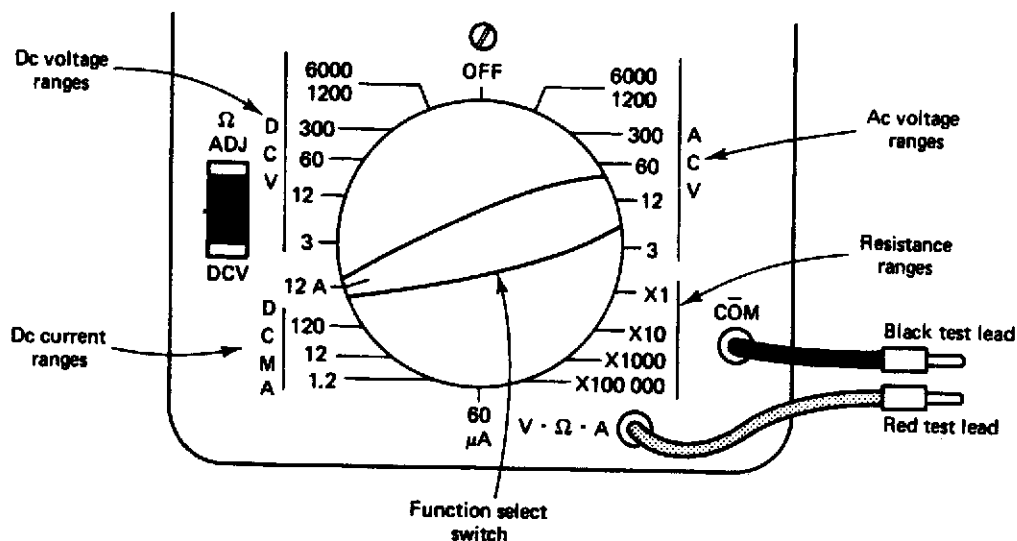


FIGURE 2-3A Controls of a Typical VOM.

Name: _____

Date: _____

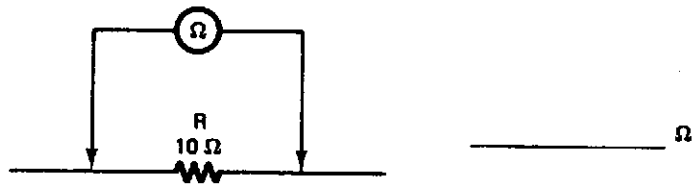


FIGURE 2-3C

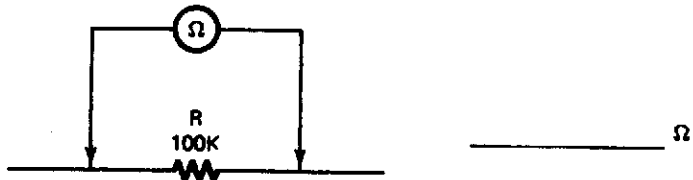


FIGURE 2-3D

Color-coded value	Measured value in ohms
15 Ω	
100 Ω	
220 Ω	
470 Ω	
1 kΩ	
5.1 kΩ	
68 kΩ	
220 kΩ	
1 MΩ	

FIGURE 2-3E

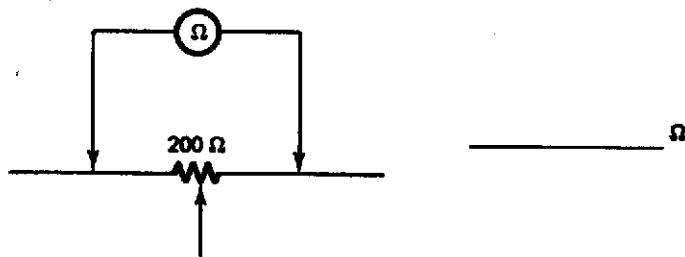


FIGURE 2-3F

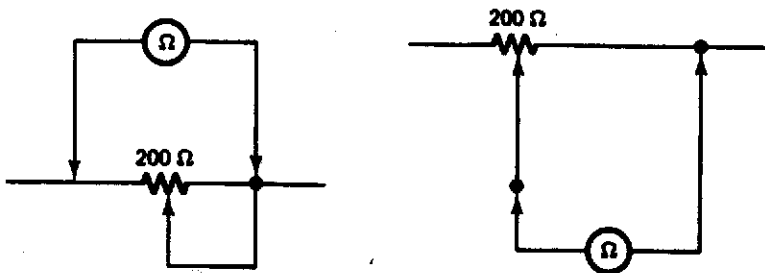


FIGURE 2-3G

ohmmeter must be zeroed prior to each resistance measurement and after each range change. Otherwise your measurements will be incorrect.

6. Notice that the ohms scale on the meter is *nonlinear*. The divisions on the right side of the scale are farther apart than those on the left side. This provides a more accurate measurement of resistance when the needle of the meter deflects and stops somewhere between the center of the ohms scale and zero. Choosing the proper range adjustment will control where the needle deflects. Adjust the function-select switch to the $\times 1$ range of the ohms function. Zero the meter, and then connect it across a $10\text{-}\Omega$ resistor. Record the precise resistance (in ohms) indicated by the needle on the ohms scale in Fig. 2-3C. The range selected for this operation was $\times 1$, which means that the number to which the needle points will be multiplied by 1.
7. Adjust the function-select switch to the $\times 100,000$ range. Zero the meter and then connect it to a $100\text{-k}\Omega$ resistor, as illustrated in Fig. 2-3D. Record the resistance (in ohms) shown by the needle on the ohms scale. The range selected for this measurement was $\times 100,000$, which means that the number to which the needle points will be multiplied by 100,000.
8. Measure and record the values of the resistors indicated in Fig. 2-3E. Remember to choose a meter range that will cause the needle to deflect somewhere between the center of the scale and zero. Always zero the meter when changing ranges, and always multiply the number indicated on the scale by the multiplier of the chosen range: $\times 1$, $\times 100$, $\times 1000$, $\times 100,000$. Never measure the resistance of a component until it has been disconnected.
9. Using the proper procedure for measuring resistance, measure and record the precise resistance of the $200\text{-}\Omega$ pot illustrated in Fig. 2-3F.
10. Adjust the control of the pot while the ohmmeter is connected. Describe how this action affects the measured resistance of the pot. _____

11. Alter the connections of the pot as illustrated in Fig. 2-3G.
12. Adjust the pot both clockwise and counterclockwise and describe how this action affects its measured resistance.

ANALYSIS

1. Why is the ohms scale of the VOM considered to be nonlinear?

2. Where on the ohms scale are the most accurate measurements found? _____
3. What is meant by the $\times 1000$ range on the ohmmeter? _____
4. What is meant by *zeroing* the ohmmeter? _____

5. Why is it necessary to zero the ohmmeter? _____

6. If the range of the ohmmeter was set to $\times 100,000$ and the needle pointed to 0.6 on the ohms scale, what would be the value of the resistance being measured? _____