MARINE INSTITUTE

Electrotechnology 1100

Experiment 1
Resistors

SAMPLE CALCULATIONS:

Using your own data, provide one worked sample of each formula used in this Lab.

Converting colors to ohmic value: Table 1-1, Step 3

$$\% \ Error = \left| \frac{Actual - Measured}{Actual} \right| * 100\%$$ Table 1-1, Step 7

$$R_{AB} = R_{AC} + R_{BC}$$ Table 1-2, Step 15

Converting ohmic value to colors: Question 2, Table 1-3

BASIC INFORMATION

There are two types of resistors: fixed; and variable.

Most fixed resistors use a standard code to encode the numeric value of a resistor on the body of the resistor using color bands. Color bands are used because they are easier to read: than numbers on small components; and after long service (overheating or color bands partially scraped off). Different manufacturers use a standard based upon four, five or six bands, but we will limit ourselves to the basic four band standard.

In each Experiment, you will have to use specific resistors, so it is important that you become comfortable with converting: color codes into resistor values; and resistor values into color codes.

In addition to fixed resistors, variable resistors (rheostats and potentiometers) are used to vary resistance in a circuit.

OBJECTIVES:

When you have completed this experiment, you should be able to:

- Convert color codes into resistor values.
- Convert resistor values into color codes.
- Measure resistance with an ohmmeter.
- Measure the resistances of a potentiometer.
- Observe how the potentiometer resistance changes.

EQUIPMENT & MATERIALS REQUIRED:

Instruments:	Analog Ohmmeter.
Resistors:	10 different value resistors with the following multiplier (third) bands: 1 - Black. 2 - Brown. 3 - Red. 3 - Orange. 1 - Yellow. 10kΩ or 5kΩ potentiometer.
Miscellaneous:	Orange board. 1 Black Alligator Clip to Banana Plug test lead. 1 Red Alligator Clip to Banana Plug test lead.

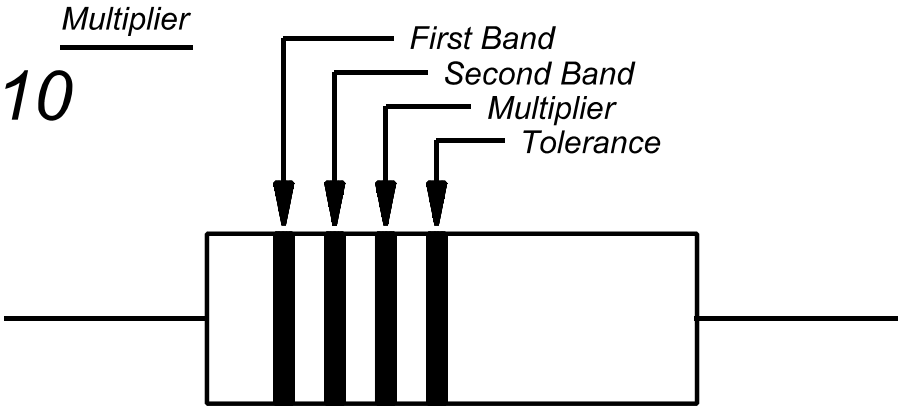
RESISTOR COLOR CODE

COLOR	FIRST BAND	SECOND BAND	MULTIPLIER	TOLERANCE
BLACK		0	$10^0 = 1$	
BROWN	1	1	$10^1 = 10$	
RED	2	2	$10^2 = 100$	
ORANGE	3	3	$10^3 = 1000$	
YELLOW	4	4	$10^4 = 10000$	
GREEN	5	5	$10^5 = 100000$	
BLUE	6	6	$10^6 = 1000000$	
VIOLET	7	7	$10^7 = 10000000$	
GREY	8	8	$10^8 = 100000000$	
WHITE	9	9	$10^9 = 1000000000$	
GOLD			$10^{-1} = 0.1$	5%
SILVER			$10^{-2} = 0.01$	10%
NO COLOR				20%

Better **B**e **R**eady **O**r **Y**our **G**reat **B**ig **V**enture **G**oes **W**rong, **G**o **S**tudy **N**ow

Bad **B**eer **R**ots **O**ur **Y**oung **G**uts **B**ut **V**odka **G**oes **W**ell, **G**et **S**mashed **N**ow

$$\frac{\text{First Band}}{\text{Second Band}} * 10^{\text{Multiplier}}$$



PROCEDURE:

1. Find 10 resistors with the color bands with the following multipliers (Third Band - 1 Black, 2 Brown, 3 Red, 3 Orange, 1 Yellow). Note: The fourth band of each resistor will be silver or gold; try to select unique resistors for each multiplier (different first two bands); and ignore fifth bands.

2. In the first four rows of Table 1-1, record the **COLOR** of each band for the resistors you selected. Put them from smallest to largest (Third Band - Black, followed by Brown, followed by Red, etc.).

3. In rows 5 and 6 of Table 1-1, determine the ohmic value and tolerance for each resistor using the Resistor Color Code Table on page 4.

4. Select a resistor for measurement and using the coded value as a guide, select an appropriate multiplier scale on the ohmmeter.

5. '*Zero the ohmmeter*' as shown in Figure 1-1. Use the Zero Adjust to make sure the pointer is pointing at zero or 0Ω.

   To eliminate parallax and ensure you are looking directly at the needle, position your eye to align the needle with the needle's reflection in the mirror behind the needle, so that you **CANNOT** see the reflection.

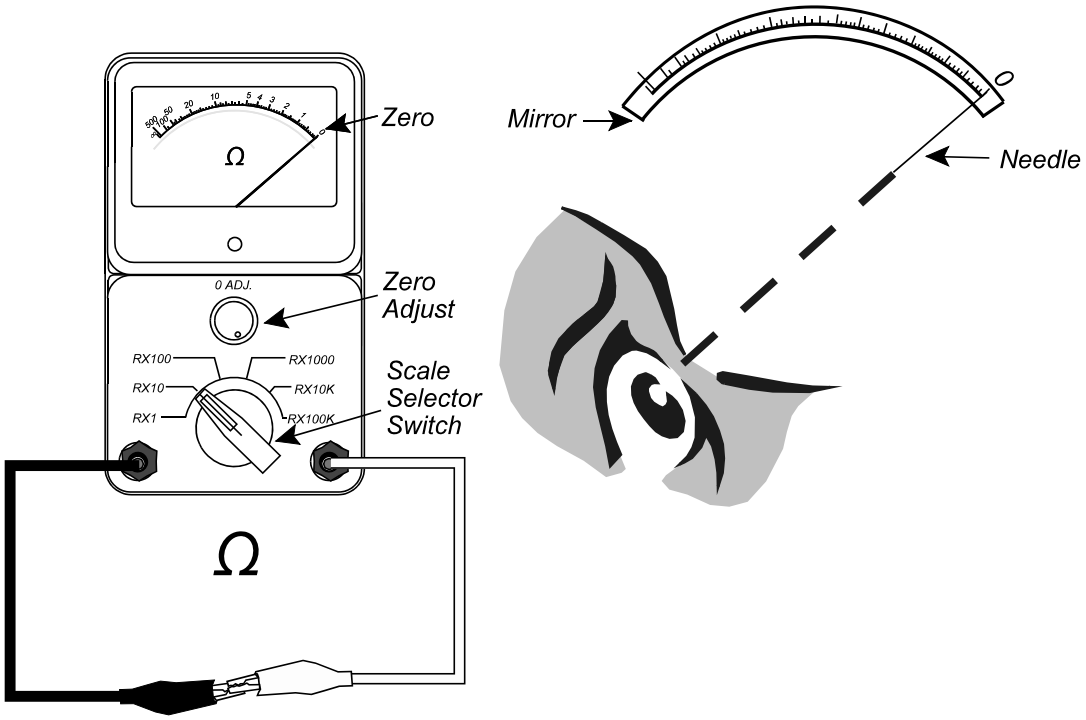


Figure 1-1

6. Connect a resistor between the terminals as shown in Figure 1-2 and read the value of the resistor off of the scale. Again, position your eye so that you cannot see the needle reflection to get the most accurate reading.

   Apply the appropriate scale multiplier as determined by the Scale Selector Switch. Record this value in Table 1-1 for the appropriate resistor.

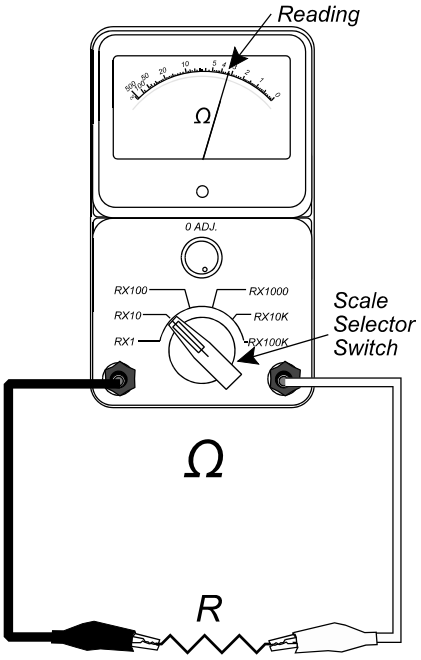


Figure 1-2

7. Calculate the percent error for the resistor using Formula 1.

$$\%\ Error = \left| \frac{Actual - Measured}{Actual} \right| * 100\% \qquad \text{Formula 1.}$$

If you calculate an % error >15%, check with a demonstrator to see if you are using the ohmmeter correctly.

8. Repeat Steps 4, 6 and 7 for the other resistors. Each time you change the Scale Selector Switch on the ohmmeter you will have to repeat Step 5 or '*Zero the ohmmeter*'.

9. Set your ohmmeter on the Rx1000 or Rx1K scale. Zero the ohmmeter.

10. Orient the 10kΩ (or 5kΩ) potentiometer as shown in Figure 1-3. Note the position of terminals A, B and C (in the center).

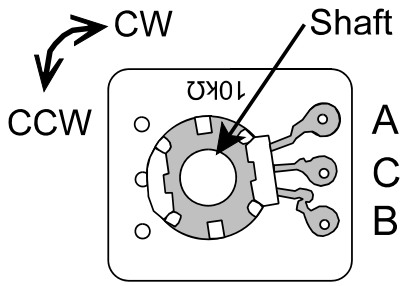


Figure 1-3

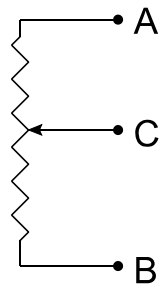


Figure 1-4

Figure 1-4 shows the schematic diagram of the potentiometer.

11. Rotate the potentiometer shaft fully clockwise (CW).

12. Measure the resistance between terminals A and B (R_{AB}) and record the value in Table 1-2.

13. Measure the resistance between terminals A and C (R_{AC}) and record the value in Table 1-2.

14. Measure the resistance between terminals B and C (R_{BC}) and record the value in Table 1-2.

15. Calculate Formula 2 to verify your results.

$$R_{AB} = R_{AC} + R_{BC} \qquad \text{Formula 2.}$$

16. Rotate the shaft of the potentiometer to approximately center position and repeat Steps 12, 13, 14 and 15.

17. Rotate the shaft of the potentiometer fully counter-clockwise (CCW) and repeat Steps 12, 13, 14 and 15.

18. **Have a demonstrator check your results before disconnecting the circuit.**

19. Disconnect your circuit and return all equipment to it's proper place.

RESULTS:

Table 1-1 - Resistor Color Codes

	Resistors									
	1	2	3	4	5	6	7	8	9	10
First Color Band										
Second Color Band										
Third Color Band	Black									
Forth Color Band										
Coded Value, Ω										
Tolerence, %										
Measured Value, Ω										
% Error										

Table 1-2 Potentiometer Resistance

Potentiometer Shaft Position	Measured Values			Calculated Value
	R_{AB} (Ω)	R_{AC} (Ω)	R_{BC} (Ω)	$R_{AB} = R_{AC} + R_{BC}$ (Ω)
Fully CW				
Center				
Fully CCW				

QUESTIONS:

1. Describe the procedure to ensure accurate ohmmeter readings, if the Scale Selector Switch is changed.

2. Complete the following table:

Table 1-3

Resistor Value	First Band	Second Band	Multiplier	Tolerance
	WHITE	**BROWN**	**RED**	**SILVER**
	ORANGE	**ORANGE**	**ORANGE**	**GOLD**
	RED	**BLACK**	**YELLOW**	**SILVER**
	BLUE	**GREY**	**BROWN**	**NO COLOR**
	VIOLET	**GREEN**	**GOLD**	**GOLD**
560Ω, 20%				
47000Ω, 5%				
18Ω, 10%				
0.1Ω, 5%				
2200Ω, 20%				

3. A resistor can be read on all scales (Rx1, Rx10, Rx100, Rx1K, etc.) because each scale of the ohmmeter goes from 0Ω to ∞. But the accuracy of the ohmmeter reading depends upon the scale selected, so there is one or possibly two accurate scales for each resistor.

You wish to measure the resistance of a 2.2kΩ, 10% resistor.

(a) What scale do you select for the greatest accuracy?

(b) Why are scales below this one less accurate?

(c) Why are scales above this one less accurate?

Hint: Use an actual 2.2kΩ or set the potentiometer to 2.2kΩ and try it.

4. What effect did moving the movable wiper arm from fully CW to fully CCW have on the potentiometer resistance between:

(a) A and C (R_{AC}).
(b) B and C (R_{BC}).
(c) A and B (R_{AB}).

Why? Refer to your measurements to support your answer.

TIP

Many questions will specifically ask you to refer to your measurements (or experimental results) to support your answer.

By quoting your **ACTUAL** data, you demonstrate that you understand the concept under investigation.

So to complete the Lab **EFFICIENTLY**, you will have to quote your data! Demonstrators may reject your answers and require you to rewrite them if you do not quote your data!

In general, as a component of good lab procedure, you should always quote your actual data when answering questions.

As preparation for next week's lab, you can calculate the theoretical current in mA for Tables 2-1, 2-2 and 2-3 in Experiment 2 (p17).

See Step 5 (p16).