ELECTRONIC WORKSHOP # 03

Resistors

Roll. No:	**Date:**
Checked by:	**Grade:**

Object: To become familiar with resistors, variable resistors and resistor color coding

Apparatus:

1). A Digital Multimeter (DMM)
2). Few fixed Resistors
3). Few Variable Resistors

Theory:

A Resistor is a component used to reduce the amount of current through a circuit. The measure of the capability of the resistor to limit the current is known as Resistance and its unit is *Ohm*. Mathematically, Resistance is given by Ohm's Law:

$$V = IR \; or \; R = \frac{V}{I}$$

Where V is the voltage applied across the material and I is the current flowing through it. Resistors are mostly made from poor conductors, the most common material being Carbon film or Metal film, low value resistors are however made by wires wound over ceramic former. There are some special types of resistors which are made from semiconductors. Resistors come in two types, fixed or variable. Fixed resistors, as the name suggests are the ones whose resistance cannot be varied whereas the resistance of variable resistors can be changed. The symbols for fixed resistors are shown in the figure-1.

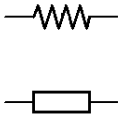


Figure-1**:** Symbols of Fixed Resistors

The resistance is not the only thing to be taken in to consideration when choosing a resistor, the tolerance and the power rating also need to be considered. Tolerance is the maximum deviation a resistance (or any other component for that matter) can exhibit. The power rating indicates how much power the resistor can safely withstand.

Fixed resistors come in standard values which are specified by the manufacturer using colored bands on made on the resistor itself, there are three band standards, the 4-Band, 5-Band and the 6-Band standard.

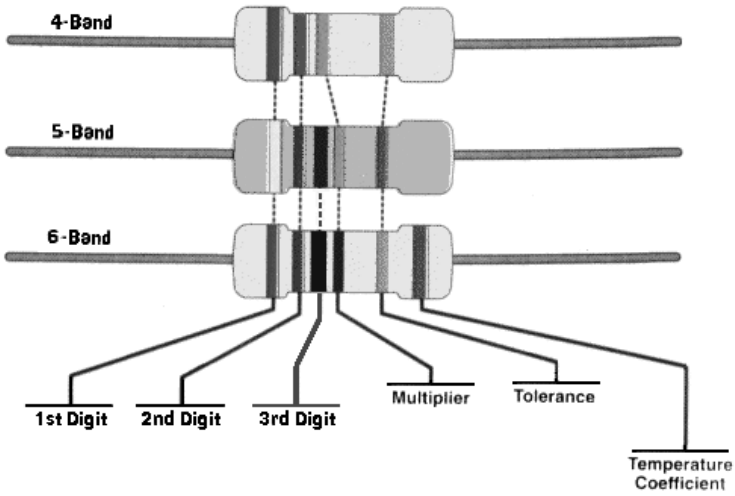


Figure-2: 4 Band and 5 Band and 6 Band Standard of Resistors

Color	**Value**	**Multiplier**	**Tolerance**
Black	0	0	-
Brown	1	1	±1%
Red	2	2	±2%
Orange	3	3	±0.05%
Yellow	4	4	-
Green	5	5	±0.5%
Blue	6	6	±0.25%
Violet	7	7	±0.1%
Grey	8	8	-
White	9	9	-
Gold	-	-1	±5%
Silver	-	-2	±10%

Table-1: Color codes to resistor bands

As seen in the above table, Gold and Silver are not used in either the Units, Tens or Hundreds bands, also, not all the colors are used in the tolerance band. As an example, if a 4 band resistor has the following color codes, Brown in 1st, Black in 2nd , Red in the 3rd and Gold in the 4th, than its resistance is going to be:

Brown	Black		Red	Gold
1	0	x	10^2	$\pm 5\%$

Its minimum and maximum resistance can be calculated using the tolerance value:

Minimum Resistance: $\left(1000 - \frac{1000x5}{100}\right)\Omega$

$(1000 - 50)\Omega$

950Ω

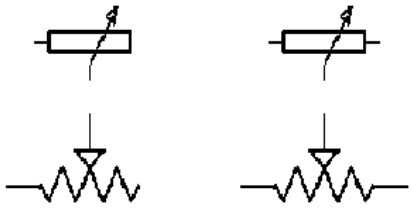
Maximum Resistance: $\left(1000 + \frac{1000x5}{100}\right)\Omega$

$(1000 + 50)\Omega$

1050Ω

Resistors come in various series (classified according to the tolerance levels) such as E6 (20% Tolerance), E12 (10% Tolerance) and E24 (5% Tolerance). Precision Resistors having tolerances of 1% are also available but they are expensive as compared to the commonly available 5% and 10% Tolerance resistors.

Variable resistors consist of a slider by which one can change their resistance. There are two types of variable resistors, the Potentiometer and the Rheostat. The potentiometer has 3 terminals whereas the Rheostat has 2. These find applications as dimmers in fans, volume control in radios etc. Figure-3 shows the symbols of variable resistors:



(a) **(b)**

Figure-3**:** Symbols of Variable Resistors (Rheostat (a), Potentiometer (b))

Some potentiometers have values written on them, on others though, the value needs to be decoded:

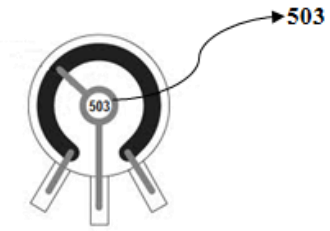


Figure-4: Potentiometer outlook

As seen in the potentiometer above, the number 503 is written on it, its value can be calculated by using the formula:

$$(1^{st}\ \text{Digit})\ \ (2^{nd}\ \text{Digit}) \times 10^{\text{Multiplier}}$$

So, its value becomes

$$50 \times 10^{3}\Omega \text{ or } 50000\Omega$$

SMD Resistors have values written on them, the first two (or 3) digits are the first two (or 3) digits of the resistance in ohms, and the third (or 4th) is the number of zeros to follow - the 'multiplier'. Resistances of less than 10 ohms have 'R' to indicate the position of the decimal point. So if a resistor has the value 330, it means its value is 33Ω and 4E3 would mean 4.3Ω.

Figure-5: SMD Resistor Colour Coding

Power ratings of resistors used in common electronics circuits are 1/8, 1/4, 1/2 and 1 Watts, higher ratings are also available. One can use the following formula for finding out an appropriate power rating for a specific resistor value:

$$P = I^2 R$$

Where P is the power dissipated by the Resistor, I is the current flowing through it and R is the value of the Resistance. As a rule of thumb, choose a resistor having power rating equal to twice the calculated value.

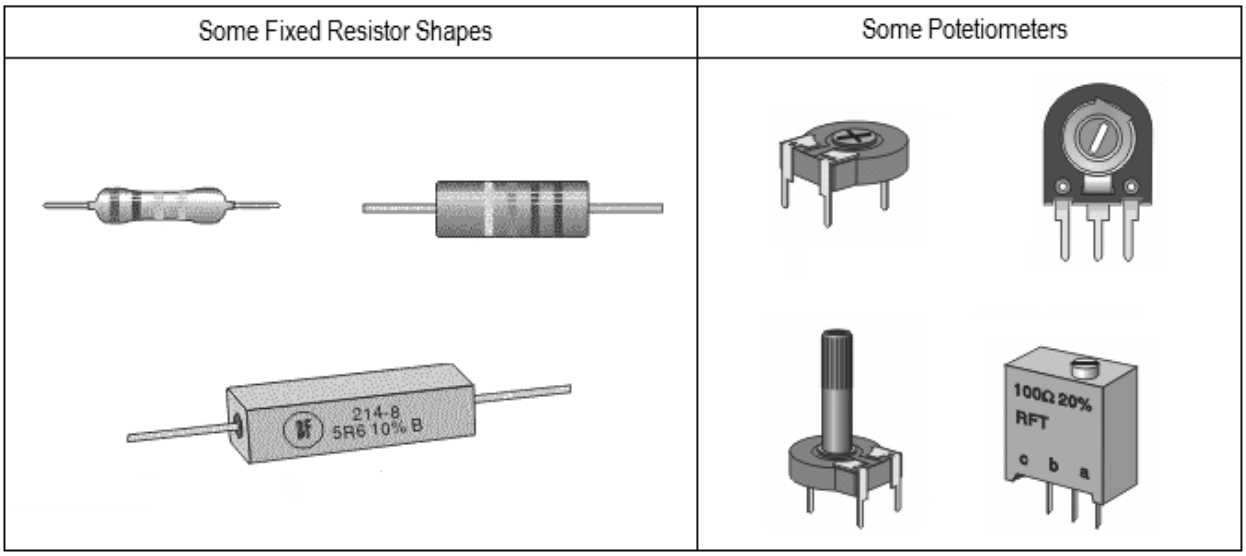


Figure-6: Some real Resistors

Procedure:

1. Take any Resistor and decode its Resistance from the Color Bands (CR).
2. Take a Multi-meter. Select the option of Ohmmeter with appropriate range.
3. Place the probes on the terminals of the Resistor to measure the Resistance (MR).
4. Calculate the Percent Error as $(CR - MR)x100/CR$.
5. If the Percent error is less than the Tolerance, the Resistor is reliable and is in accordance with specifications.
6. Repeat (1) through (6) four times.
7. Take a Potentiometer and connect its two end terminals with the Ohmmeter.
8. Turn the knob of the Potentiometer in any direction, while observing its Resistance.
9. Connect the probe of the Ohmmeter across the middle terminal of the Potentiometer and any one of the end-terminals.
10. Turn the knob of the Potentiometer fully clockwise and note down its Resistance.
11. Turn the knob of the Potentiometer slowly in counter-clockwise direction while observing its Resistance on the Ohmmeter.

Observations:

S. N.o	Resistance		Percent Error	Tolerance	Implication
	Coded	Measured			
1.					
2.					
3.					
4.					
5.					

Table-2: Difference between rated and real value of a Resistor

Questions:

1. Write down the values of the following resistors in ohms:

i. 2E3 ii. 5E4 iii. 94R2 iv. 712 v. 1203 vi. 333

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_____
_____

2. Can the Potentiometer be used as a Rheostat?

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3. Write down few applications of Variable Resistors.

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4. Write down typical power ratings for carbon, wire wound, SMD and metal film resistors.

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