Applied Physics Lecture 5

Review:

BOOK: Basic electronics Solid State by B.L Theraja

Chapter 1 Circuit Fundamentals (complete) covered in lecture 1 and 2

Chapter 2 Resistive Circuits (complete. exclude last topic of complex circuits) covered in lecture 3 and 4

Lecture 5 (Chapter 5 Passive Circuit Elements)

Topics included from chapter 5:

Resistors (5.1-5.15), Inductors (5.19-5.23) Capacitors (5.35-5.49)

Resistors (5.1-5.15)

The components which make up an electronic circuit are called elements.

There are two types of components in a circuit: Active component and Passive component

Active component supplies energy to an electric circuit and can electrically control the current. All electronic circuits must have at least one active component. They are energy producers or energy donors.

Examples are Voltage sources, generators, different types of transistors and diodes etc.

Passive component can only receive energy which it can either dissipate (waste) or absorb. It cannot generate a signal. They are energy consumers or energy acceptors.

Examples are Resistors, capacitors and inductors.

Resistor: Opposes the flow of current. Its applications are

(i) To limit the current

(ii) To divide the voltage (control IR drop)

(iii) To provide load

(iv) To generate heat (in some cases)

They have many shapes and sizes. They have two categories: Fixed and variable.

Fixed Resistors: Their values are set during manufacturing and cannot be changed.

Variable Resistors: They are designed so that their resistance values can be changed easily.

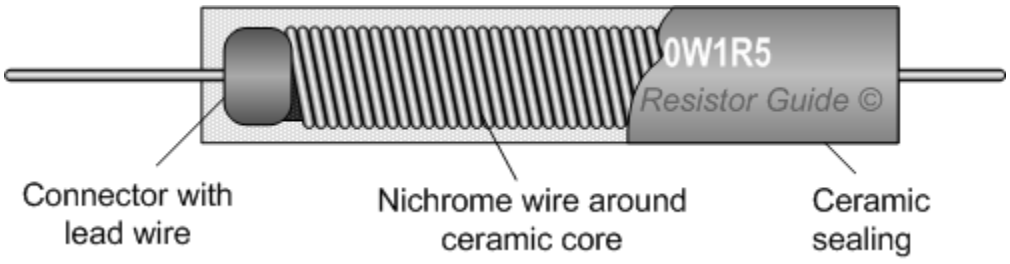
Resistor Types

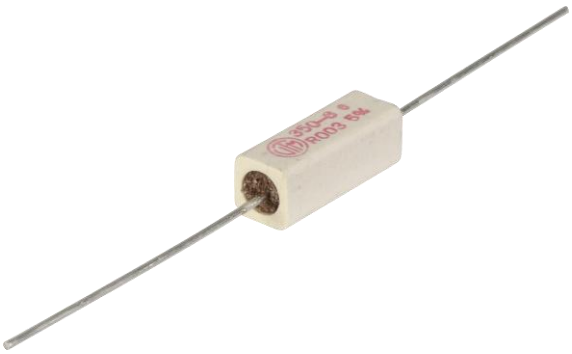
There are many types of resistors and can be either fixed or variable.

1. Wire wound resistors
2. Carbon composition type
3. Carbon film type
4. Cermet film type
5. Metal thin film

Wire-Wound Resistors

Long thin wire (nichrome or any other alloy) wound around ceramic (insulating) core and then sealed.

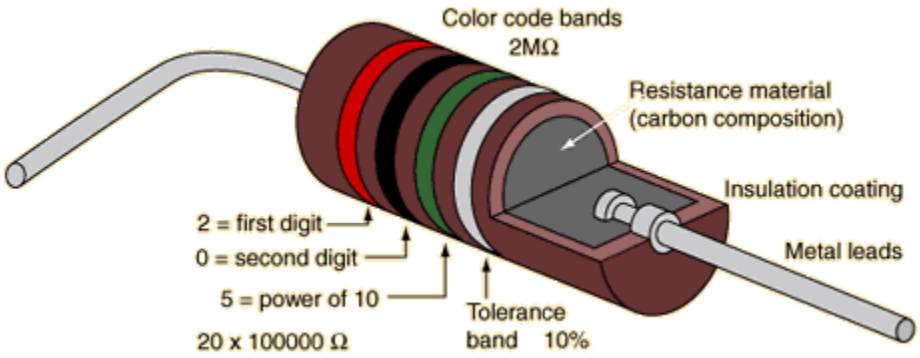




Wire length determines the value of resistance. Their values of power rating and resistance ranges from 5W to several hundred watts and 1 ohms to 100k ohms.

Carbon-Composition Resistors

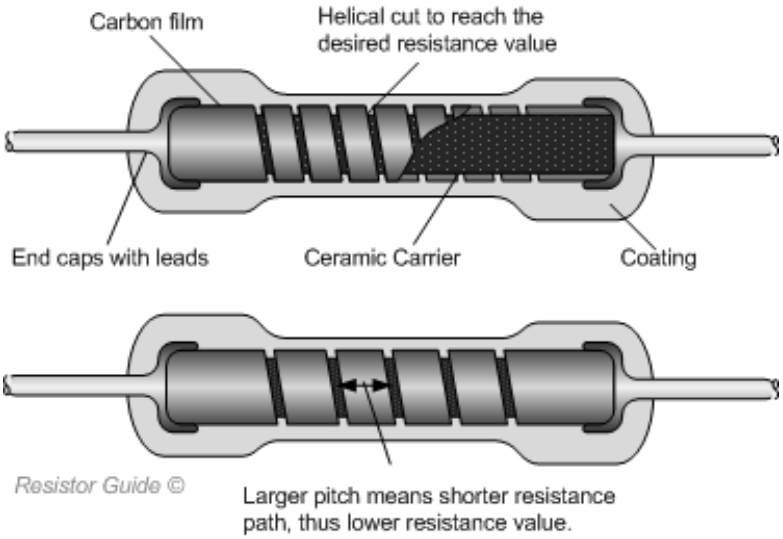
It is made up of mixture of finely grinded carbon, insulating material and a resin binder. The ratio of carbon to insulating material sets the resistance value. The mixture is formed into rods and conductive lead connections are made and finally encapsulated in insulating coating.



Their power ratings are usually 1/10, 1/8, 1/4 , 1/2 , 1, 2 Watt and resistance value ranges from 1 ohm to 20 Mega ohm (10^6). They are widely used in electronic circuits because they are smaller, inexpensive and have low power dissipation.

Carbon Film Resistors

Resistive material (carbon) is deposited on a high grade ceramic rod (substrate).



Cermet Film Resistors

Film of conductive paste (ceramic and metal) is deposited on a ceramic substrate. They are more stable at high temperatures than carbon composite resistors. Resistance value is controlled by thickness of film.

Metal Thin Film Resistors

Thin metal film is vacuum deposited on cylindrical insulator. They are more accurate have high resistance values. They are difficult to manufacture because thin films may not be uniform so resistance value cannot be controlled.

Power Rating

When current flows through resistor it gives off heat. The maximum power that a resistor can dissipate without being damaged is specified by its power rating.

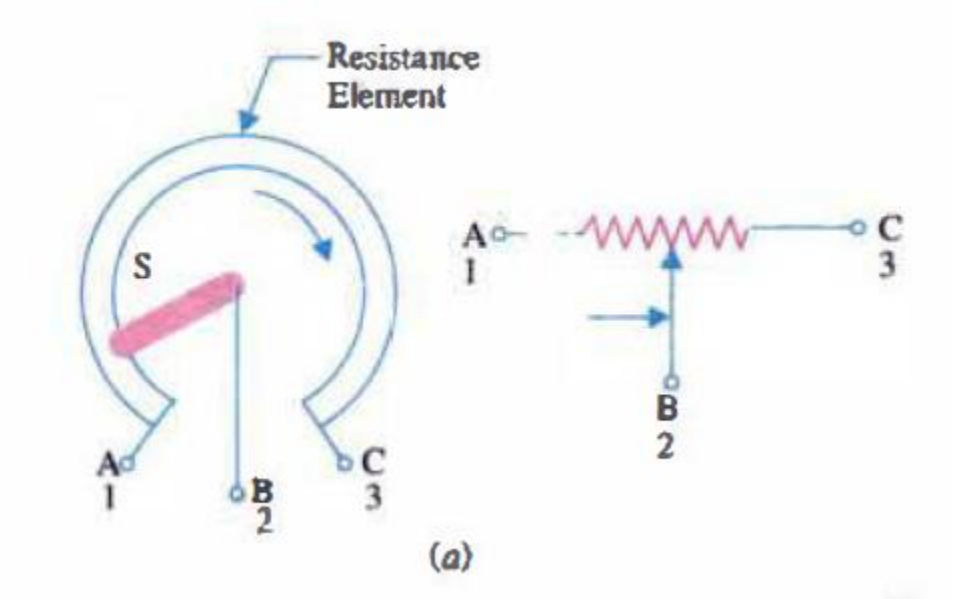
Power rating depends upon the composition, size and shape of the resistor. The larger the surface area the more power it can dissipate. Greater the physical size of a resistor more power rating is. Power rating also gives the highest voltage that can be applied across a resistor without internal sparking.

When resistor is used in a circuit, its power rating must be greater than the maximum power that it will have to handle. e.g. if resistor have to dissipate 0.75W in a circuit then resistor of slightly higher rating like 1W should be used for safety.

Variable Resistors

Their resistance value can be changed easily. A sliding arm S is attached to a rotating shaft. The rotation of the shaft in both directions change the value of resistance. The length between points A and B, B and C controls the value of resistance

Its working is given as

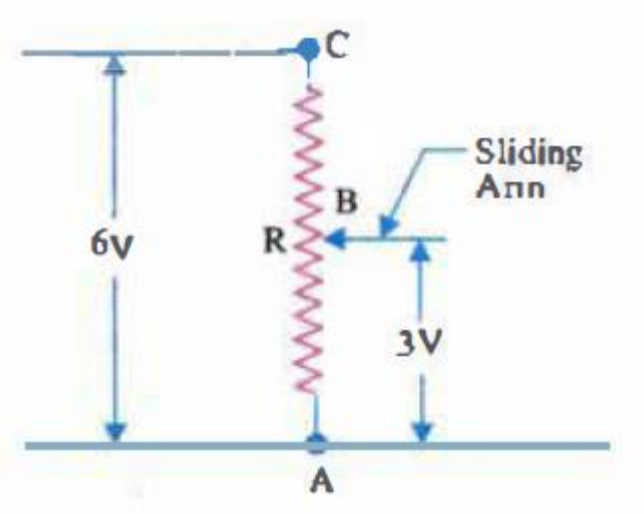


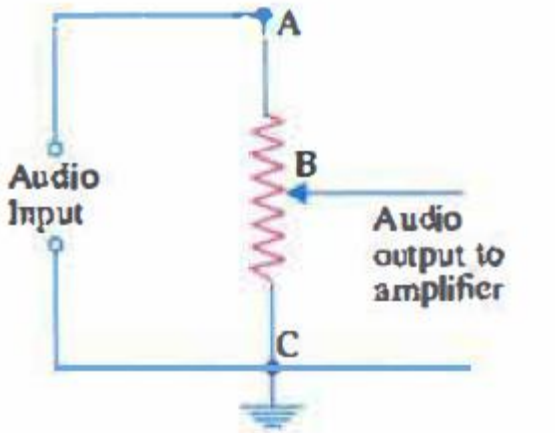
They can be either carbon composition or wire wound type.

Potentiometers

A variable resistor used to divide the voltage. Example is volume control in radio and television.

They have three terminals, the centre one being connected to the variable arm.

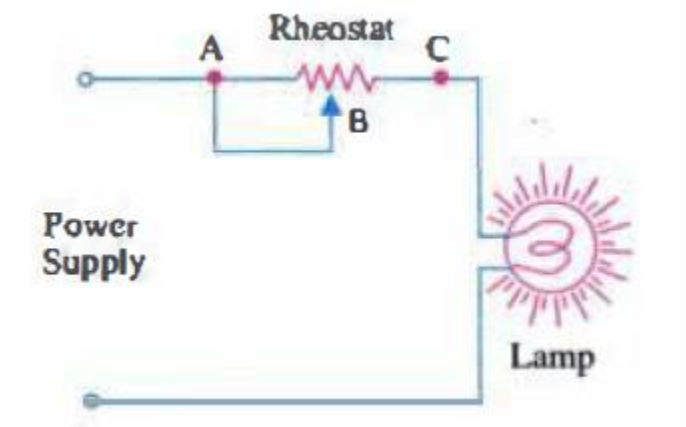




Rheostats

A variable resistor that controls the current is called rheostat. It is connected in series and control high currents.

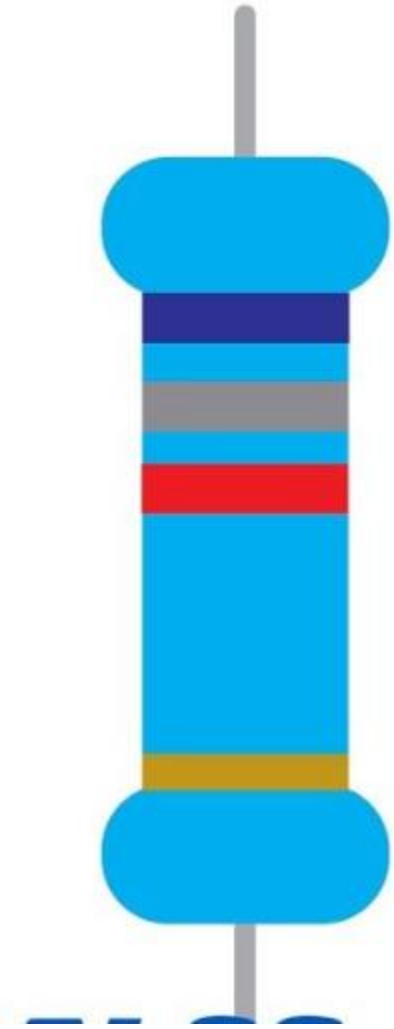
The resistance BC is used in the circuit.



Fusible Resistors

They are used for protection. They act as a fuse and burn easily so disconnect the circuit. They are same in appearance to other resistors. Their value is less than 15 ohms.

Color Coding



COLOR	DIGITS		MULTIPLIER
BLACK	0	0	10^0
BROWN	1	1	10^1
RED	2	2	10^2
ORANGE	3	3	10^3
YELLOW	4	4	10^4
GREEN	5	5	10^5
BLUE	6	6	10^6
VIOLET	7	7	10^7
GREY	8	8	10^8
WHITE	9	9	10^9
GOLD			10^{-1}
SILVER			10^{-2}

Tolerance

The possible variation from the marked resistance value e.g. 1000 ohm resistor with tolerance of 10% will have actual value between 900 and 1100 ohms.

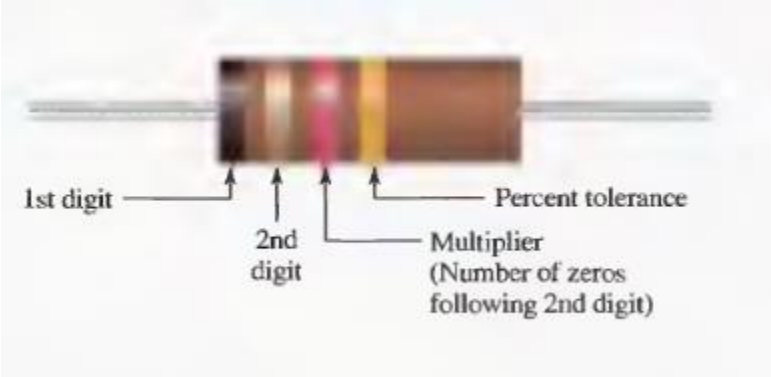
Silver ±10%, ±Gold 5%, no band ±20%.

Three bands

Three bands give value of resistance. Absence of 4th bands means tolerance of ±20%.

Four bands

Three bands give value of resistance and fourth gives tolerance.



Five bands