WHAT IS RESISTOR ??

- A RESISTOR IS A PASSIVE TWO-TERMINAL ELECTRICAL COMPONENT THAT IMPLEMENTS ELECTRICAL RESISTANCE AS A CIRCUIT ELEMENT.

- THE RATIO OF THE VOLTAGE APPLIED ACROSS A RESISTOR'S TERMINALS TO THE INTENSITY OF CURRENT THROUGH THE CIRCUIT IS CALLED RESISTANCE.

- THIS RELATION IS REPRESENTED BY OHM'S LAW:

$$V = I R$$

UNIT & SYMBOL

- THE OHM (SYMBOL: Ω) IS THE SI UNIT OF ELECTRICAL RESISTANCE, NAMED AFTER GEORG SIMON OHM.

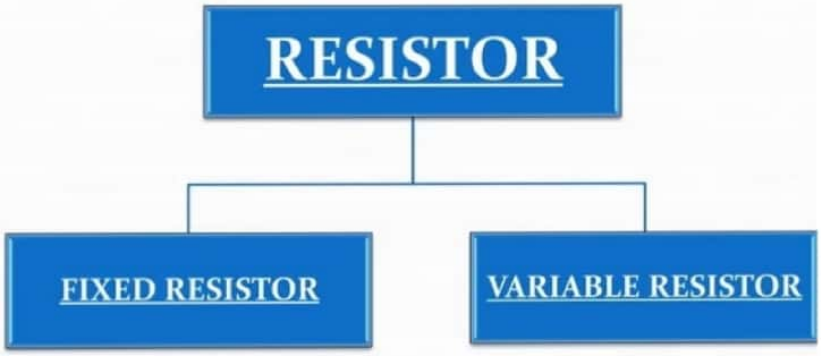
- AN OHM IS EQUIVALENT TO A VOLT PER AMPERE

- OTHER DERIVED UNITS ARE MILLI OHM (1 MΩ = 10^{-3} Ω), KILO OHM (1 KΩ = 10^{3} Ω), AND MEGA OHM (1 MΩ = 10^{6} Ω).

FIXED RESISTOR

VARIABLE RESISTOR

TYPES OF RESISTOR



FIXED RESISTOR

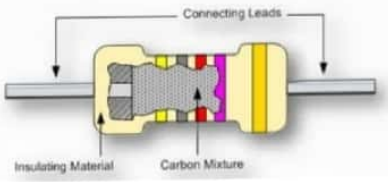
- CARBON COMPOSITE RESISTOR
- FILM RESISTOR
- WIRE WOUND RESISTOR
- RESISTANCE WIRE

VARIABLE RESISTOR

- RHEOSTAT
- POTENTIOMETER
- THERMISTOR
- HUMISTOR
- VARISTOR
- PHOTORESISTOR

CARBON COMPOSITE RESISTOR

- LOW INDUCTANCE
- IDEAL FOR HIGH FREQUENCY APPLICATIONS
- VERY CHEAP TO MAKE
- HAVE VERY LARGE TOLERANCES

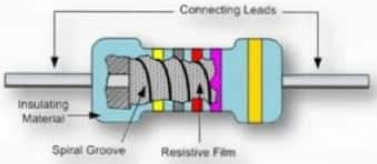


FILM RESISTOR

➢THE RESISTIVE VALUE OF THE RESISTOR IS CONTROLLED BY INCREASING THE DESIRED THICKNESS OF THE DEPOSITED FILM.

➢RESISTANE UPTO **10**MΩ CAN BE OBTAINED.

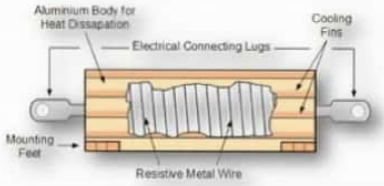
➢HAVE TOLERANCE **1%** OR LESS



WIRE WOUND RESISTOR

➢MADE BY WINDING A THIN METAL ALLOY WIRE ONTO AN INSULATING CERAMIC FORMER IN THE FORM OF A SPIRAL HELIX

➢ AVAILABLE IN VERY LOW OHMIC AND HIGH PRECISION VALUES
(FROM **0.01** TO **100**KΩ)



RHEOSTAT

➢RHEOSTAT IS A ADJUSTABLE RESISTOR USED IN APPLICATIONS THAT REQUIRE ADJUSTMENT OF CURRENT OR VARYING OF RESISTANCE IN AN ELECTRIC CIRCUIT

➢A SPECIAL TYPE OF RHEOSTAT IS THE POTENTIOMETER

POTENTIOMETER

- A POTENTIOMETER IS, A POT, IN ELECTRONICS TECHNOLOGY IS A THREE-TERMINAL RESISTOR WITH A SLIDING CONTACT THAT FORMS AN ADJUSTABLE VOLTAGE DIVIDER.
- POTENTIOMETERS ARE COMMONLY USED TO CONTROL ELECTRICAL DEVICES SUCH AS VOLUME CONTROLS, JOYSTICKS ETC.

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THERMISTOR

- A THERMISTOR IS A TYPE OF RESISTOR WHOSE RESISTANCE VARIES SIGNIFICANTLY WITH TEMPERATURE
- THERMISTORS CAN BE USED AS CURRENT-LIMITING DEVICES FOR CIRCUIT PROTECTION, AS REPLACEMENTS FOR FUSES

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HUMISTOR

- A HUMISTOR IS A TYPE OF RESISTOR WHOSE RESISTANCE VARIES SIGNIFICANTLY WITH HUMIDITY
- A HUMIDITY SENSOR MEASURES THE HUMIDITY LEVEL BY MEASURING THE CHANGE IN THE RESISTANCE OF AN ELEMENT

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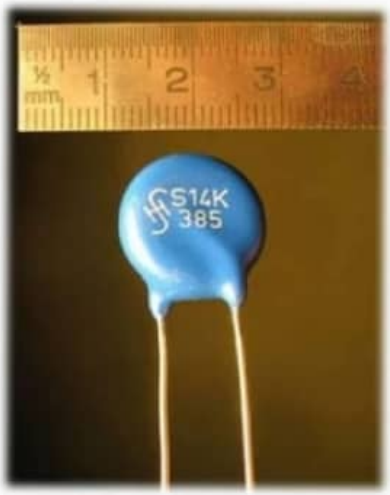
VARISTOR

➢ A VARISTOR (OR VOLTAGE DEPENDENT RESISTOR) FUNCTION IS TO CONDUCT SIGNIFICANTLY INCREASED CURRENT WHEN VOLTAGE IS EXCESSIVE.

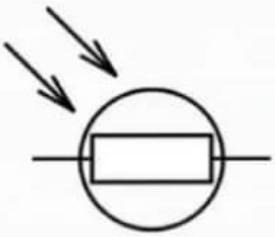


HIGH VOLTAGE VARISTOR

PHOTORESISTOR

➢A PHOTORESISTOR OR LIGHT DEPENDENT RESISTOR (LDR) EXHIBITS PHOTOCONDUCTIVITY.

➢PHOTORESISTORS IN MANY CONSUMER ITEMS SUCH AS STREET LIGHTS, CLOCK RADIOS, ALARM DEVICES ETC



14.9 COMBINATION OF RESISTORS

(i) Series combination (ii) Parallel combination

Resistors can be connected in two ways.

(i) Series Combination

In series combination, resistors are connected end to end (Fig. 14.12) and electric current has a single path through the circuit. This means that the current passing through each resistor is the same.

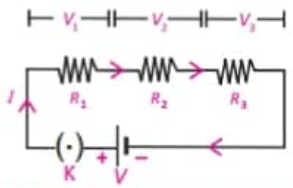


Fig.14.12: Three resistors in series combination

Equivalent Resistance of Series Circuit

The total voltage in a series circuit divides among the individual resistors so the sum of the voltage across the resistance of each individual resistor is equal to the total voltage supplied by the source. Thus, we can write as

$$V = V_1 + V_2 + V_3 \quad \ldots\ldots\ldots (14.6)$$

where V is the voltage across the battery, and V_1, V_2, V_3 are the voltages across resistors R_1, R_2 and R_3 respectively. If I is the current passing through each resistor, then from Ohm's law

$$V = IR_1 + IR_2 + IR_3$$

$$V = I(R_1 + R_2 + R_3) \quad \ldots\ldots\ldots (14.7)$$

We can replace the combination of resistors with a single resistor called the equivalent resistance R_e such that the same current passes through the circuit. From Ohm's law

$$V = IR_e$$

Thus, Eq. (14.7) becomes

$$IR_e = I(R_1 + R_2 + R_3)$$

$$R_e = R_1 + R_2 + R_3 \quad \ldots\ldots\ldots (14.8)$$

Thus, the equivalent resistance of a series combination is equal to the sum of the individual resistances of the combination.

If resistances R_1, R_2, R_3, ..., R_n are connected in series, then the equivalent resistance of the combination will be given by

$$R_e = R_1 + R_2 + R_3 + \ldots\ldots + R_n$$

Do you know?

We use heating effect of an electric current for different purposes. For example, when a current flows through the filament of a bulb, it glows white hot and gives out light. Electric heaters have very thin wires that glow red hot when a current flows.

Quick Quiz

Which metal is used as the filament of an electric bulb? Explain with reason.

Point to ponder!

(ii) Parallel Combination

In parallel combination one end of each resistor is connected with positive terminal of the battery while the other end of each resistor is connected with the negative terminal of the battery (Fig.14.13). Therefore, the voltage is same across each resistor which is equal to the voltage of the battery i.e.,

$$V = V_1 = V_2 = V_3$$

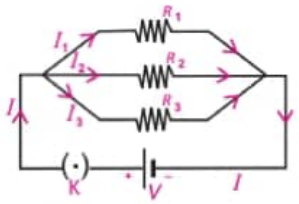


Fig 14.13: Three resistors in parallel combination

Equivalent Resistance of Parallel Circuit

In parallel circuit, the total current is equal the sum of the currents in various resistances i.e.,

$$I = I_1 + I_2 + I_3 \quad \text{..... (14.9)}$$

Since the voltage across each resistance is V, so by Ohm's law

$$I_1 = \frac{V}{R_1}, I_2 = \frac{V}{R_2} \text{ and } I_3 = \frac{V}{R_3}$$

Thus, Eq.14.9 becomes

$$I = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$I = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right) \quad \text{..... (14.10)}$$

We can replace the combination of resistors with a single resistor called the equivalent resistance R_e such that the same current passes through the circuit. From Ohm's law $I = V/R_e$ Thus, Eq. 14.10 becomes

$$\frac{V}{R_e} = V\left[\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right]$$

$$\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \quad \text{..... (14.11)}$$

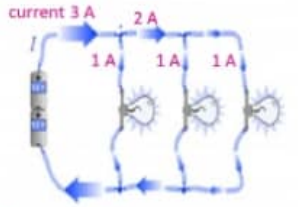
Thus, the reciprocal of equivalent resistance of a parallel combination is sum of the reciprocals of the individual resistances, which is less than the smallest resistance of the combination. If resistances $R_1, R_2, R_3, \ldots\ldots, R_n$ are connected in parallel, then the equivalent resistance of the combination will be given by

$$\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots\ldots\ldots + \frac{1}{R_n}$$

Parallel circuits have two big advantages over series circuits.

1. Each device in the circuit receives the full battery voltage.
2. Each device in the circuit may be turned off independently without stopping the current flowing to the other devices in the circuit. This principle is used in household wiring.

For your information



In parallel circuit current divides into branches.

RESISTOR POWER RATING

- THE POWER RATING OF RESISTORS CAN BE CALCULATED USING THE FORMULA :-

$$\text{Power}\,(P) = V \times I = I^2R = \frac{V^2}{R}$$

- THE LARGER THE POWER RATING, THE GREATER THE PHYSICAL SIZE OF THE RESISTOR.

- WHEN USED IN AC CIRCUITS THE AC IMPEDANCE OF A RESISTOR IS EQUAL TO ITS DC RESISTANCE.

Colour Code Table

COLOUR	DIGIT	MULTIPLIER	TOLERANCE
BLACK	0	10^0	-
BROWN	1	10^1	± 1%
RED	2	10^2	± 2%
ORANGE	3	10^3	-
YELLOW	4	10^4	-
GREEN	5	10^5	± 0.5%
BLUE	6	10^6	± 0.25%
VIOLET	7	10^7	± 0.1%
GREY	8	10^8	-
WHITE	9	10^9	-
GOLD	-	10^{-1}	± 5%
SILVER	-	10^{-2}	± 10%
NONE	-	-	± 15%