Enhanced Guided Notes: Set 3

Circuits, Resistance, and Related Issues

Topics:

Voltage applies the pressure and initiates a current.

What resists the current?

What is its units of measurement? _____

What is the symbol? _____

- The opposition is due to collisions and friction between free e- and other e-, ions, and atoms in the path of motion and converts the supplied energy into _____ raising _____ of electrical components

Which would be the hottest with the same current flow through the same sectional area of material?

Copper
Porcelain
Silicon

Why?

A. Resistance in Circular Wires

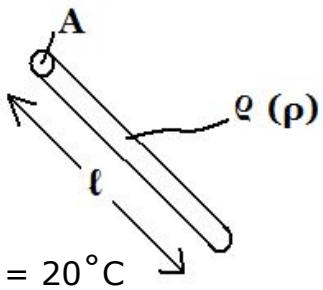
Due to

1)

2)

3)

4)



$$R = \varrho \frac{\ell}{A}$$

□ or ρ = cmil - Ω/ft @ T = 20°C

ℓ= feet

A = area in circular mils (cmil or CM)

□ is a material identification resistive factor and can be found on pg. 64 Table 3.1 for a variety of materials.

What does a higher resistivity do to the resistance of the conductor?

What does an increase in Area do to the resistance of a conductor?

B. Circular Mils and Square Mils

Cmil (CM) – circular mils and is used in most commercial wire tables.

1 mil = 1/1000 inches, or 1000 mils = 1 in.

a wire with a diameter of _____ mil has an area of ___ cm

A_{CM} =

Converting CM to sq mils

1CM = □ /4 sq

or

1 sq mil = 4/ □

❋ Examples:

What is the resistance of a 250 ft length of contractor power cord with a copper wire of 0.05 in diameter at 20°C?

What is the resistance of a tungsten electrode in a TIG welder with dimensions of 0.125” x 0.125” by 4” in length at 20°C? (They are usually round!)

Why is Cu preferred over silver and gold as a conductor?

Why not aluminum?

Resistance in Metric Units

$$R = \rho\frac{\ell}{A} \Rightarrow \rho = \frac{RA}{\ell} \qquad \frac{\Omega - cm^2}{cm} = \Omega - cm$$

resistivities on pg. 70 table 3.3!

Convert tungsten's resistivity to metric units using ℓ(Ω- em) = 1.662 x 10-7 x (value in CM - Ω/ft) at 20°C

C. Temperature Effects and Inferred Absolute Temperature

Temperature Effects

Conductors	Semiconductors	Insulators

Inferred Absolute Temp.

- we approximate the Resist versus Temp curve with a _____ fit curve.

- The zero value (projected) from this curve fit is the _____

_____

- Values for different conductors found on pg 74 Table 3.6

$$\frac{|T_1| + T_1}{R_1} = \frac{|T_1| + T_2}{R_2} \text{ or for copper } \frac{234.5 + T_1}{R_1} = \frac{234.5 + T_2}{R_2}$$

Temperature Coefficient of Resistance

$$\alpha_{20} = \frac{1}{|T_1| + 20^\circ C}$$

$R1 = R_{20}[1 + \square_{20}(T1-20^\circ C)]$

Using the second equation, what can we conclude about size of temp coefficients of resistance to the materials resistance to changes in temp?

To calculate resistance with all the controlling parameters

$$R = \rho \frac{\ell}{A} [1 + \alpha_{20} \Delta T]$$

ΔT = Change in Temp
$\square_{20}$ = Temp coefficient
ℓ = length
A = cross-sectional area
R = Resistance

If the temperature change is small with a typical temperature coefficient used is the results, is the resistance smaller or greater than with a large change in temp?

❋ Examples:

The resistance of a copper wire is 60Ω at 20°C. What would its resistance be at 60°C?

Find the resistance of a tungsten wire that is 2 feet long with a cross-sectional area of 0.125 in^2 and a change in ambient air temperature of 30°C.

D. Superconductors

Conductors of electric charge with _____ resistance for all practical purposes

What is the Cooper Effect?

Define "critical temp" (Tc)

E. Resistors

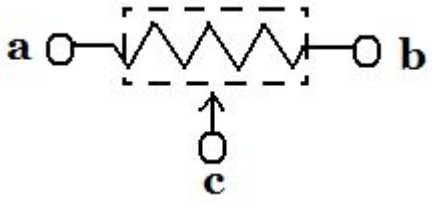
Fixed or _____

What is an advantage for both types?

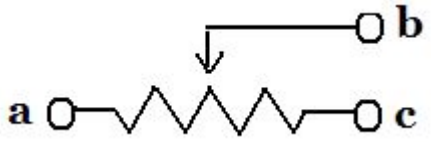
- For a particular style and manufacturer, the size of a resistor _____ with power or wattage rating, however, this size does not reflect its _____ level

- If a 2 or _____ terminal variable resistor is used to control resistance, it is called a _____
- If a 3 terminal device is used to control potential, it's called a _____

Potentiometer



Rheostat Symbol



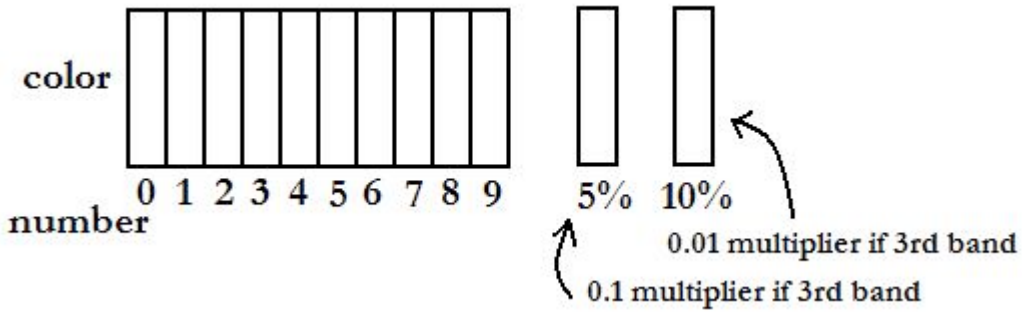
Color Coding and Standard Resistor Values

Always read from the end with the band closest to it

_____ _____ bands represent 1st and 2nd digits, respectively, and define numerical value of resistance.

_____ band designates power of ten multiplier to first two digits

fourth band represents the manufacturers _____
omitting means to assume ±20%



Can only go smaller than 10Ωw/gold or silver on 3rd band

This scheme is used on all important electrical elements

Why are color codes used on resistors rather than numerals?

5 Bands

first _____ bands are numerals

fourth is _____

fifth is tolerance indicator

6 bands

same as five with sixth indicating temp coefficient

Brown = 100 PPM Red = _____ PPM

Orange = 15 PPM Yellow = _____ PPM

F. Conductance

- The reciprocal of resistance is a measure of how well a material conducts electricity

- Conductance is measured in _____ with a symbol ____ to represent it.

$$G = \frac{I}{R}$$

R = resistance (Ω)
G = conductance (G)

? A large conductance in a material will do what to its resistance?

$$G = \frac{A}{\rho \ell}$$

□ = length
A = cross-sectional area
□ = resistivity $\frac{CM \cdot \Omega}{ft}$ @ T = 20°C

Prove this equation true using what you know about resistance.

G. Ohmmeters

1)

2)

3)

4)

NOTE

Never hook up an ohmmeter to a live _____!
Never store a VOM or DMM in the resistance mode!

- Examples:

What is the resistance of the following resistor?

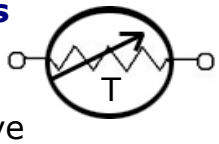
Brown, red, orange, gold

What is the resistance of this resistor?

Red, purple/violet, blue
black, gold, yellow

What is the conductance of a 1 square inch area, 2 foot long copper wire?

H. Thermistors and Varistors



A thermistor
- is temperature sensitive
- has negative temperature coefficients
- when encountering an increase in temperature will drop its internal resistance

- Plot the temp vs. specific resistance curve and define of it a conductor, insulator, or semiconductor.

Varistor
- voltage dependant nonlinear resistors

- suppress _____ _____ transients
- can limit voltage that can appear across terminals

- Plot the voltage versus current curve or a varistor.