Basic Electronics

- Electric Charge
- Voltage
- Current
- Resistance
- Current And Voltage Source
- Resistors
- Current Control & Protection

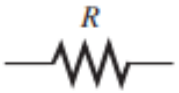
Resistance

- When there is current through a material, the free electrons move through the material and occasionally collide with atoms. These collisions cause the electrons to lose some of their energy, thus restricting their movement.
- The more collisions, the more the flow of electrons is restricted. This restriction varies and is determined by the type of material.
- The property of a material to restrict or oppose the flow of electrons is called resistance, R.

Resistance

- Resistance is the opposition to current.

- Resistance is expressed in ohms, symbolized by the Greek letter omega ( ).



- One ohm (1) of resistance exists if there is one ampere (1 A) of current in a material when one volt (1 V) is applied across the material

Conductance

- Conductance The reciprocal of resistance is conductance, symbolized by G.
- It is a measure of the ease with which current is established. The formula is

$$G = 1/R$$

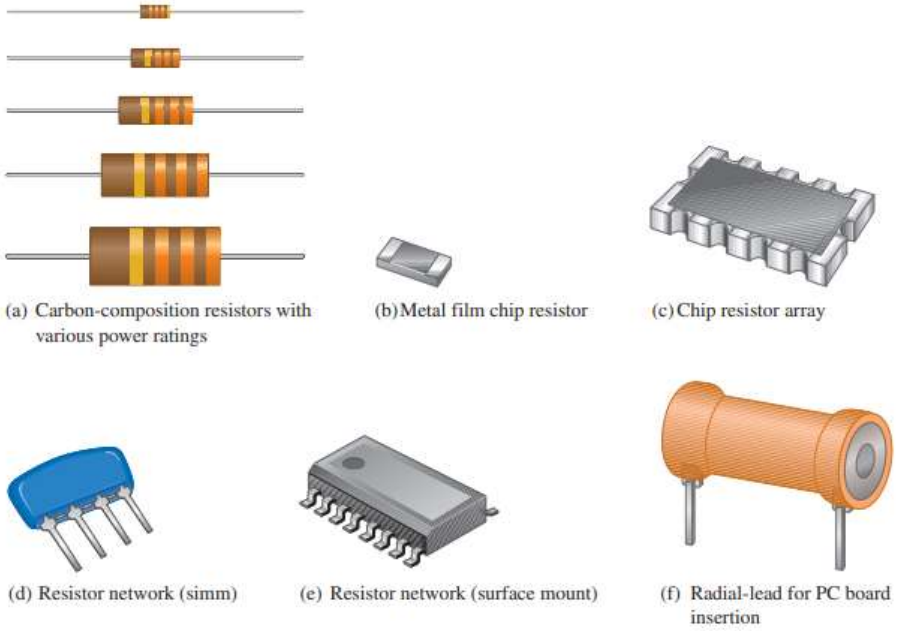
- The unit of conductance is the siemens, abbreviated S

Resistors

- A component that is specifically designed to have a certain amount of resistance is called a resistor.
- The principal applications of resistors are to limit current in a circuit, to divide voltage, and, in certain cases, to generate heat.
- Although resistors come in many shapes and sizes, they can all be placed in one of two main categories: fixed or variable.

Fixed Resistors

- Fixed Resistors Fixed resistors are available with a large selection of resistance values that are set during manufacturing and cannot be changed easily.



(a) Carbon-composition resistors with various power ratings

(b) Metal film chip resistor

(c) Chip resistor array

(d) Resistor network (simm)

(e) Resistor network (surface mount)

(f) Radial-lead for PC board insertion

Fixed Resistors Color Codes

Resistor 4-band color code.

	Digit	Color
Resistance value, first three bands: First band—1st digit Second band—2nd digit Third band—multiplier (number of zeros following the 2nd digit)	0	Black
	1	Brown
	2	Red
	3	Orange
	4	Yellow
	5	Green
	6	Blue
	7	Violet
	8	Gray
	9	White
Fourth band—tolerance	±5%	Gold
	±10%	Silver

Fixed Resistors Color Codes

- The color code is read as follows:
- Start with the band closest to one end of the resistor. The first band is the first digit of the resistance value. If it is not clear which is the banded end, start from the end that does not begin with a gold or silver band.
- The second band is the second digit of the resistance value.
- The third band is the number of zeros following the second digit, or the multiplier.

Fixed Resistors Color Codes

- The fourth band indicates the percent tolerance and is usually gold or silver.
- For example, a 5% tolerance means that the actual resistance value is within 5% of the color-coded value. Thus, a resistor with a tolerance of 5% can have an acceptable range of values from a minimum of to a maximum of

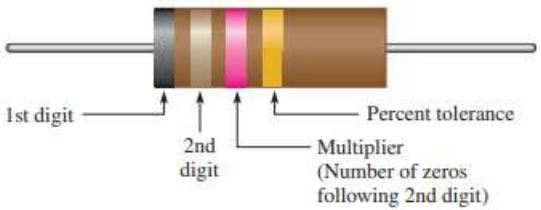


FIGURE 27
Color-code bands on a 4-band resistor.

Fixed Resistors Color Codes

EXAMPLE 4

Find the resistance value in ohms and the percent tolerance for each of the color-coded resistors shown in Figure 28.

FIGURE 28

Solution

(a) First band is red = 2, second band is violet = 7, third band is orange = 3 zeros, fourth band is silver = 10% tolerance.

$$R = \mathbf{27{,}000\ \Omega \pm 10\%}$$

(b) First band is brown = 1, second band is black = 0, third band is brown = 1 zero, fourth band is silver = 10% tolerance.

$$R = \mathbf{100\ \Omega \pm 10\%}$$

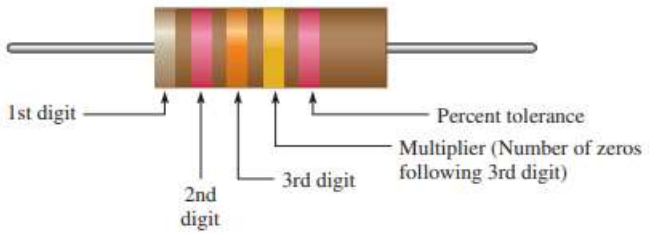
(c) First band is green = 5, second band is blue = 6, third band is green = 5 zeros, fourth band is gold = 5% tolerance.

$$R = \mathbf{5{,}600{,}000\ \Omega \pm 5\%}$$

Related Problem A certain resistor has a yellow first band, a violet second band, a red third band, and a gold fourth band. Determine its value in ohms and its percent tolerance.

Five Band Color Codes

- Certain precision resistors with tolerances of 2%, 1%, or less are generally color coded with five bands. Begin at the band closest to one end.
- The first band is the first digit of the resistance value, the second band is the second digit, the third band is the third digit, the fourth band is the multiplier (number of zeros after the third digit), and the fifth band indicates the percent tolerance.



Five Band Color Code Table

	DIGIT	COLOR
Resistance value, first three bands: First band—1st digit Second band—2nd digit Third band—3rd digit Fourth band—multiplier (number of zeros following 3rd digit)	0	Black
	1	Brown
	2	Red
	3	Orange
	4	Yellow
	5	Green
	6	Blue
	7	Violet
	8	Gray
	9	White
Fourth band—multiplier	0.1	Gold
	0.01	Silver
Fifth band—tolerance	±2%	Red
	±1%	Brown
	±0.5%	Green
	±0.25%	Blue
	±0.1%	Violet

Five Band Color Code Example

EXAMPLE 5

Find the resistance value in ohms and the percent tolerance for each of the color-coded resistors shown in Figure 30.

▲ FIGURE 30

Solution

(a) First band is red = 2, second band is violet = 7, third band is black = 0, fourth band is gold = ×0.1, fifth band is red = ±2% tolerance.

$$R = 270 \times 0.1 = \mathbf{27\ \Omega \pm 2\%}$$

(b) First band is yellow = 4, second band is black = 0, third band is red = 2, fourth band is black = 0, fifth band is brown = ±1% tolerance.

$$R = \mathbf{402\ \Omega \pm 1\%}$$

(c) First band is orange = 3, second band is orange = 3, third band is red = 2, fourth band is orange = 3, fifth band is green = ±0.5% tolerance.

$$R = \mathbf{332{,}000\ \Omega \pm 0.5\%}$$

Related Problem

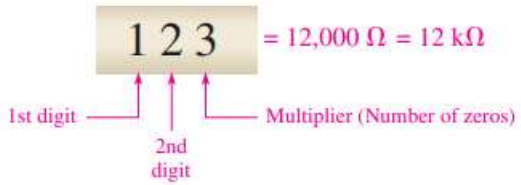
A certain resistor has a yellow first band, a violet second band, a green third band, a gold fourth band, and a red fifth band. Determine its value in ohms and its percent tolerance.

Resistor Label Codes

- Not all types of resistors are color coded. Many, including surface-mount resistors, use typographical marking to indicate the resistance value and tolerance. These label codes consist of either all numbers (numeric) or a combination of numbers and letters (alphanumeric).
- In some cases when the body of the resistor is large enough, the entire resistance value and tolerance are stamped on it in standard form.

Resistor Label Codes

- Numeric labeling uses three digits to indicate the resistance value.
- The first two digits give the first two digits of the resistance value, and the third digit gives the multiplier or number of zeros that follow the first two digits. This code is limited to values of or greater.

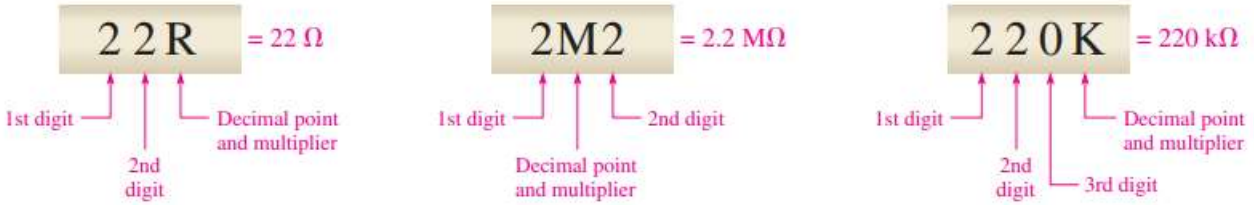


Resistor Label Codes

- Another common type of marking is a three- or four-character label that uses both digits and letters.
- An alphanumeric label typically consists of only three digits or two or three digits and one of the letters R, K, or M. The letter is used to indicate the multiplier, and the position of the letter indicates the decimal point placement.

Resistor Label Codes

- The letter R indicates a multiplier of 1 (no zeros after the digits), the K indicates a multiplier of 1000 (three zeros after the digits), and the M indicates a multiplier of 1,000,000 (six zeros after the digits).
- In this format, values from 100 to 999 consist of three digits and no letter to represent the three digits in the resistance value.



Resistor Label Codes

EXAMPLE 6

Interpret the following alphanumeric resistor labels:

(a) 470 **(b)** 5R6 **(c)** 68K **(d)** 10M **(e)** 3M3

Solution

(a) 470 = **470 Ω** **(b)** 5R6 = **5.6 Ω** **(c)** 68K = **68 kΩ**

(d) 10M = **10 MΩ** **(e)** 3M3 = **3.3 MΩ**

Related Problem What is the resistance indicated by 1K25?