

Resistance

General

Introduction

INTRODUCTION

Placing a voltage across a wire or simple circuit results in a flow of charge or current through the wire or circuit. The question remains, however, What determines the level of current that results when a particular voltage is applied? Why is the current heavier in some circuits than in others?

The answers lie in the fact that there is an opposition to the flow of charge in the system that depends on the components of the circuit.

Resistance

Resistance

- This opposition to the flow of charge through an electrical circuit, called **resistance**, has the units of **ohms** and uses the Greek letter *omega* (Ω) as its symbol.

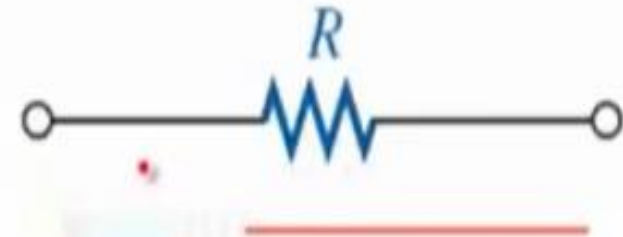


FIG. 3.1 *Resistance symbol and notation.*

- The graphic symbol for resistance, which resembles the cutting edge of a saw.

Resistance

Resistance

CIRCULAR WIRES

The resistance of any material is due primarily to four factors:

- *Material*
- *Length*
- *Cross-sectional area*
- *Temperature of the material*



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Resistance

CIRCULAR WIRES

- The higher the resistivity, the more the resistance
- The longer the length of a conductor, the more the resistance
- The smaller the area of a conductor, the more the resistance
- The higher the temperature of a conductor, the more the resistance.

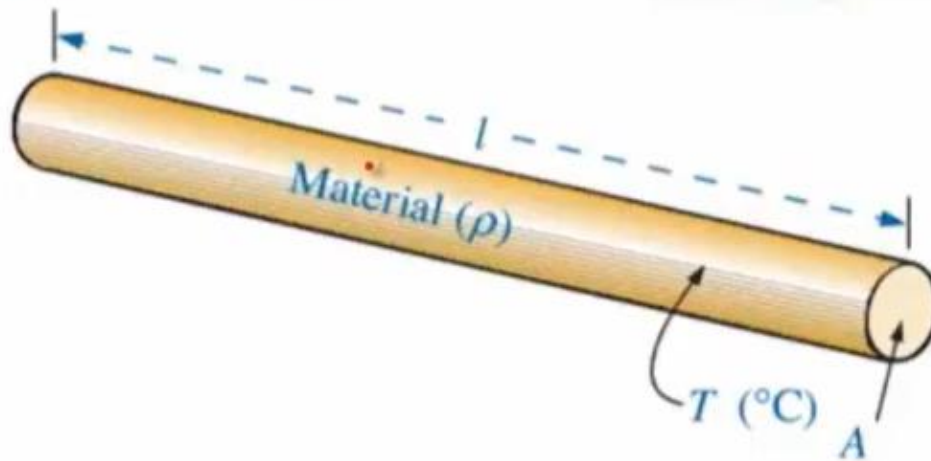
$$R = \rho \frac{l}{A}$$

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Resistance

CIRCULAR WIRES

The first three elements are related by the following basic equation for resistance:



$$R = \rho \frac{l}{A}$$

FIG. 3.2 Factors affecting the resistance of a conductor.

Resistance of circular Wires

Resistance CIRCULAR WIRES

Resistivity (ρ) of various materials.

Material	ρ (CM- Ω /ft)@20°C
Silver	9.9
Copper	10.37
Gold	14.7
Aluminum	17.0
Tungsten	33.0
Nickel	47.0
Iron	74.0
Constantan	295.0
Nichrome	600.0
Calorite	720.0
Carbon	21,000.0

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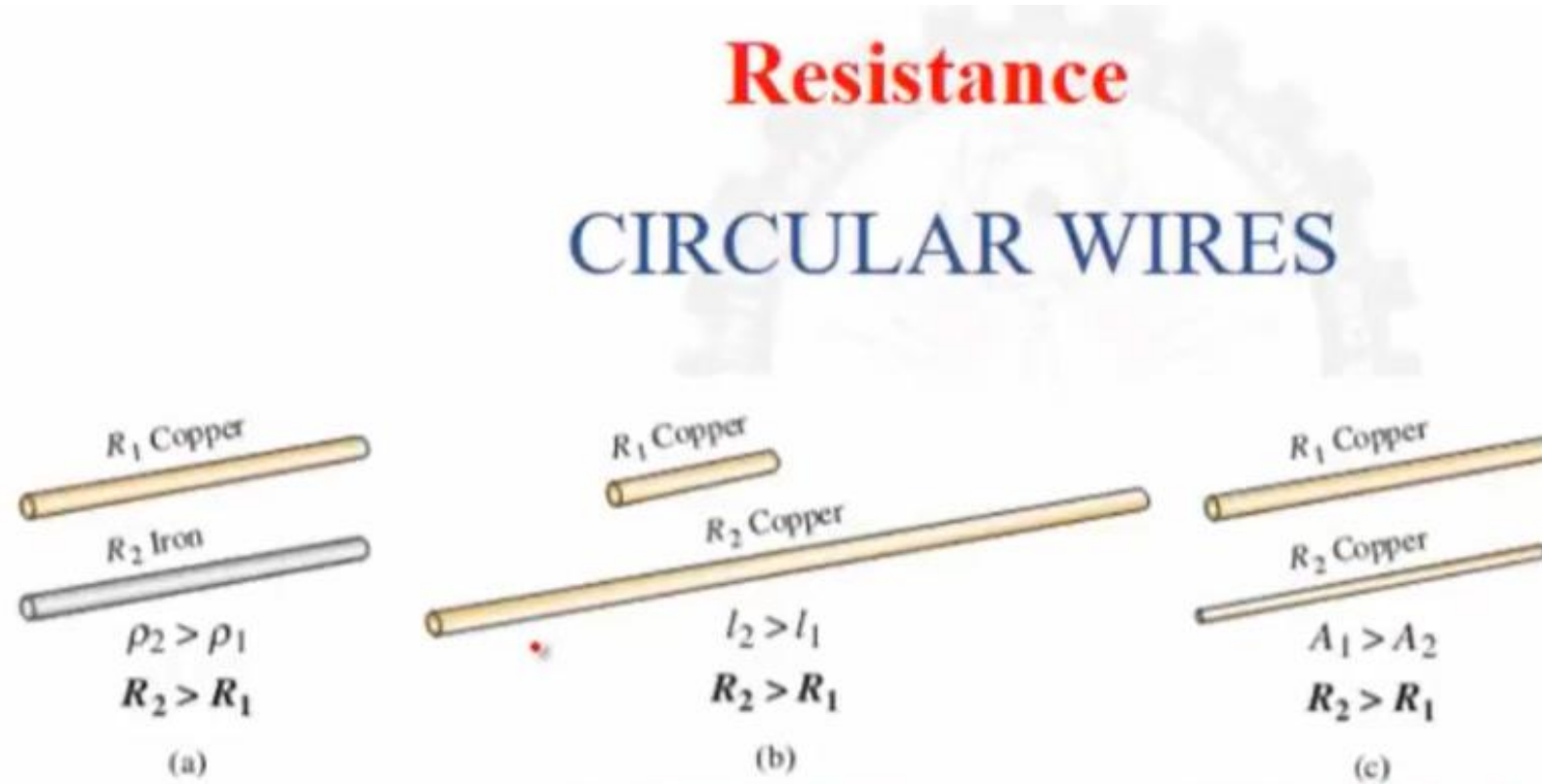


FIG. 3.3 Cases in which $R_2 > R_1$. For each case, all remaining parameters that control the resistance level are the same.

Types of resistance

Resistance

TYPES OF RESISTORS

Fixed Resistors

- Resistors are made in many forms, but all belong in either of two groups: fixed or variable.
- The most common of the low-wattage, fixed type resistors is the film resistor.

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TYPES OF RESISTORS

Fixed Resistors

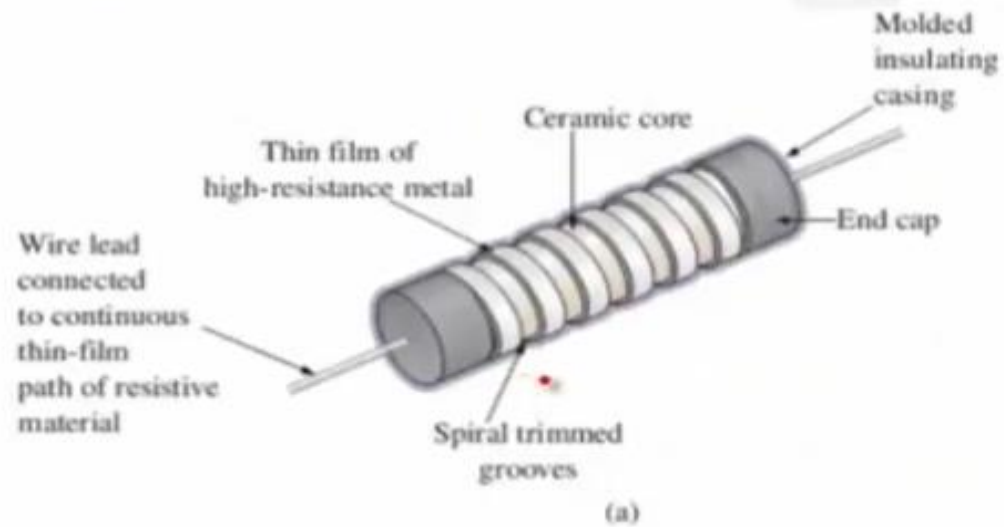


Fig3.4 Film resistors: (a) construction; (b) types.

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TYPES OF RESISTORS

Fixed Resistors

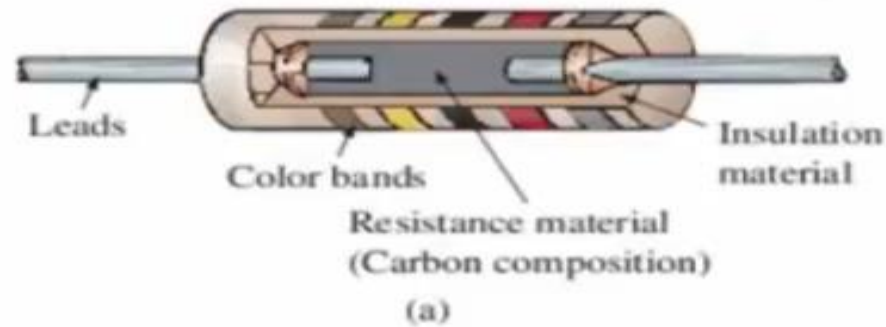


Fig3.5 : Fixed-composition resistors: (a) construction; (b) appearance

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Resistance

TYPES OF RESISTORS

Fixed Resistors

For a particular style and manufacture the size of resistor increase with the power wattage

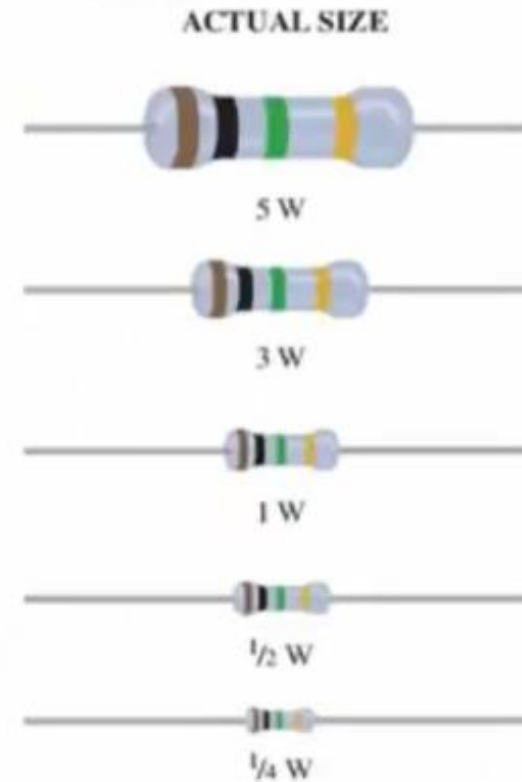
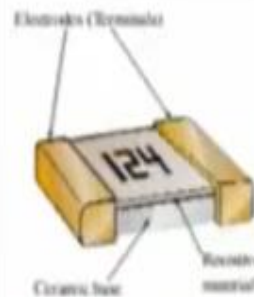
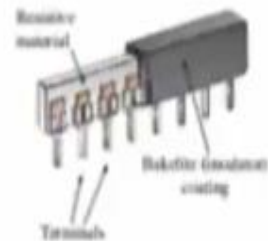


FIG3. 6 Fixed metal-oxide resistors of different wattage ratings.

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Resistance



Types of resistance

Resistance

TYPES OF RESISTORS

Variable Resistors

- Variable resistors, as the name implies, have a terminal resistance that can be varied by turning a dial, knob, screw, or whatever seems appropriate for the application.
- They can have two or three terminals, but most have three terminals. If the two- or three-terminal device is used as a variable resistor, it is usually referred to as a **rheostat**.

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TYPES OF RESISTORS

Variable Resistors

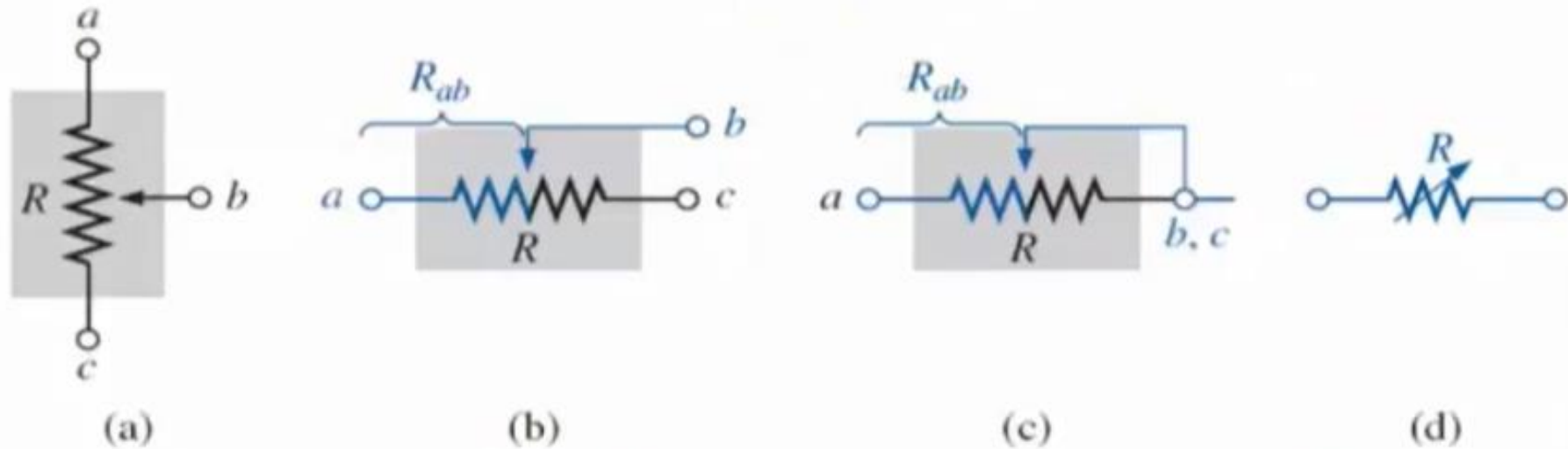


FIG. 3.8 Potentiometer: (a) symbol; (b) and (c) rheostat connections; (d) rheostat symbol.

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TYPES OF RESISTORS

Variable Resistors

The sum of the resistances between the wiper arm and each outside terminal equals the full rated resistance of the potentiometer.

This is demonstrated in Fig. 18(b), where $250\text{ k}\Omega + 750\text{ k}\Omega$. Specifically,

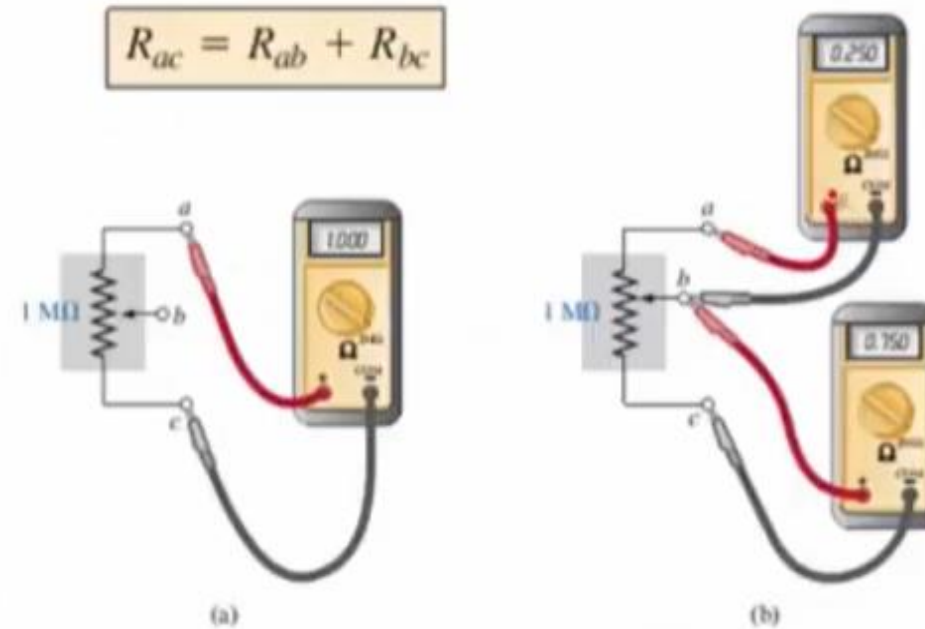


FIG. 3.18 Resistance components of a potentiometer: (a) between outside terminals; (b) between wiper arm and each outside

Color coding

Resistance

COLOR CODING AND STANDARD RESISTOR VALUES

- A wide variety of resistors, fixed or variable, are large enough to have their resistance in ohms printed on the casing.
- Some, however, are too small to have numbers printed on them, so a system of **color coding** is used.
- For the thin-film resistor, four, five, or six bands may be used.
- The four-band scheme is described.

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COLOR CODING AND STANDARD RESISTOR VALUES



FIG. 3.9 *Color coding for fixed resistors.*

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COLOR CODING AND STANDARD RESISTOR VALUES

- The first two bands represent the first and second digits, respectively.
- The third band determines the power-of-ten multiplier for the first two.
- The fourth band is the manufacturer's tolerance, which is an indication of the precision by which the resistor was made.



Number	Color
0	Black
1	Brown
2	Red
3	Orange
4	Yellow
5	Green
6	Blue
7	Violet
8	Gray
9	White

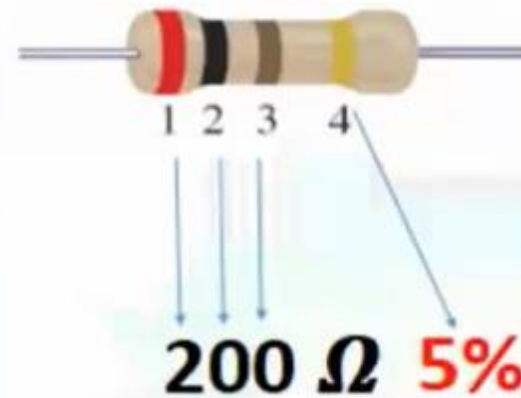
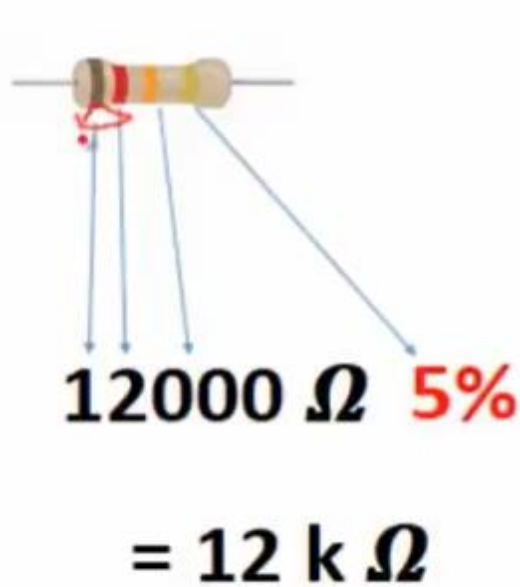
±5% (0.1 multiplier if 3rd band)	
±10% (0.01 multiplier if 3rd band)	

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COLOR CODING AND STANDARD RESISTOR VALUE

EXAMPLE 11 Find the value of the resistor in Fig.



Number		Color
0		Black
1		Brown
2		Red
3		Orange
4		Yellow
5		Green
6		Blue
7		Violet
8		Gray
9		White

$\pm 5\%$
(0.1 multiplier
if 3rd band)



Gold

$\pm 10\%$
(0.01 multiplier
if 3rd band)



Silver

Surface Mounting Resistance (SMT)

Resistance

Surface Mount Resistors (SMD)

In general, surface mount resistors are marked in three ways: color coding, three symbols, and two symbols.

- The **color coding** is the same as just described earlier in this section for through-hole resistors.
- The **three-symbol** approach uses three digits. The first two define the first two digits of the value; the last digit defines the power of the power-of-ten multiplier.
- The **two-symbol** marking uses a letter followed by a number.

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Surface Mount Resistors (SMD)

Three-symbol example

820 is $82 \times 10^0 = 82 \Omega$
223 is $22 \times 10^3 = 22 k\Omega$

Tow-symbol example

A = 1.0	B = 1.1	C = 1.2	D = 1.3
E = 1.5	F = 1.6	G = 1.8	H = 2
J = 2.2	K = 2.4	L = 2.7	M = 3
N = 3.3	P = 3.6	Q = 3.9	R = 4.3
S = 4.7	T = 5.1	U = 5.6	V = 6.2
W = 6.8	X = 7.5	Y = 8.2	Z = 9.1

Example :

$$C3 = 1.2 \times 10^3 = 1.2 k\Omega$$

Ohm meters

Resistance

OHMMETERS

The **ohmmeter** is an instrument used to perform the following tasks and several other useful functions:

- *Measure the resistance of individual or combined elements.*
- *Detect open-circuit (high-resistance) and short-circuit (low resistance) situations.*
- *Check the continuity of network connections and identify wires of a multilead cable.*
- *Test some semiconductor (electronic) devices.*

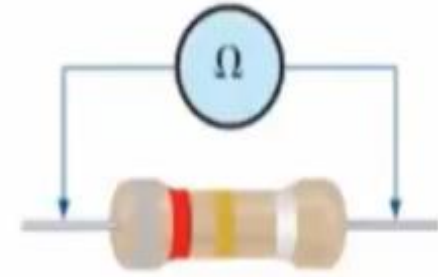


FIG. 3.28 *Measuring the resistance of a single element.*

Conclusion

Resistance **Conclusion**

In this chapter, we discussed the parameters that determine the resistance of an element and explain the broad range of commercially available resistors available today.

Reading the value of each resistance from the color code or labeling has been introduced.