Chapter 1

Components, Quantities, and Units

Introduction

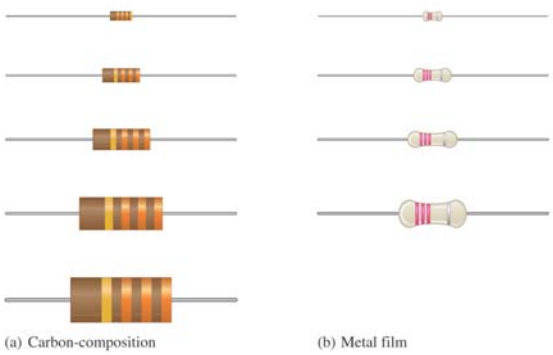
- This chapter will give you a preview of the types of things you will study throughout this book

Objectives

- Recognize common electrical components and measuring instruments
- State basic electrical and magnetic quantities and their units
- Use Scientific notation to express quantities
- Use engineering notation and metric prefixes to express large and small quantities
- Convert from one metric-prefixed unit to another

Resistors

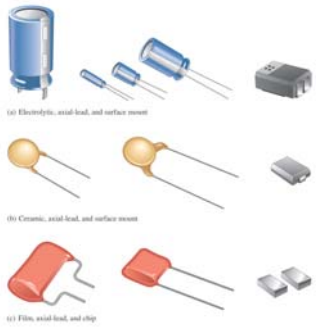
- Resistors limit electrical current in a circuit



(a) Carbon-composition (b) Metal film

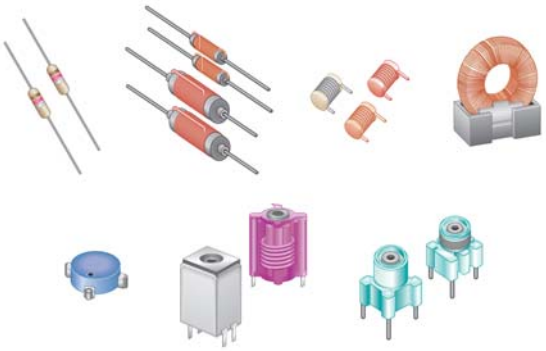
Capacitors

- Capacitors store electrical charge and are used to block dc and pass ac



Inductors

- Inductors, or coils, are used to store energy in an electromagnetic field



Transformers

- Transformers are used for ac coupling, or to increase/decrease ac voltages

Electronic Instruments

Electronic Instruments

- A DC power supply provides current and voltage to power electronic circuits
- A function generator provides electronic signals for our circuits
- A digital multimeter (DMM) can be used as a voltmeter, ammeter or ohmmeter, depending upon the function selected

Oscilloscope

- The oscilloscope us used for observing and measuring ac voltage signals in a circuit
- Digital storage scopes are able to store waveforms
- Some digital scopes are can perform analysis on waveforms

Digital Multimeter

- A digital multimeter (DMM) measures voltage, current or resistance, depending upon the function selected
  - A voltmeter is used to measure voltage across a component or circuit
  - An ammeter is used to measure current through a circuit
  - An ohmmeter is used to measure resistance

Electrical Units

- Letters are used in electronics to represent quantities and units
- The units and symbols are defined by the SI system
  - The term SI is the French abbreviation for *System International*

Electrical Units

QUANTITY	SYMBOL	UNIT	SYMBOL
capacitance	C	farad	F
charge	Q	coulomb	C
conductance	G	siemens	S
current	I	ampere	A
energy	W	joule	J
frequency	f	hertz	Hz
impedance	Z	ohm	Ω
inductance	L	henry	H
power	P	watt	W
reactance	X	ohm	Ω
resistance	R	ohm	Ω
voltage	V	volt	V

Magnetic Units

- Letters are also used to represent magnetic quantities and units in the SI system

QUANTITY	SYMBOL	UNIT	SYMBOL
flux density	B	tesla	T
magnetic flux	ϕ	weber	Wb
magnetizing force	H	ampere-turns/meter	At/m
magnetomotive force	F_m	ampere-turn	A t
permeability	μ	webers/ampere-turns-meter	Wb/Atm
reluctance	$\mathcal{R}$	ampere-turns/weber	At/Wb

Scientific Notation

- Scientific notation is a convenient method of expressing large and small numbers
- A quantity is expressed as a number between 1 and 10, and a power of ten

Example:

5000 would be expressed as 5×10^3 in Scientific notation.

Powers of Ten

- The power of ten is expressed as an exponent of the base 10
- Exponent indicates the number of places that the decimal point is moved to the right (positive exponent) or left (negative exponent) to produce the decimal number

Engineering Notation

Engineering notation is similar to Scientific notation, except that engineering notation can have from 1 to 3 digits to the left of the decimal place, and the powers of 10 are multiples of 3

Metric Prefixes

Metric prefixes are symbols that represent the powers of ten used in Engineering notation

METRIC PREFIX	SYMBOL	POWER OF TEN	VALUE
pico	p	10^{-12}	one-trillionth
nano	n	10^{-9}	one-billionth
micro	μ	10^{-6}	one-millionth
milli	m	10^{-3}	one-thousandth
kilo	k	10^{3}	one thousand
mega	M	10^{6}	one million
giga	G	10^{9}	one billion
tera	T	10^{12}	one trillion

Example of Metric Prefix

Consider the quantity 0.025 amperes, it could be expressed as **25×10^{-3} A** in Engineering notation, or using the metric prefix as **25 mA**

Scientific notation vs Engineering notation

Consider the number: 23,000

In Scientific notation it would be expressed as: 2.3×10^{4}

In Engineering notation it would be expressed as: 23×10^{3}

Metric Unit Conversions

- When converting from a larger unit to a smaller unit, move the decimal point to the right

$$0.52 \times 10^{-3} = 520 \times 10^{-6}$$

- When converting from a smaller unit to a larger unit, move the decimal point to the left

$$1200 \times 10^{-9} = 1.2 \times 10^{-6}$$

- Determine the number of places that the decimal point is moved by finding the difference in powers of ten of the units being converted

Summary

- Resistors limit electric current
- Capacitors store electrical charge
- Inductors store energy in their electromagnetic field
- Transformers magnetically couple ac voltages, and may step these voltages up/down

Summary

- Power supplies provide current and voltage
- Voltmeters measure voltage
- Ammeters measure current
- Ohmmeters measure resistance
- Digital Multimeters (DMM) measure voltage, current and resistance

Summary

- Function generators provide electronic signals for our circuits
- An oscilloscope is used for observing and measuring voltages in a circuit

Summary

- Scientific notation expresses a number as one digit to the left of the decimal point times a power of ten
- Engineering notation expresses a number as one, two or three digits to the left of the decimal point times a power of ten that is a multiple of 3
- Metric symbols represent powers of 10 that are multiples of 3