

# Main Template

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# 1 INTRODUCTION

## 1.1 CATEGORIZATION OF COMPONENTS

Rather than trying to understand full circuits at once, it is easier to break them into two groups: **passive** components and **active** components.

### Passive Components

1.1

Passive components are ones that don't require any power supply to operate. For example, a resistor or a capacitor are both passive components.

### Active Circuits

1.2

Active components require power to operate. In other words, they need to be connected to a power supply to function. Logic gates (74LSXX) are active since they require a power supply.

Another way to divide components is between **linear** and **non-linear**.

### Linear Components

1.3

Linear components are... They also can be subdivided into components that store energy (capacitors and inductors) and components that dissipate energy (resistors).

### Non-Linear Components

1.4

...

## 1.2 OVERVIEW OF CONCEPTS

### 1.2.1 CHARGE AND CURRENT

#### Charge

1.5

Charge ( $Q$ ) is an electrical property of the atomic particles of which matter consists, measured in coulombs ( $C$ ).

$$Q(t) = \int i(t) dt$$

When charged particles move in space over time, such as throughout a wire in a circuit, an electrical current is generated.

#### Electric Current

1.6

Electric current ( $I$ ) is the time rate of change of charge, measured in amperes ( $A$ ).

$$i(t) = \frac{dQ}{dt}$$

Current is simply a rate of change of a charge, and thus the two are related as the others' derivative/integral.

### 1.2.2 DC vs. AC

#### Direct Current

1.7

A direct current (dc) flows only in one direction and can be constant or time varying.

There are two ways of describing the *direction* in which the electrons flow in a direct current: **conventional flow** and **electron flow**. Both are shown in Figure 1.

#### Alternating Current

1.8

An alternating current (ac) is a current that changes direction with respect to time.

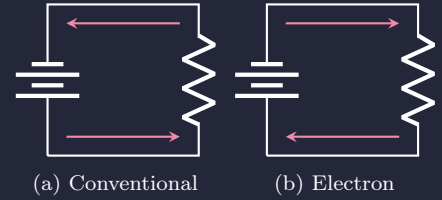


Figure 1: Electron Flow in Direct Currents

#### Voltage

1.9

Voltage (or *potential difference*) is the energy required to move a unit charge from a reference point (-) to another point (+), measured in Volts (V).

$$v(t) = v_b - v_b = \frac{dw}{dQ} = \frac{dE}{dQ}$$

### 1.2.3 POWER AND ENERGY

#### Power

1.10

Power is the time rate of expending or absorbing energy measured in watts (W). It is the rate of change of energy.

$$p(t) = \frac{dE}{dt} = \frac{dE \cdot dQ}{dt \cdot dQ} = \frac{dE}{dQ} \cdot \frac{dQ}{dt} = v \cdot i$$

#### Energy

1.11

Energy is the capacity to do work measured in Joules (J).

$$E(t) = \int p(t) dt$$

Again, these two values are related as the derivative/integral of the other.

## 1.3 CIRCUIT ELEMENTS

### Ideal Independent Source

1.12

An ideal independent source is an active element that provides a specified voltage or current that is completely independent of other circuit elements.

### Ideal Dependent Source

1.13

Also called an *Ideal Controlled Source*, this is an active element in which the source quantity is controlled by another voltage or current.

There are four types of dependent sources:

1. Voltage Controlled Voltage Source (VCVS)
2. Voltage Controlled Current Source (VCCS)
3. Current Controlled Voltage Source (CCVS)
4. Current Controlled Current Source (CCCS)