

## Resistor and Sources

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คณะเทคโนโลยีสารสนเทศและการสื่อสาร  
มหาวิทยาลัยพะเยา

คมกริช มาเที่ยง

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## วัตถุประสงค์ของเนื้อหา

- เข้าใจนิยาม หน่วยวัดทางไฟฟ้า และสัญลักษณ์ทางไฟฟ้า
- สามารถอ่านค่าความต้านทานได้
- สามารถเข้าใจและคำนวณค่าความต้านทานในการต่อแบบอนุกรมและขนานได้
- สามารถแปลงค่าความต้านทานในการรูปแบบ Star-delta และ delta-star ได้

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## Standard SI prefixes

Multiplier	Prefix	Symbol
$10^{18}$	exa	E
$10^{15}$	peta	P
$10^{12}$	tera	T
$10^9$	giga	G
$10^6$	mega	M
$10^3$	kilo	k
$10^2$	hecto	h
10	deka	da
$10^{-1}$	deci	d
$10^{-2}$	centi	c
$10^{-3}$	milli	m
$10^{-6}$	micro	$\mu$
$10^{-9}$	nano	n
$10^{-12}$	pico	p
$10^{-15}$	femto	f
$10^{-18}$	atto	a

### Example:

$$I_1 = 10\text{mA} \quad V_{ab} = 5\text{V}$$

$$C_1 = 85\mu\text{F} \quad P = 100\text{MW}$$

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## Electric current

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

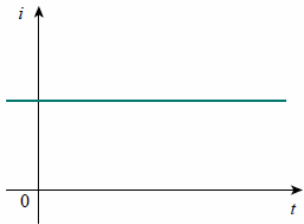
The relationship between current ( $i$ ), Charge ( $q$ ) and time ( $t$ ):

$$i = \frac{dq}{dt}$$

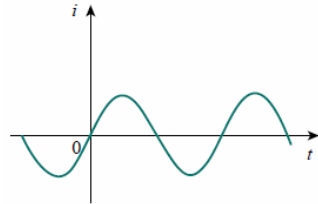
$$1 \text{ amperes} = 1 \text{ Coulomb / second}$$

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## AC & DC



A **direct current (DC)** is a current that remains **constant with time**.



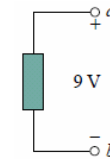
A **alternating current (AC)** is a current that **varies sinusoidally with time**.

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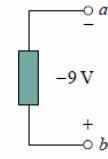
## Voltage

**Voltage** ( or potential difference) is the energy required to move a unit charge through an element, measured in **volts (V)**.

$$V_{ab} = \frac{dw}{dq}, \quad w: \text{energy}$$



$$V_{ab} = 9V$$



$$V_{ab} = -9V$$

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## Circuit Element

### ■ Source

#### ■ Ideal independent source

- Is an active element that provides a specified voltage or current that is completely **independent of other circuit variables**.

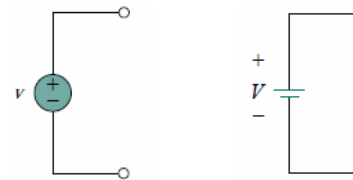
#### ■ Ideal dependent (or controlled) source

- Is an active element in which the source quantity is **controlled by another voltage or current**.

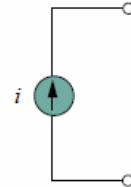
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## Ideal independent source

### independent voltage source



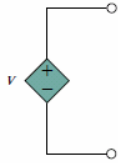
### independent current source



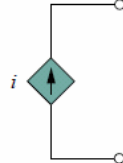
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## Ideal dependent source

Dependent voltage source



Dependent current source



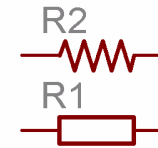
### Type of dependent source:

1. VCVS – a voltage-controlled voltage source.
2. CCVS – a current-controlled voltage source.
3. VCCS – a voltage-controlled current source.
4. CCCS – a current-controlled current source.

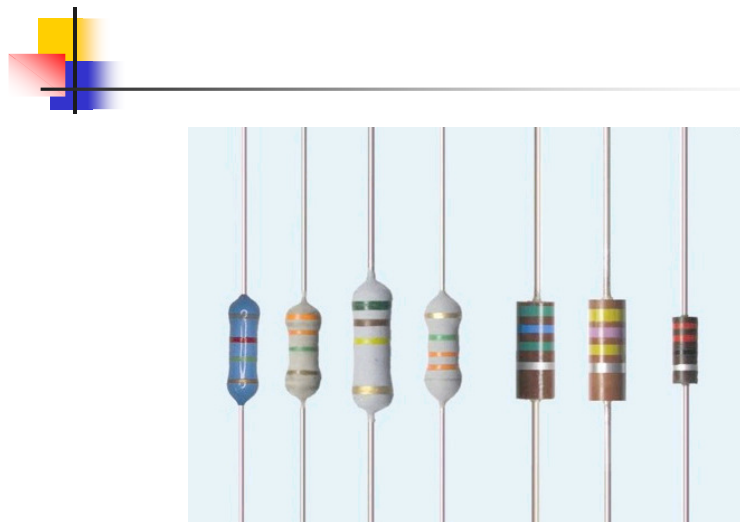
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## Resistor

- Resistors are elements of electrical networks and electronic circuits.
- The **primary characteristics** of a resistor are the **resistance**, measured in **Ohms** ( $\Omega$ ).

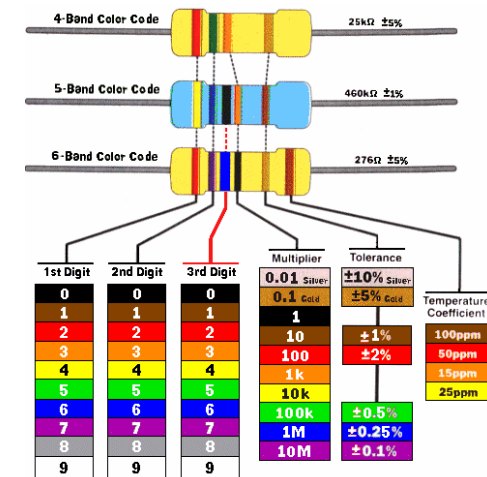


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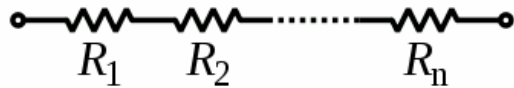
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## Resistor reading



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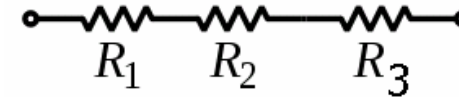
## Series resistors



$$R_T = R_1 + R_2 + \dots + R_n$$

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## Example



$$R_1 = 800k\Omega$$

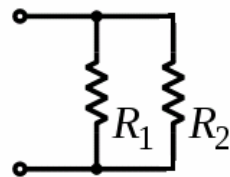
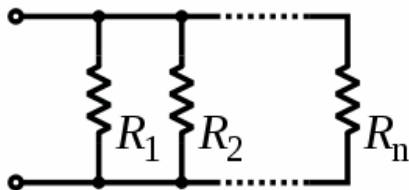
$$R_2 = 101k\Omega$$

$$R_3 = 10k\Omega$$

$$R_T = R_1 + R_2 + R_3 = (800 + 101 + 10)k\Omega = 911k\Omega$$

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## Parallel Resistors

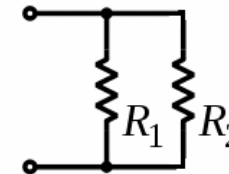


$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \dots + \frac{1}{R_n}$$

$$R_T = R_1 \parallel R_2 = \frac{R_1 R_2}{R_1 + R_2}$$

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## Example



$$R_1 = 4k\Omega$$

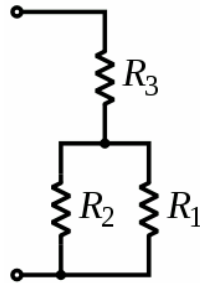
$$R_2 = 6k\Omega$$

$$R_T = R_1 \parallel R_2 = \frac{R_1 R_2}{R_1 + R_2} = \frac{4k * 6k}{4k + 6k} \Omega = \frac{24M}{10k} \Omega = 2.4k\Omega$$

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## Resistors network

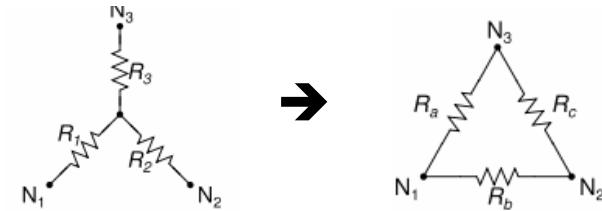
Example:



$$R_T = (R_1 \parallel R_2) + R_3 = \left( \frac{R_1 R_2}{R_1 + R_2} \right) + R_3$$

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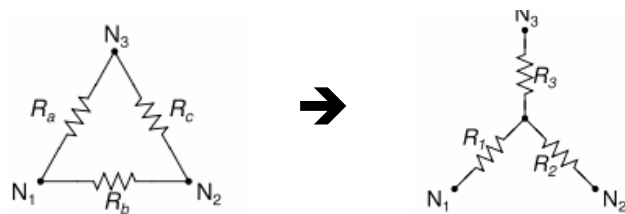
## Star-Delta transform



$$R_a = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_2} \quad R_b = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_3} \quad R_c = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_1}$$

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## Delta-Star transform



$$R_1 = \frac{R_c R_b}{R_a + R_b + R_c} \quad R_2 = \frac{R_b R_c}{R_a + R_b + R_c} \quad R_3 = \frac{R_c R_a}{R_a + R_b + R_c}$$

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