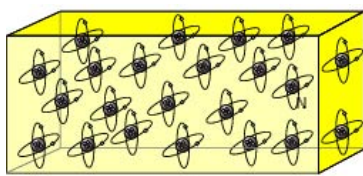


Basic Elements of Electricity

Jee-Hwan Ryu

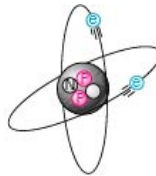
School of Mechanical Engineering
Korea University of Technology and Education

물질의 구조



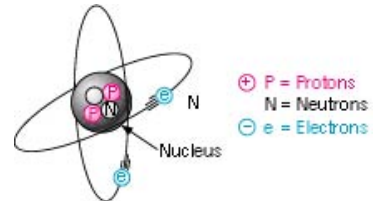
(a)

(a) 원소: 여러 유사 원자

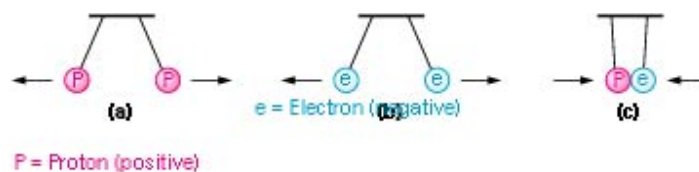


(b)

(b) 원자: 최소단위



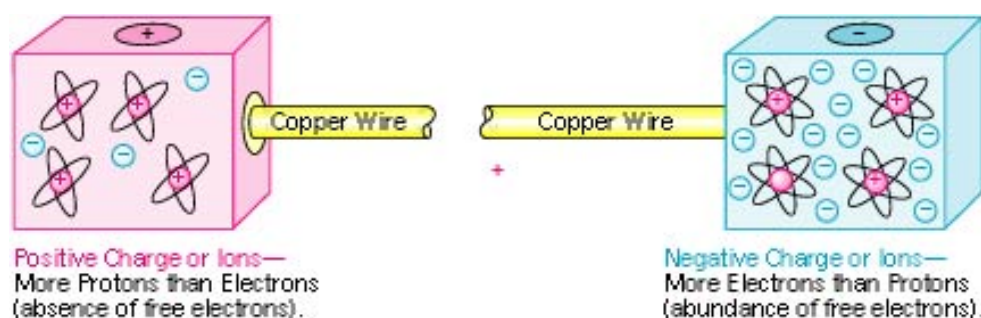
Protons: 양자
Neutrons: 중성자
Electrons: 전자



같은 극은 반발, 다른 극은 흡인

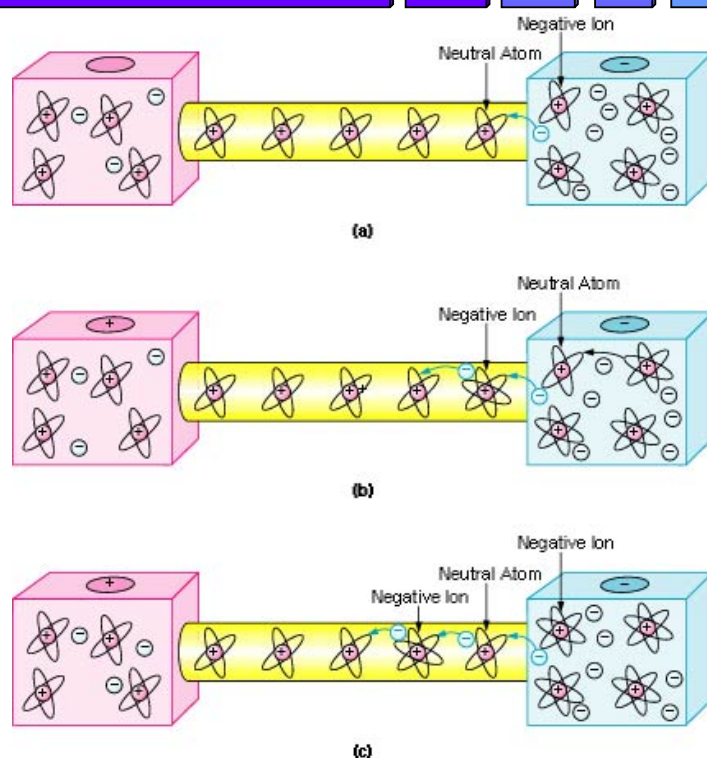
전류 (Electrical Current)

- 전류: 한 지점에서 다른 지점으로 전자가 이동하는 것
- 양이온 (positive ion): 양전하 수 > 전자 수 인 원자
- 음이온 (negative ion): 양전하 수 < 전자 수 인 원자



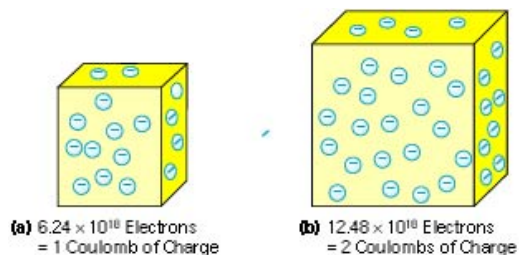
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전자의 이동에 의한 전류



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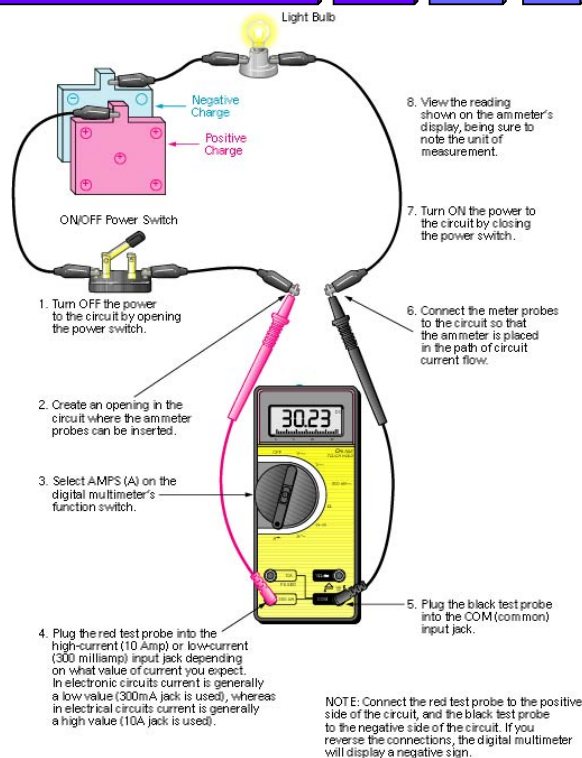
전류 (I) 의 단위



1 쿨롬 (Coulomb)의 전하에는 6.24×10^{18} 개의 전자가 존재

6.24×10^{18} 개의 전자가 1초 동안에 도체의 한 점을 통과할 때 1A의 전류가 흐른다.

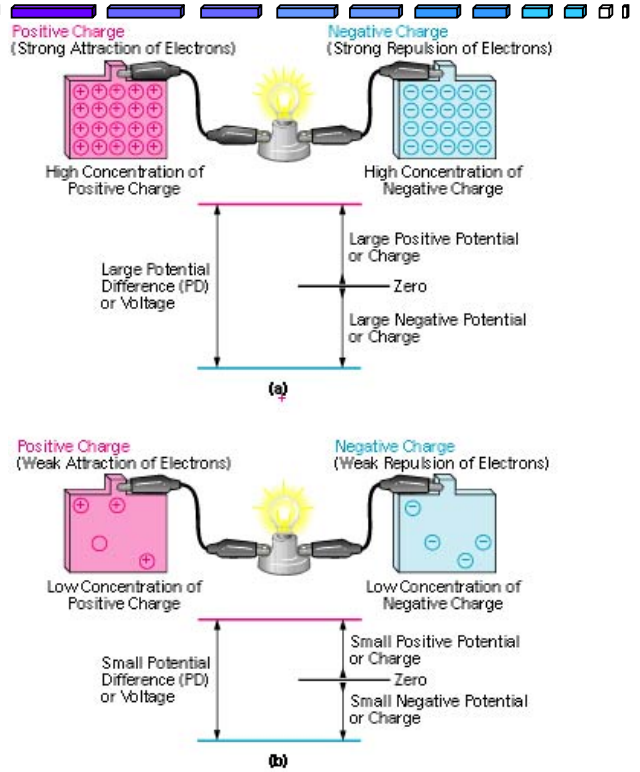
전류의 측정



낮은 저항 필요

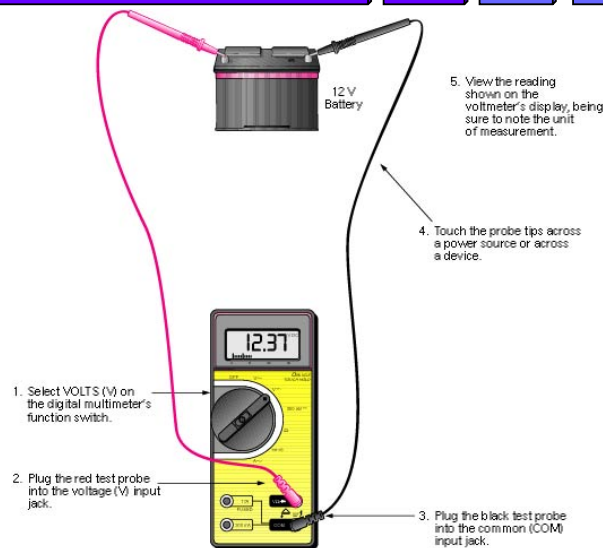
전압 (Voltage)

- 전압 (Voltage): 전자에 가하는 힘 또는 압력, 일을 할 수 있는 능력
- 전동력 (Electron moving force) 또는 기전력 (electromotive force: emf) : 두 점간의 전위차이로 인하여 전자운동이 발생하는 힘
- 단위: volt
- 1(V): 두 점 사이에 6.24×10^{18} 개의 전자를 움직이는데 필요한 전압(전위차)



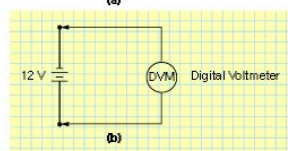
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전압 측정



높은 저항 필요

NOTE: If test leads are reversed, a negative sign will show in the display.



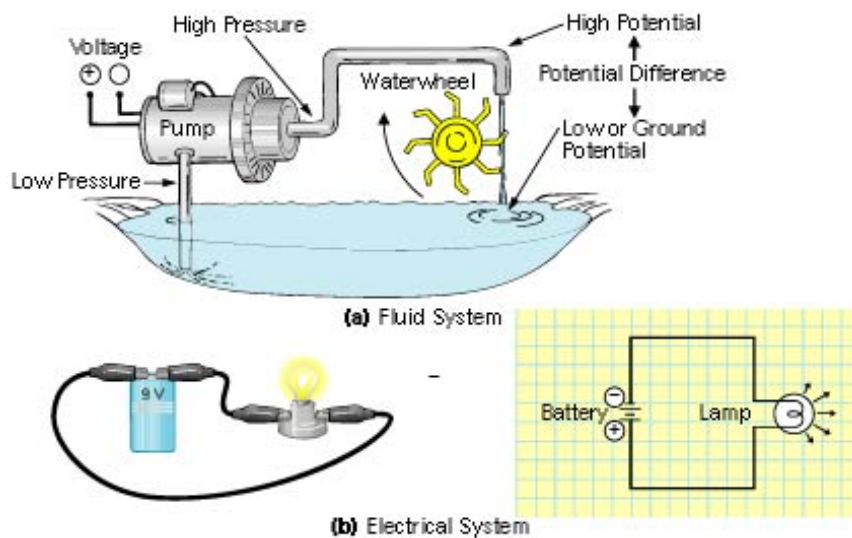
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전압 전류의 단위

이름	부호	값
Pico	p	10^{-12}
Nano	n	10^{-9}
Micro	μ	10^{-6}
Milli	m	10^{-3}
Kilo	k	10^3
Mega	M	10^6
Giga	G	10^9
Tera	T	10^{12}

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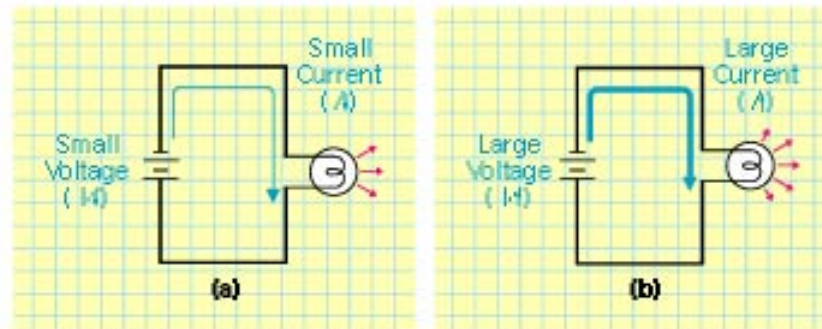
Mechanical and Electrical Analogy



(a) Fluid System	Equivalent to (=)	(b) Electrical System
Pump generates pressure, which is the water moving force.		Battery generates voltage, which is the electron moving force.
Water current flow.		Electron current flow.
High pressure or potential.		High voltage or potential.
Low pressure or potential.		Low voltage or potential.

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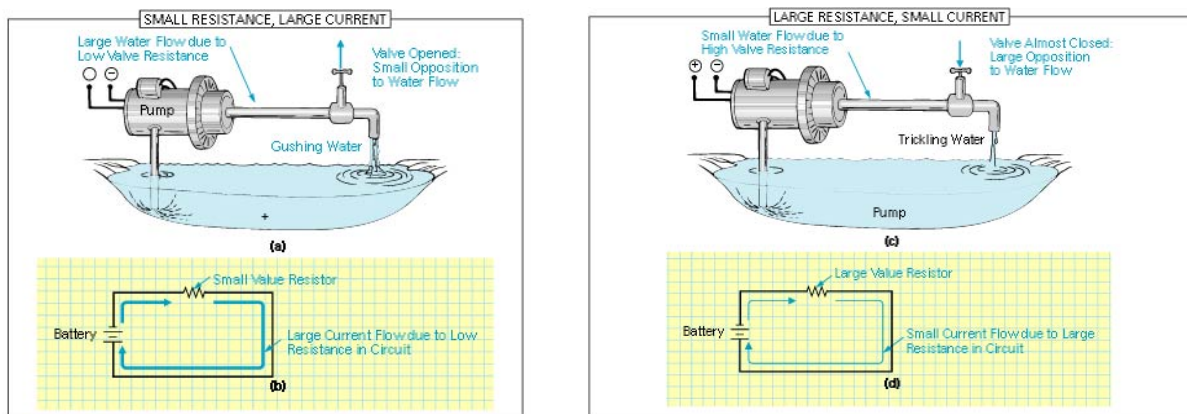
전압과 전류의 관계



전류 (I) 는 전압에 정비례 한다.
 ->압력이 증가하면 유체의 흐름도 증가

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저항 (Resistance)



저항: 열의 형태로 에너지를 방사시켜 전류의 흐름을 방해하는 것

저항은 전류에 반비례

기호: R 단위: ohm [Ω]

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컨덕턴스 (Conductance)

- 회로 또는 경로에 전류가 얼마나 잘 흐를 수 있는가를 측정하는 것으로, 저항의 역수
- 단위 지멘스 (S)

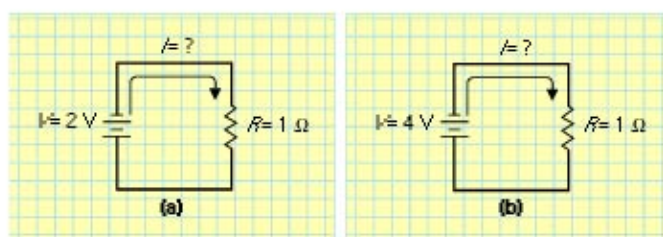
$$\text{컨덕턴스 } (G) = \frac{1}{\text{저항 } (R)}$$

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Ohm's Law

- 회로에 흐르는 전류는 이 회로의 전압에 정비례하고 저항에 반비례 한다.

$$\text{전류 } (I) = \frac{\text{전압 } (V)}{\text{저항 } (R)}$$



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도체의 저항

- 물리적 저항

$$R = \frac{\rho \times l}{a}$$

R = 도체의 저항 (Ω)

ρ = 도체의 고유저항

l = 도체의 길이

a = 도체의 면적

- 온도의 영향

- 온도 상승 \rightarrow 저항 증가

에너지, 일과 전력

- 에너지 (Energy): 일을 할 수 있는 능력

- $E = \text{전하}(C) \times \text{전압}(V)$

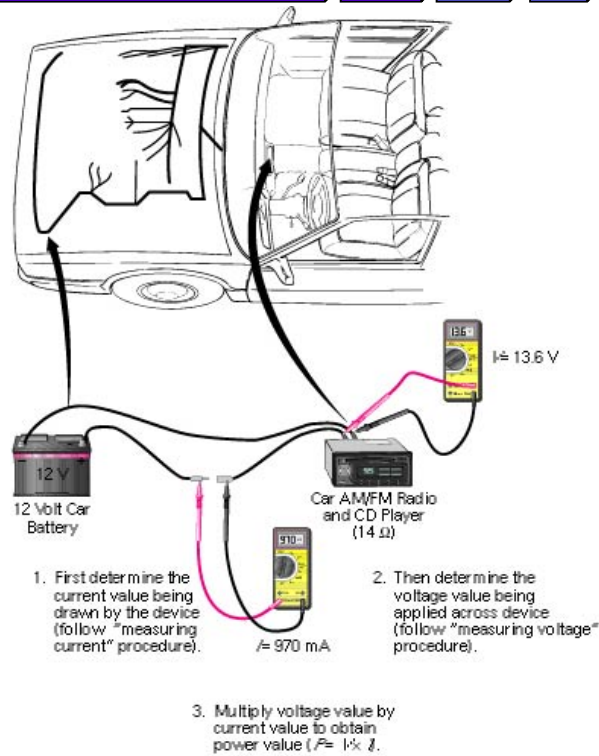
- 일 (Work): 에너지가 한 상태에서 다른 형태로 변화하는 것

- 줄 (Joule): 일과 에너지의 단위

- 전력(P): 일이 수행된 비율, 단위 초당 줄(J/s), watt(W)

- $P = V \times I$

전력의 측정



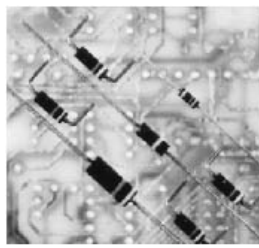
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저항기 (Resistor)

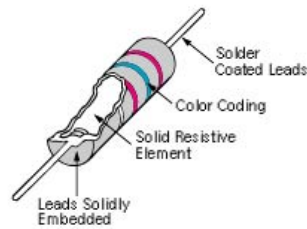
- Why we use resistor ?
- Fixed-value resistor
- Variable resistor
 - 스피커로 흐르는 전류를 제어하여 음량 조절

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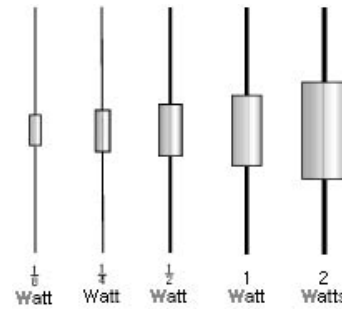
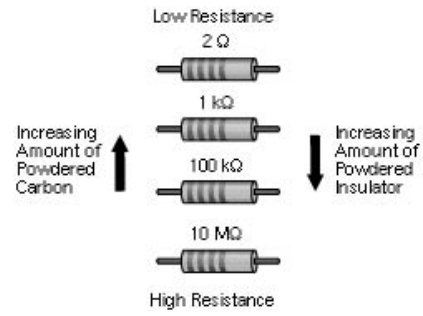
Fixed-value resistor: carbon composition resistor



(a)



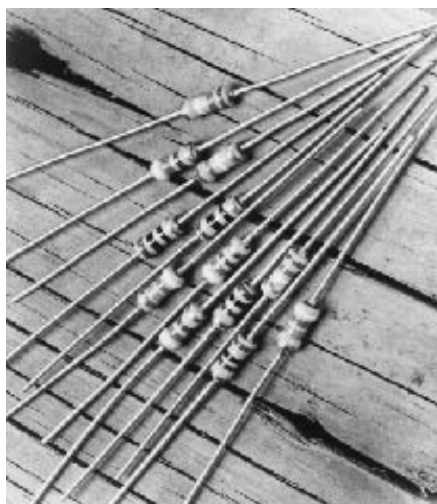
(b)



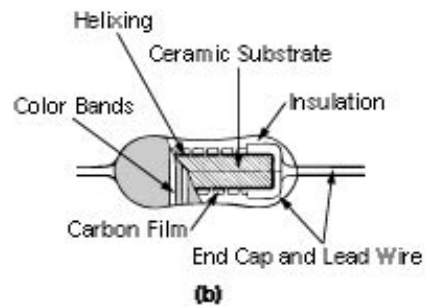
1. 염가
2. 허용오차 큼 $\pm 10\%$

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Fixed-value resistor: carbon film resistor



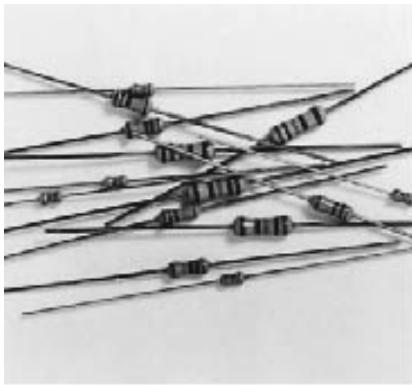
(a)



1. 온도특성 우수
2. 허용오차 $\pm 2\% \sim 5\%$

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Fixed-value resistor: metal film resistor



(a)



(b)

1. 온도특성 우수
2. 허용오차 0.1% ~ 1%

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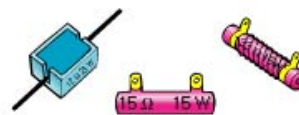
Fixed-value resistor: wirewound resistor



(a)



(b)



(c)

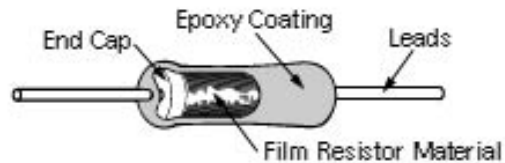
1. 절연체에 고 저항 전선(보통 니크롬선)이 감긴 저항기
2. 허용오차 1%
3. 크기가 크고 제작이 어려워 고가

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Fixed-value resistor: metal oxide resistor



(a)



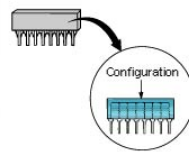
(b)

1. 온도특성 매우 우수하나 고가

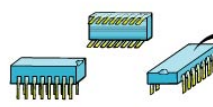
Fixed-value resistor: thick-film resistor



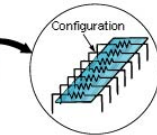
(a)



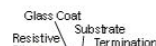
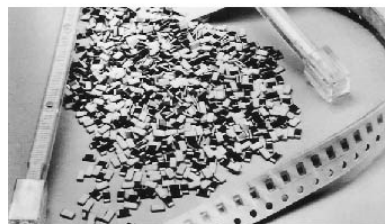
(a) SIP (Single In-line Package)



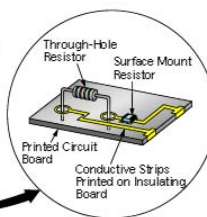
(b)



(b) DIP (Dual In-line Package)

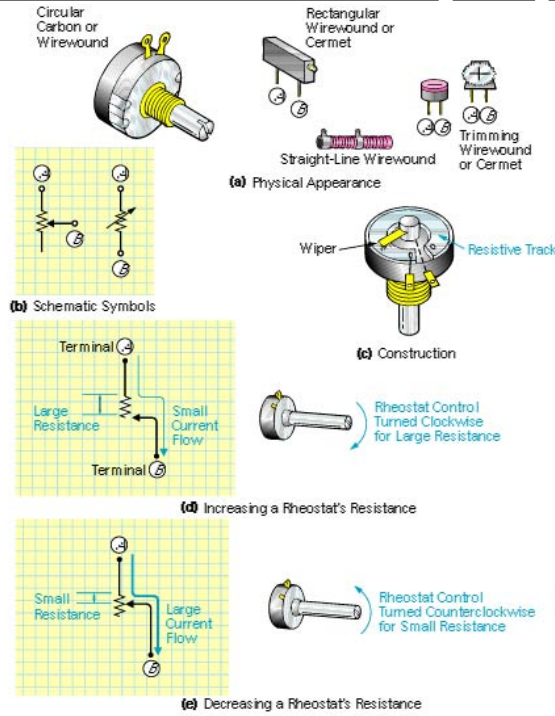


(c)



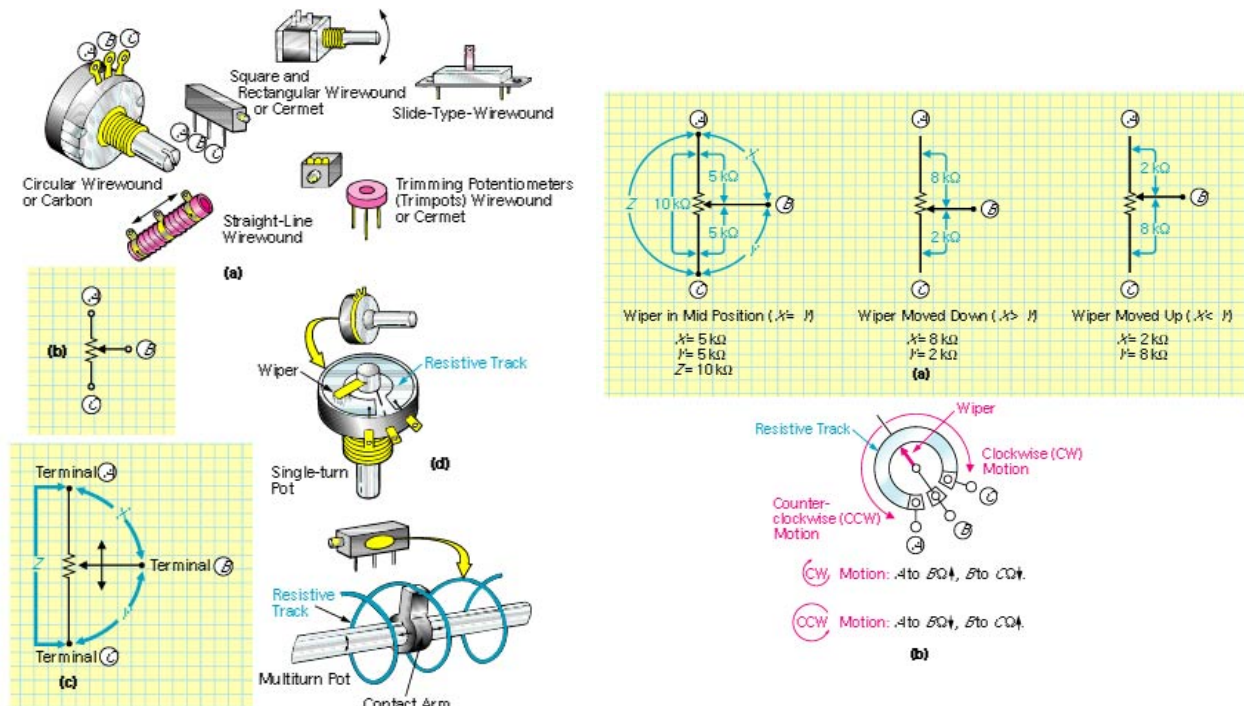
(c) Chip resistor

Variable Resistor: Rheostat (가감저항기, 단자 2개)



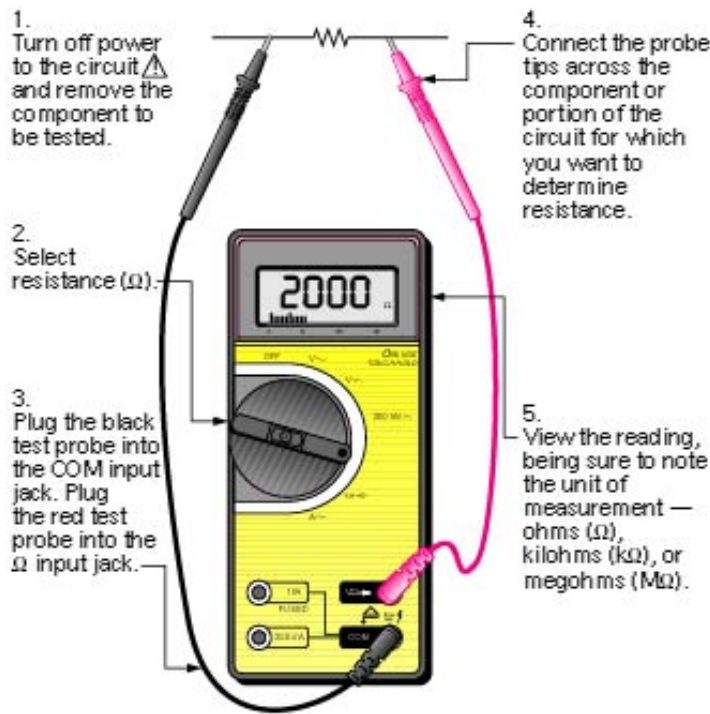
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Variable Resistor: Potentiometer (전위차계, 3단자)



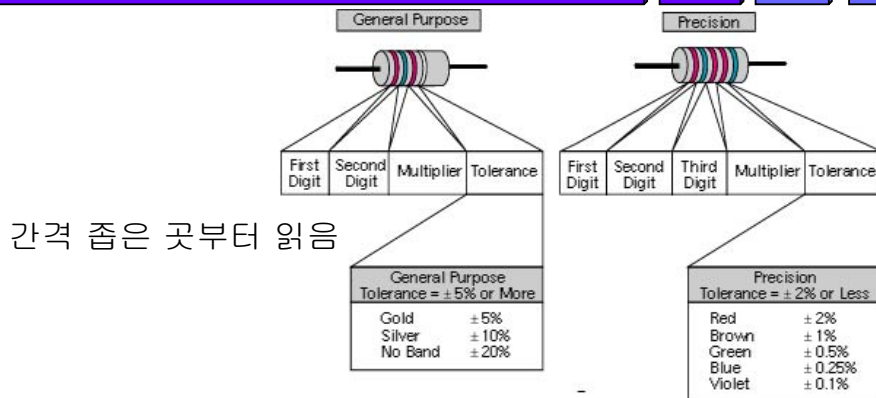
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저항의 측정



계측기의 내부전원 사용

저항기 부호



출처: 전자공학개론

	Color	Digit Value	Multiplier	
Big	Black	0	1	One
Beautiful	Brown	1	10	One Zero
Roses	Red	2	100	Two Zeros
Occupy	Orange	3	1000	Three Zeros
Your	Yellow	4	10000	Four Zeros
Garden	Green	5	100000	Five Zeros
But	Blue	6	1000000	Six Zeros
Violets	Violet	7	10000000	Seven Zeros
Grow	Gray	8	-	
Wild	White	9	-	
So	Silver	-	10 ⁻² or 0.01	1/100
Get some	Gold	-	10 ⁻¹ or 0.1	1/10
Now	None			

Examples



35, 10%

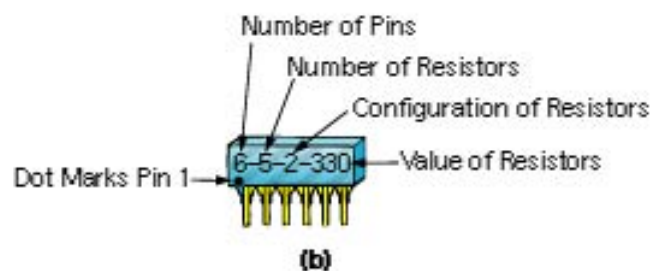
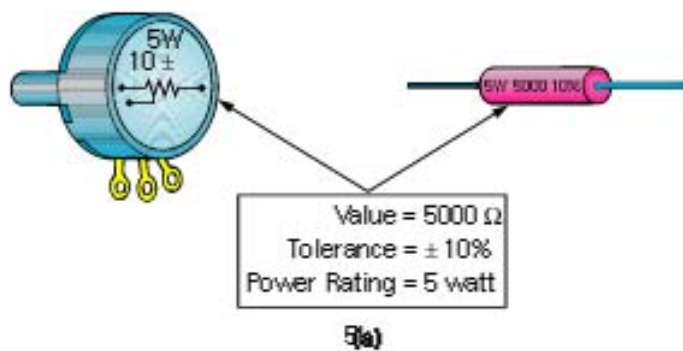


56×10^2 , 20%



225×10^{-1} , 0.25%

기타 저항 표시법



저항기의 열 방출

- 저항기의 원자는 전자의 흐름을 방해, 저항기의 원자와 전자의 마찰에 의해 열 발생

$$P = V \times I \quad P = I^2 \times R \quad P = \frac{V^2}{R}$$