# Questions?

- Project?

# Show and tell

# Introduction to electronics

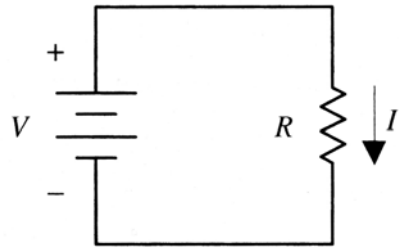
- Based on “Practical Electronics for Inventors” by P. Scherz
  - All the drawing and sketches are from this book

- Today
  - Overview of the key components
  - Simple circuits design

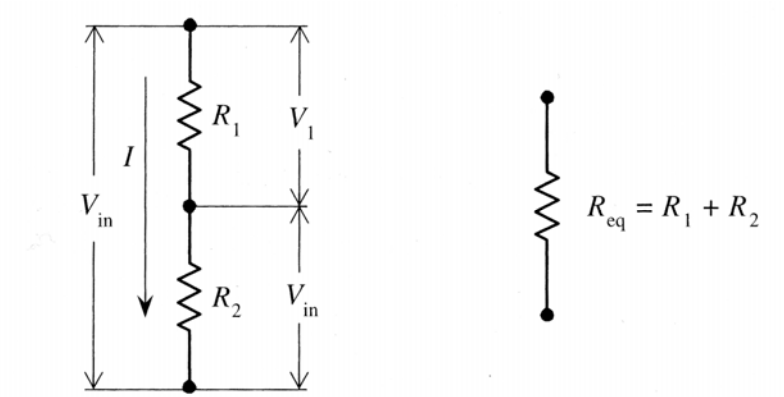
# Resistor: key facts

$$V = RI$$

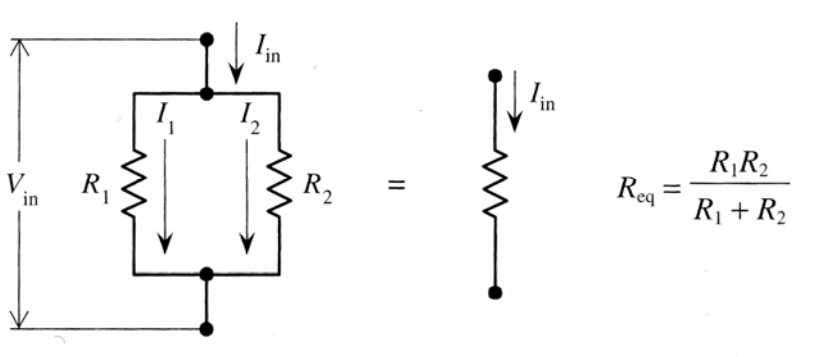
$$I = \frac{V}{R}$$




$$R_{eq} = R_1 + R_2$$

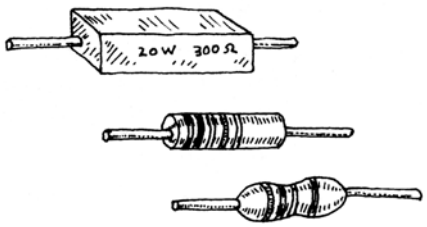



$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$

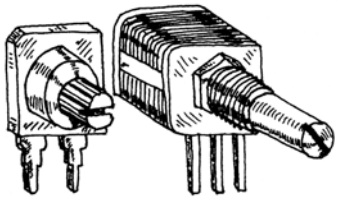



Illustrations from “Practical Electronics for Inventors” by P. Scherz

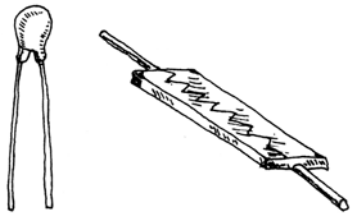
# Resistor: Examples




Fixed Resistors

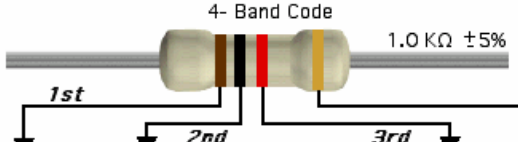


Potentiometers
and
Trimmers

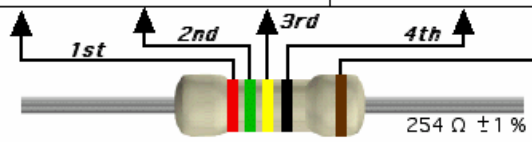


Thermistors
and
Phototransistors

## RESISTOR COLOR CODE GUIDE




| Color | 1st Band | 2nd Band | 3rd Band | Decimal Multiplier | Tolerance |
|---|---|---|---|---|---|
| Black | 0 | 0 | 0 | 1 | |
| Brown | 1 | 1 | 1 | 10 | ± 1 % |
| Red | 2 | 2 | 2 | 100 | ± 2 % |
| Orange | 3 | 3 | 3 | 1K | 1,000 |
| Yellow | 4 | 4 | 4 | 10K | 10,000 |
| Green | 5 | 5 | 5 | 100K | 100,000 |
| Blue | 6 | 6 | 6 | 1M | 1,000,000 |
| Violet | 7 | 7 | 7 | 10M | 10,000,000 |
| Gray | 8 | 8 | 8 | | 100,000,000 |
| White | 9 | 9 | 9 | | 1,000,000,000 |
| Gold | | | | 0.1 | ± 5 % |
| Silver | | | | 0.01 | ± 10 % |
| None | | | | | ± 20 % |




5- Band Code

### Calculation


First Band **Red** ---------- **2**
Second Band **Black** ---------- **0**
Multiplier Band **Yellow** -- **x10,000**
Tolerance Band **Silver** -------**10 %**

The Gold or Silver band is always placed to the right.
The resistor value is read from the left to right.

If there is no tolerance band, then find the side that has a band closest to a lead and make that the first band.

Equation

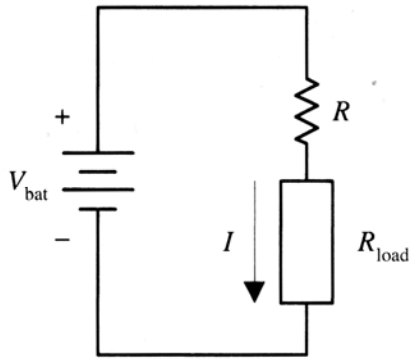
20 x 10,000 = 200,000
1,000 = 1K
**Resistor = 200 KΩ**
with a ± 10 % Tolerance

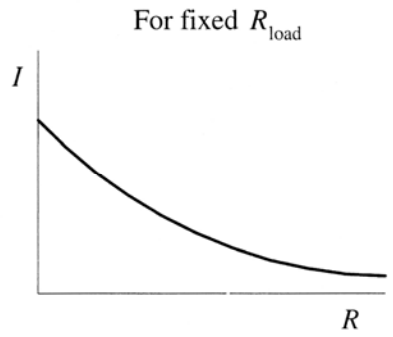


Illustrations from “Practical Electronics for Inventors” by P. Scherz

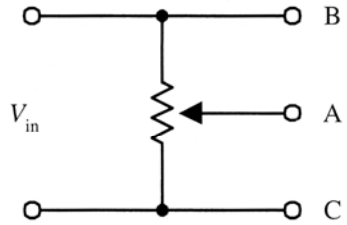
# Resistor: Key circuits

- Load limiting

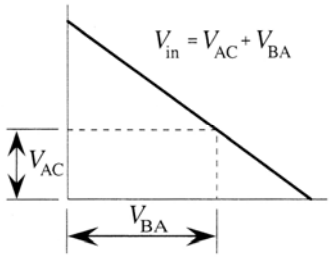



- Voltage control




3-terminal linear-tapered pot
(using all 3 terminals)

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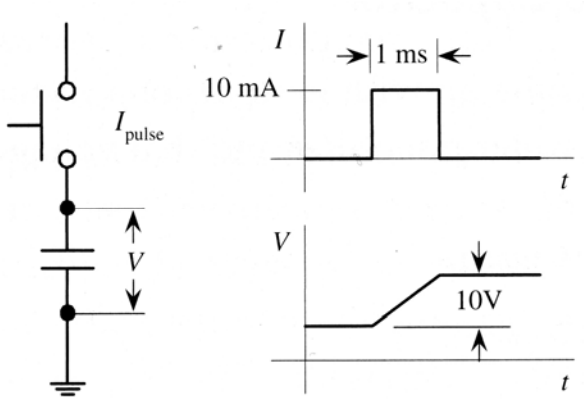
# Capacitor: key facts

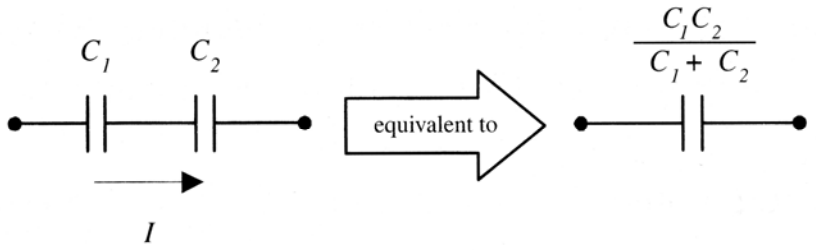
$$I = C\frac{\partial V}{\partial t}$$

$$\partial V = \frac{I}{C}\partial t$$

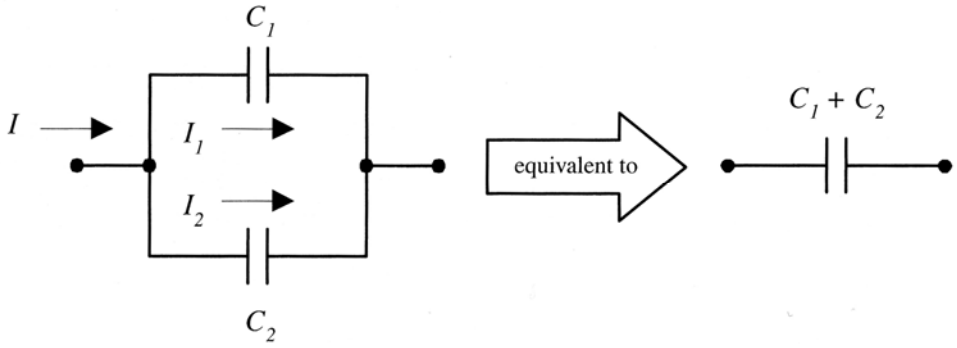



C = 1 μF

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$$

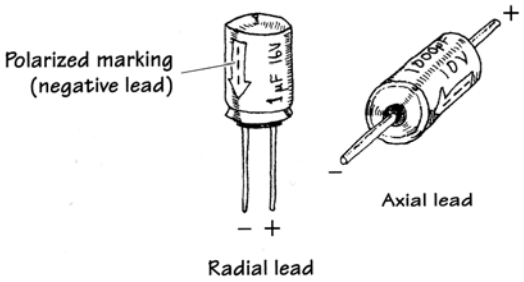


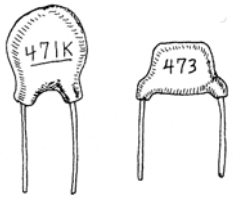

$$C_{eq} = C_1 + C_2$$

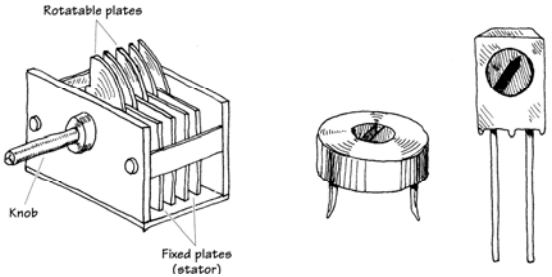



Illustrations from “Practical Electronics for Inventors” by P. Scherz

# Capacitor: Examples



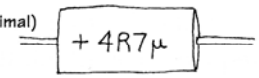

### Electrolytic

(note, M here isn't a tolerance)

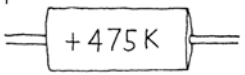
Label says: 100 MF
Actual value: 100 µF
(M means micro(µ))


### Tantalum

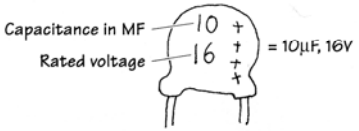
Label says: 4R7µ
Actual value: 4.7µF
(R represents a decimal)




Label says: 475K
Actual value: 47 x $10^5$pF
with 10% tolerance
(K = 10% tolerance)



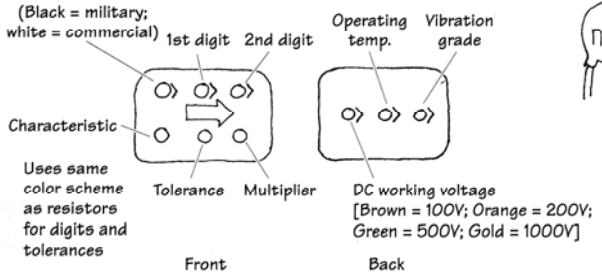

### Dipped Tantalum



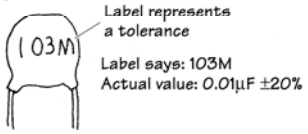

### Mylar

Label says: 0.1M
Actual value: 0.1µF
(M means micro)

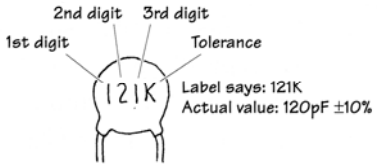

### Standard



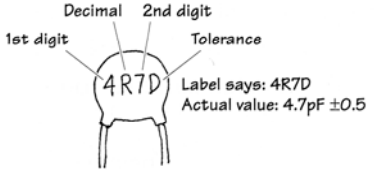

### Ceramic




Label says: 103M
Actual value: 0.01µF ±20%




Label says: 121K
Actual value: 120pF ±10%




Label says: 4R7D
Actual value: 4.7pF ±0.5

### European Marking


Label says: 68p
Actual value: 68pF


Label says: p68
Actual value: 0.68pF


Label says: n68
Actual value: 0.68µF

*Multipliers*

0 = none
1 = × 10
2 = × 100
3 = × 1000
4 = × 10,000

*Tolerance*

Z = +80%, –20% (asymmetric capacitor construction)
M = ±20%
K = ±10% B = ±0.1%
J = ±5% A = ±0.05%
G = ±2%
F = ±1%
D = ±0.5%
C = ±0.25%
B = ±0.1%
A = ±0.05%

1pF = $1 \times 10^{-12}$ F
1nF = $1 \times 10^{-9}$ F
1µF = $1 \times 10^{-6}$ F

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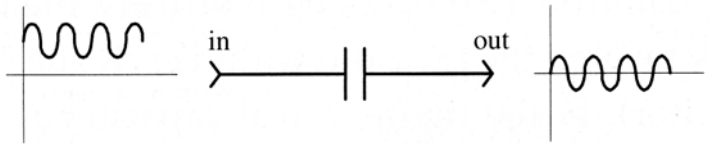
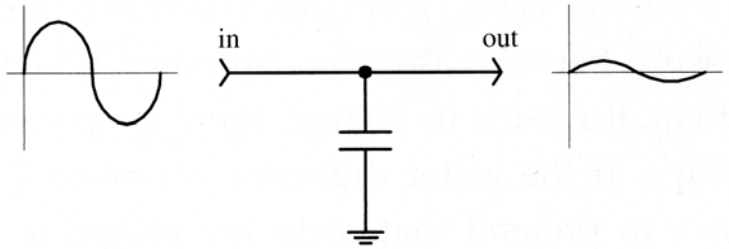
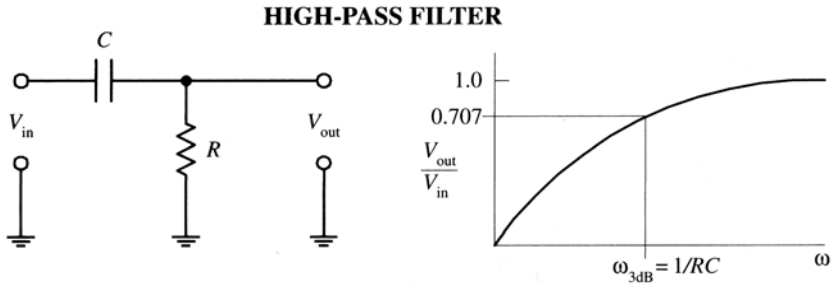
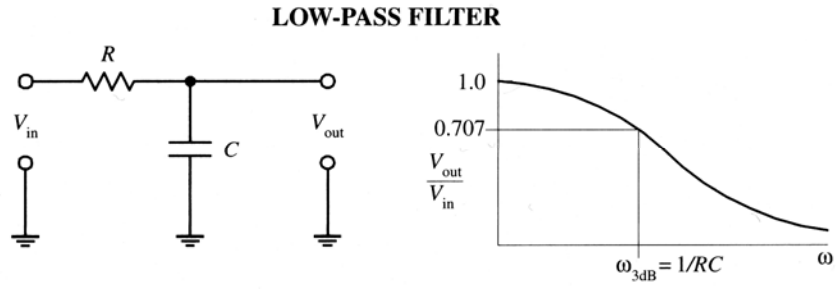
# Capacitor: Key circuits

- Filtering

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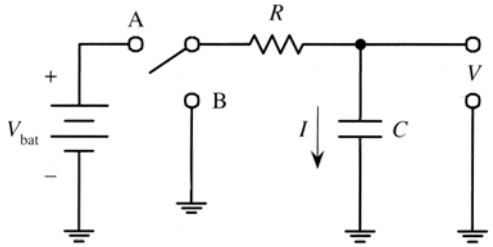
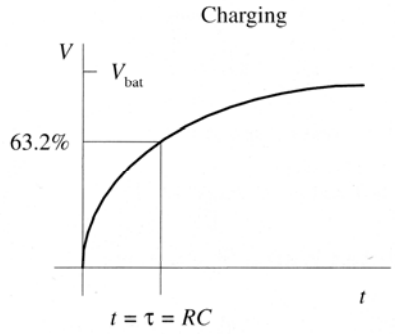
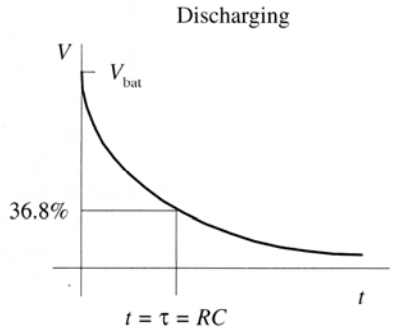
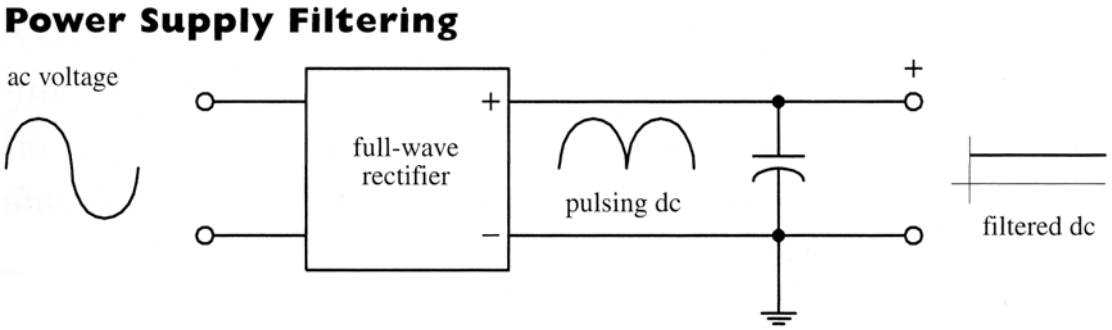
# Capacitor: Key circuits (II)

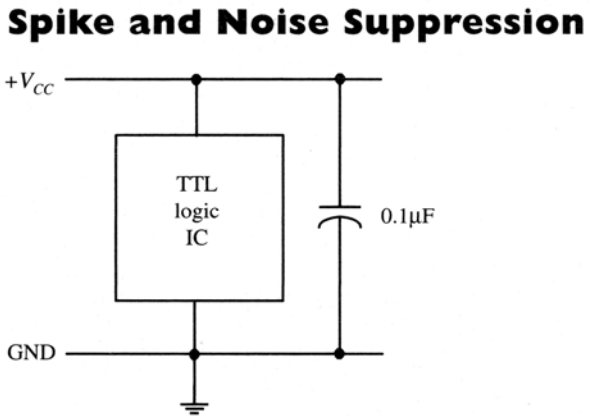
- Low-pass filter




Be careful about discharge

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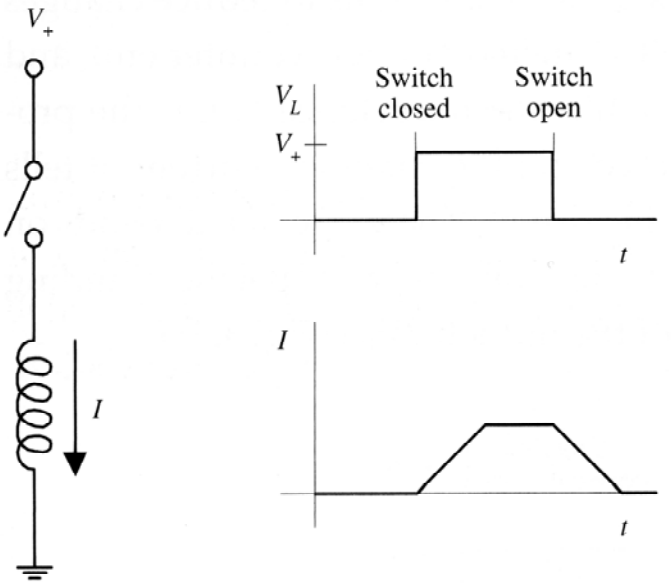
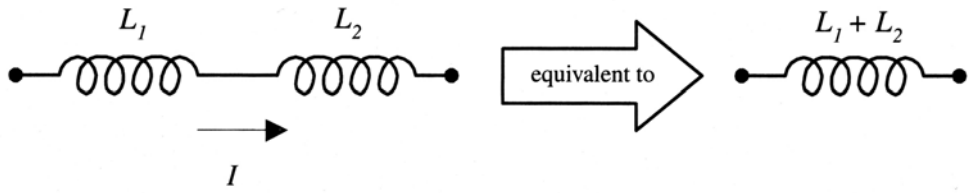
# Inductor: key facts

$$V = L\frac{\partial I}{\partial t}$$

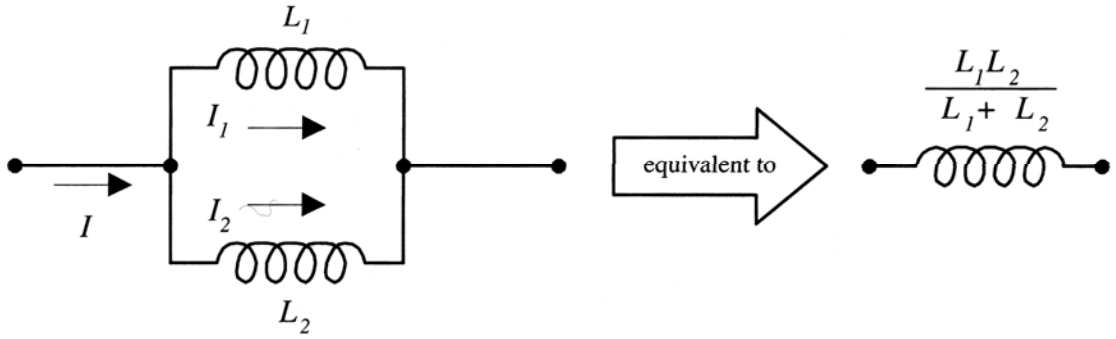
$$\partial I = \frac{V}{L}\partial t$$




$$L_{eq} = L_1 + L_2$$




$$\frac{1}{L_{eq}} = \frac{1}{L_1} + \frac{1}{L_2}$$

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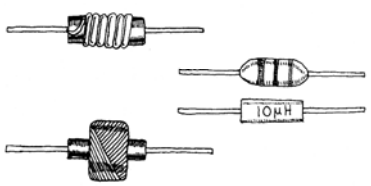
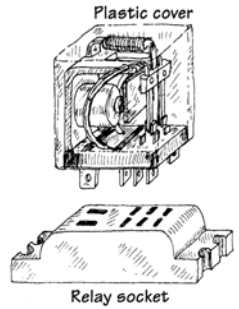
# Inductor: Examples

**Chokes**

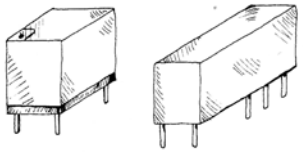




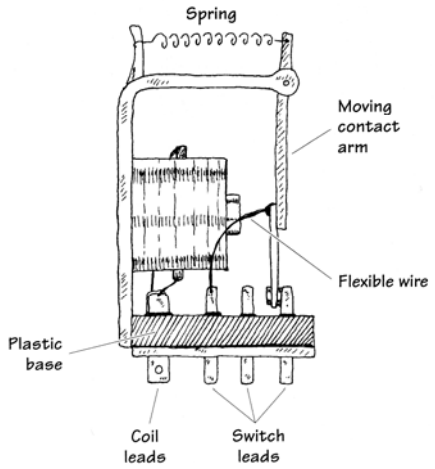
**Subminiature Relays**

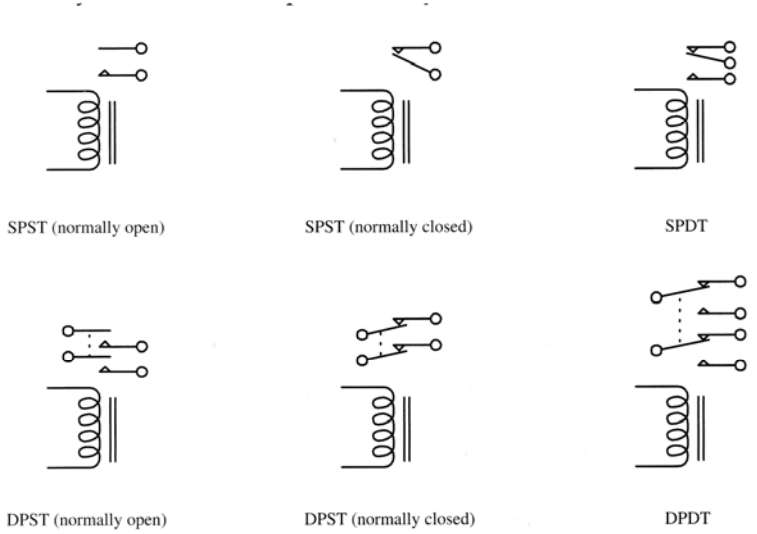



**Miniature Relays**



Mechanical Relay

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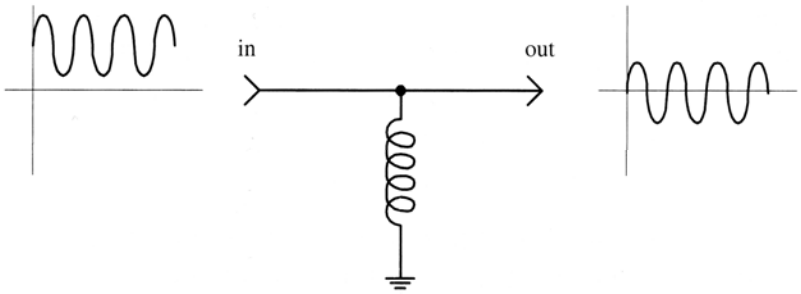
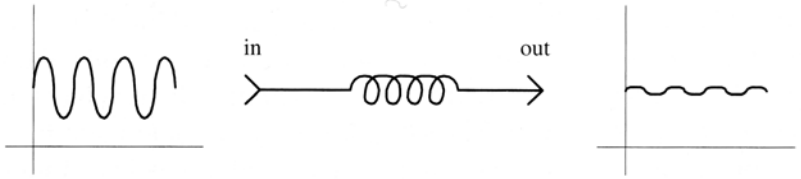
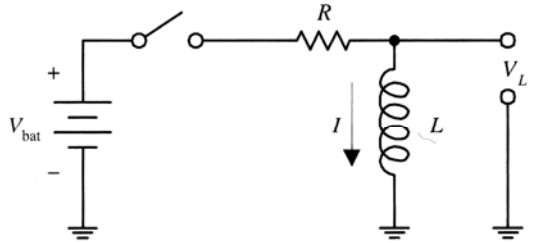
# Inductor: Key circuits

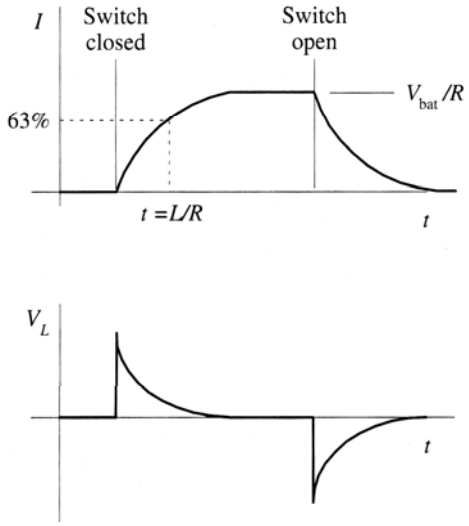
- Filtering




- Spike

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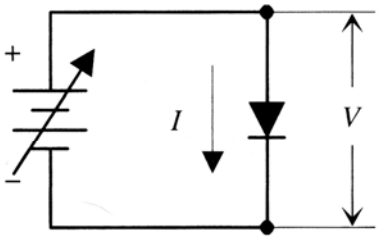
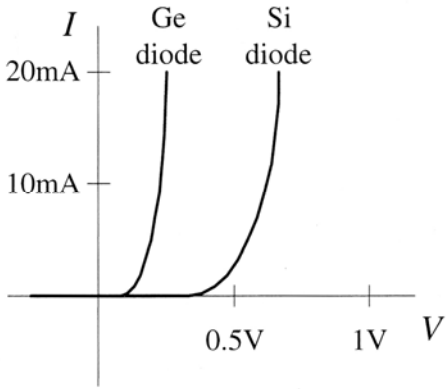
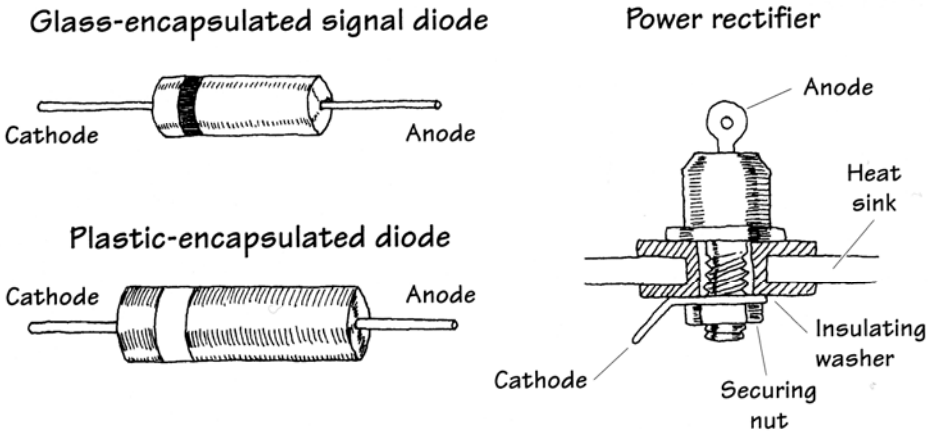
# Diode: key facts

- Unidirectional conduction




- Examples

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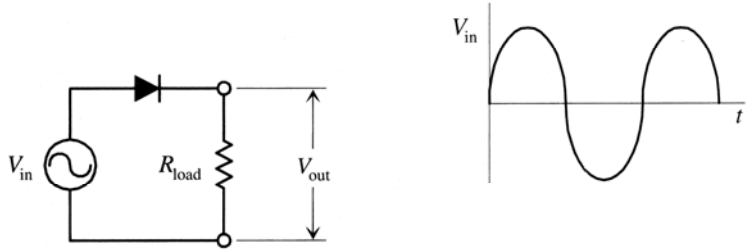
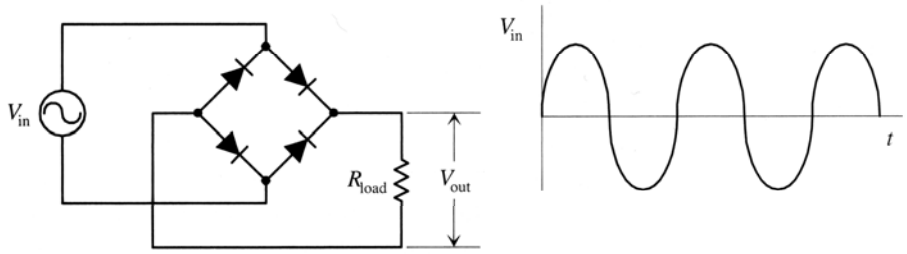
# Diode: Key circuits

- Rectifier

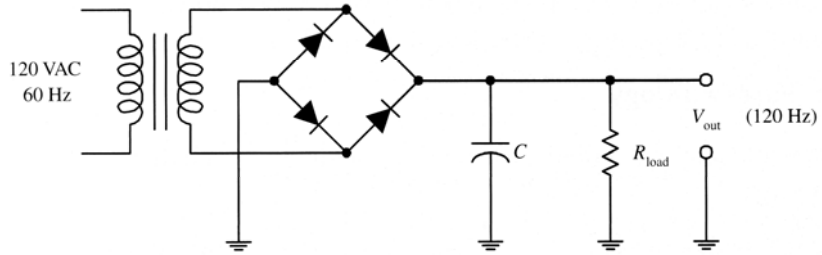
**Half-Wave Rectifier**

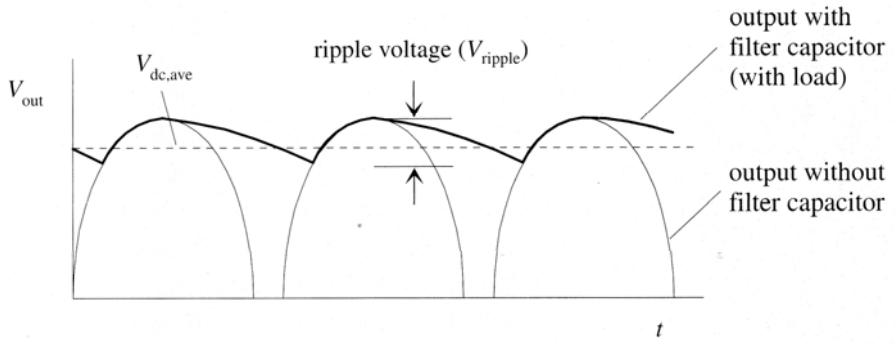



**Full-Wave Bridge Rectifier**




**Basic AC-to-DC Power Supply**

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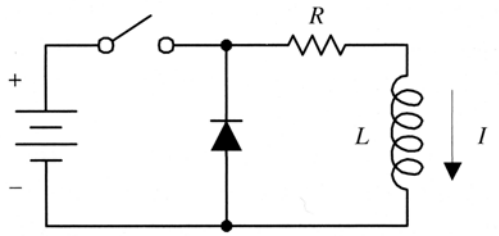
# Diode: Key circuits (II)

- Spike suppressor



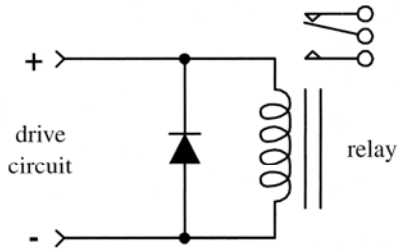
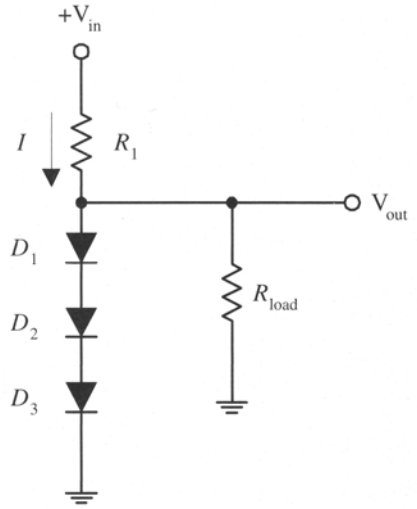




FIGURE 4.14 (*Continued*)

- Voltage regulator

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