Circuitos Digitais

Chaves

Prof. Marcelo Grandi Mandelli

mgmandelli@unb.br

Chaves

- Chaves???

Chaves

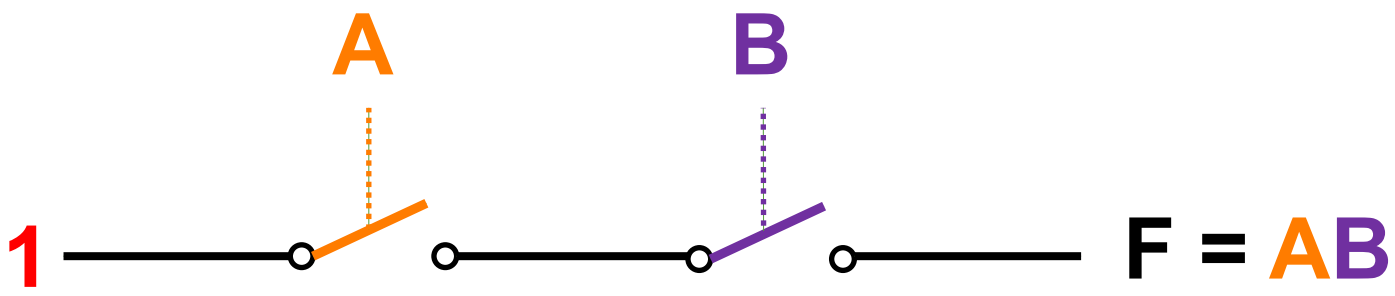
- Chaves???

Chaves

- Representações mais simples para sistemas de hardware
- Um meio de representar funções lógicas

Chaves

- Representação da função lógica AND



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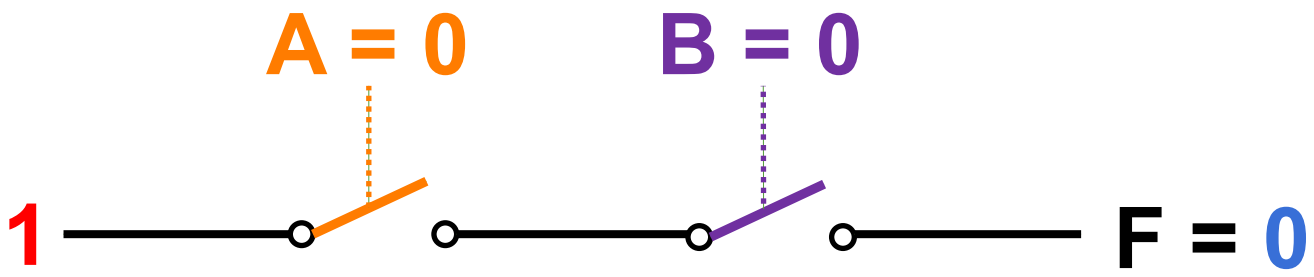

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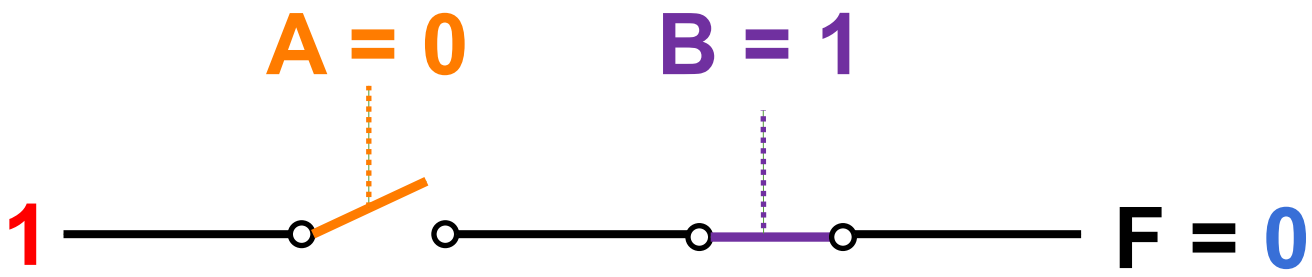

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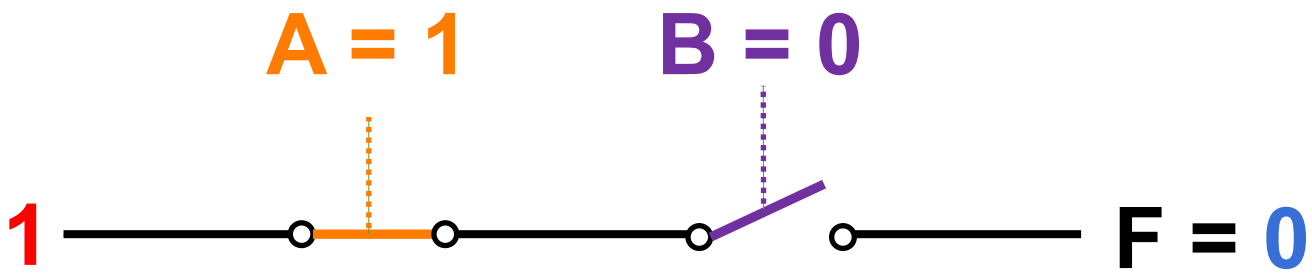

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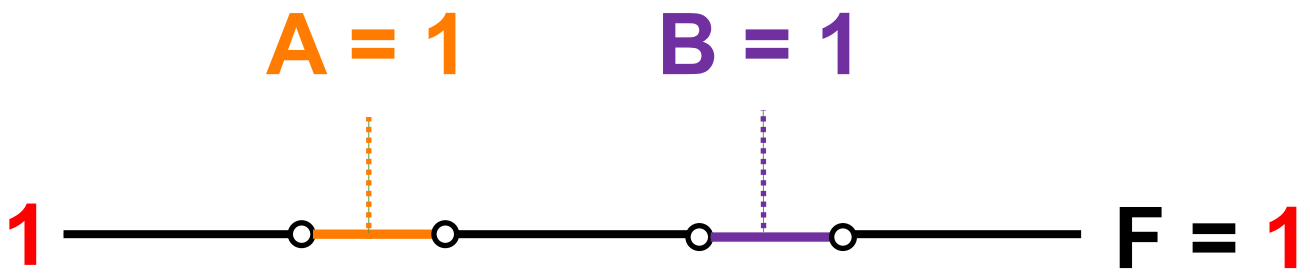

Chaves

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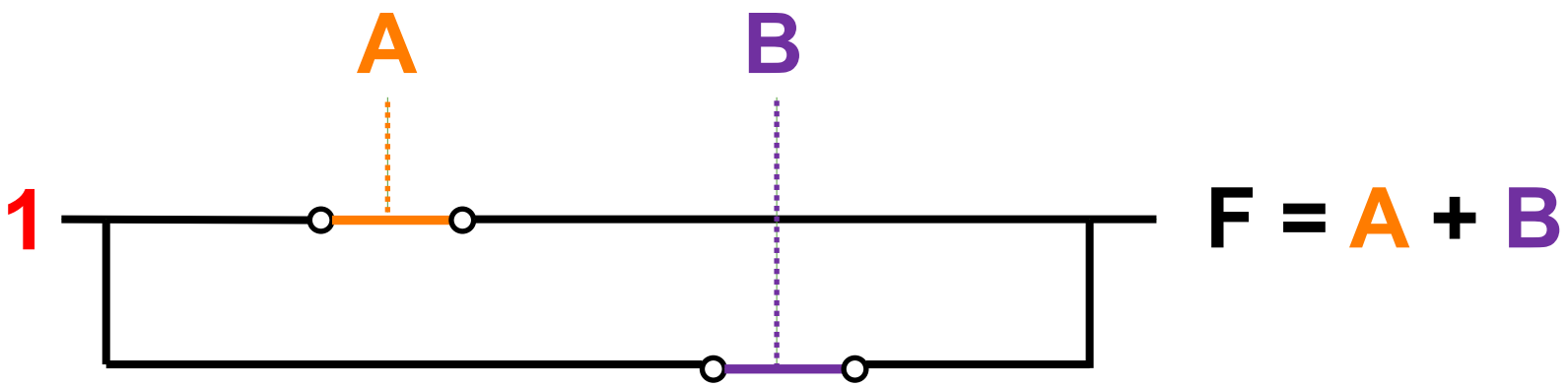

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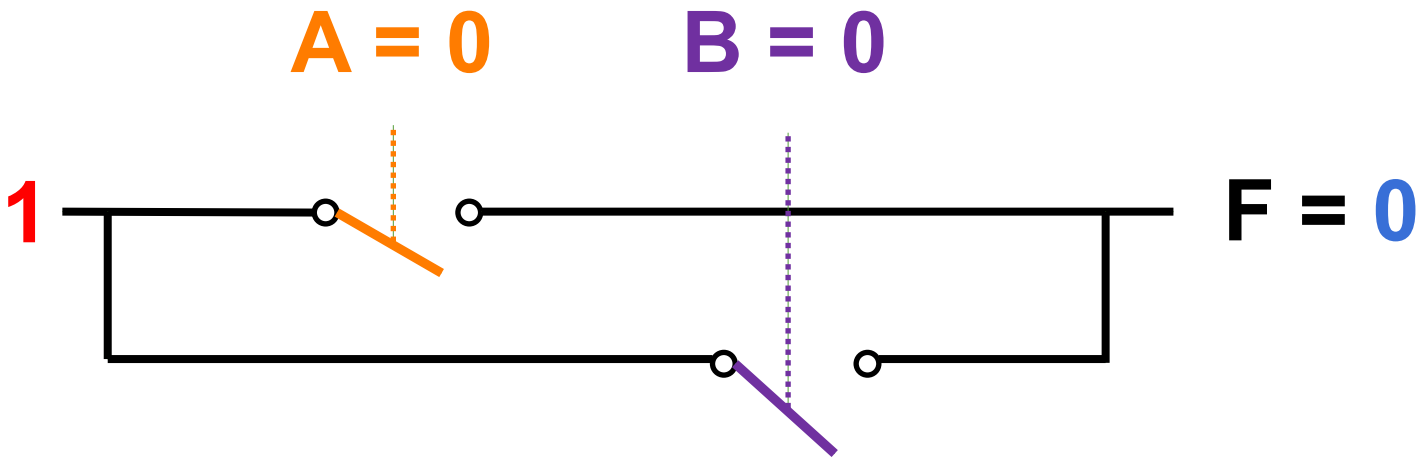

Chaves

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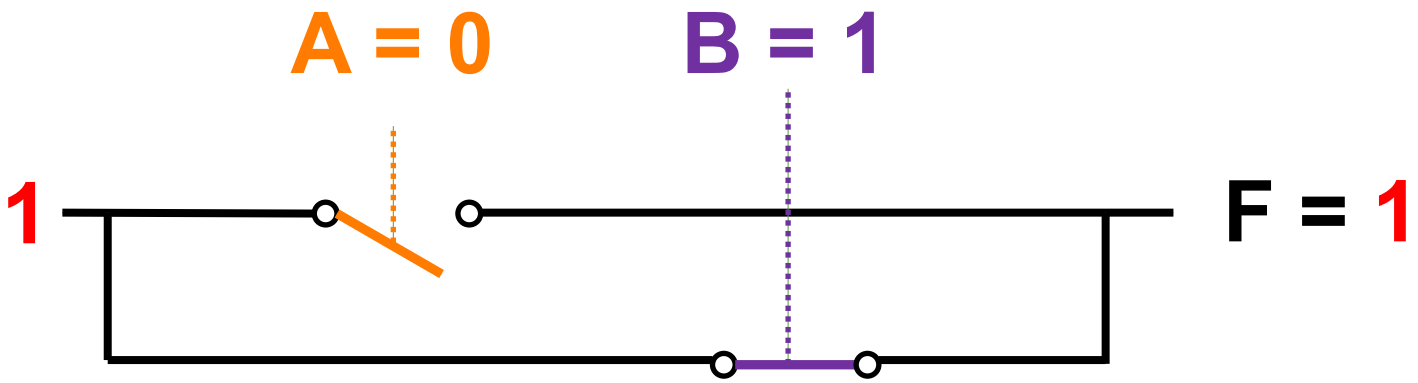

Chaves

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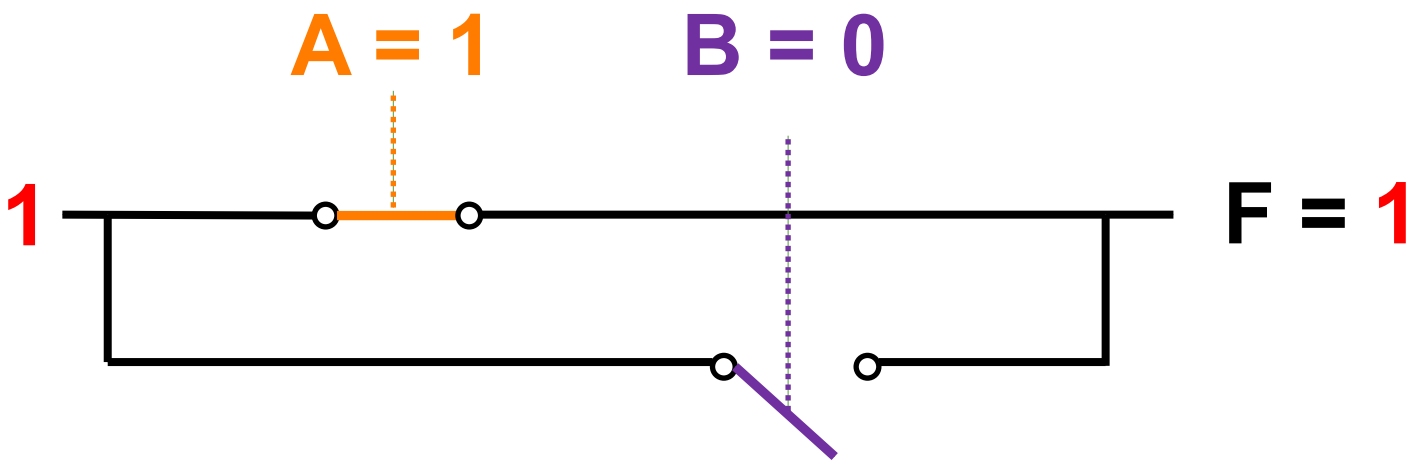

Chaves

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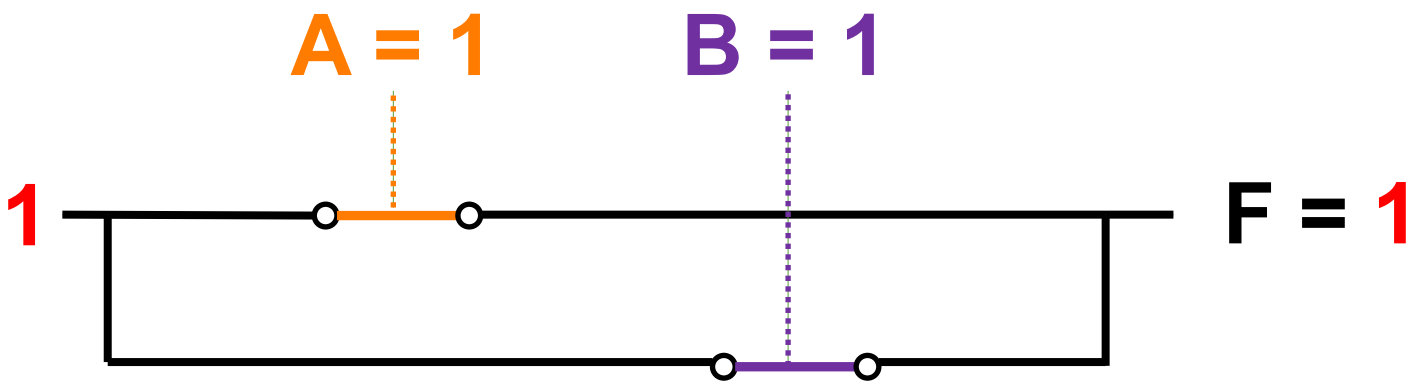
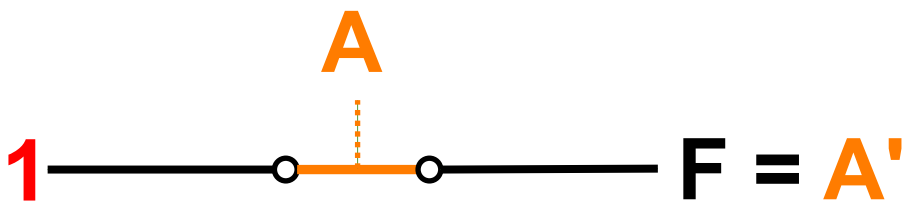


Chaves

- Representação da função lógica NOT



Chaves

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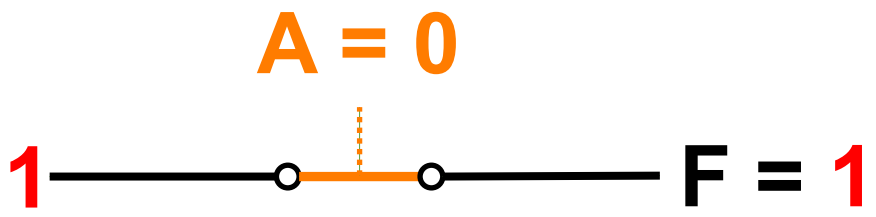

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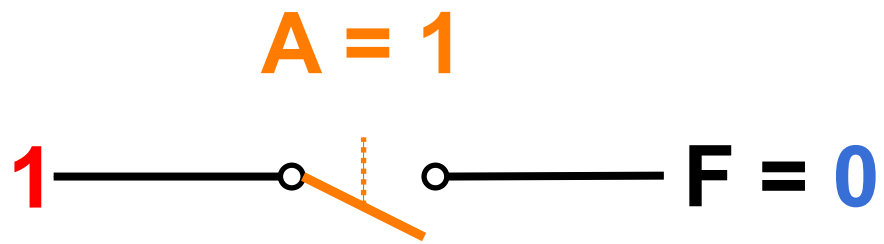
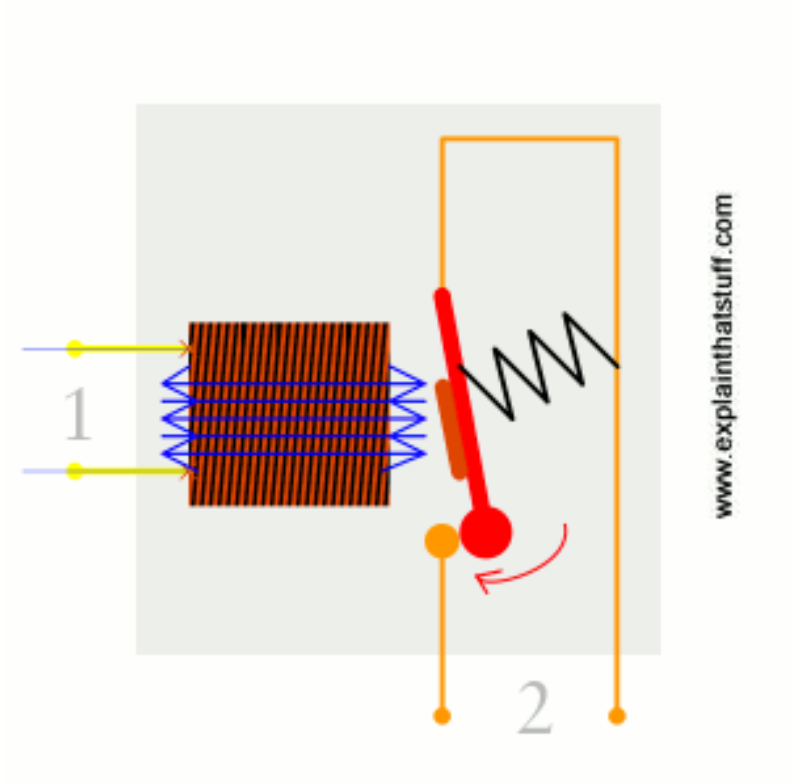


Outros Dispositivos de Chaveamento...

- Relés
- Válvulas
- Transistores

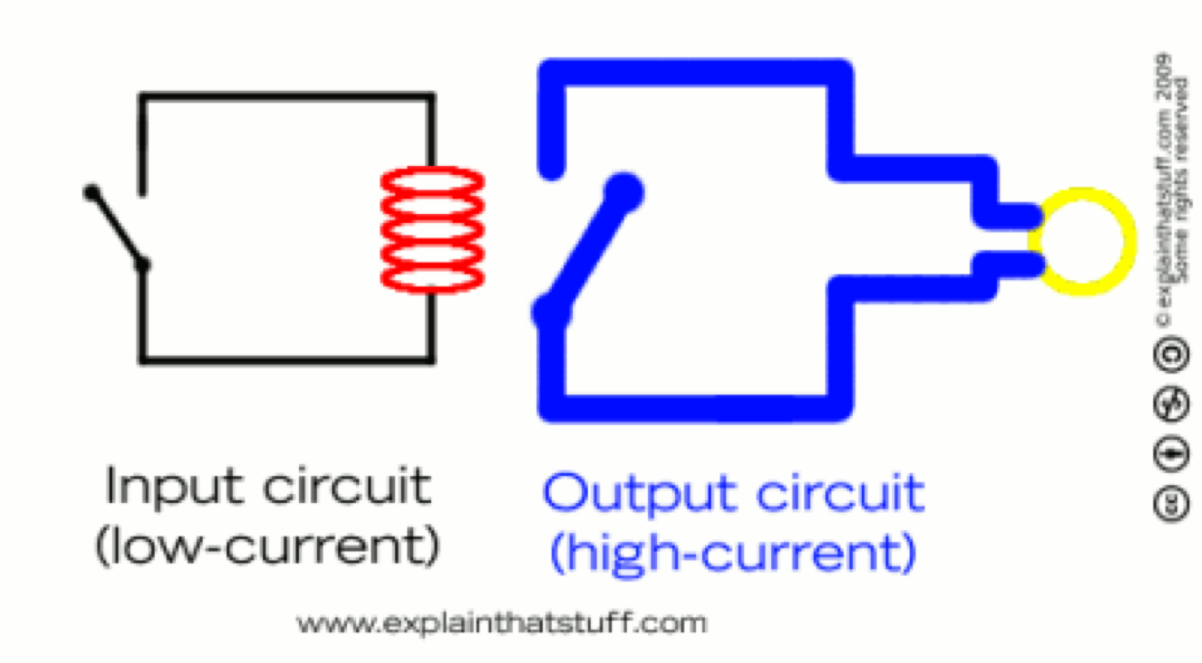
Relé

- São chaves operadas por eletroímãs



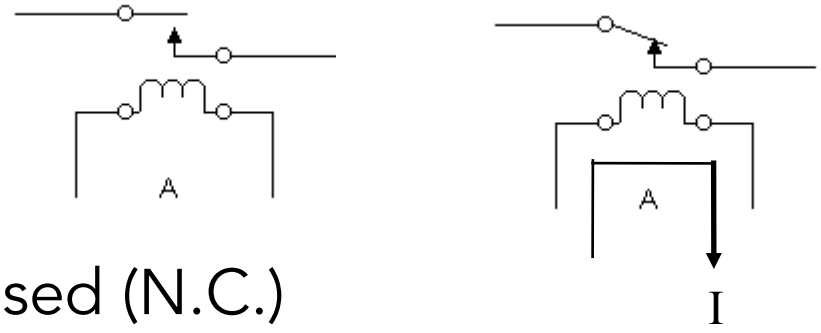
Relé

- São chaves operadas por eletroímãs

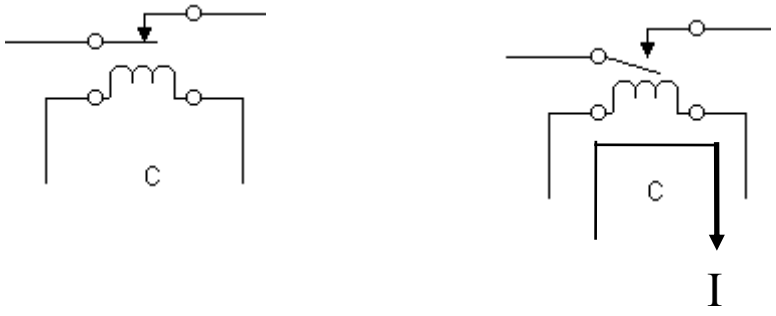


Relé

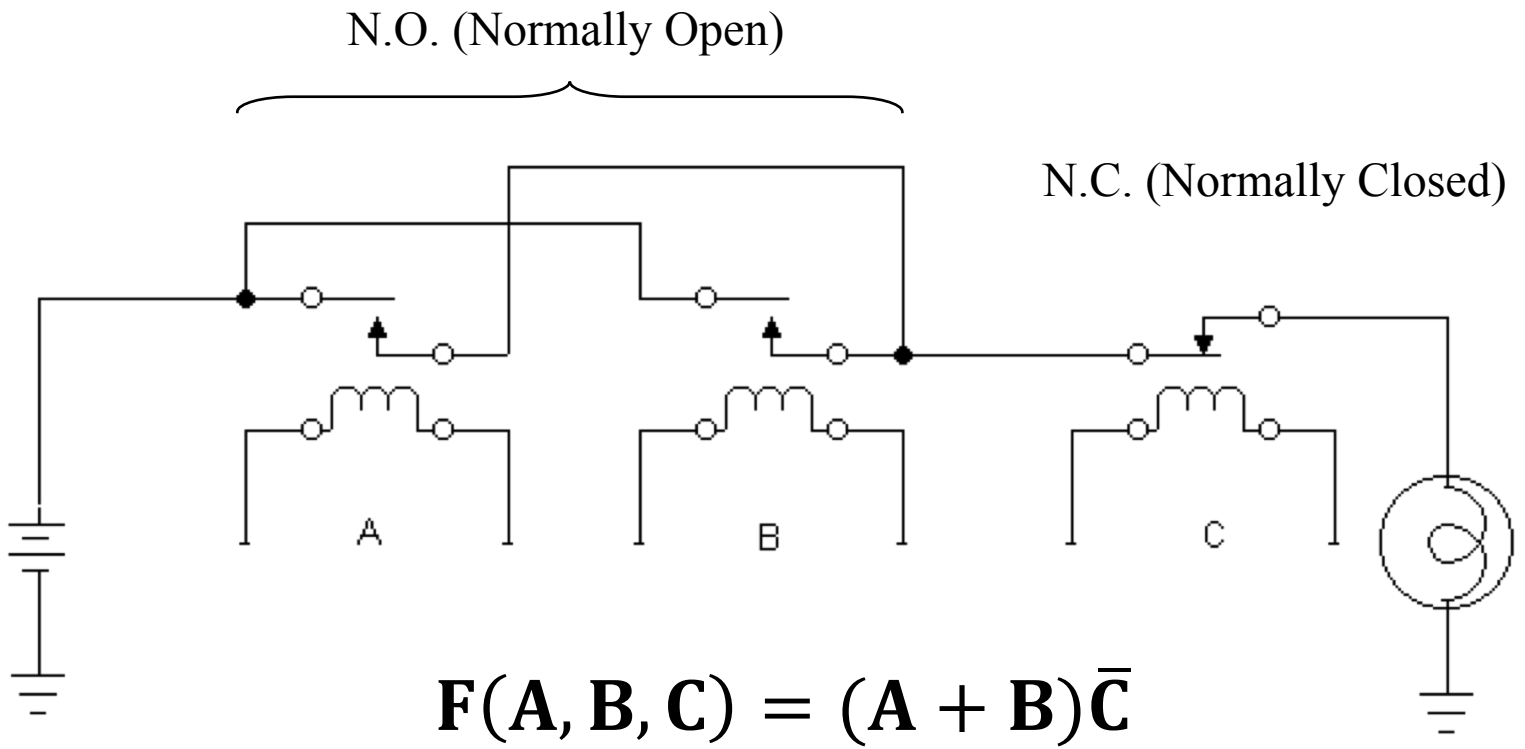
- São chaves operadas por eletroímãs
- Dois tipos:
  - Normally Open (N.O.)



  - Normally Closed (N.C.)



Relé



$$\mathbf{F(A, B, C) = (A + B)\bar{C}}$$

A = fluxo de corrente no eletromagneto do relé A

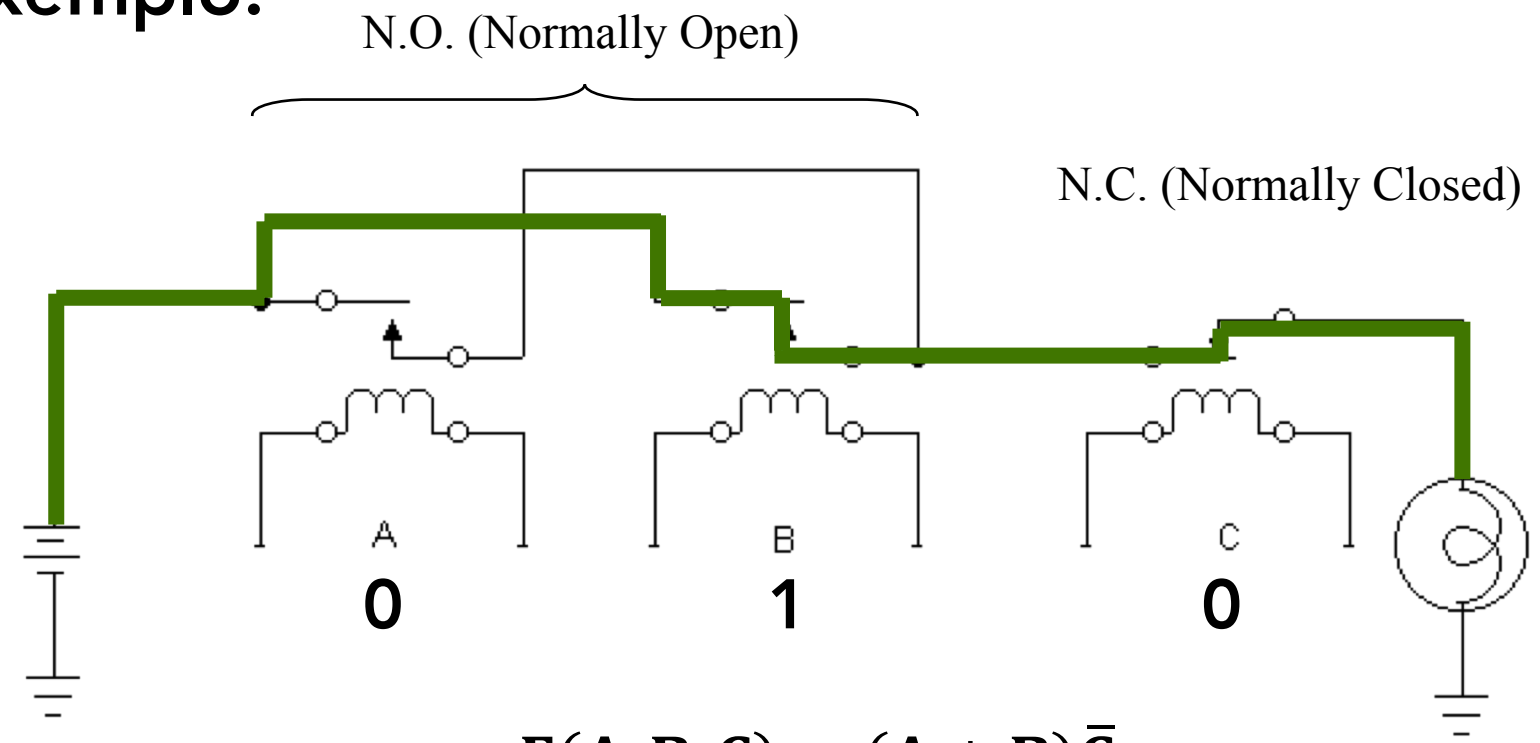
B = fluxo de corrente no eletromagneto do relé B

C = fluxo de corrente no eletromagneto do relé C

f(A,B,C) = lâmpada acesa

Relé

Exemplo:



$$\mathbf{F(A, B, C) = (A + B)\overline{C}}$$
$$\mathbf{F(A, B, C) = (0 + 1)\overline{0}}$$
$$\mathbf{F(A, B, C) = (1)1}$$
$$\mathbf{F(A, B, C) = 1}$$

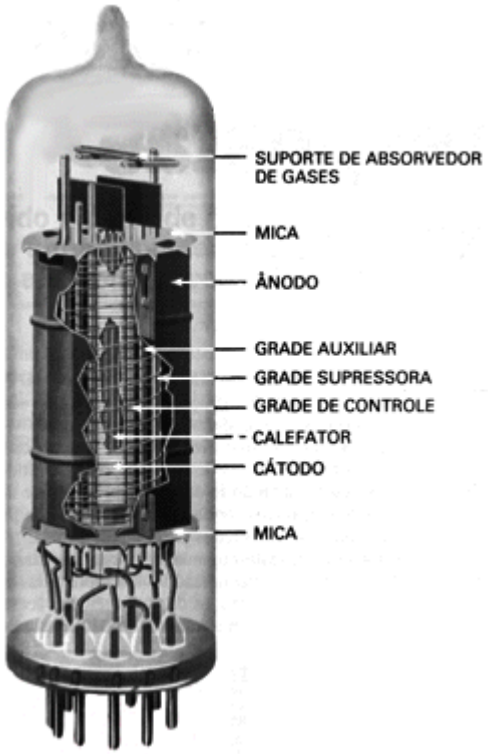
Relé

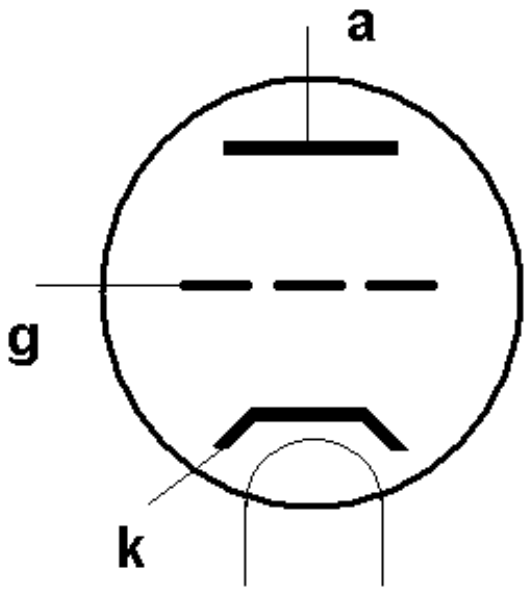
- Por causa do acionamento mecânico, chaves e relés produzem circuitos lentos e pouco confiáveis, e portanto com aplicações limitadas

- Relés não são utilizados atualmente para construir circuitos lógicos

Válvula

- Inventada em 1906





Válvula

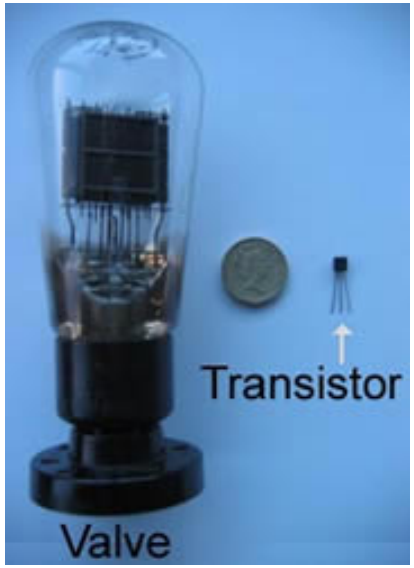
- Vantagem: tempo de comutação (on/off) muito menor que relés eletromecânicos.
- Desvantagem: Alta tensão e dissipação térmica.
- Vantagens hoje em dia: Robusta a transientes elétricos, fortes impulsos eletromagnéticos, tempestade solar, guerra nuclear, etc.
- Uso: Transmissores de Rádio e TV (alta potência), forno de microondas, amplificadores de áudio (alta potência), etc

Válvula

- ENIAC (Electronic Numerical Integrator And Calculator)
- 1° computador eletrônico
- Início dos anos 40 → Universidade da Pennsylvania, EUA
- Utilizava 18.000 válvulas e 1.500 relés

Transistor

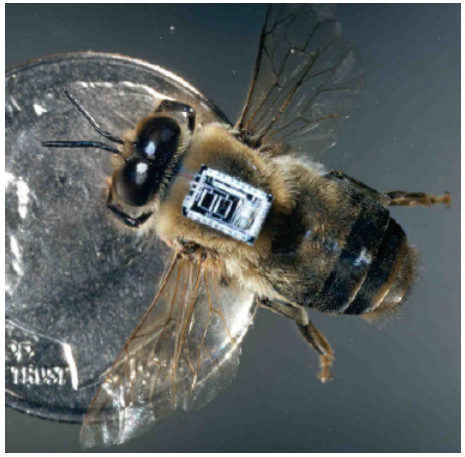
- Inventado em 1950
- Chave eletrônica
- Menores, geram menos calor e são muito mais rápidos que as válvulas



Transistor

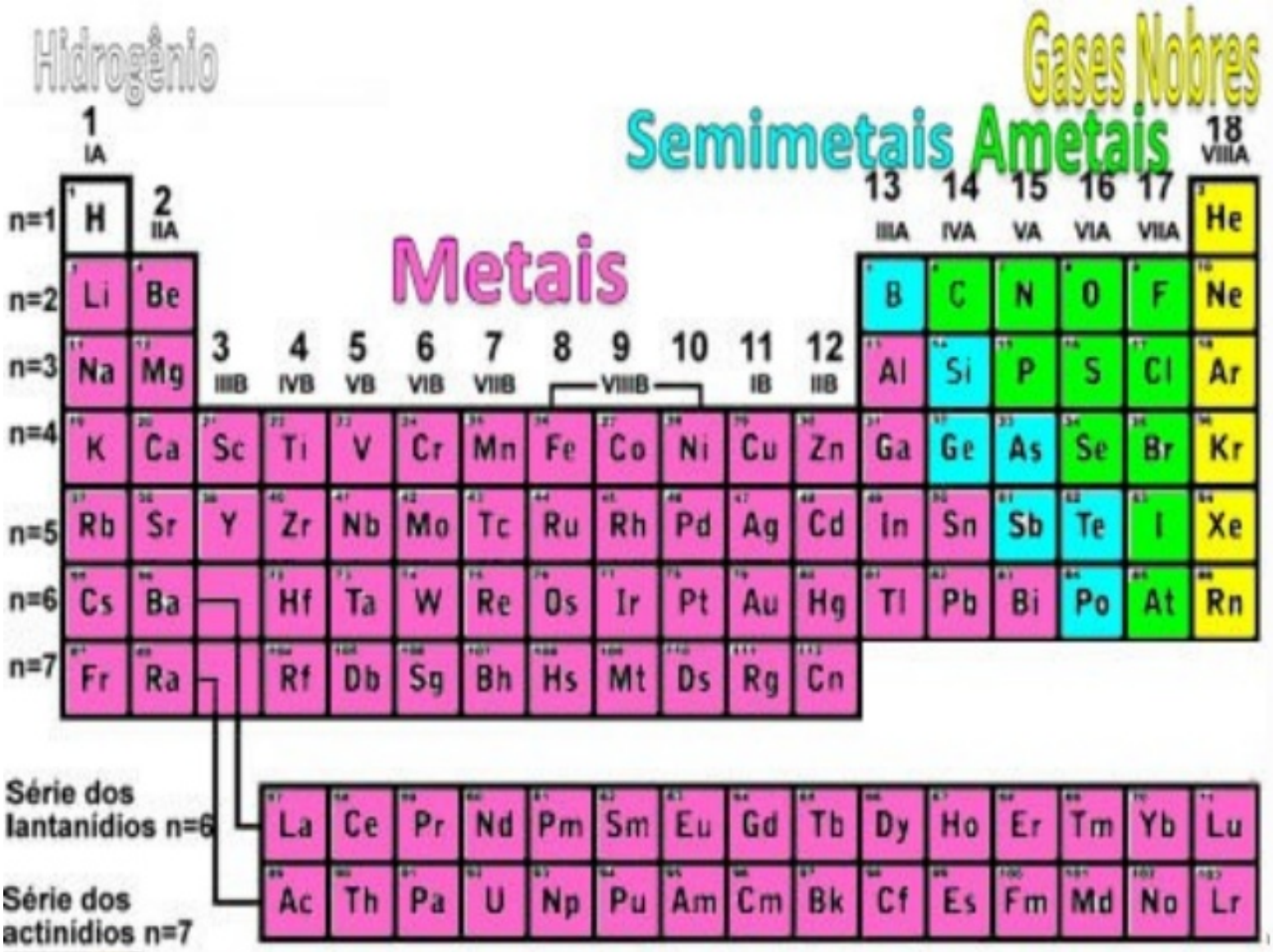
- Possibilitou os circuitos integrados (CIs)
- CIs são classificados de acordo com suas complexidades.

Name	Signification	Year	Transistors number[46]	Logic gates number[47]
SSI	*small-scale integration*	1964	1 to 10	1 to 12
MSI	*medium-scale integration*	1968	10 to 500	13 to 99
LSI	*large-scale integration*	1971	500 to 20,000	100 to 9,999
VLSI	*very large-scale integration*	1980	20,000 to 1,000,000	10,000 to 99,999
ULSI	*ultra-large-scale integration*	1984	1,000,000 and more	100,000 and more



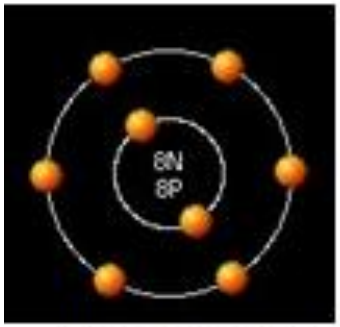
Transistor

- Tipos de transistores com os quais os circuitos integrados são implementados:
  - transistores de junção bipolar (BJT – *bipolar-junction transistor*) → **lógica TTL**
    - SSI e MSI
  - são MOSFETs (*metal-oxide semiconductor field-effect transistors*) → **lógica NMOS, CMOS**
    - SSI, MSI, LSI, VLSI, ULSI...
- **Utiliza semicondutores em sua fabricação**
  - **Silício ou germânio**

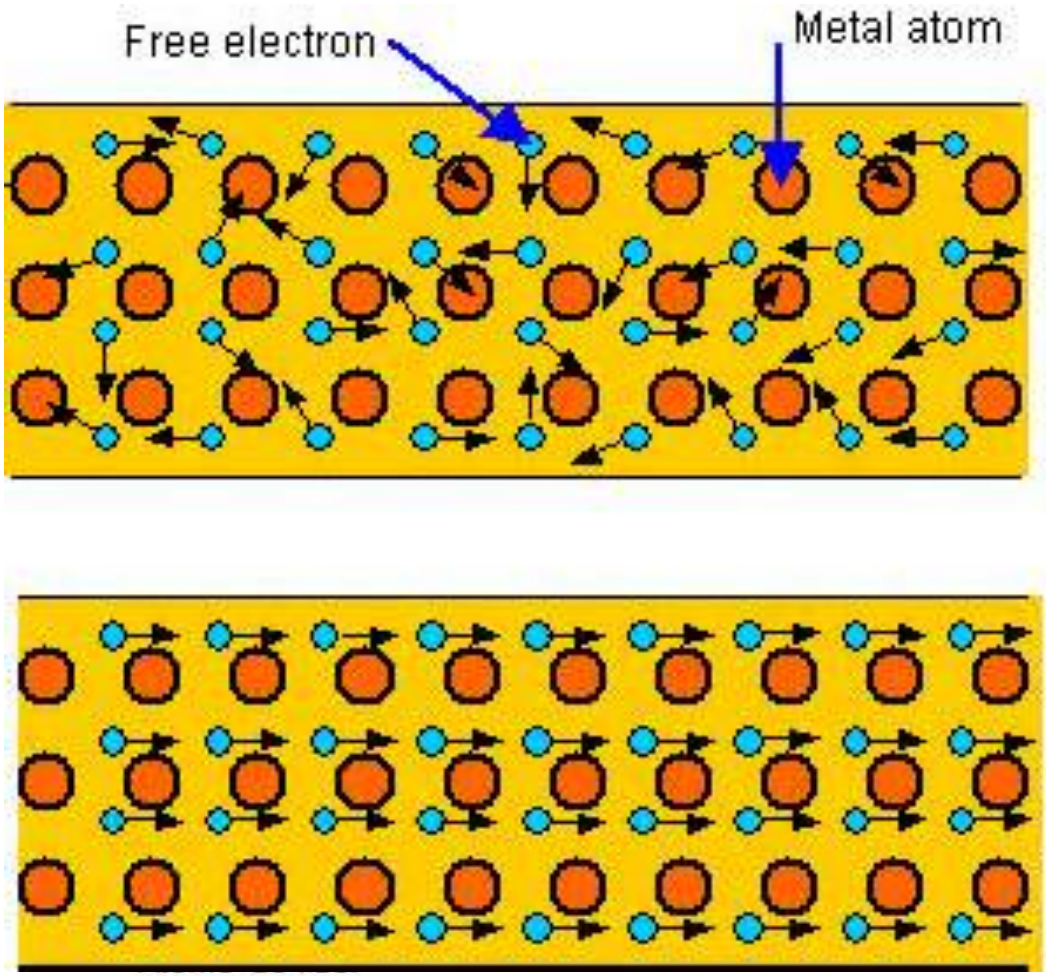

Hidrogênio
Gases Nobres
Semimetais
Ametais
Metais
1 IA
2 IIA
3 IIIB
4 IVB
5 VB
6 VIB
7 VIIB
8
9 VIIIB
10
11 IB
12 IIB
13 IIIA
14 IVA
15 VA
16 VIA
17 VIIA
18 VIIIA
n=1
n=2
n=3
n=4
n=5
n=6
n=7
H
He
Li Be
B C N O F Ne
Na Mg
Al Si P S Cl Ar
K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr
Rb Sr Y Zr Nb Mo Tc Ru Rh Pd Ag Cd In Sn Sb Te I Xe
Cs Ba Hf Ta W Re Os Ir Pt Au Hg Tl Pb Bi Po At Rn
Fr Ra Rf Db Sg Bh Hs Mt Ds Rg Cn
Série dos lantanídios n=6
La Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu
Série dos actinídios n=7
Ac Th Pa U Np Pu Am Cm Bk Cf Es Fm Md No Lr

Os metais são bons condutores

Átomo de sódio

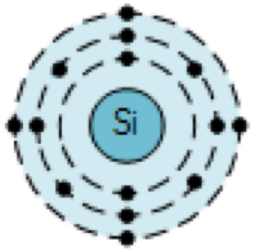


Átomo de oxigênio

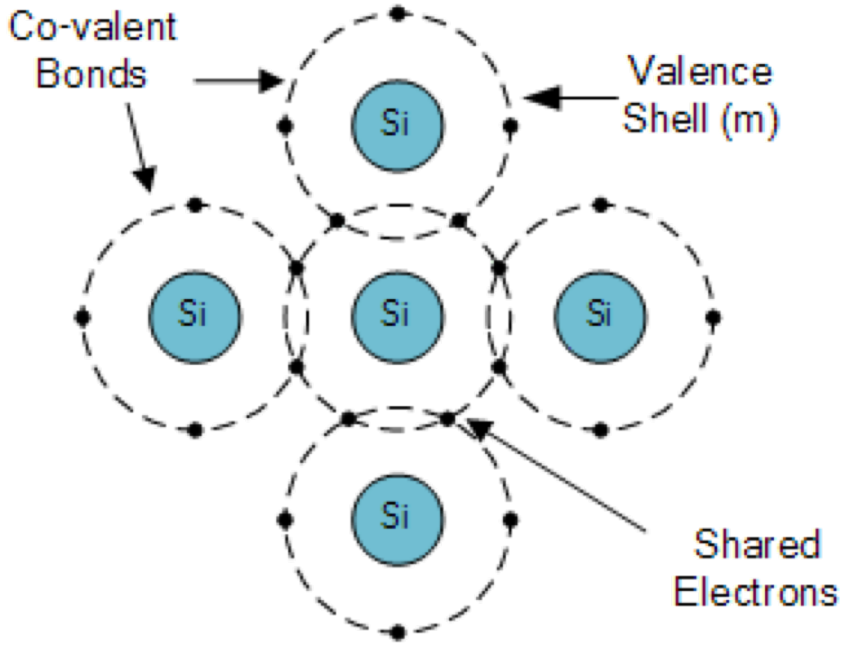


Semicondutor puro Si

A Silicon Atom,
Atomic number = "14"

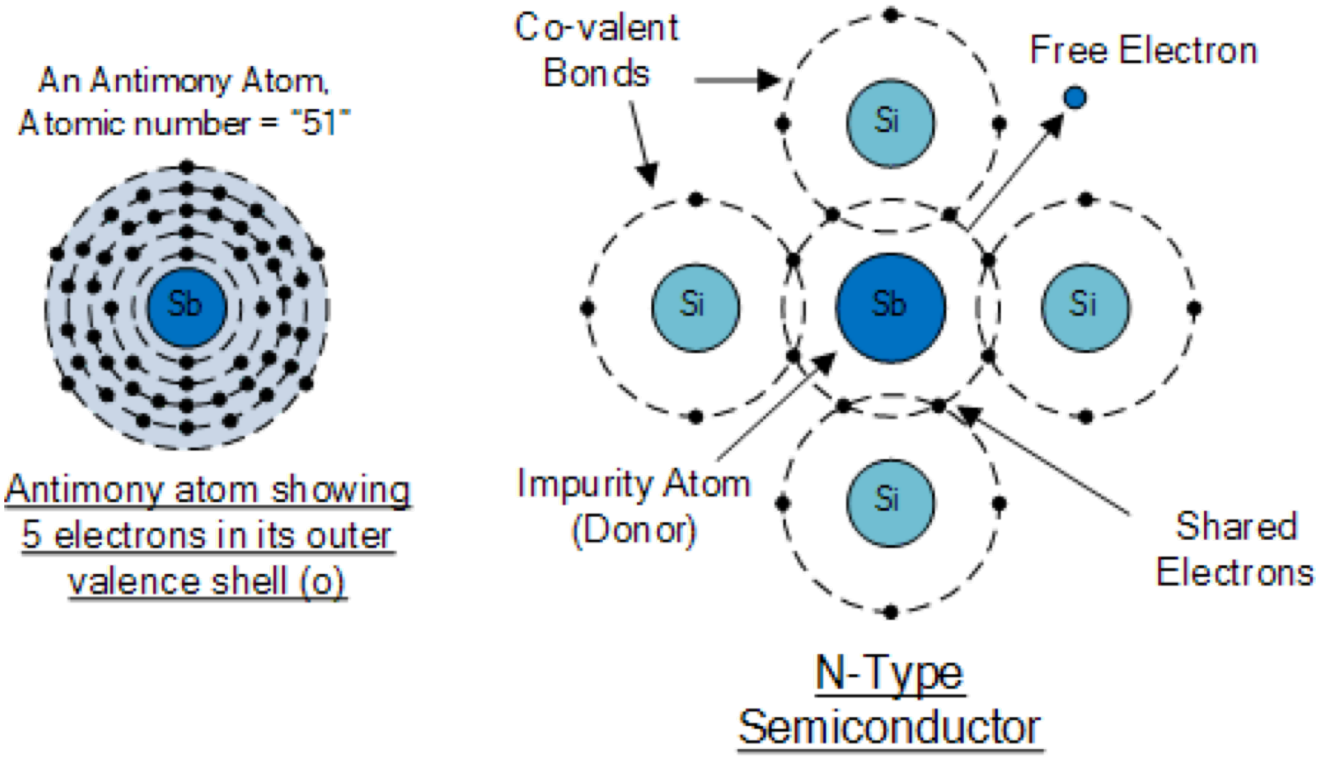


Silicon atom showing
4 electrons in its outer
valence shell (m)



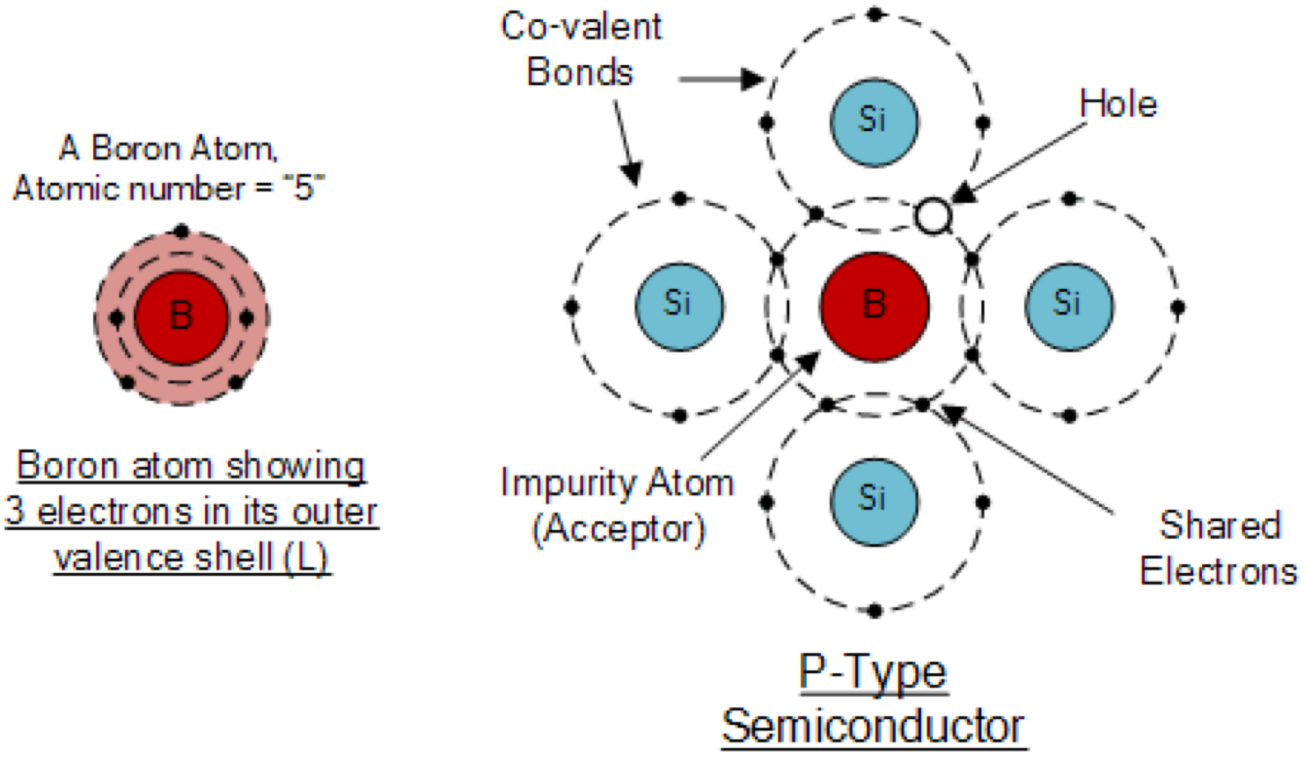
Silicon Crystal Lattice

Semicondutor tipo-N



Adiciona-se à estrutura cristalina do material semicondutor um elemento com excesso de 1 elétron em sua camada de valência

Semicondutor tipo-P



Adiciona-se à estrutura cristalina do material semicondutor um elemento com ausência de 1 elétron em sua camada de valência

Video

https://www.youtube.com/watch?v=IcrBqCFLHIY

Transistor MOS

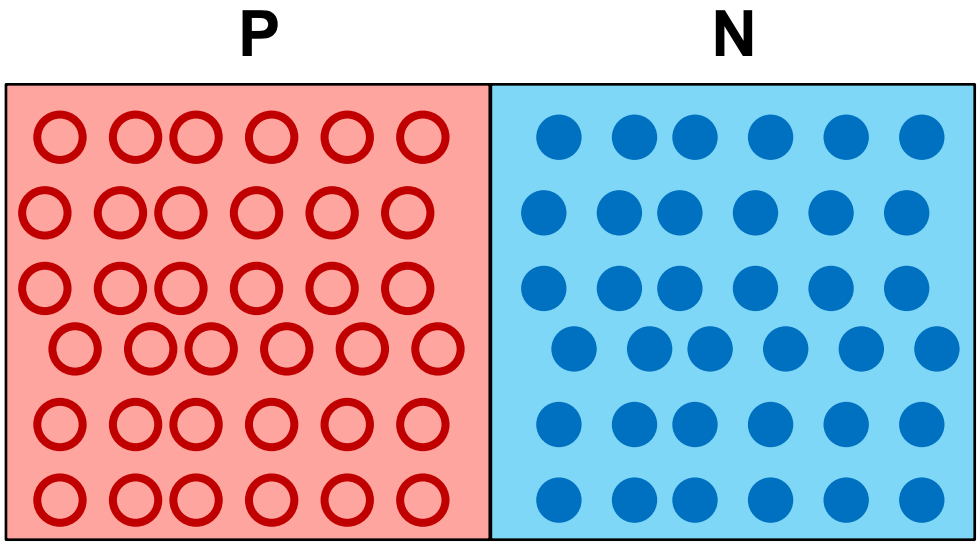
- Metal-Oxide Semiconductor field-effect transistors
- Patenteado dez anos antes da invenção do transistor bipolar
- Pela dificuldade de fabricação, somente começaram a ser produzidos a partir de 1960
- 2 tipos:
  - PMOS
  - NMOS

Transistor MOS

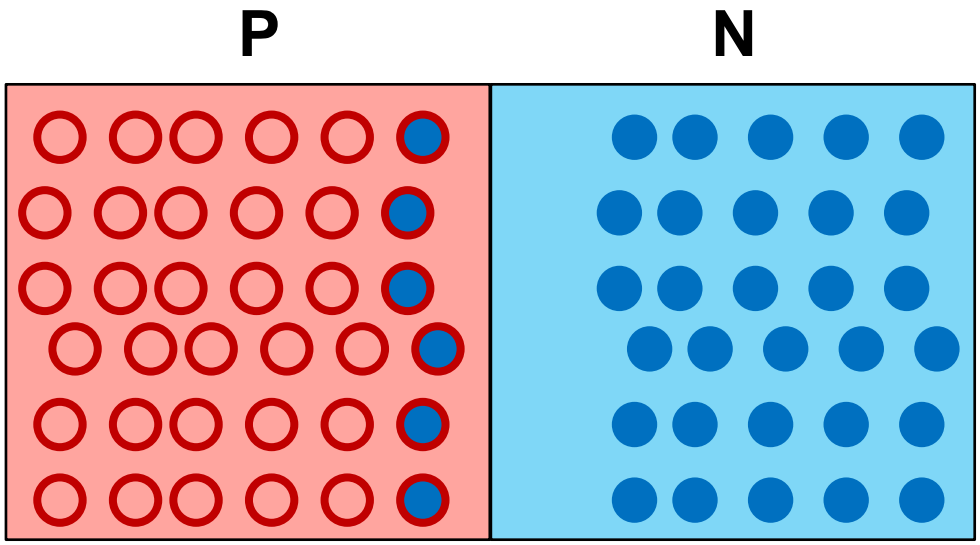
- Slides UFRGS

Diodo

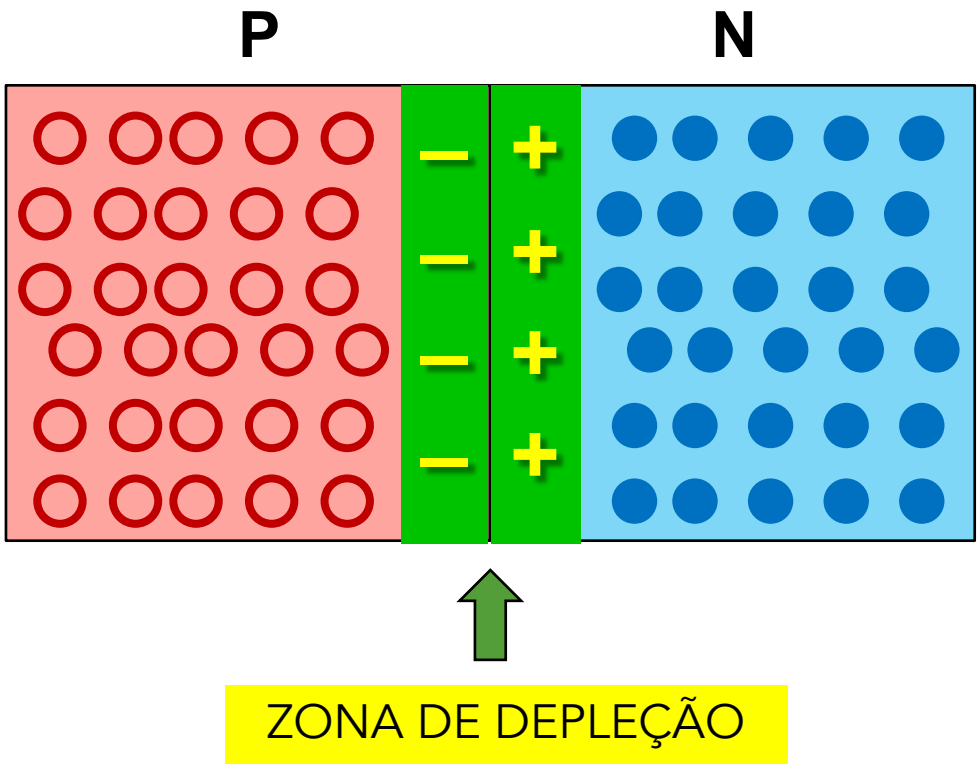
- Para entender seu funcionamento, primeiro vamos entender como funciona um **diodo**



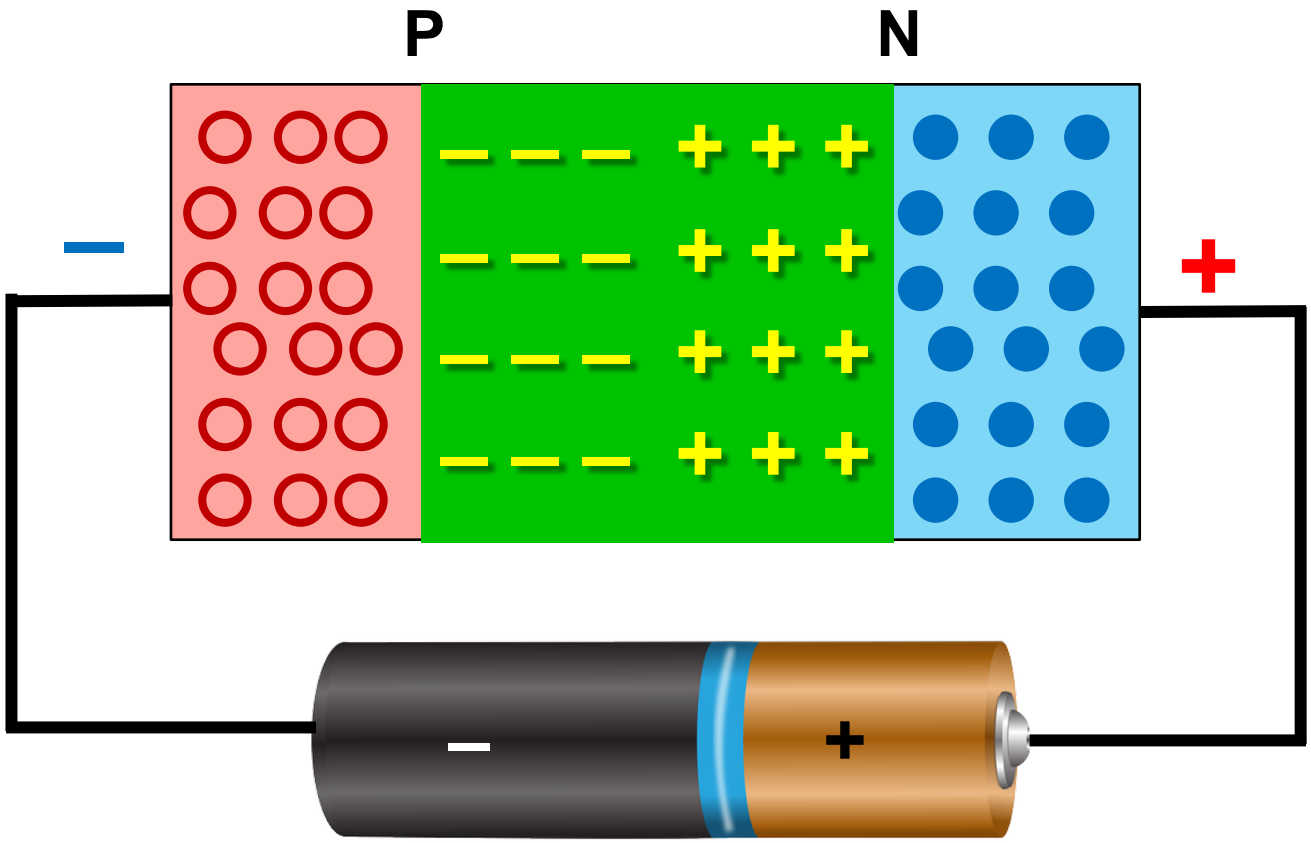
Diodo



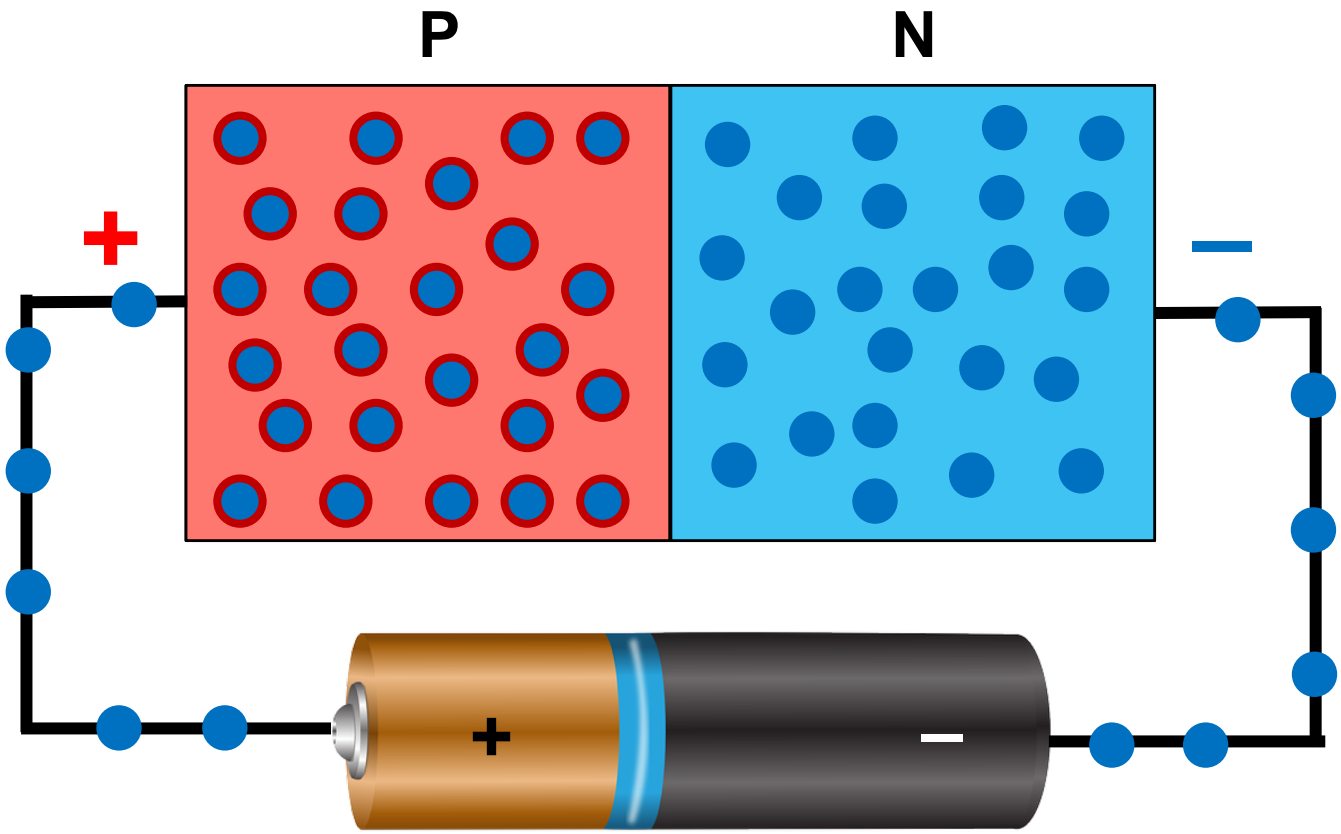
Diodo



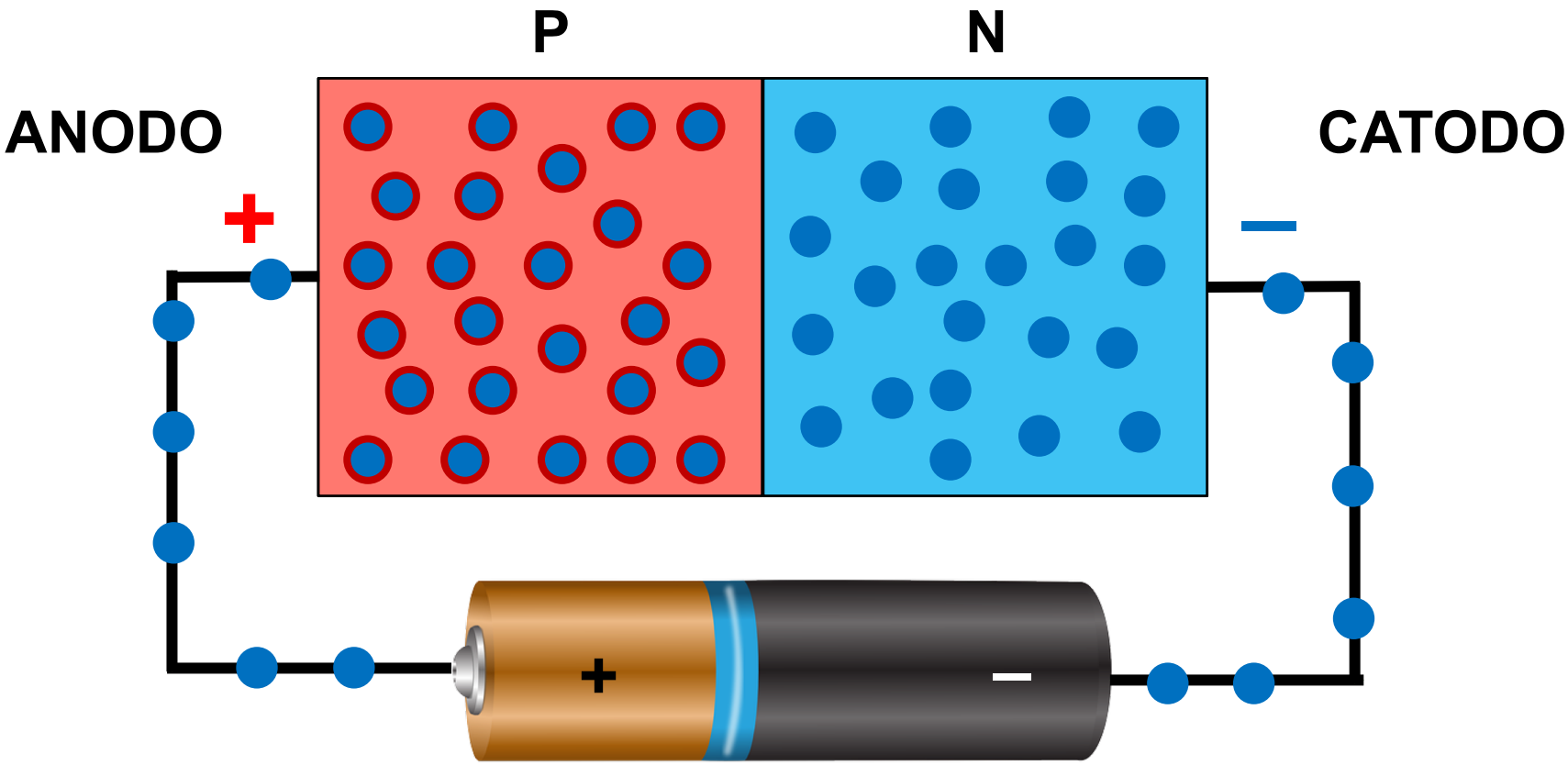
Diodo



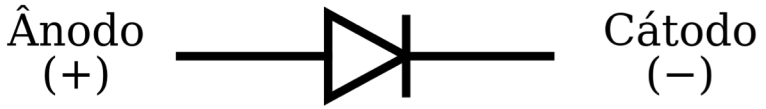
Diodo

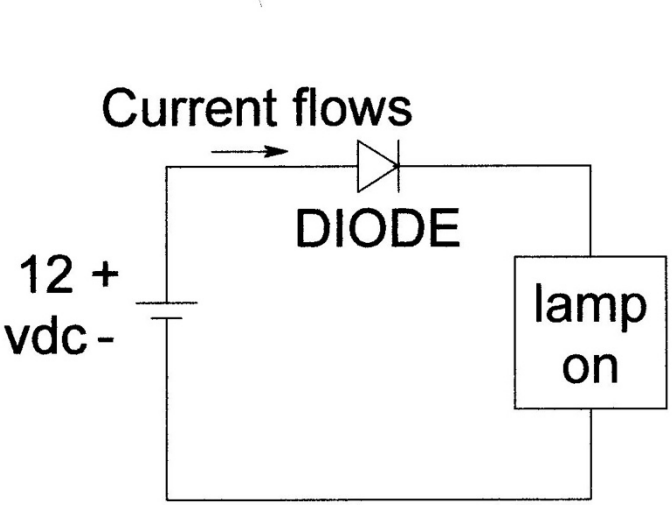


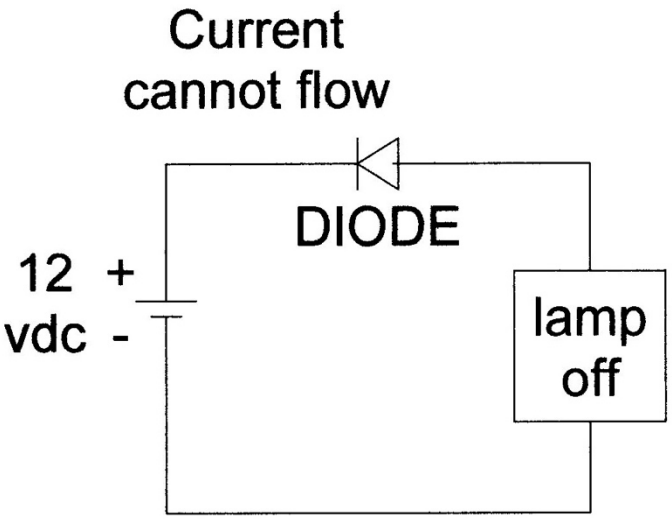
Diodo



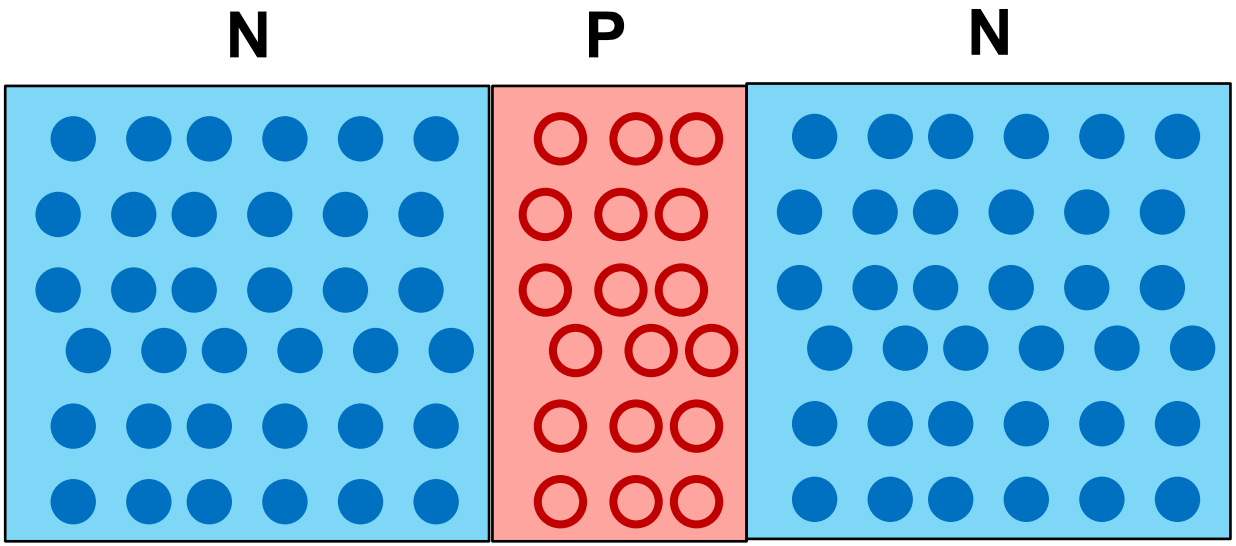
Diodo


Ânodo
(+)
Cátodo
(−)

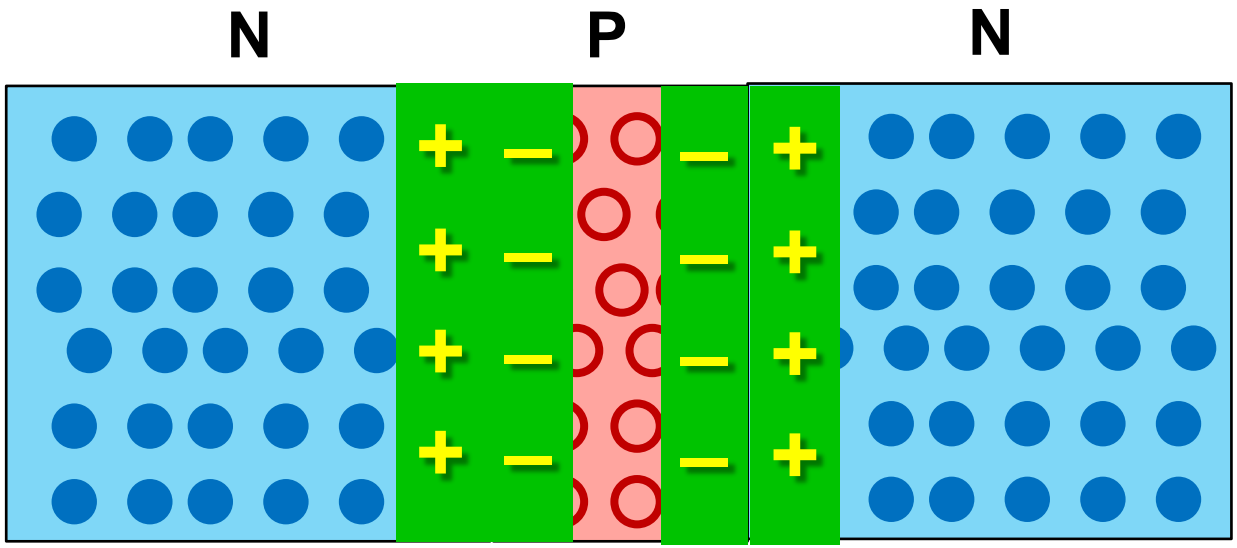

Current flows
DIODE
12 +
vdc -
lamp
on


Current
cannot flow
DIODE
12 +
vdc -
lamp
off

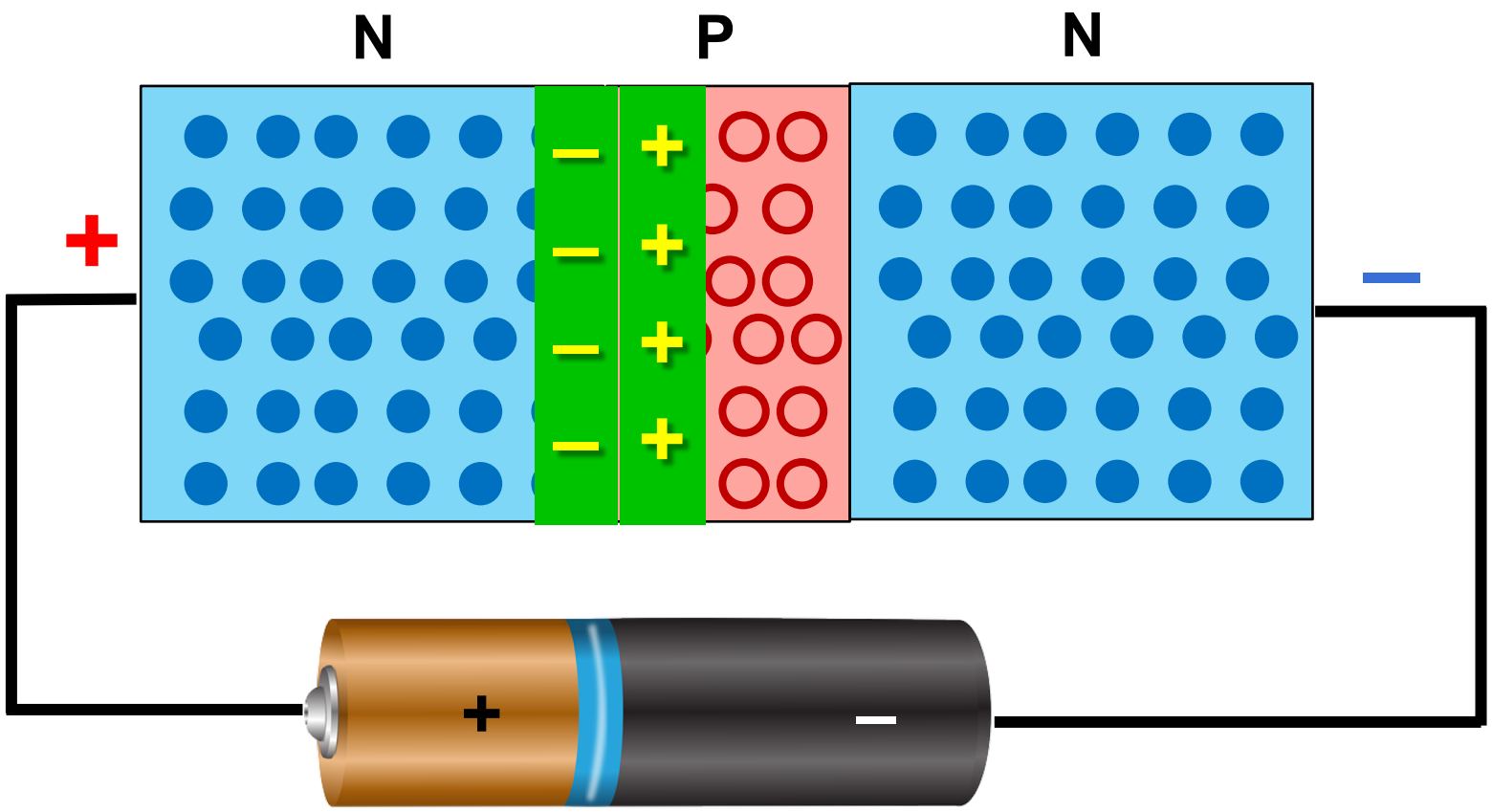
Transistor Bipolar



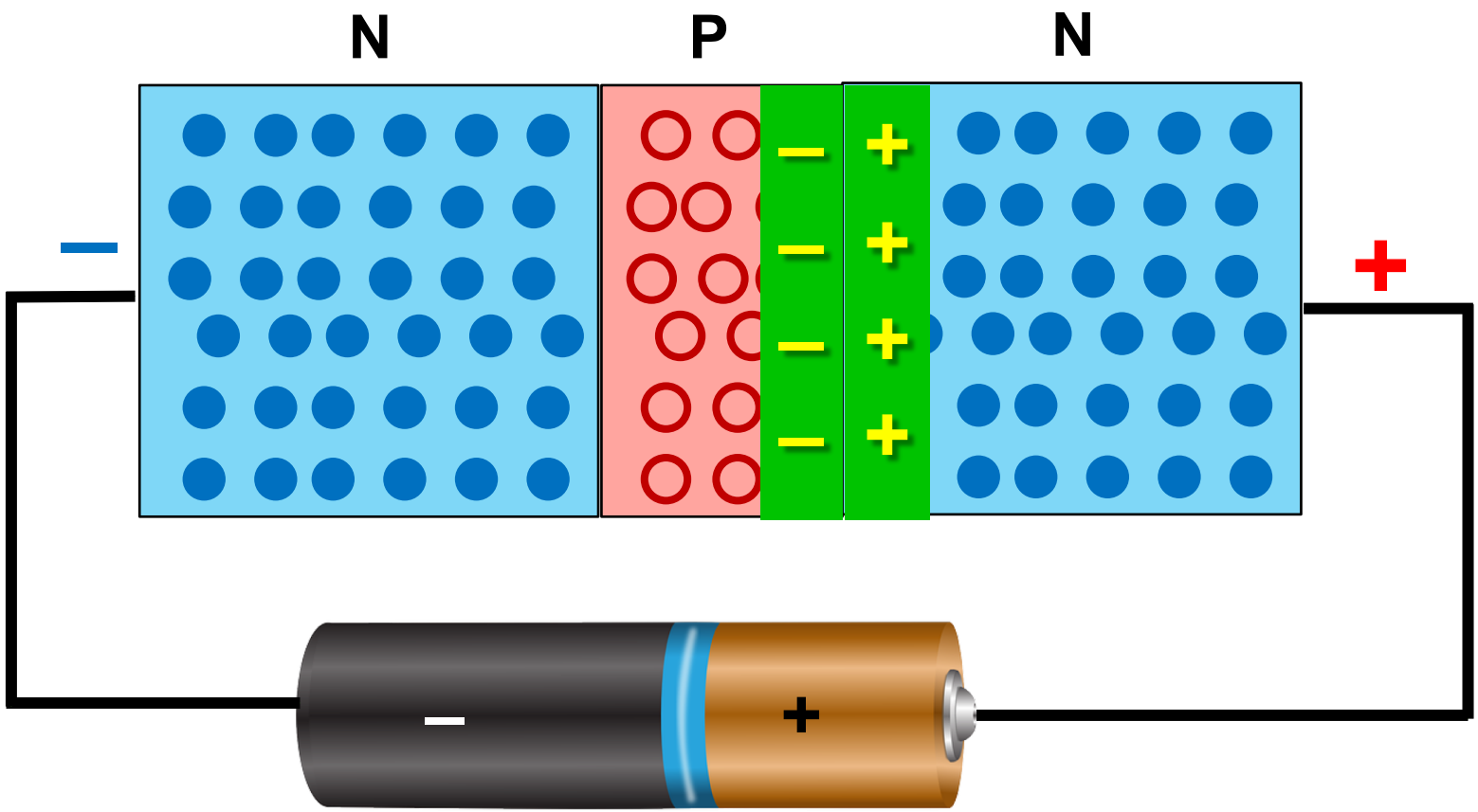
Transistor Bipolar



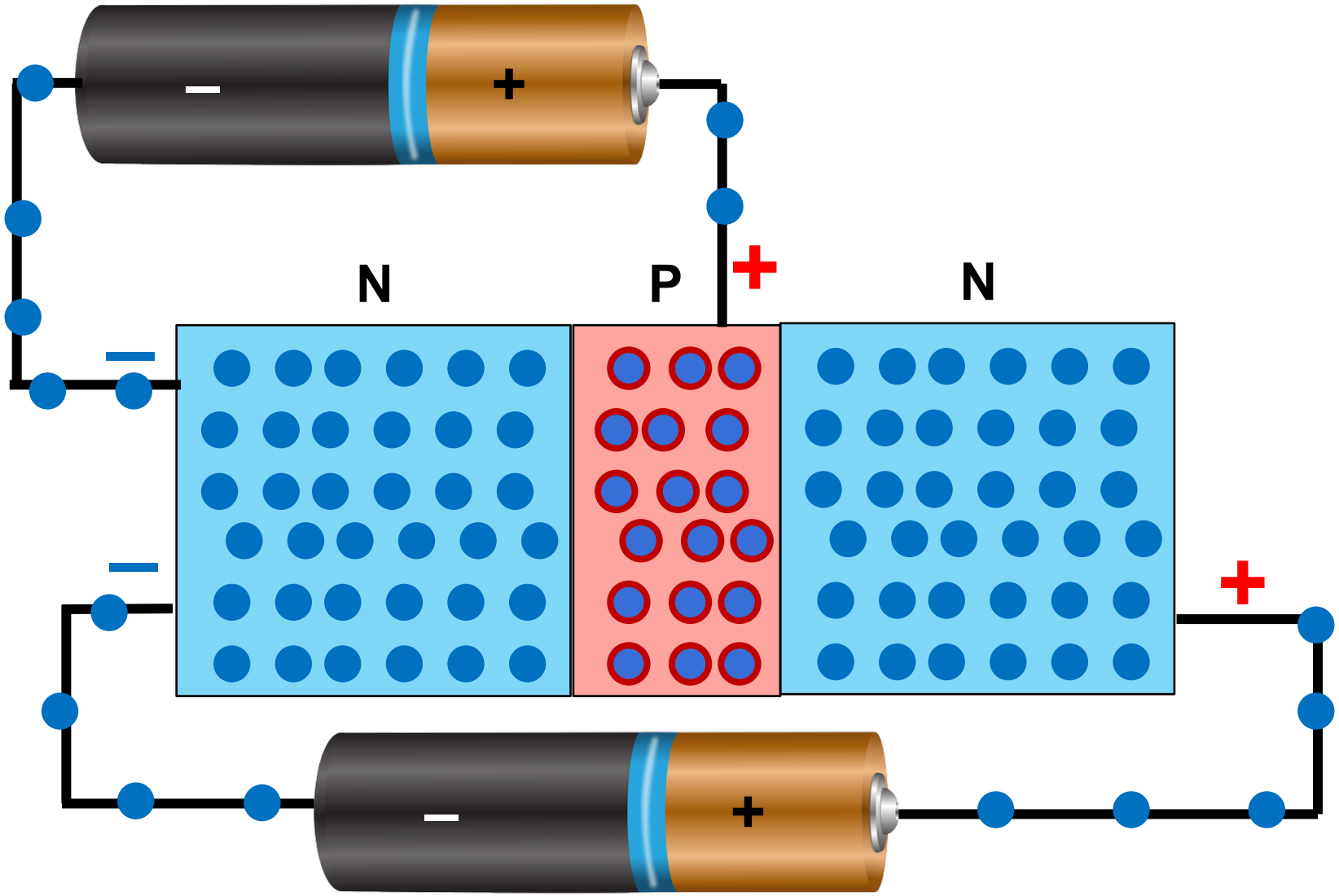
Transistor Bipolar



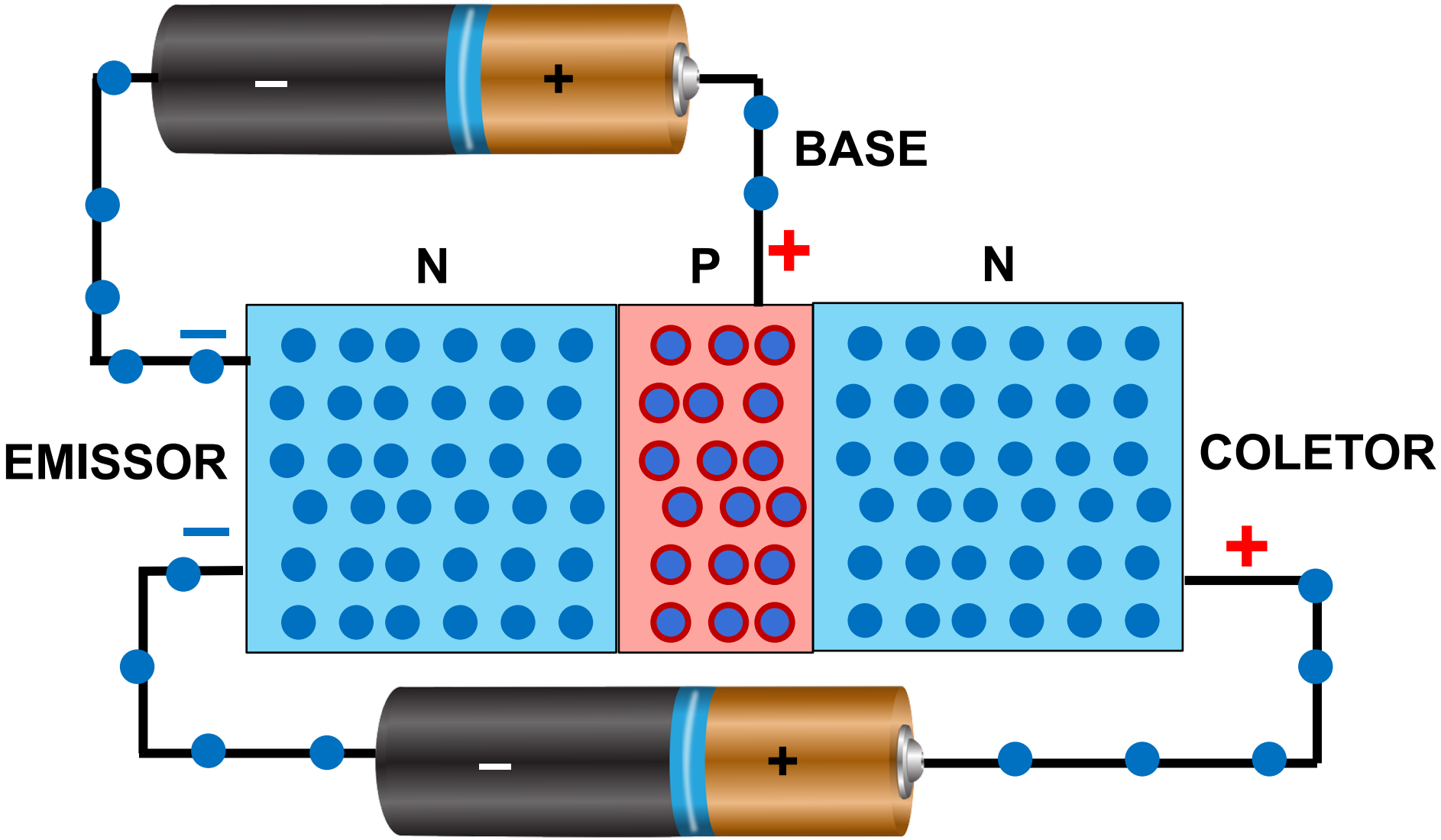
Transistor Bipolar



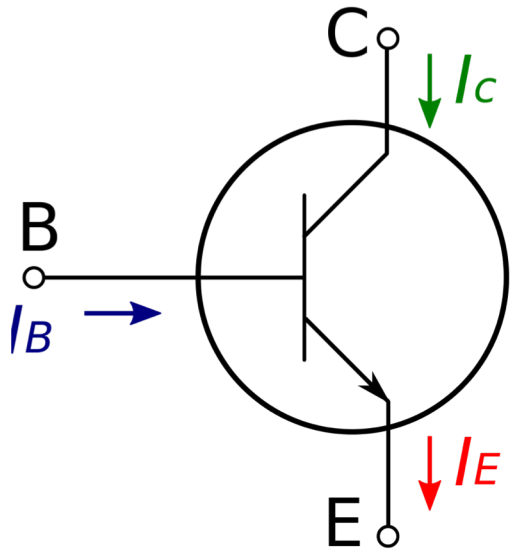
Transistor Bipolar

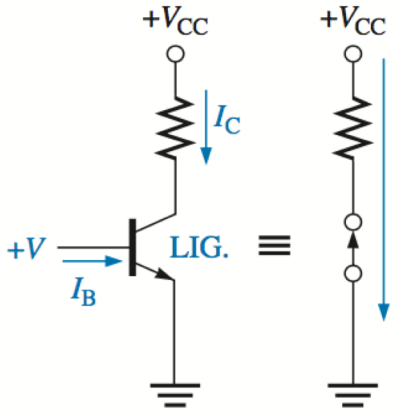


Transistor Bipolar

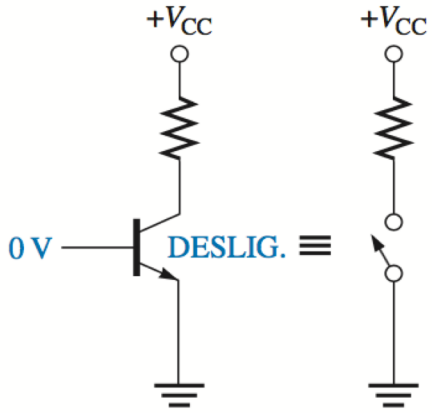


Transistor Bipolar





(a) Transistor saturado (LIG.) e o circuito equivalente ideal com uma chave



(b) Transistor DESLIG. e o circuito equivalente ideal com uma chave

Transistor Bipolar

- http://www.learnabout-electronics.org/Semiconductors/bjt_04.php

- https://youtu.be/7ukDKVHnac4?t=2m10s