**Centro Federal de Educação Tecnológica de Santa Catarina**
**Departamento de Eletrônica**

**Retificadores**

# Características dos diodos

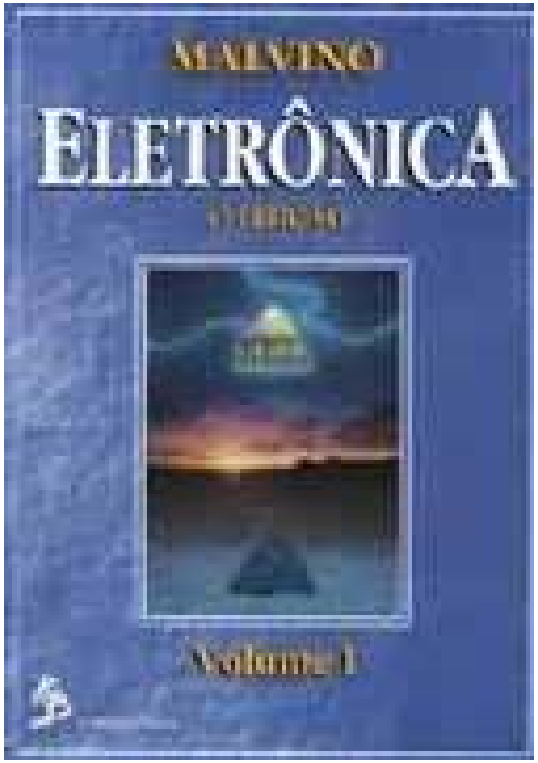
**Prof. Clóvis Antônio Petry.**

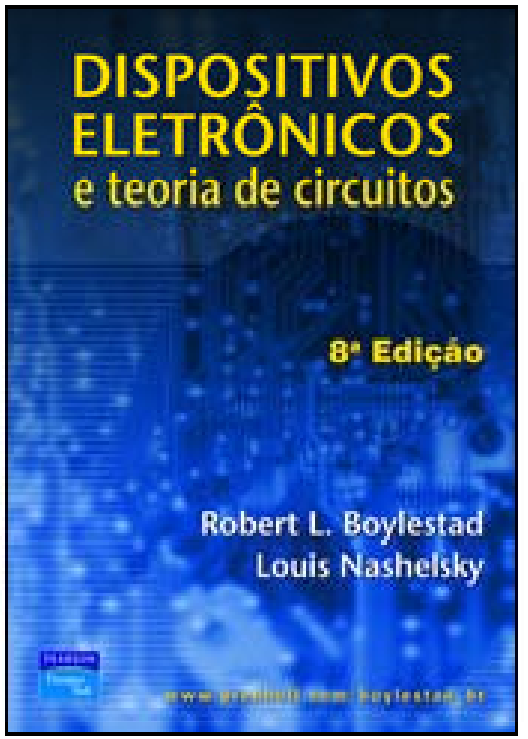
**Florianópolis, outubro de 2007.**

# Bibliografia para esta aula

**Capítulo 1: Diodos semicondutores**

1. Características dos diodos.

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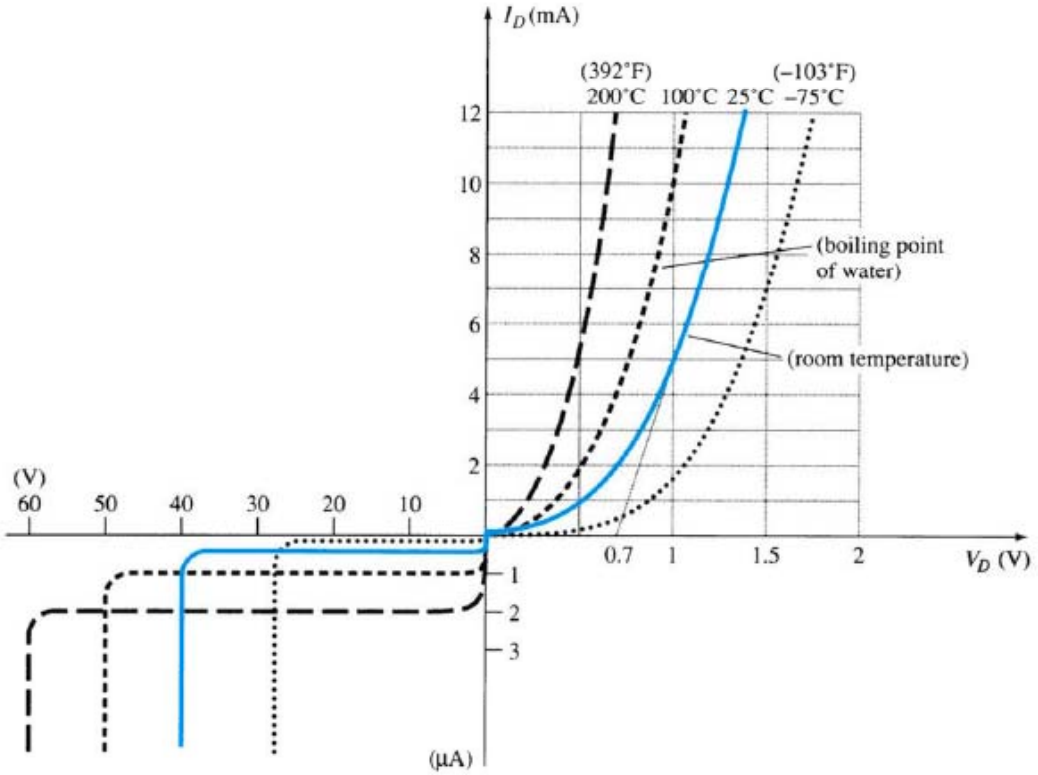
# Nesta aula

**Seqüência de conteúdos:**

1. Efeito da temperatura;
2. Silício versus germânio;
3. Região zener;
4. Resistências do diodo;
5. Modelo ideal do diodo;
6. Modelo simplificado do diodo;
7. Modelo linear por partes do diodo;
8. Características dos diodos;
9. Testes de diodos com multímetros.

# Efeito da temperatura na junção P-N

A corrente de saturação reversa $I_S$ terá sua amplitude praticamente dobrada para aumento de 10 ºC na temperatura.



# Efeito da temperatura na junção P-N

**Exemplo 2.6 – Eletrônica, vol. 1:**

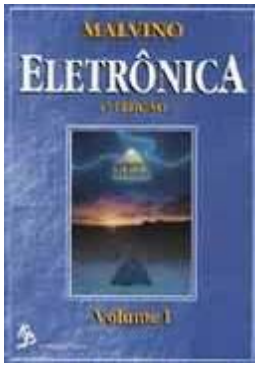
- Qual a barreira de potencial de um diodo de silício quando a temperatura na junção for de 100 ºC.

**Solução:** Se a temperatura na junção aumentar para 100 ºC, a barreira de potencial diminui para:

$$\left(100^{o}C - 25^{o}C\right) \cdot 2\,mV = 150\,mV = 0{,}15V$$

A barreira de potencial passa a ser:

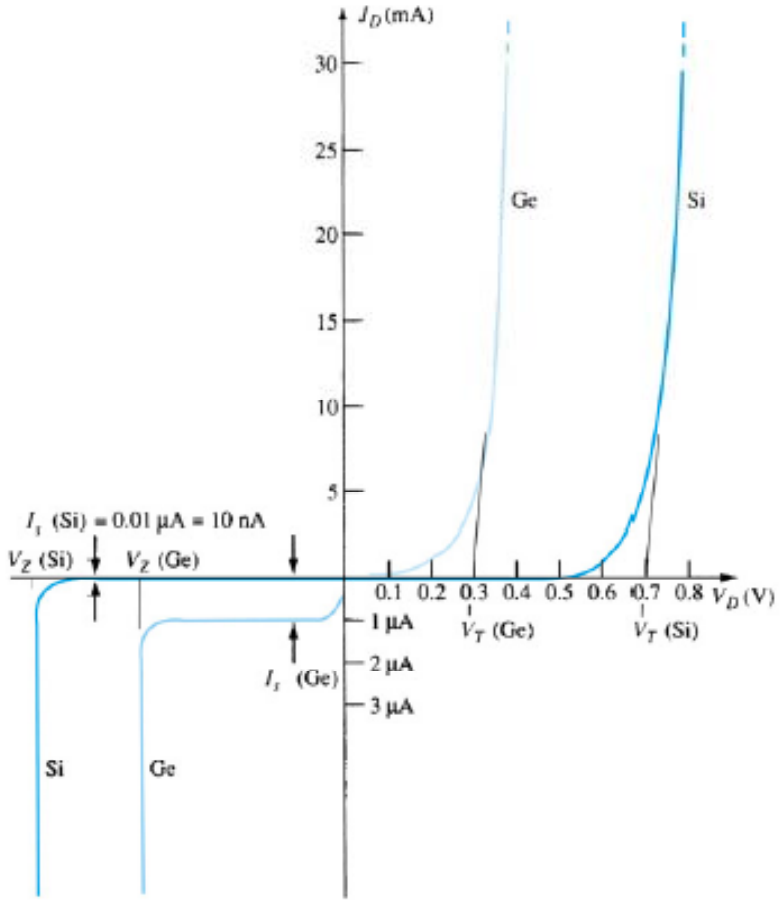
$$V_B = 0{,}7V - 0{,}15V = 0{,}55V$$



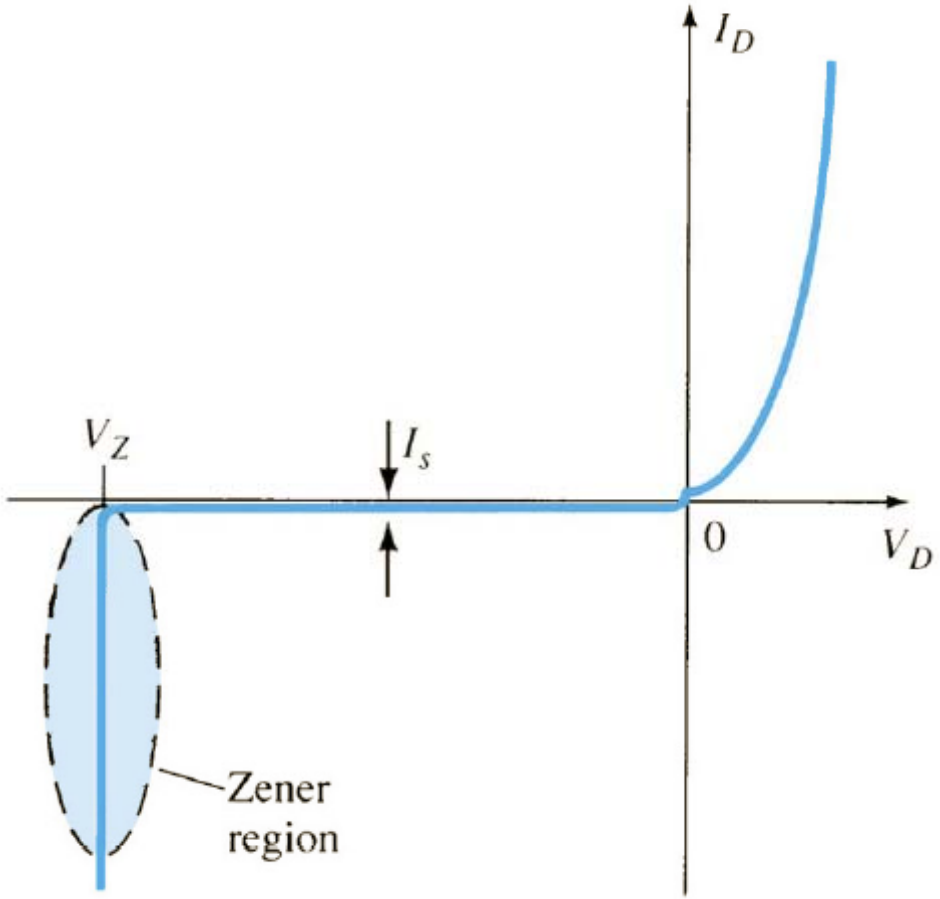

Exemplo 2.6 do Malvino.

# Silício versus germânio

- Tensão reversa:
  - Silício: 1000 V;
  - Germânio: 400 V.
- Temperatura de operação:
  - Silício: 200 ºC;
  - Germânio: 100 ºC.
- Queda de tensão direta:
  - Silício: 0,7 V;
  - Germânio: 0,3 V.



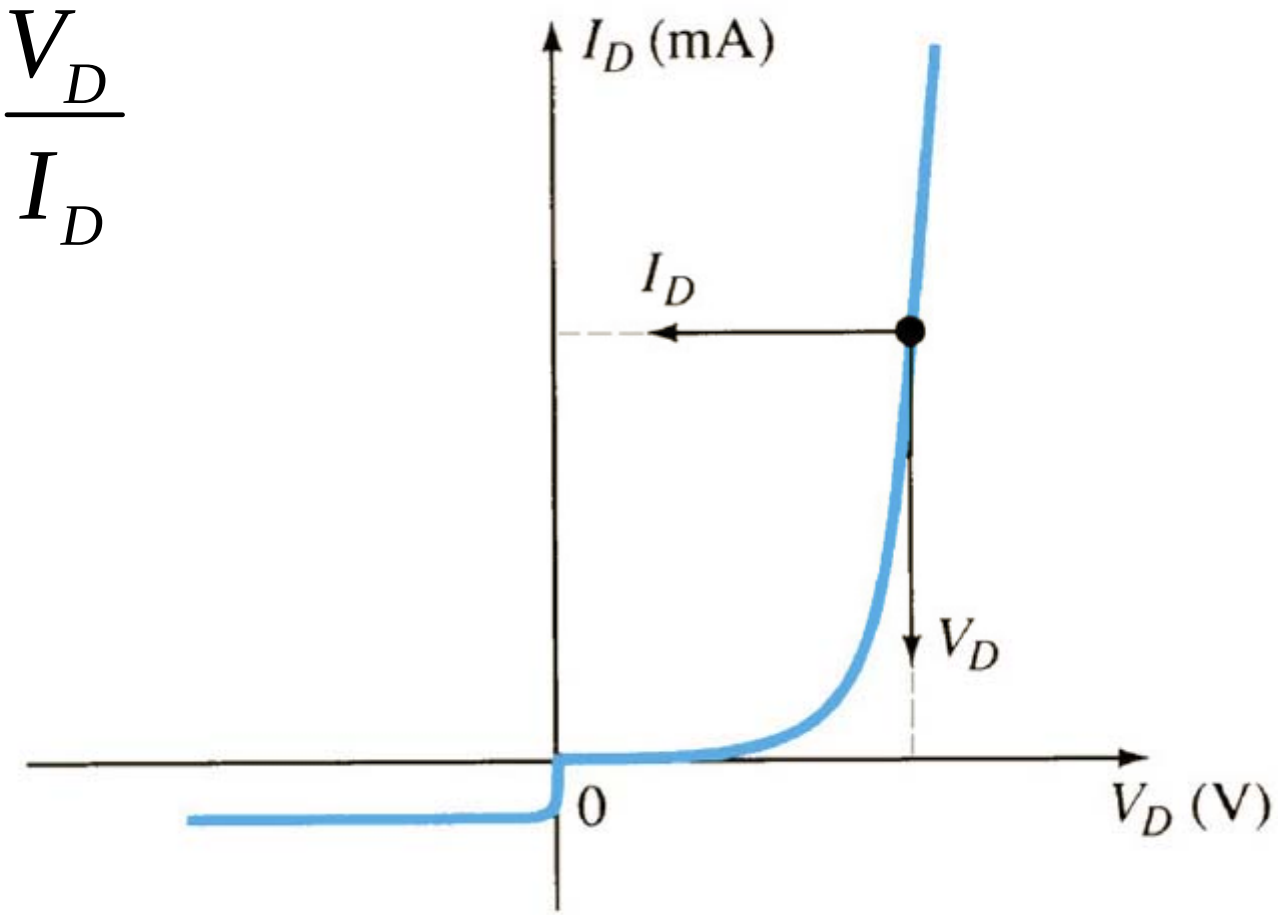
# Diodo – Região zener



# Resistências do diodo

**Resistência CC ou estática:**

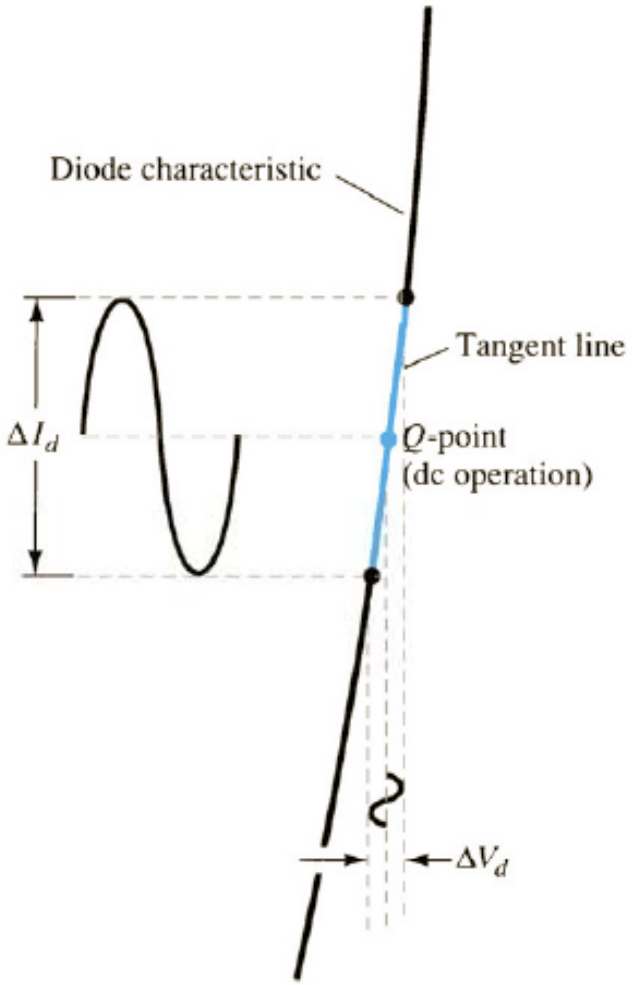
$$R_D = \frac{V_D}{I_D}$$

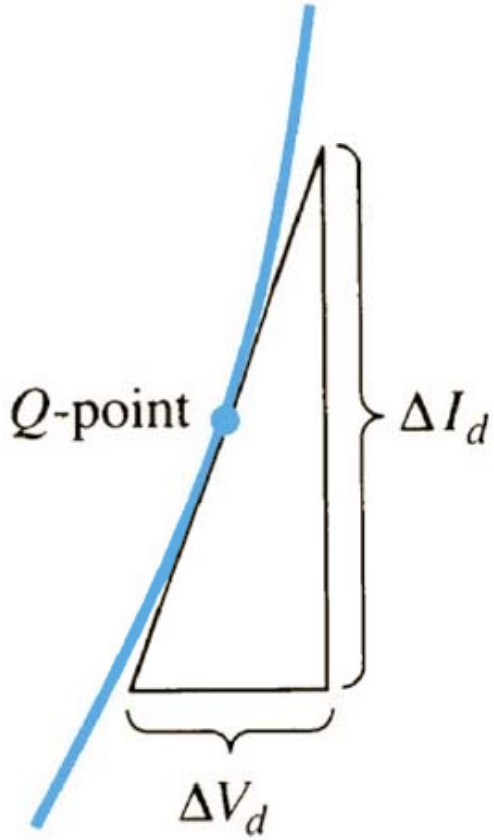


# Resistências do diodo

**Resistência CA ou dinâmica:**

$$r_D = \frac{\Delta V_D}{\Delta I_D}$$

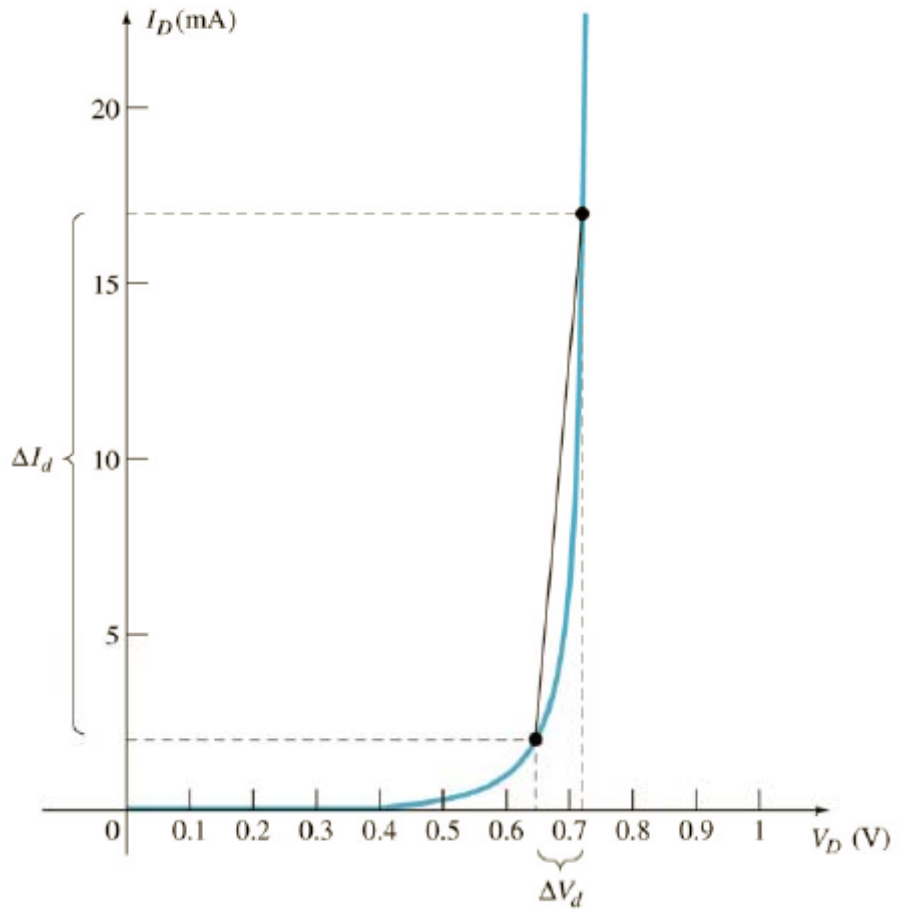


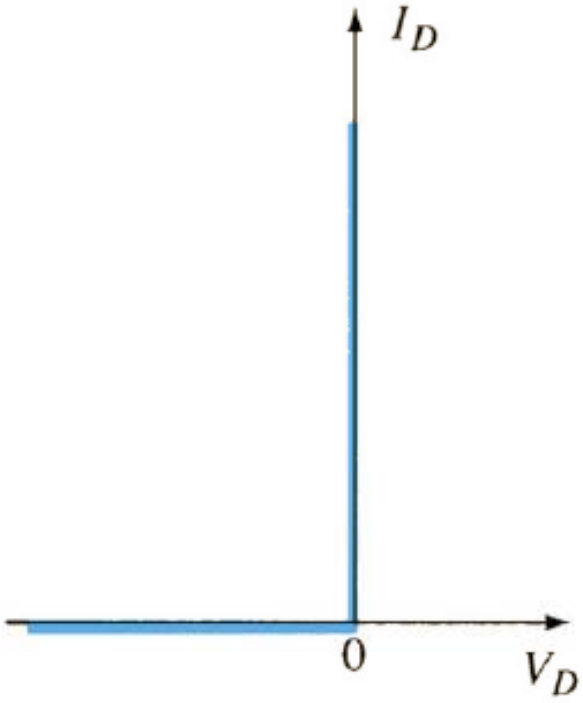
# Resistências do diodo

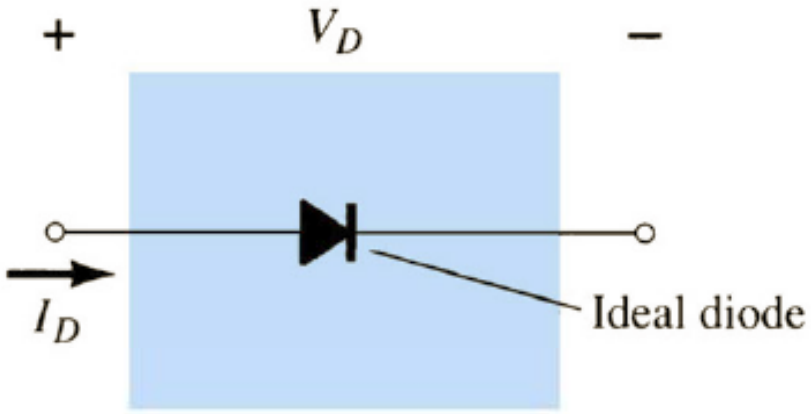
**Resistência CA média ou resistência de corpo:**

$$r_{av} = \frac{\Delta V_d}{\Delta I_d}$$



# Modelo ideal do diodo

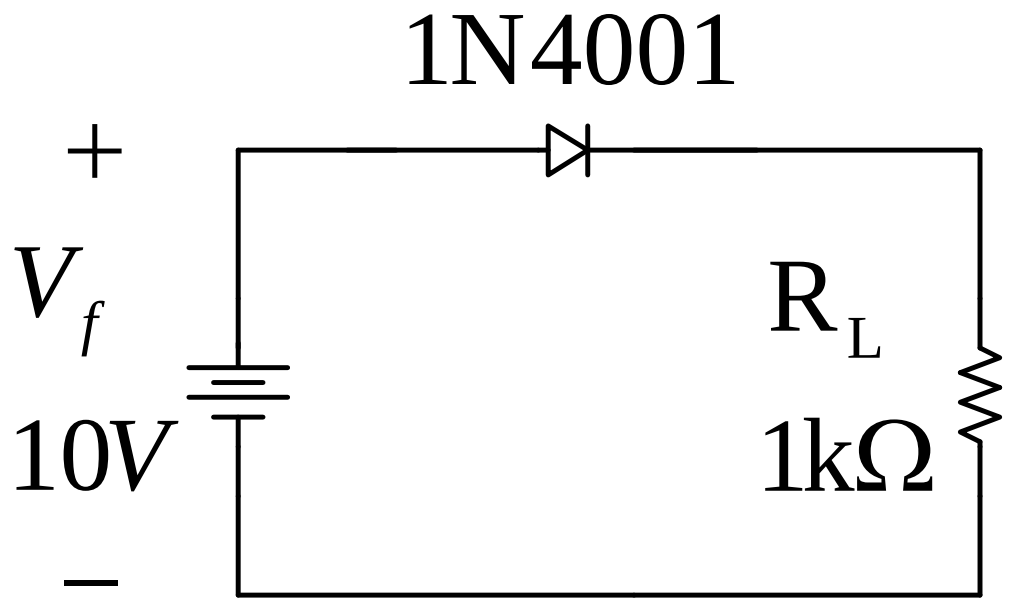


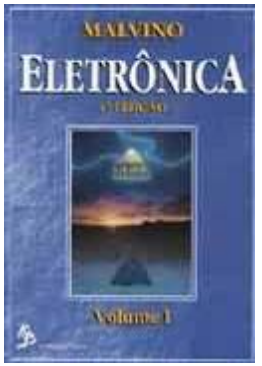



# Modelo ideal do diodo

**Exemplo 3.4 – Eletrônica, vol. 1:**

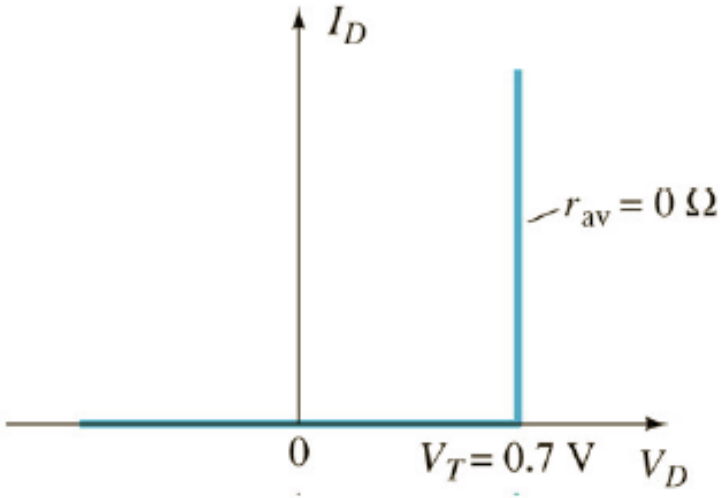
- Use a aproximação do diodo ideal para calcular a corrente de carga, a tensão na carga, a potência na carga, a potência no diodo e a potência total no circuito da figura abaixo.

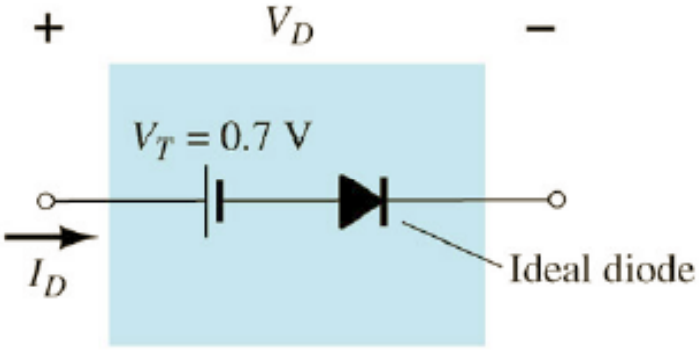



Exemplo 3.4 do Malvino.

# Modelo simplificado do diodo



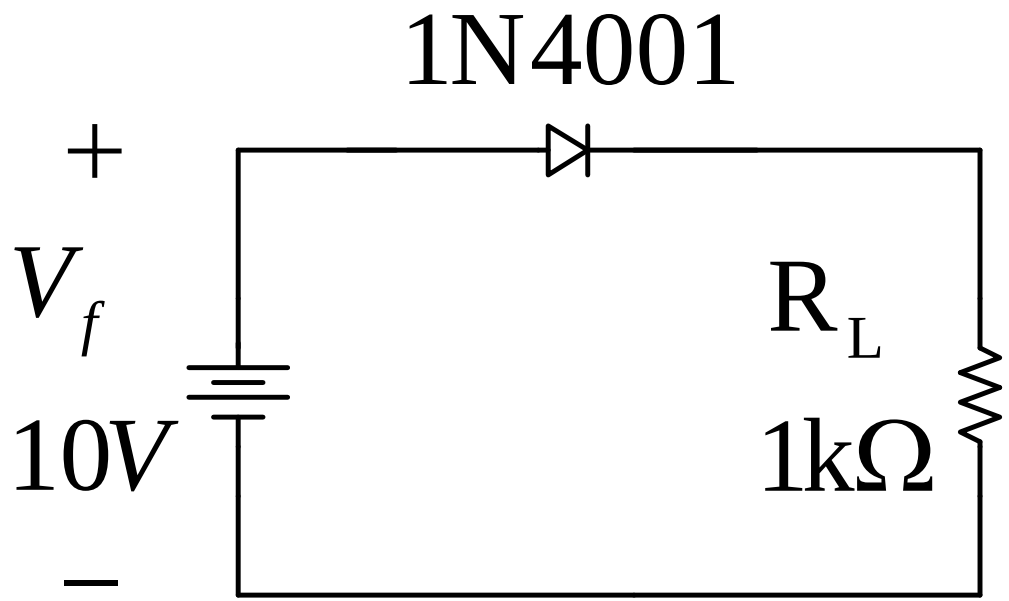



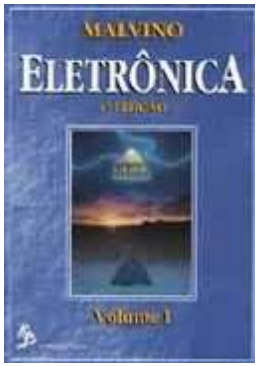

Exemplo 3.5 do Malvino.

# Modelo simplificado do diodo

**Exemplo 3.5 – Eletrônica, vol. 1:**

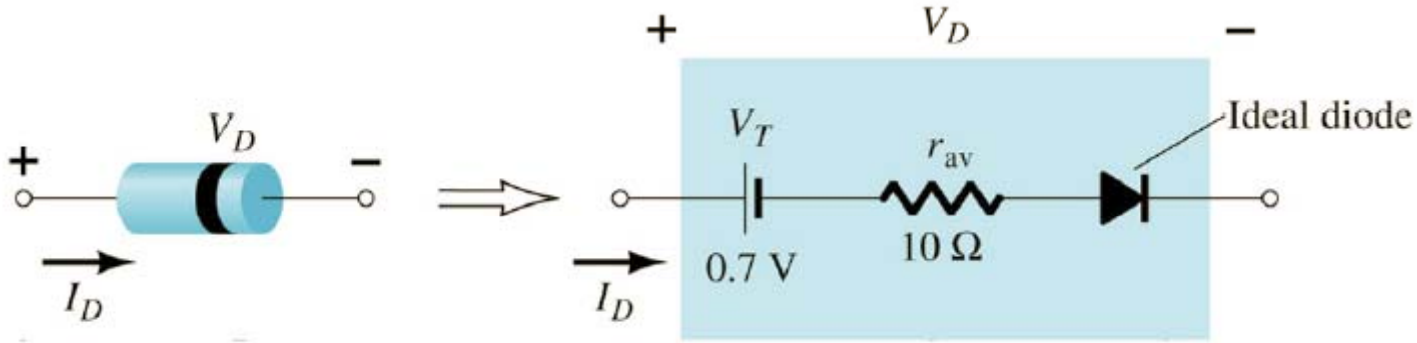
- Use a segunda aproximação para calcular a corrente na carga, a tensão na carga, a potência na carga, a potência no diodo e a potência total para o circuito abaixo.

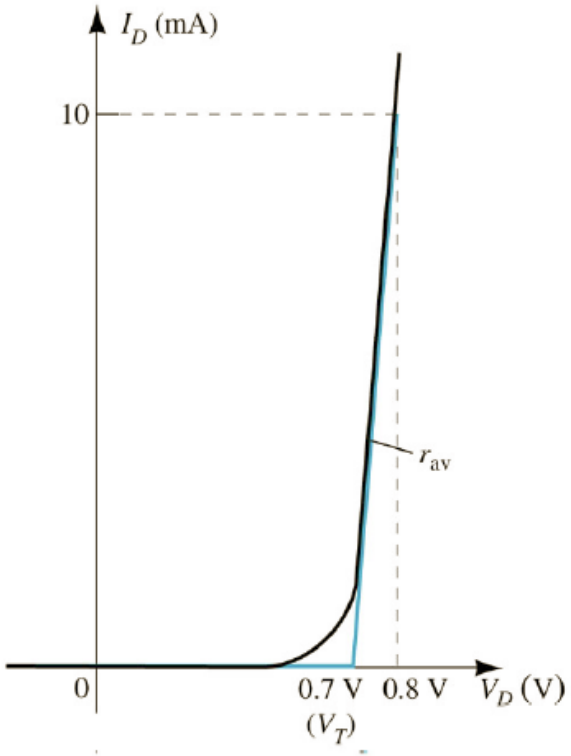



Exemplo 3.5 do Malvino.

# Modelo linear por partes do diodo



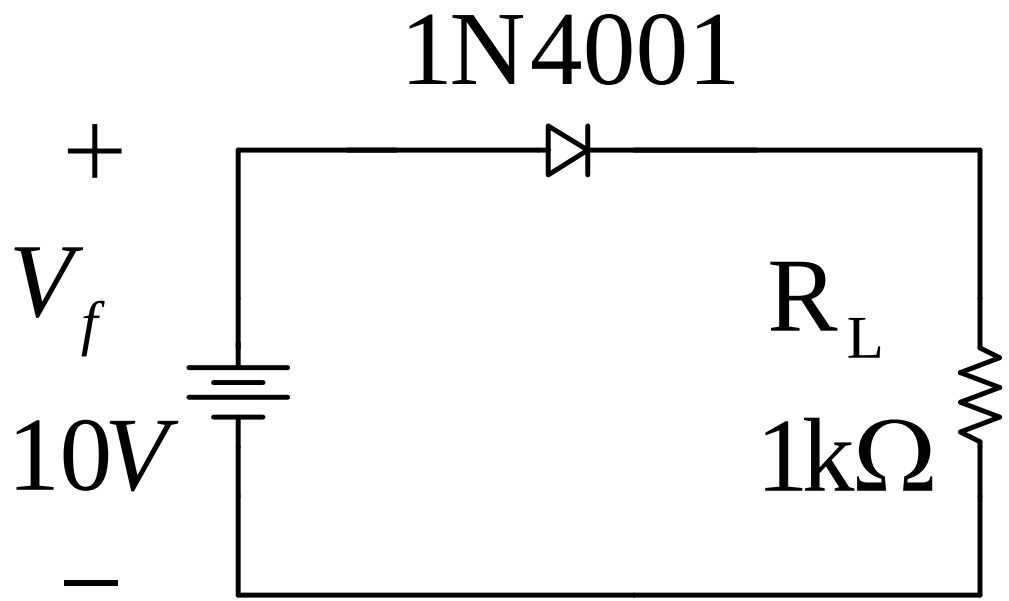



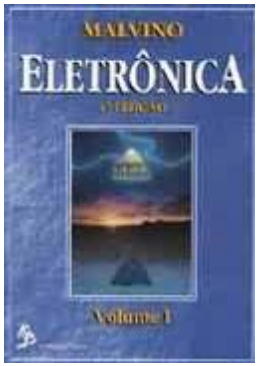

Exemplo 3.6 do Malvino.

# Modelo linear por partes do diodo

**Exemplo 3.6 – Eletrônica, vol. 1:**

- Use a terceira aproximação para calcular a corrente na carga, a tensão na carga, a potência na carga, a potência no diodo e a potência total para o circuito abaixo. A resistência de corpo do diodo 1N4001 é 0,23Ω.




Exemplo 3.6 do Malvino.

# Características dos diodos

**As principais características (grandezas) são:**

1. Corrente máxima direta ($I_F$ ou $I_o$);
2. Tensão de ruptura reversa:
   - VRRM = Tensão de pico inverso repetitivo;
   - VRWM = Tensão de pico inverso de trabalho;
   - VR = Tensão de bloqueio CC.
3. Queda de tensão direta ($v_F$);
4. Corrente reversa máxima ($I_R$).
5. Entre outras ....

# Características dos diodos

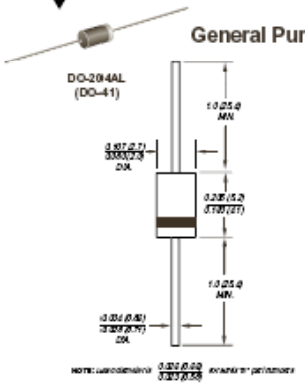
VISHAY

**1N4001 thru 1N4007**

Vishay Semiconductors
formerly General Semiconductor

## General Purpose Plastic Rectifier

Reverse Voltage
50 to 1000V
Forward Current 1.0A




Dimensions in inches and (millimeters)

### Features

- Plastic package has Underwriters Laboratories Flammability Classification 94V-0
- Construction utilizes void-free molded plastic technique
- Low reverse leakage
- High forward surge capability
- High temperature soldering guaranteed: 350°C/10 seconds, 0.375" (9.5mm) lead length, 5 lbs. (2.3kg) tension

### Mechanical Data

Case: JEDEC DO-204AL, molded plastic body
Terminals: Plated axial leads, solderable per MIL-STD-750, Method 2026
Polarity: Color band denotes cathode end
Mounting Position: Any
Weight: 0.012 oz., 0.3 g

### Maximum Ratings & Thermal Characteristics

Ratings at 25°C ambient temperature unless otherwise specified.

| Parameter | Symb. | 1N 4001 | 1N 4002 | 1N 4003 | 1N 4004 | 1N 4005 | 1N 4006 | 1N 4007 | Unit |
|---|---|---|---|---|---|---|---|---|---|
| Maximum repetitive peak reverse voltage | $V_{RRM}$ | 50 | 100 | 200 | 400 | 600 | 800 | 1000 | V |
| * Maximum RMS voltage | $V_{RMS}$ | 35 | 70 | 140 | 280 | 420 | 560 | 700 | V |
| * Maximum DC blocking voltage | $V_{DC}$ | 50 | 100 | 200 | 400 | 600 | 800 | 1000 | V |
| * Maximum average forward rectified current 0.375" (9.5mm) lead length at TA = 75°C | $I_{F(AV)}$ | 1.0 | | | | | | | A |
| * Peak forward surge current 8.3ms single half sine-wave superimposed on rated load (JEDEC Method) TA = 75°C | $I_{FSM}$ | 30 | | | | | | | A |
| * Maximum full load reverse current, full cycle average 0.375" (9.5mm) lead length $T_L$ = 75°C | $I_{R(AV)}$ | 30 | | | | | | | µA |
| Typical thermal resistance(1) | $R_{\theta JA}$<br>$R_{\theta JL}$ | 50<br>25 | | | | | | | °C/W |
| * Maximum DC blocking voltage temperature | $T_A$ | +155 | | | | | | | V |
| * Operating junction and storage temperature range | $T_J$, $T_{STG}$ | –50 to +175 | | | | | | | °C |

### Electrical Characteristics

Ratings at 25°C ambient temperature unless otherwise specified.

| | | | |
|---|---|---|---|
| Maximum instantaneous forward voltage at 1.0A | $V_F$ | 1.1 | V |
| * Maximum DC reverse current at rated DC blocking voltage TA = 25°C<br>TA = 125°C | $I_R$ | 5.0<br>50 | µA |
| Typical junction capacitance at 4.0V, 1MHz | $C_J$ | 15 | pF |

Note: (1) Thermal resistance from junction to ambient at 0.375" (9.5mm) lead length, P.C.B. mounted * JEDEC registered values




Bulletin PD-20731 rev. C 12/03


International
IOR Rectifier

**MUR820**
**MURB820**
**MURB820-1**

## Ultrafast Rectifier

### Features

- Ultrafast Recovery Time
- Low Forward Voltage Drop
- Low Leakage Current
- 175°C Operating Junction Temperature

$t_{rr}$ = 25ns
$I_{F(AV)}$ = 8Amp
$V_R$ = 200V

### Description/Applications

International Rectifier's MUR.. series are the state of the art Ultra fast recovery rectifiers specifically designed with optimized performance of forward voltage drop and ultra fast recovery time.
The planar structure and the platinum doped life time control, guarantee the best overall performance, ruggedness and reliability characteristics.
These devices are intended for use in the output rectification stage of SMPS, UPS, DC-DC converters as well as free-wheeling diode in low voltage inverters and chopper motor drives.
Their extremely optimized stored charge and low recovery current minimize the switching losses and reduce over dissipation in the switching element and snubbers.

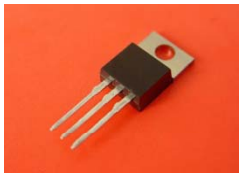
### Absolute Maximum Ratings

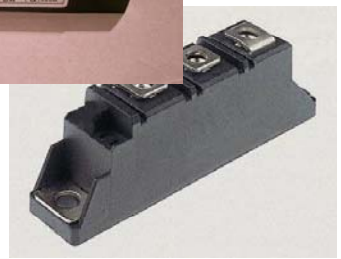
| | Parameters | Max | Units |
|---|---|---|---|
| $V_{RRM}$ | Peak Repetitive Peak Reverse Voltage | 200 | V |
| $I_{F(AV)}$ | Average Rectified Forward Current<br>Total Device, (Rated $V_R$), $T_C$ = 150°C | 8 | A |
| $I_{FSM}$ | Non Repetitive Peak Surge Current | 100 | |
| $I_{FM}$ | Peak Repetitive Forward Current<br>(Rated $V_R$, Square wave, 20 KHz), $T_C$ = 150°C | 16 | |
| $T_J$, $T_{STG}$ | Operating Junction and Storage Temperatures | -65 to 175 | °C |

Case Styles

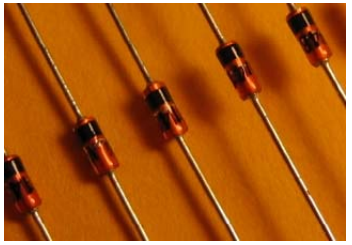
| MUR820 | MURB820 | MURB820-1 |
|---|---|---|
|  |  |  |
| TO-220AC | $D^2PAK$ | TO-262 |

# Características dos diodos

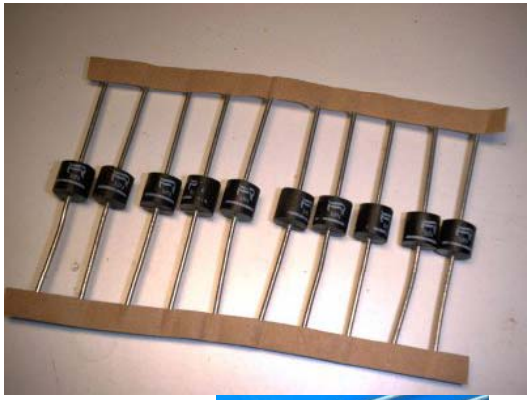





Diodos de potência

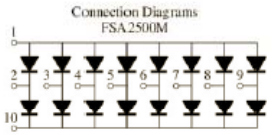


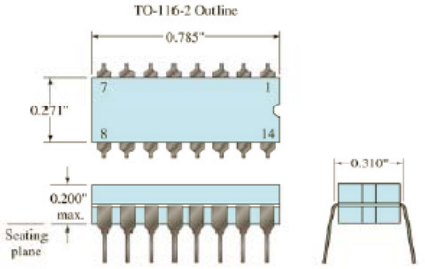
Diodos de sinal



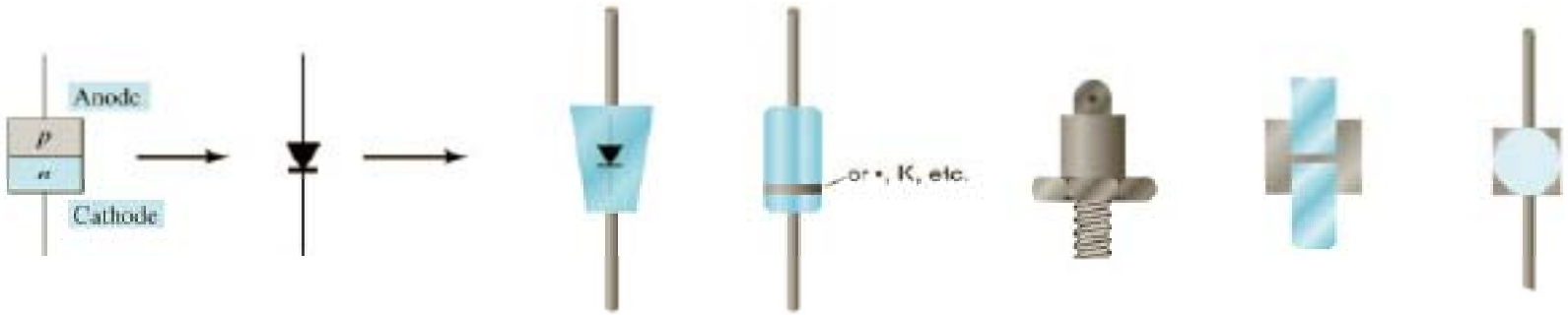
Diodos de uso geral

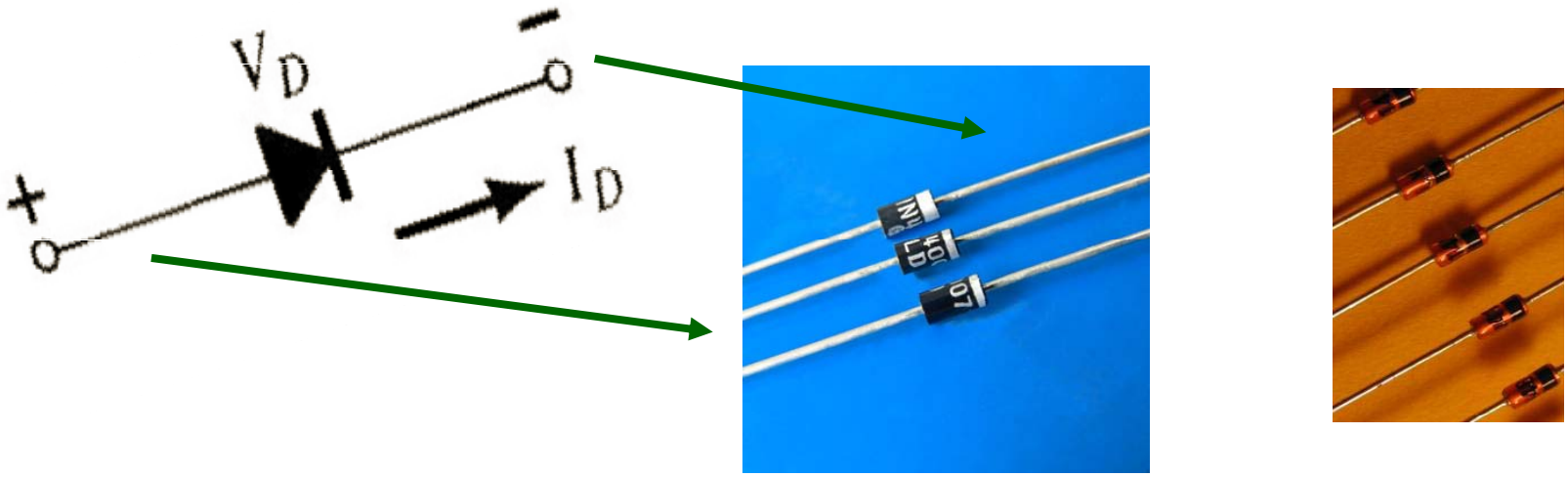
Circuitos integrados de diodos



# Identificação dos terminais de um diodo



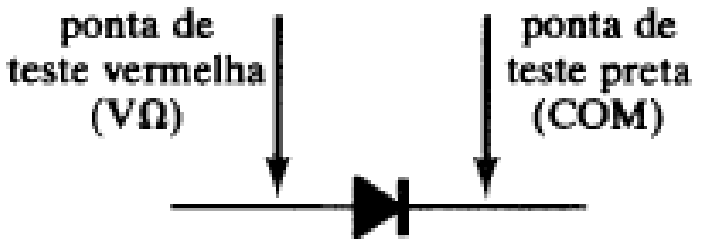
# Testando diodos com o multímetro

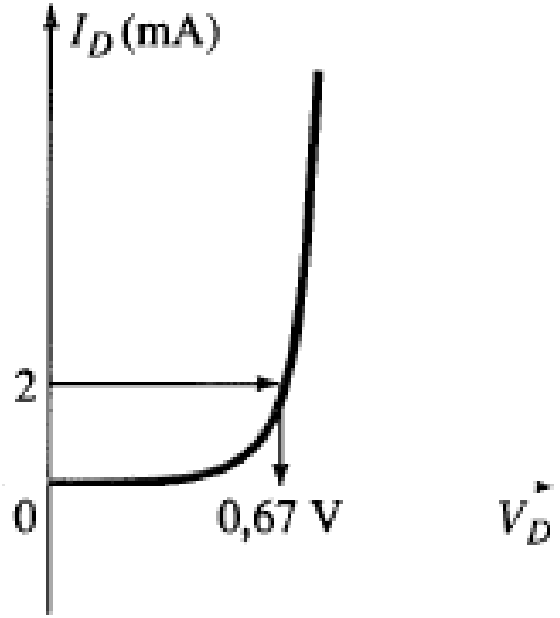

Escala para teste de diodos


Escala para teste de diodos

# Testando diodos com o multímetro

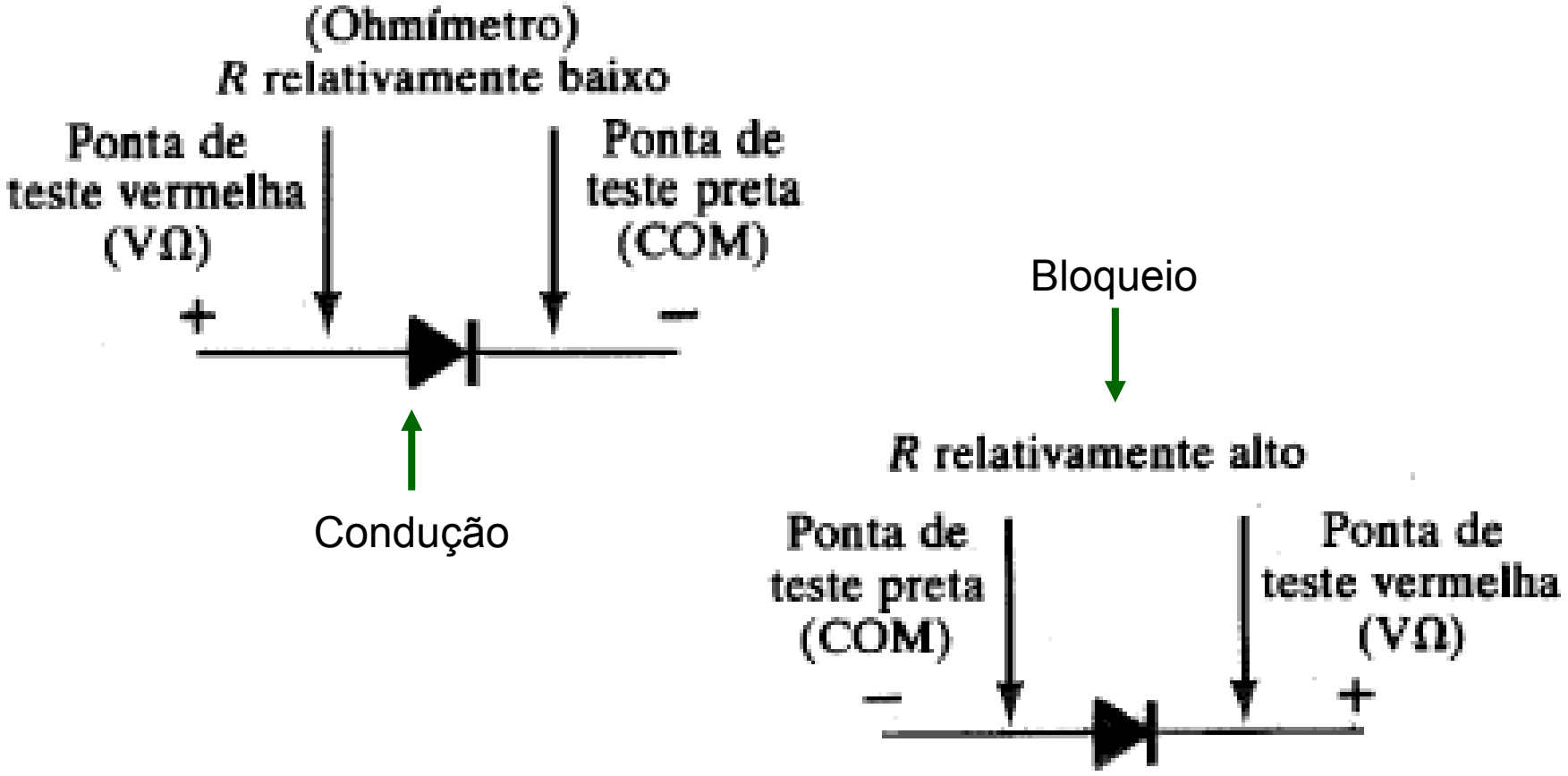
**Polarização direta:**



# Testando diodos com o multímetro

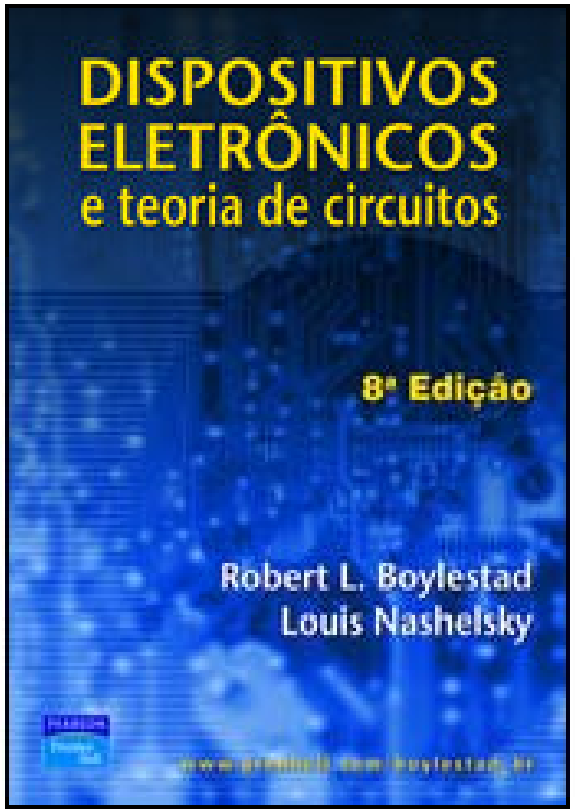
**Testes com ohmímetro:**



# Na próxima aula

**Capítulo 1: Diodos semicondutores**

1. Laboratório:
   - Identificação de diodos;
   - Testes de diodos com multímetro.

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