Diode

Aufbau, Eigenschaften & Verwendung

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- Eigenschaften & Verwendung
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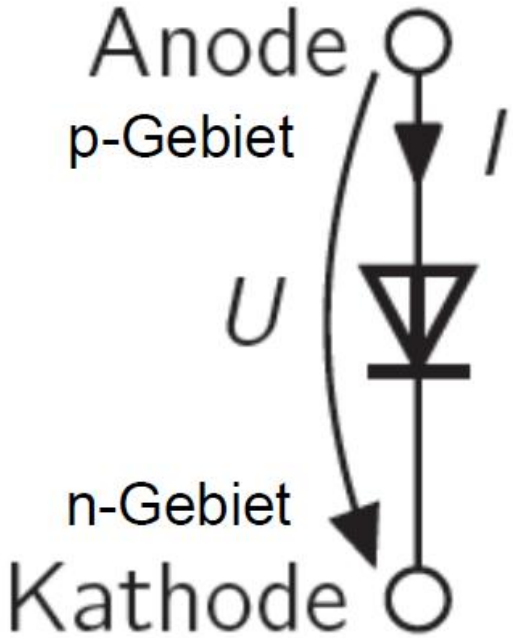
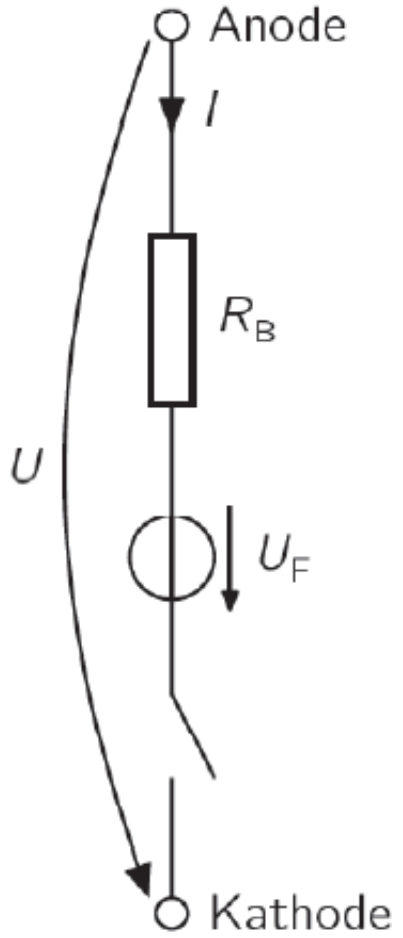
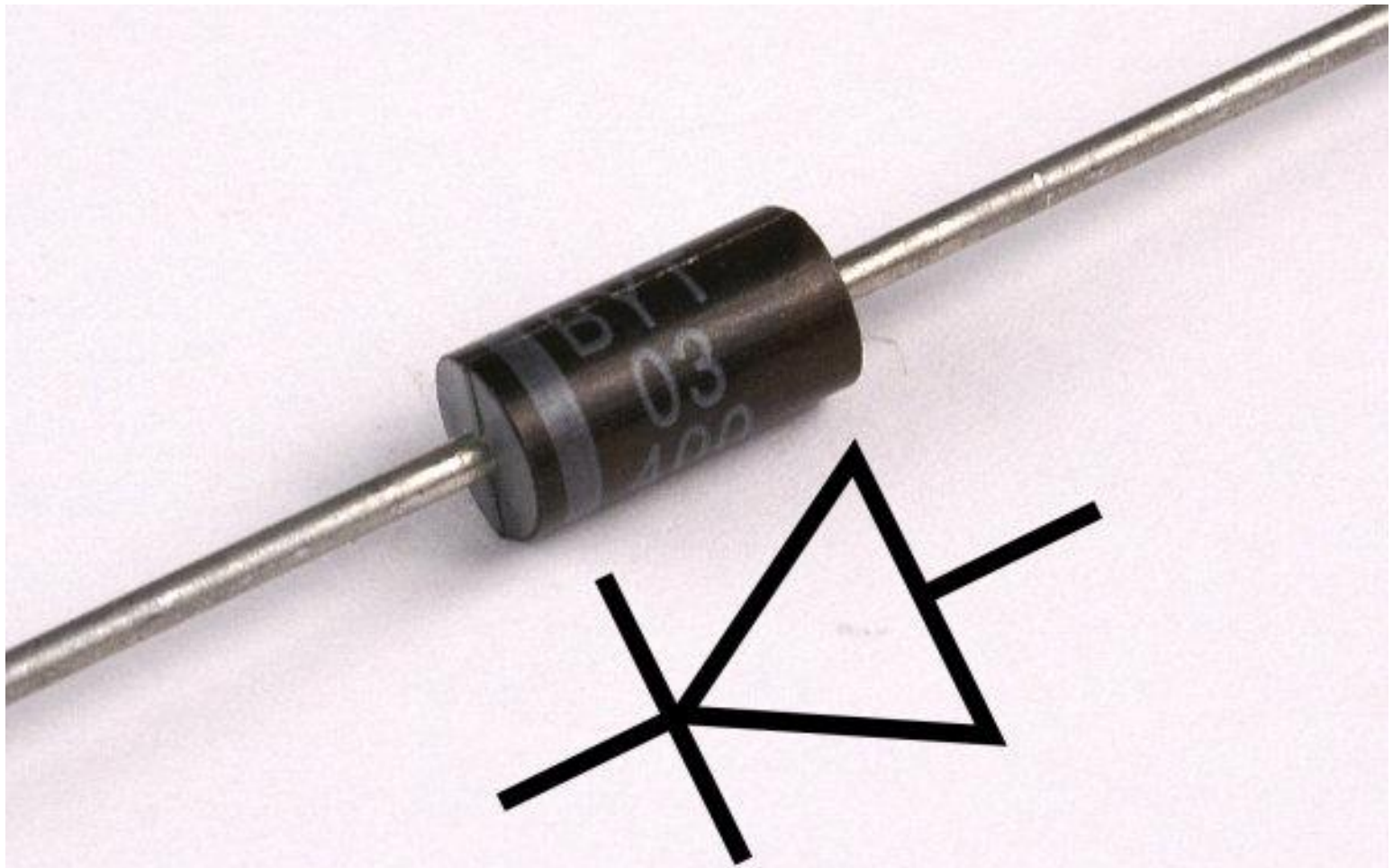
Schaltzeichen & Ersatzschaltbild







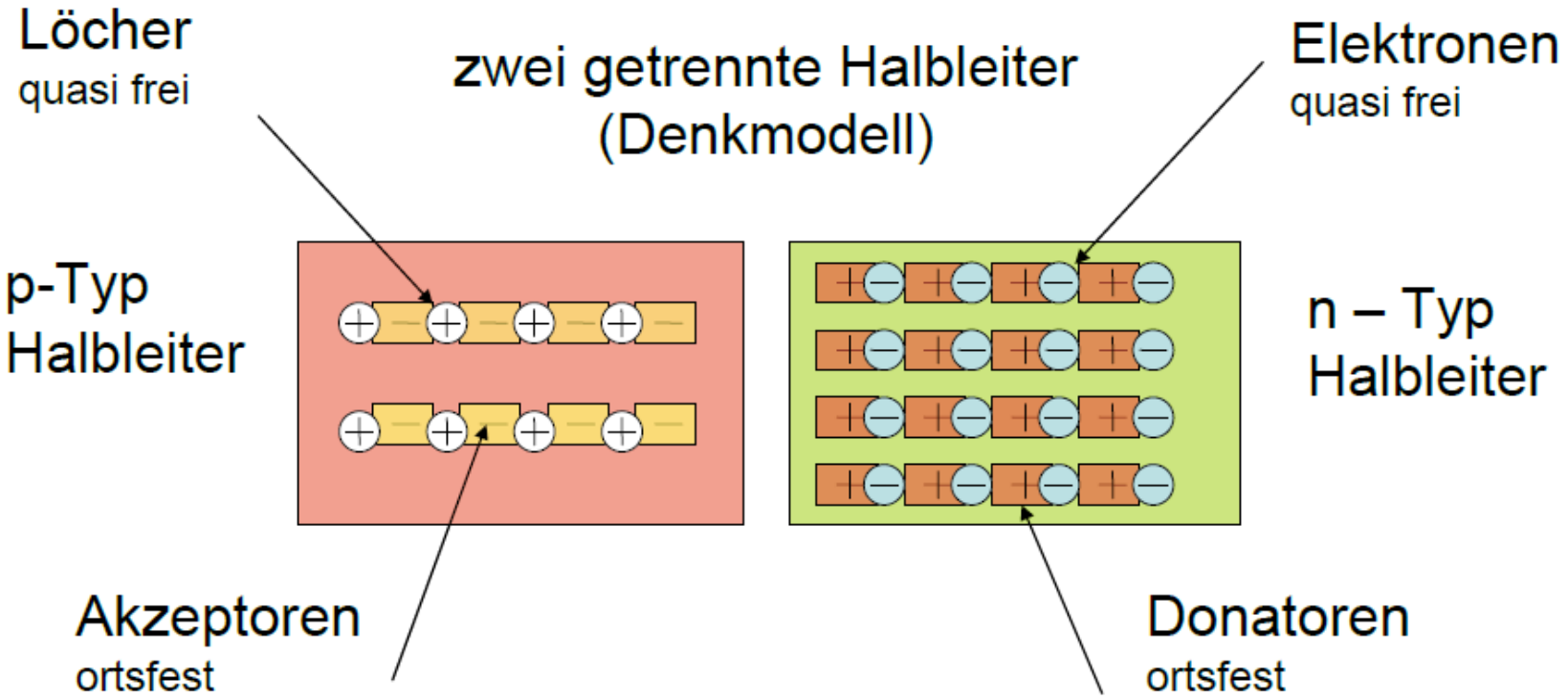
http://www.projektlabor.tu-berlin.de/fileadmin/fg52/onlinekurs/fehlersuche/diode.jpg

Anwendungsgebiete

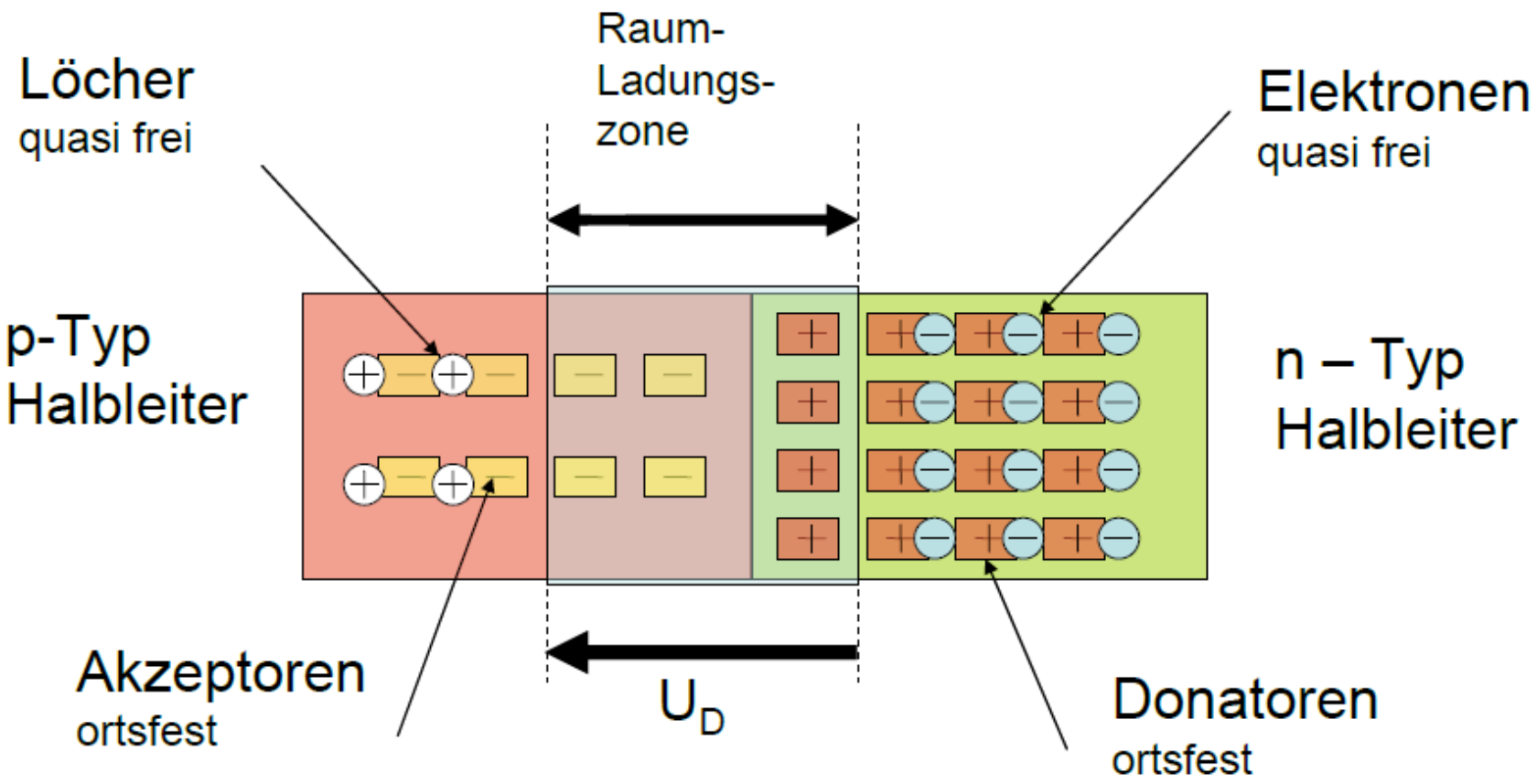
- Gleichrichter
- Verpolungsschutz
- Spannungsstabilisierung (Zener-Diode)
- Abstimmung von Schwingkreisen (Kapazitätsdiode)
- Erzeugung sichtbares Licht (LED)

Aufbau

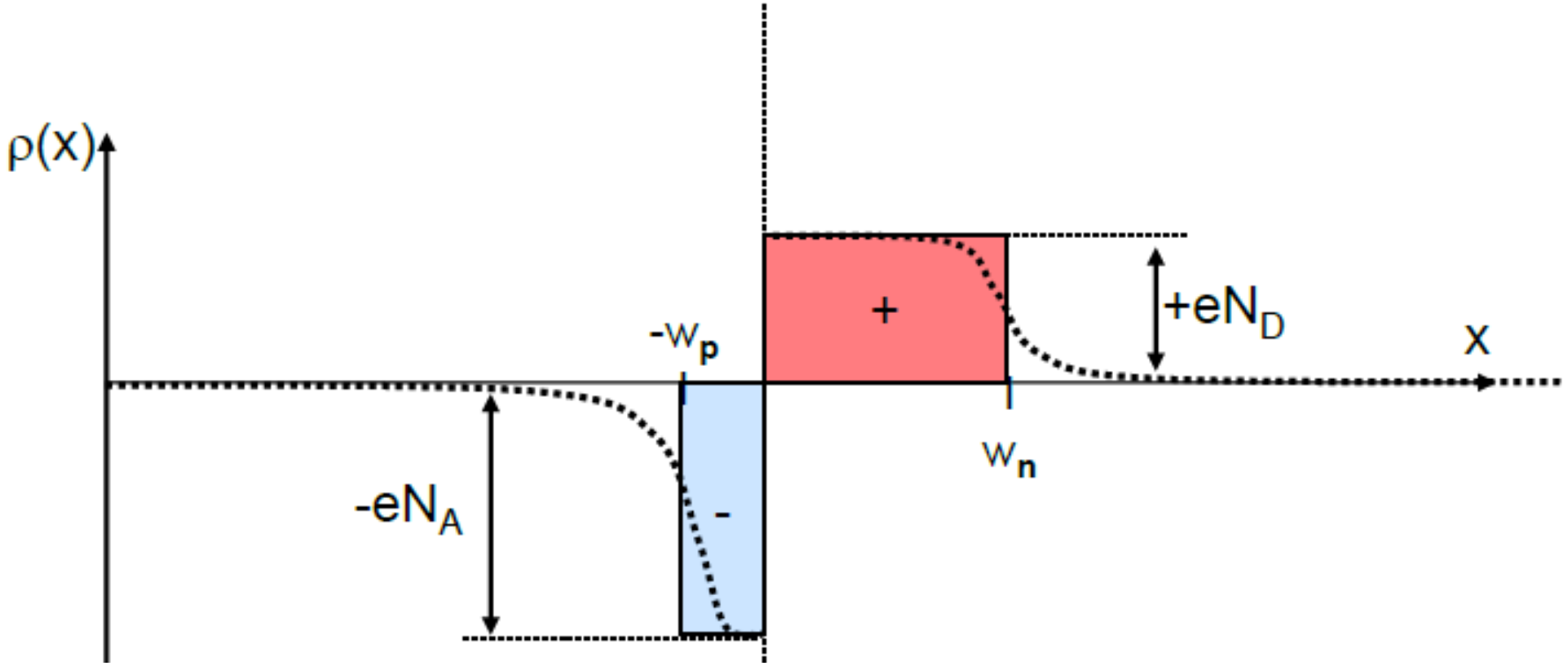
- zwei unterschiedliche Dotierungszonen (p- & n-Gebiet), deren Enden mit metallischen Kontakten versehen sind

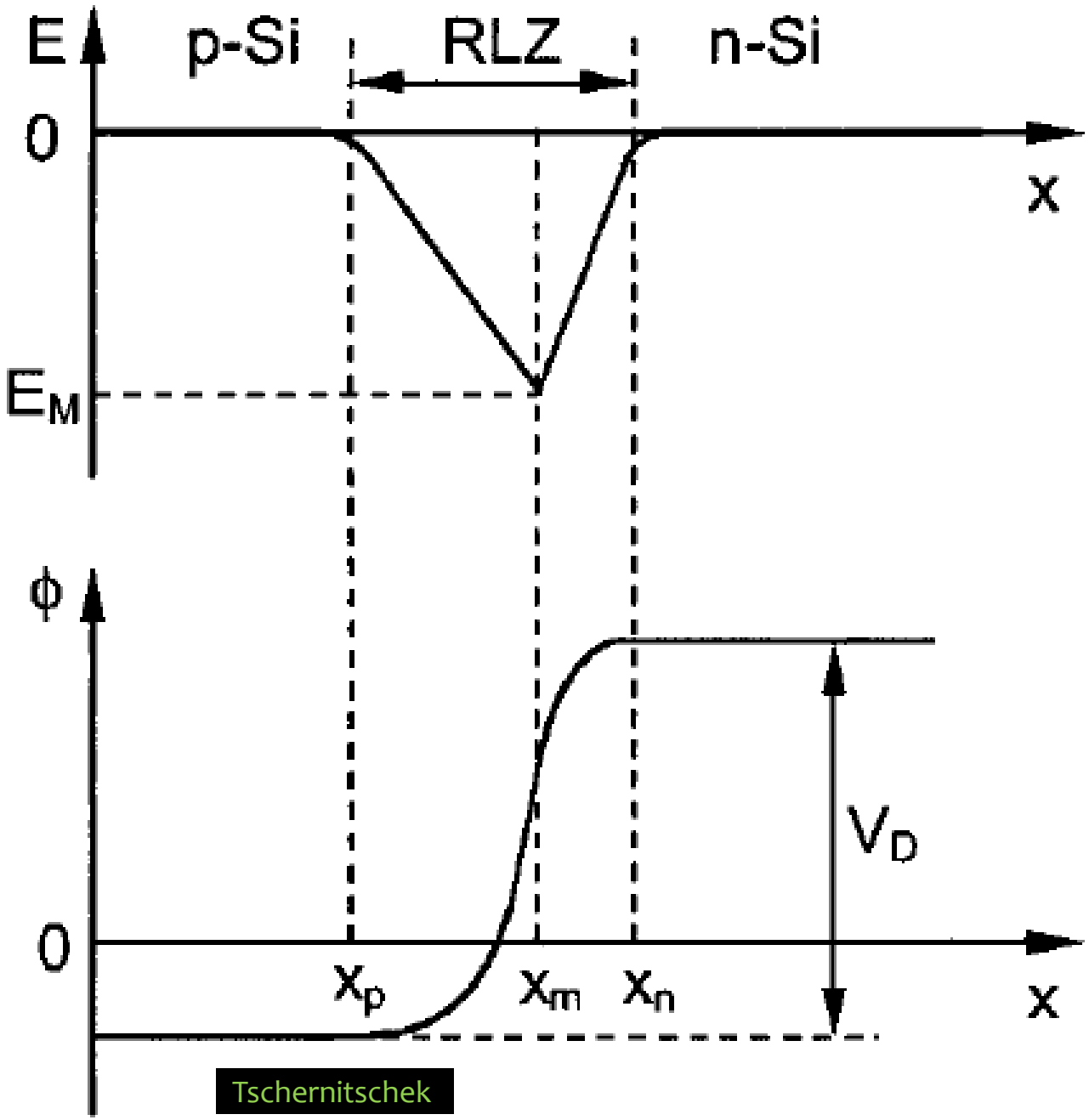


Aufbau


Löcher
quasi frei
Raum-
Ladungs-
zone
Elektronen
quasi frei
p-Typ
Halbleiter
n – Typ
Halbleiter
Akzeptoren
ortsfest
U_D
Donatoren
ortsfest

Aufbau





Tschernitschek

$$E(-x_p \le x < 0) = \int_{x=-x_p}^{x} \frac{-eN_A}{\varepsilon} dx$$

$$= -\frac{eN_A(x + x_p)}{\varepsilon}$$

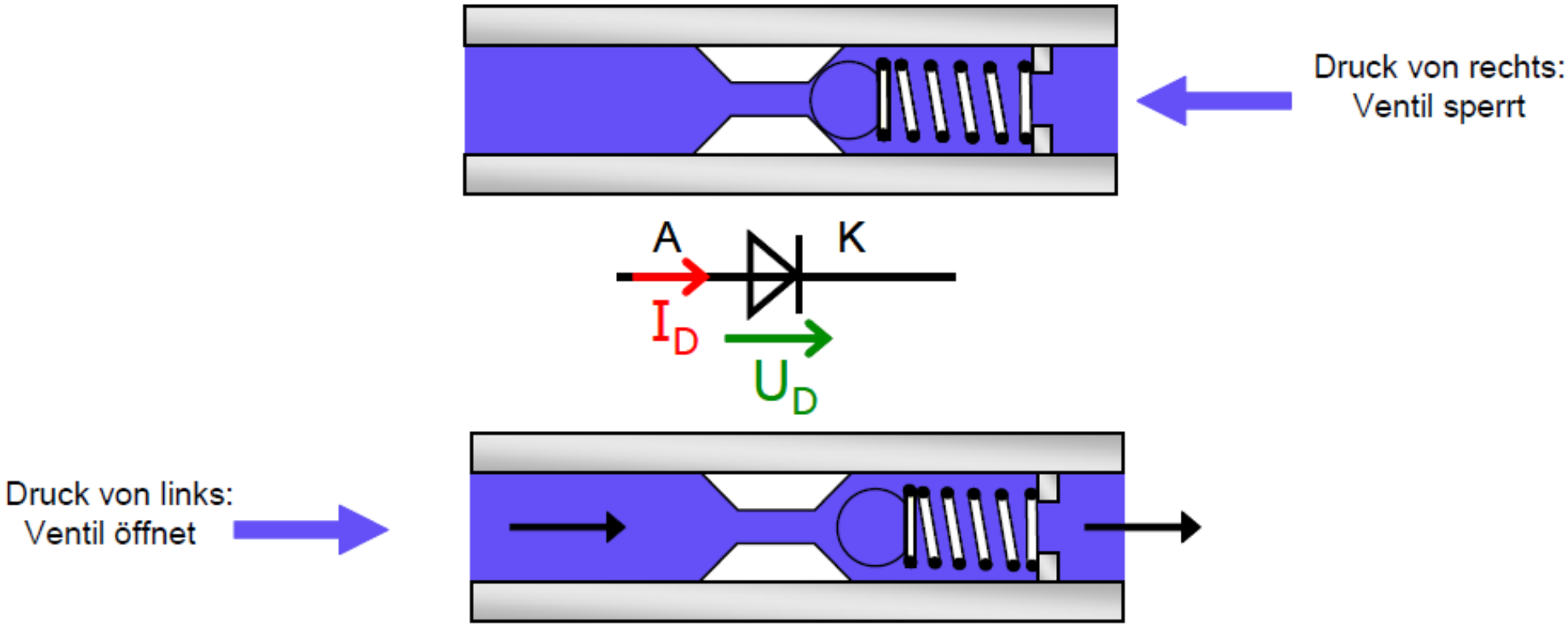
$$E(x = 0) = -\frac{eN_A x_p}{\varepsilon}$$

$$E(0 < x \le x_n) = \int_{x}^{x=x_n} \frac{eN_D}{\varepsilon} dx$$

$$= \frac{eN_D x_n}{\varepsilon}$$

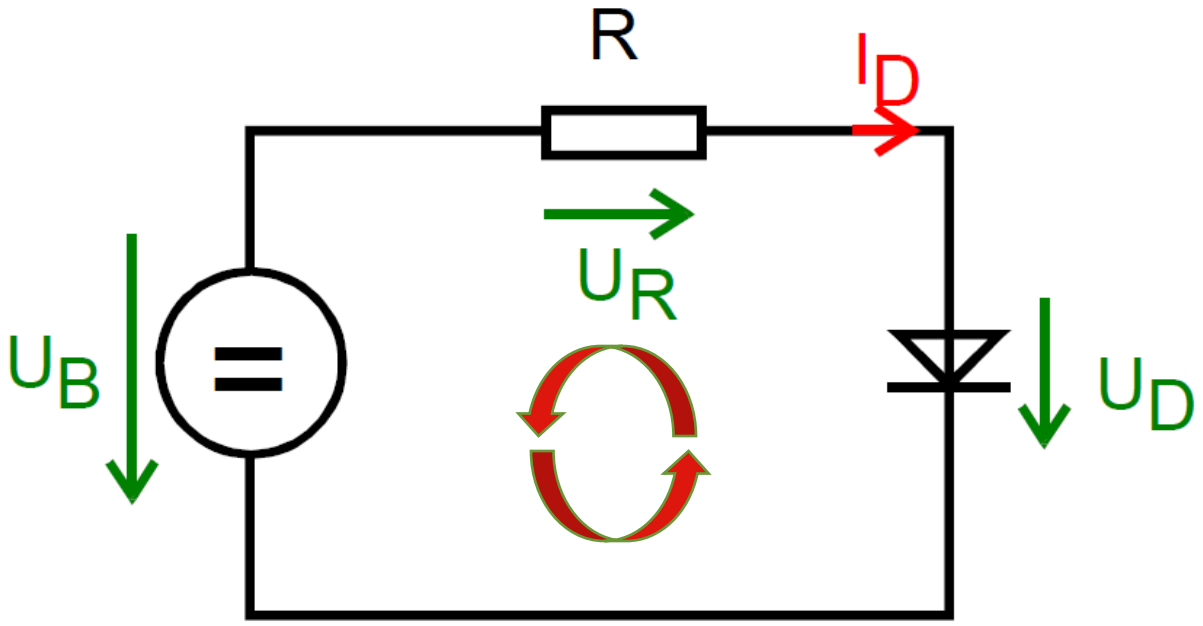
$$\vec{E} = -grad(\Phi) \longrightarrow \Phi = -\int_{-x_p}^{+x_n} \vec{E} \cdot d\vec{x}$$

Hydraulisches Äquivalent



Diodenkennlinie

- Herleitung idealisierte Kennlinie:

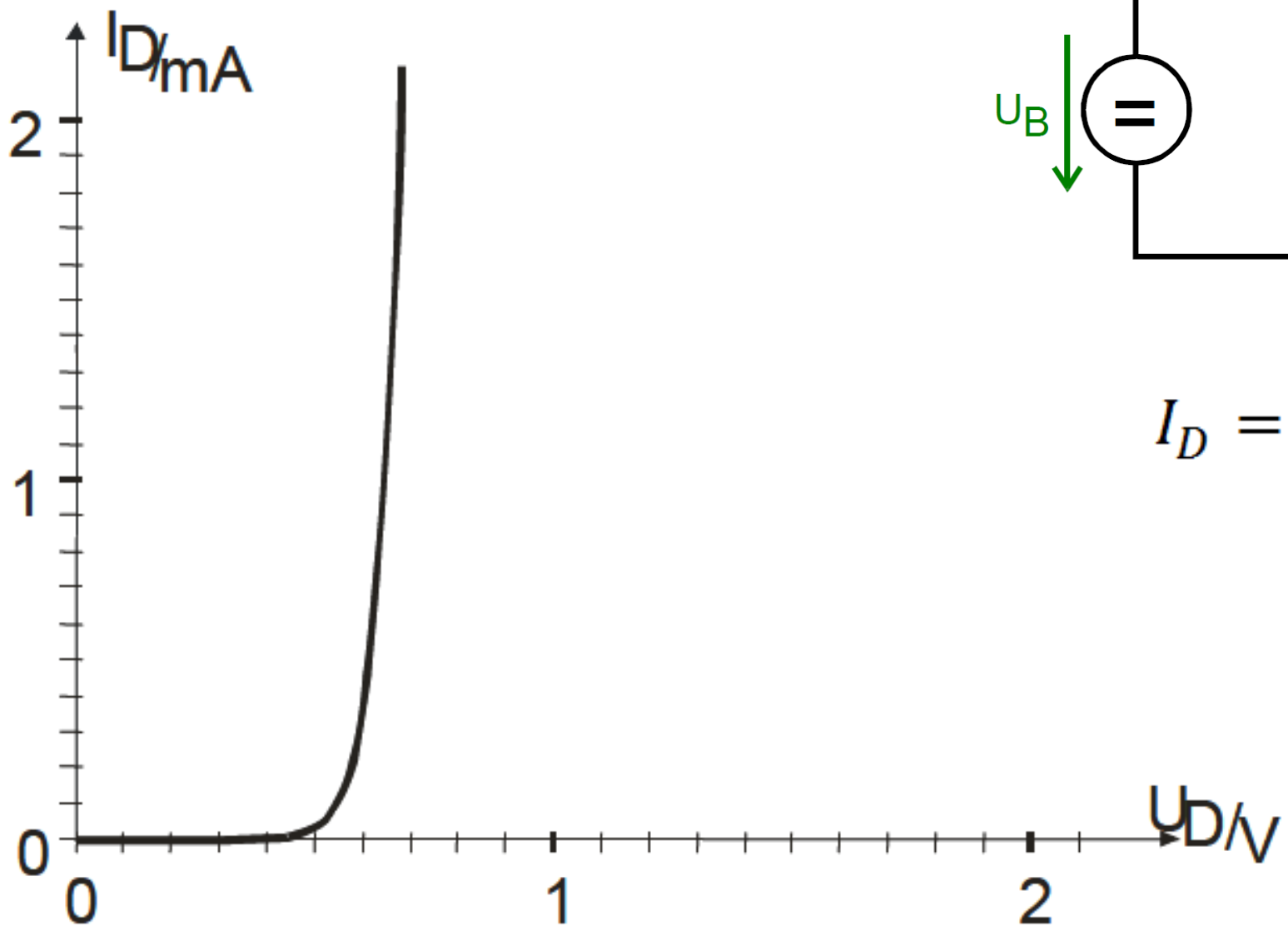


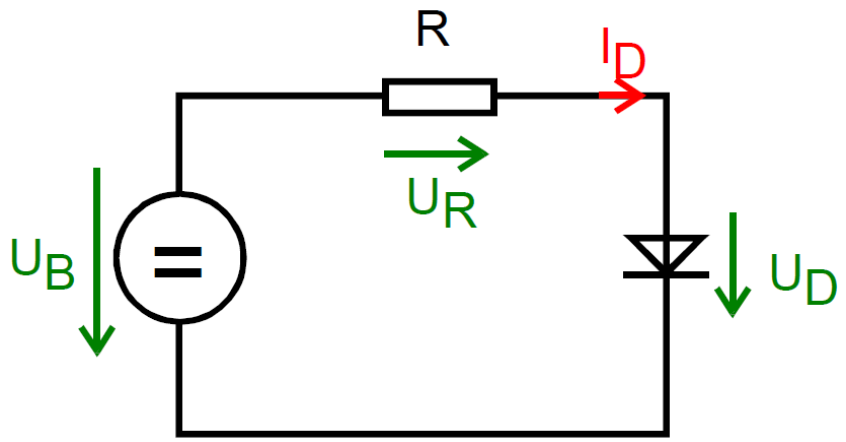
$$\sum U = 0 = U_B - U_D - U_R$$

$$\rightarrow U_D = U_B - U_R$$

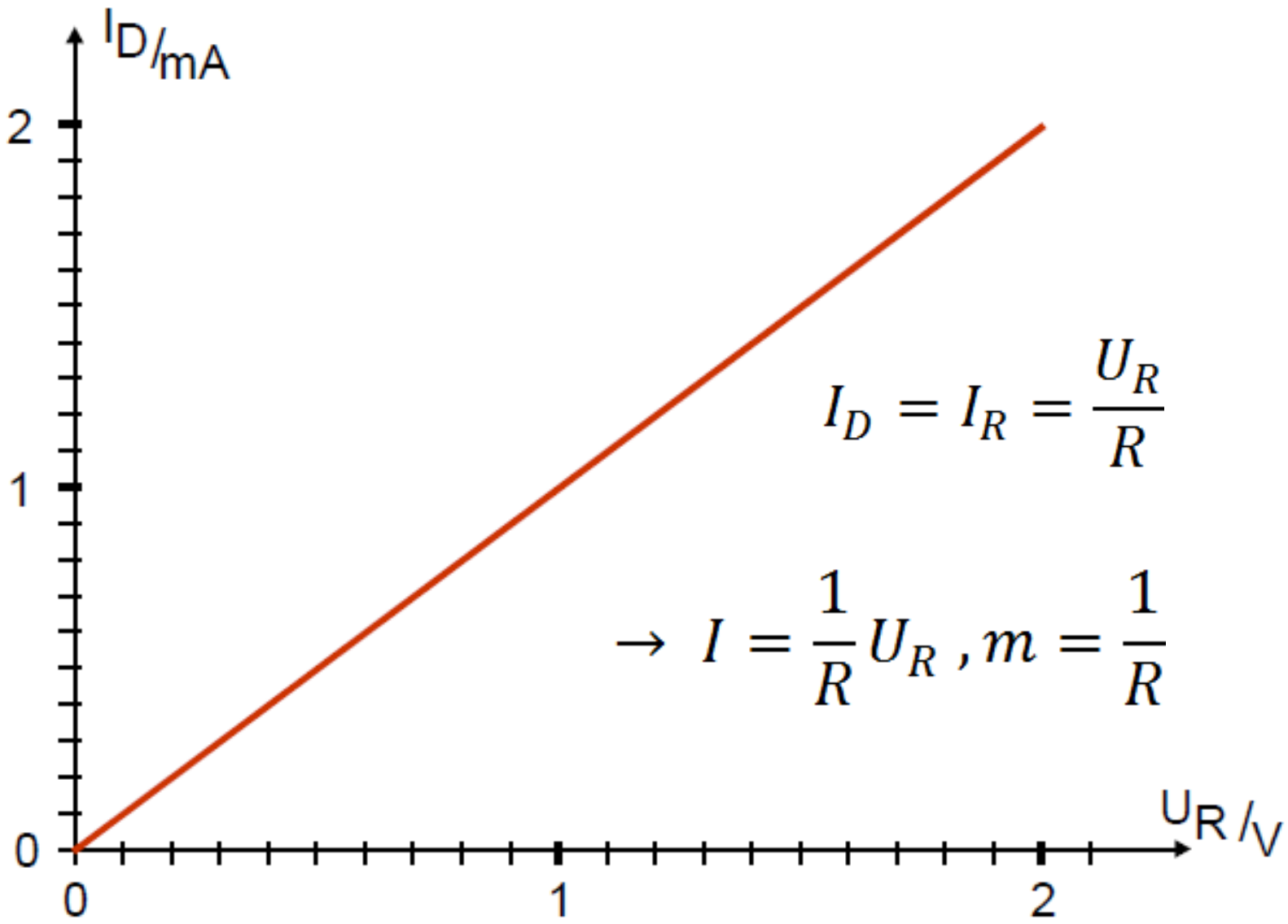
$$\rightarrow U_R = U_B - U_D$$

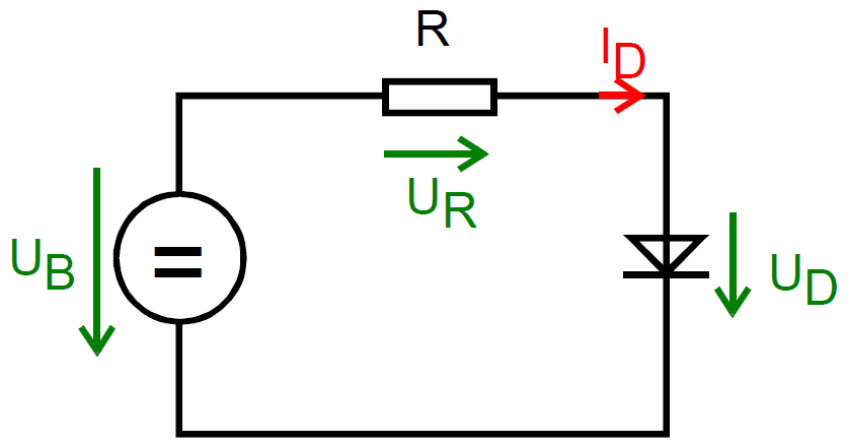
$$U_B = 2V\,, R = 1k\Omega$$





$$I_D = I_R = \frac{U_R}{R}$$





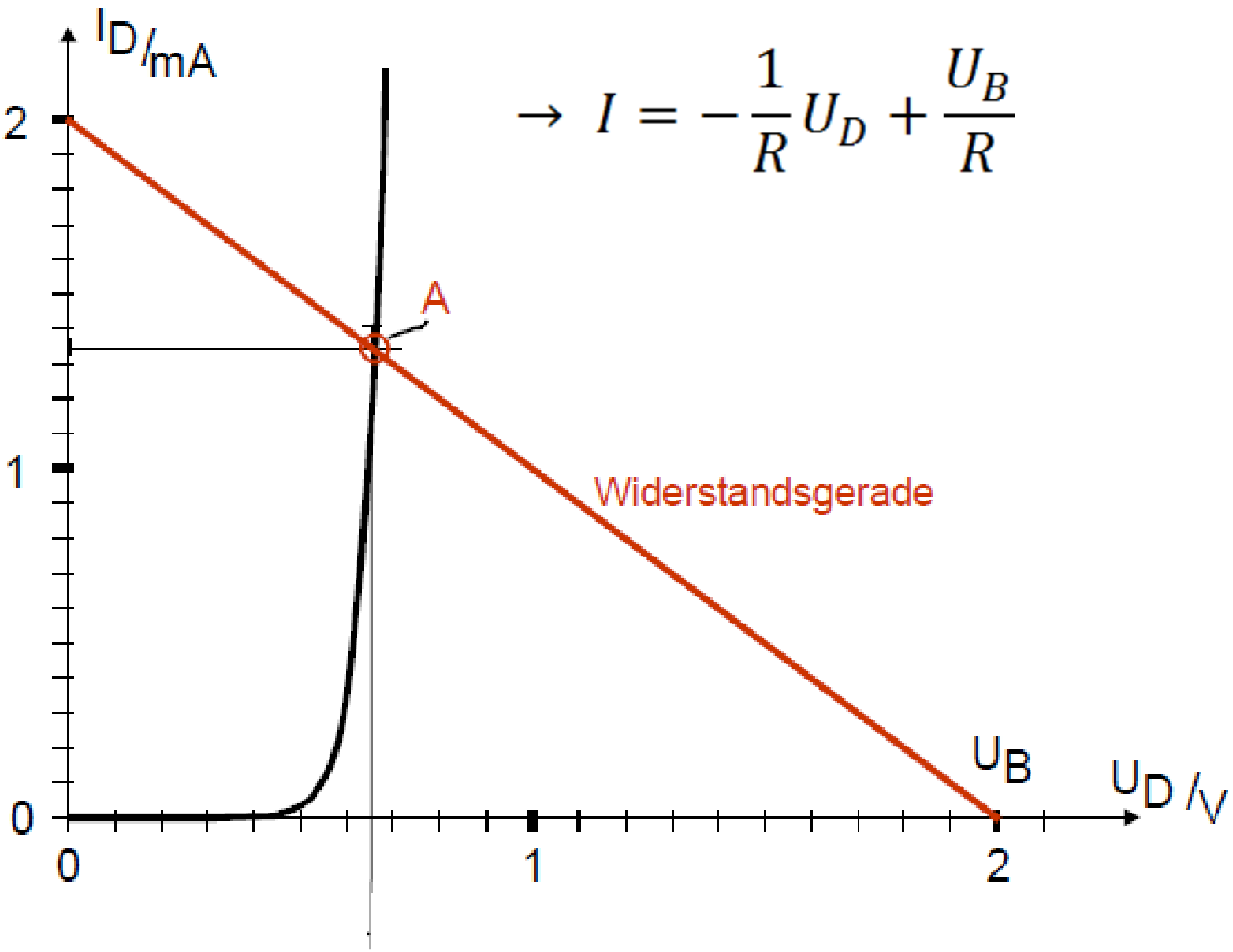
$$I_D = I_R = \frac{U_R}{R}$$

$$\rightarrow I = \frac{1}{R} U_R \, , m = \frac{1}{R}$$

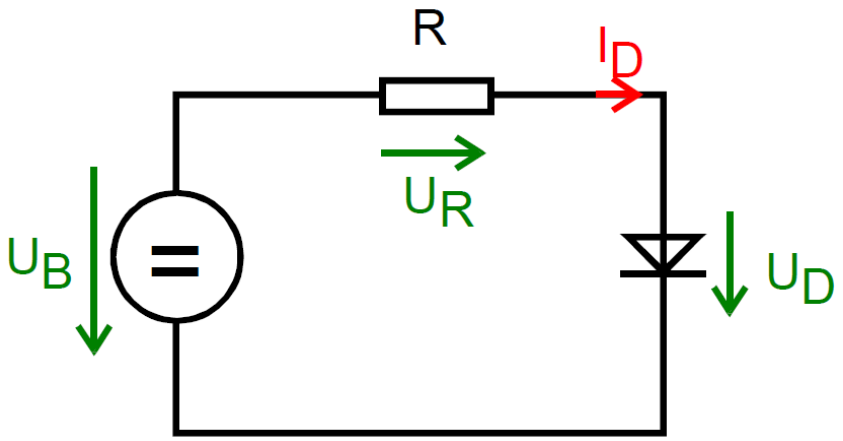
$$I = \frac{U_R}{R} = \frac{U_B - U_D}{R}$$

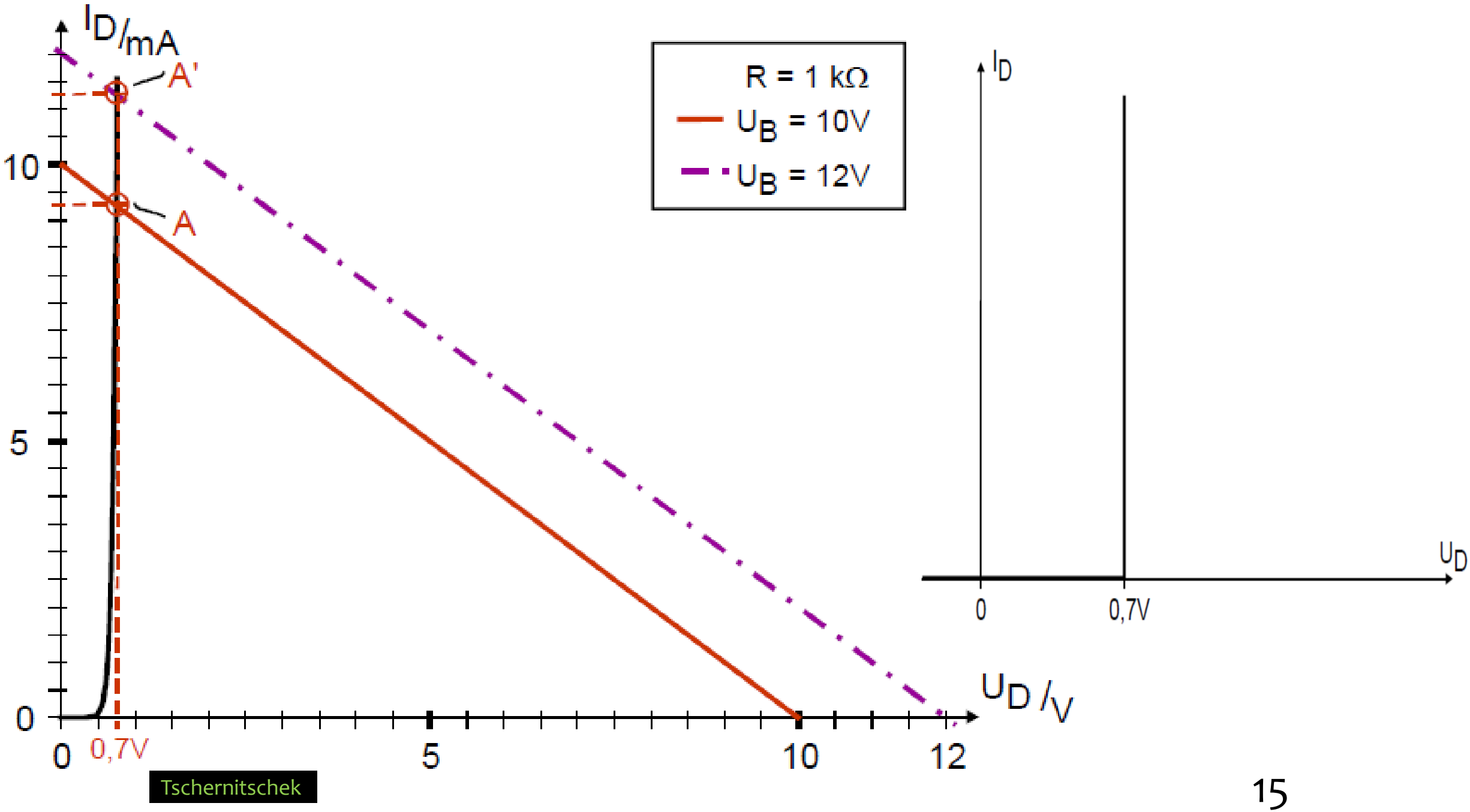
$$\rightarrow I = -\frac{1}{R} U_D + \frac{U_B}{R}$$

Tschernitschek

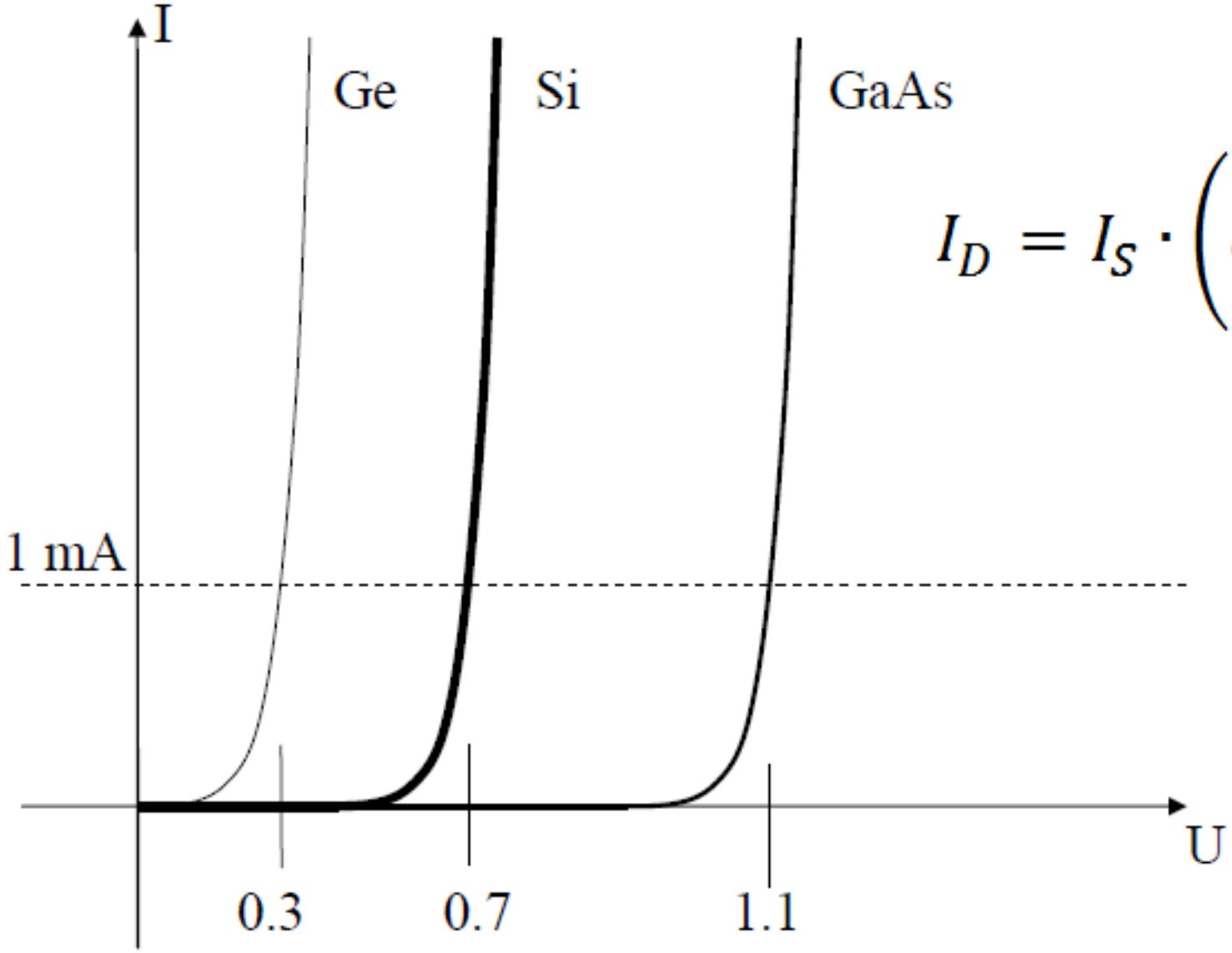


$$\rightarrow I = -\frac{1}{R}U_D + \frac{U_B}{R}$$





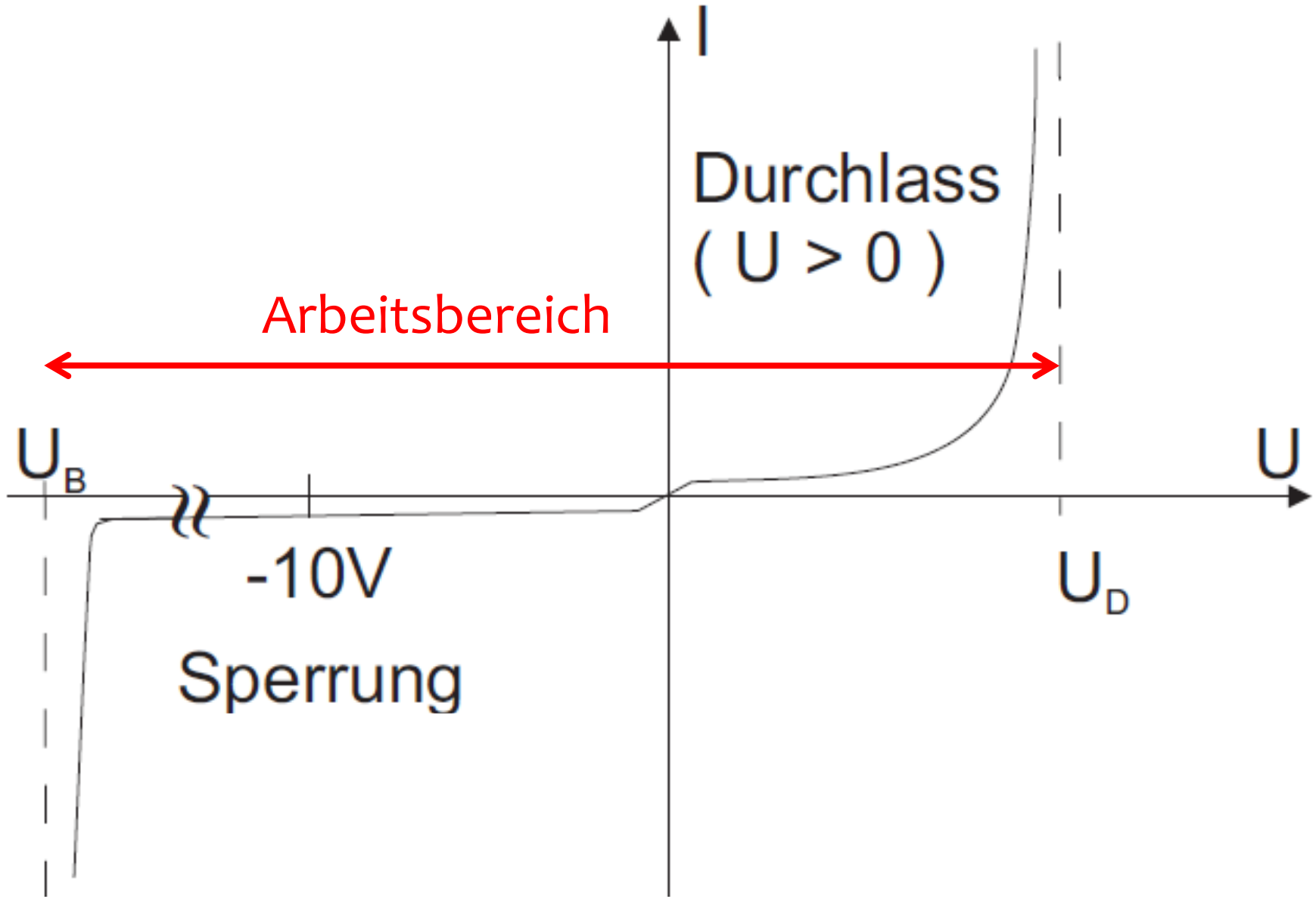
Tschernitschek



$$I_D = I_S \cdot \left(e^{\frac{U_D}{U_T}} - 1 \right), U_T = \frac{kT}{e}$$

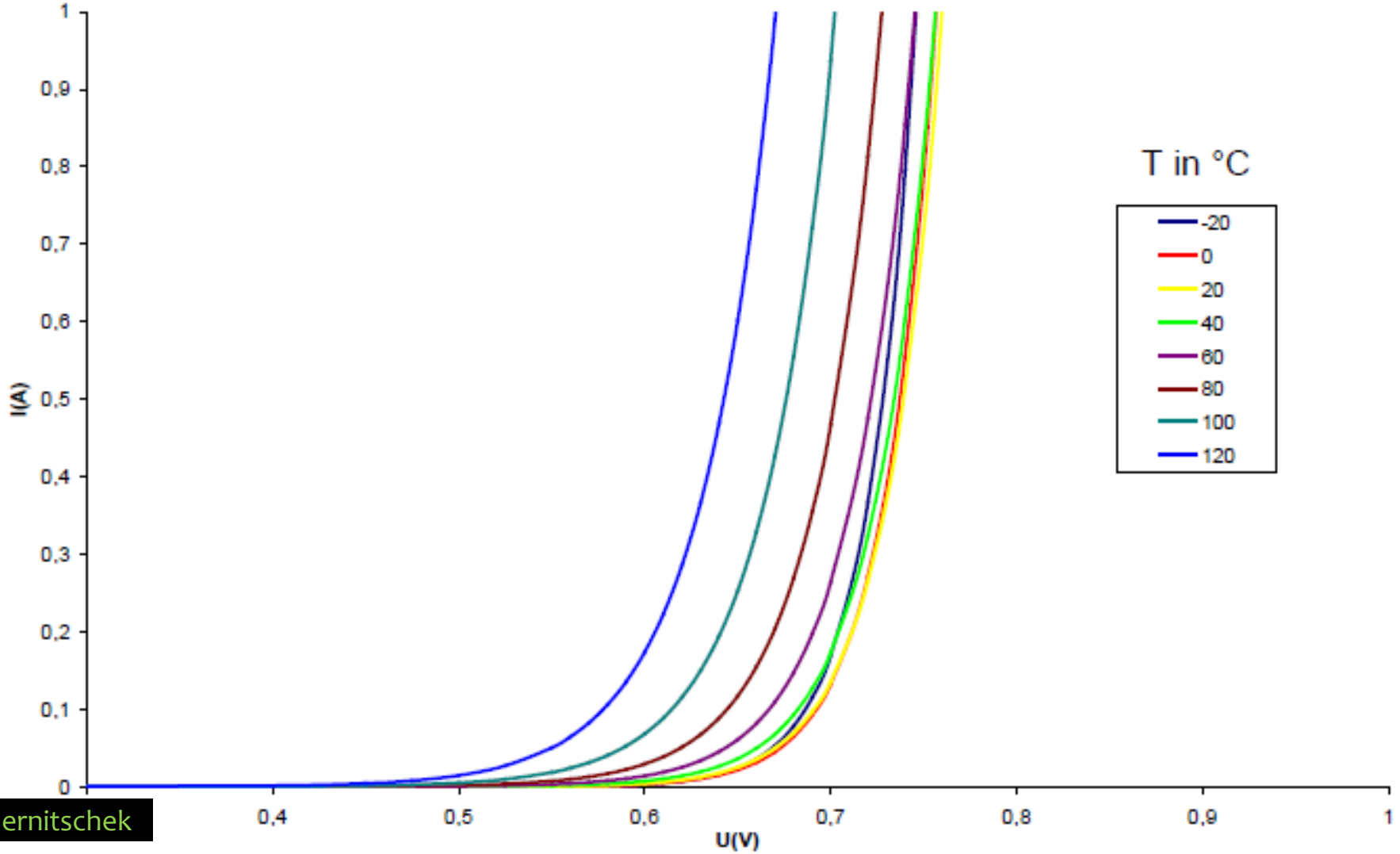
$$\lim_{U \to -\infty} I(U) = I_S \cdot (-1)$$

Tschernitschek



Tschernitschek

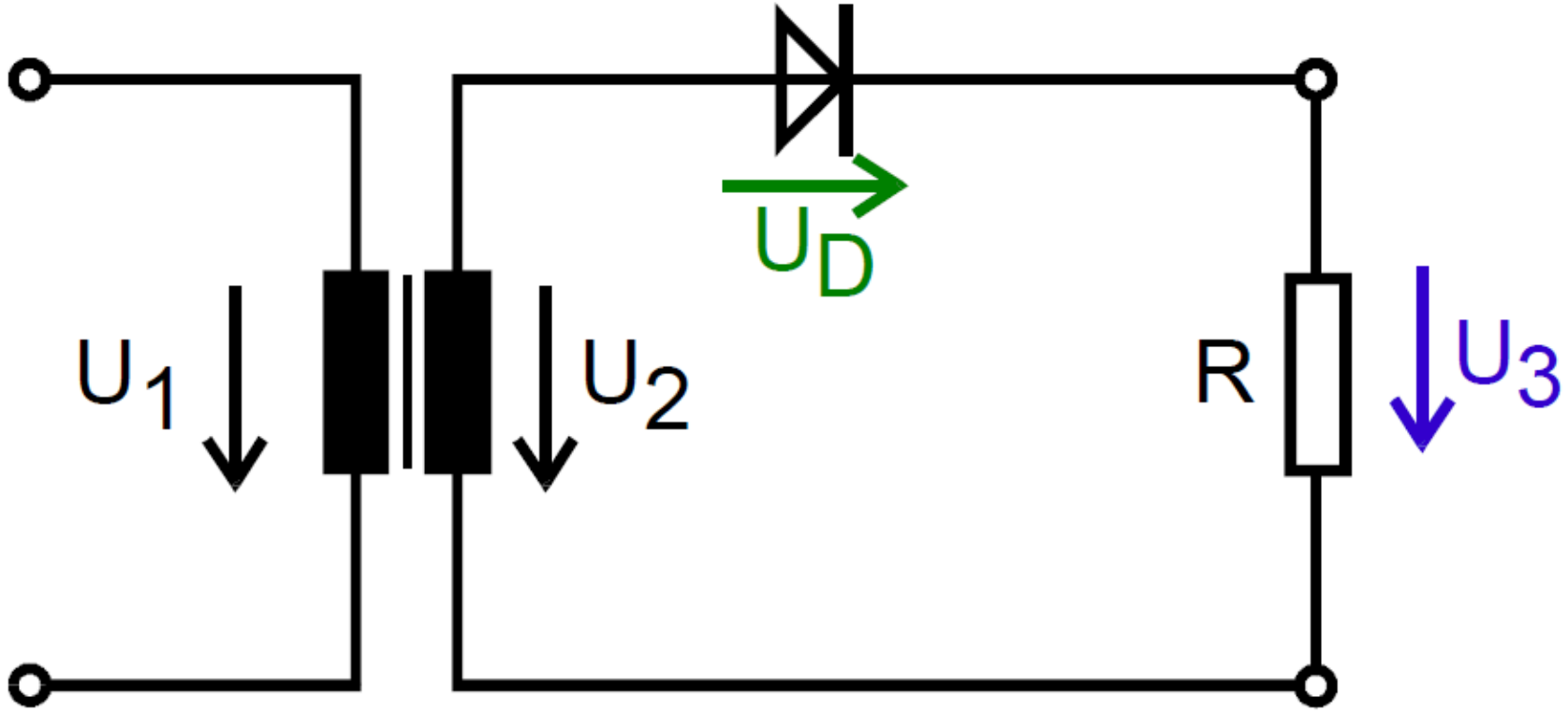
Temperaturabhängigkeit der Kennlinie

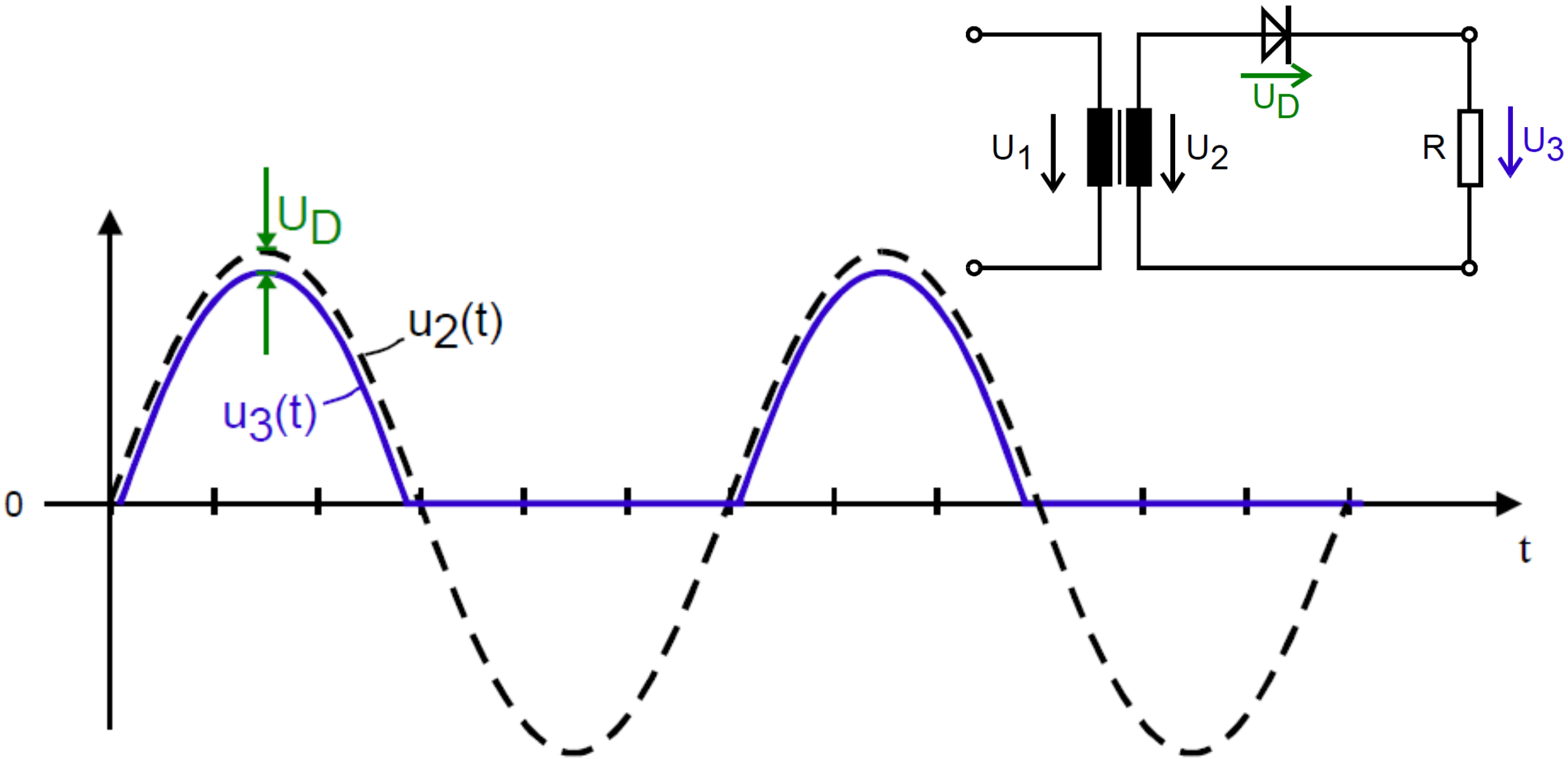


Tschernitschek

Schaltungen mit Dioden

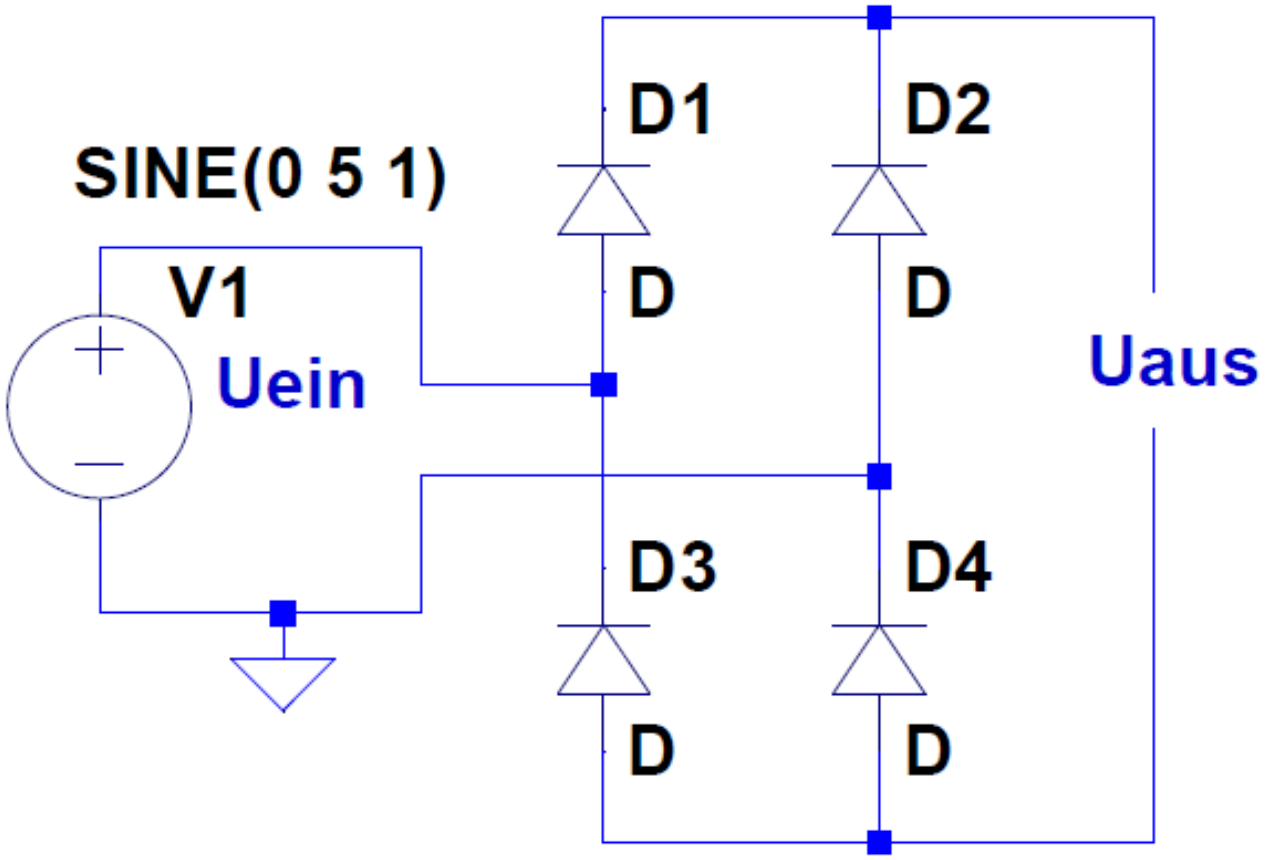
- Einweggleichrichter:

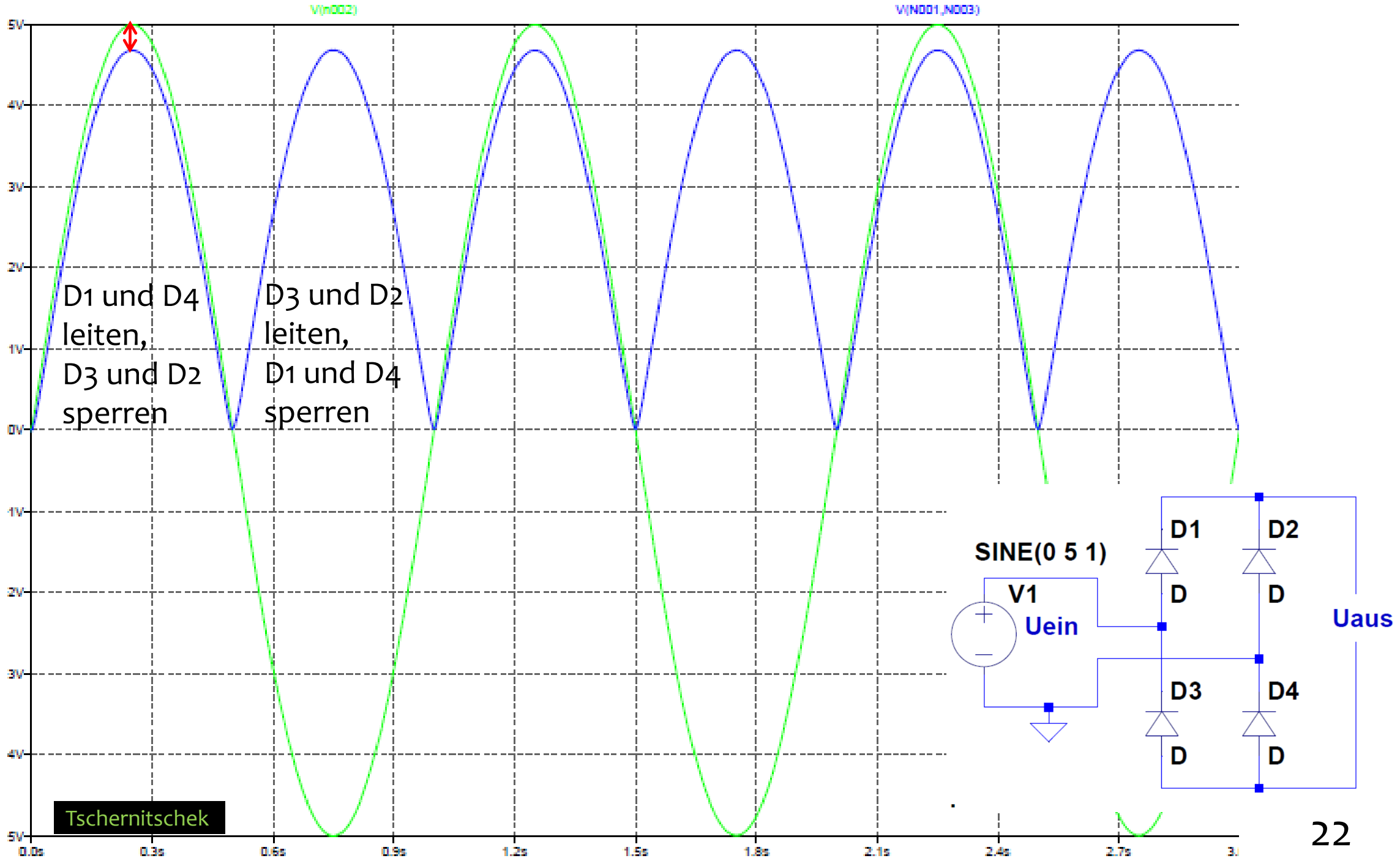



U1
U2
UD
R
U3
UD
u2(t)
u3(t)
0
t

Schaltungen mit Dioden

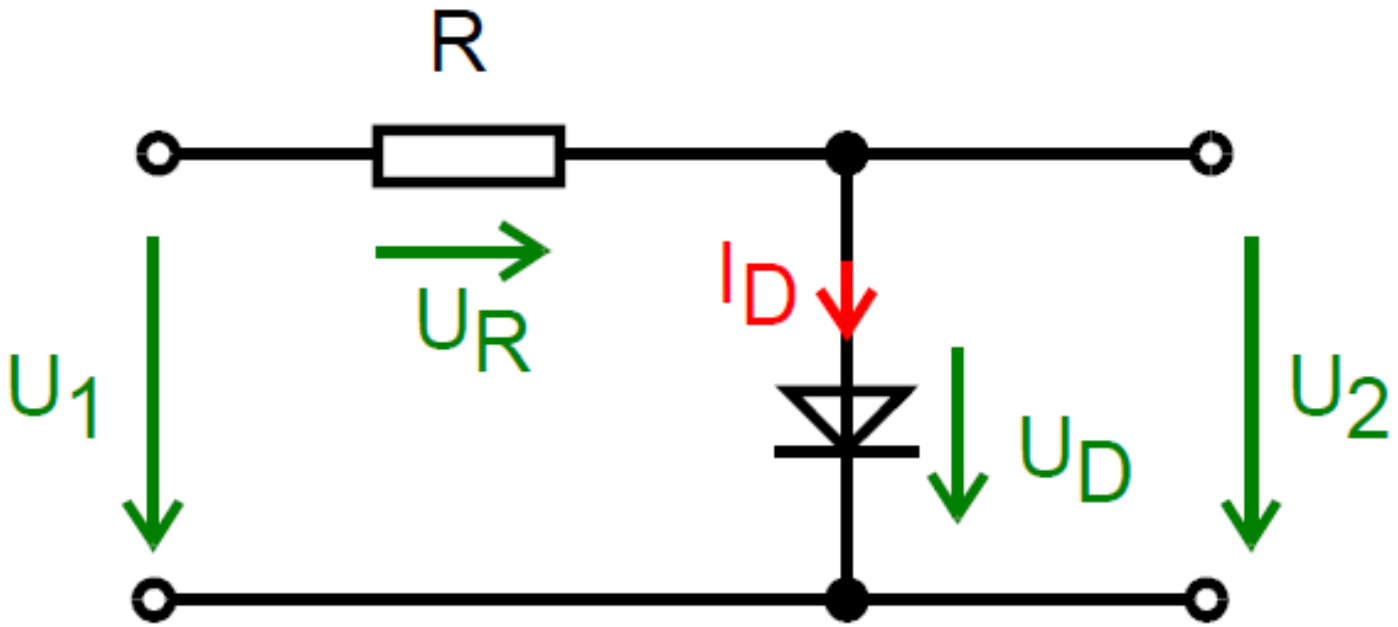
- Brückengleichrichter (Graetz-Schaltung):

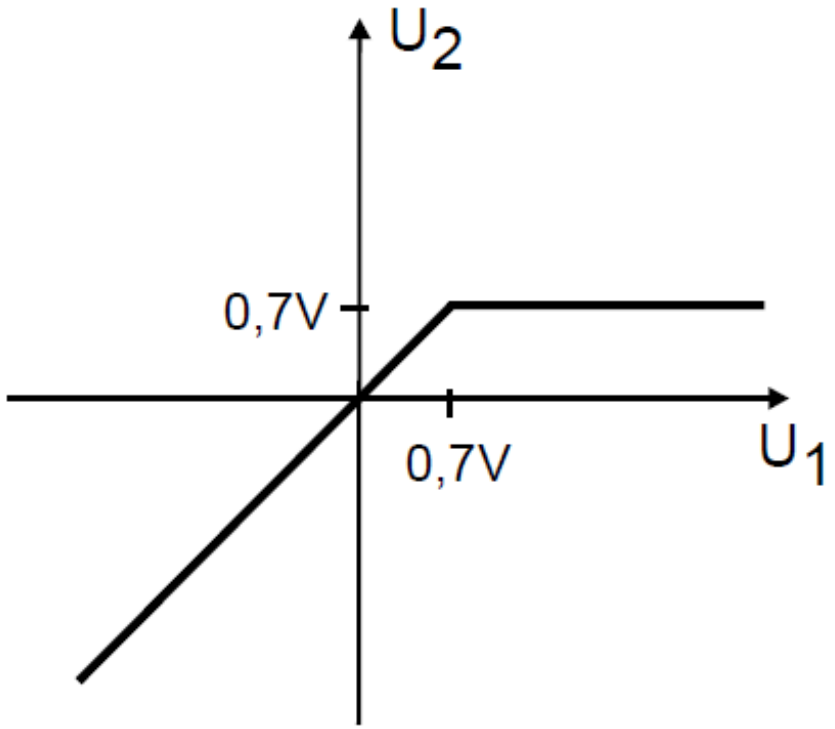



V(n002)
V(N001,N003)
5V
4V
3V
2V
1V
0V
1V
2V
3V
4V
5V
0.0s
0.3s
0.6s
0.9s
1.2s
1.5s
1.8s
2.1s
2.4s
2.7s
D1 und D4 leiten, D3 und D2 sperren
D3 und D2 leiten, D1 und D4 sperren
SINE(0 5 1)
V1
Uein
D1
D2
D
D
D3
D4
D
D
Uaus
Tschernitschek

Schaltungen mit Dioden

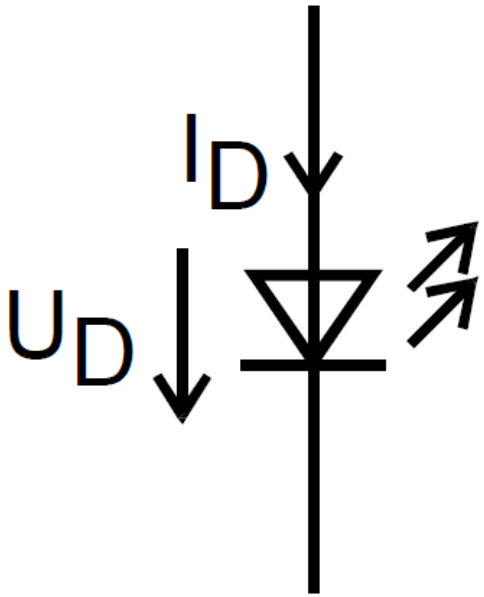
- Begrenzerschaltungen:

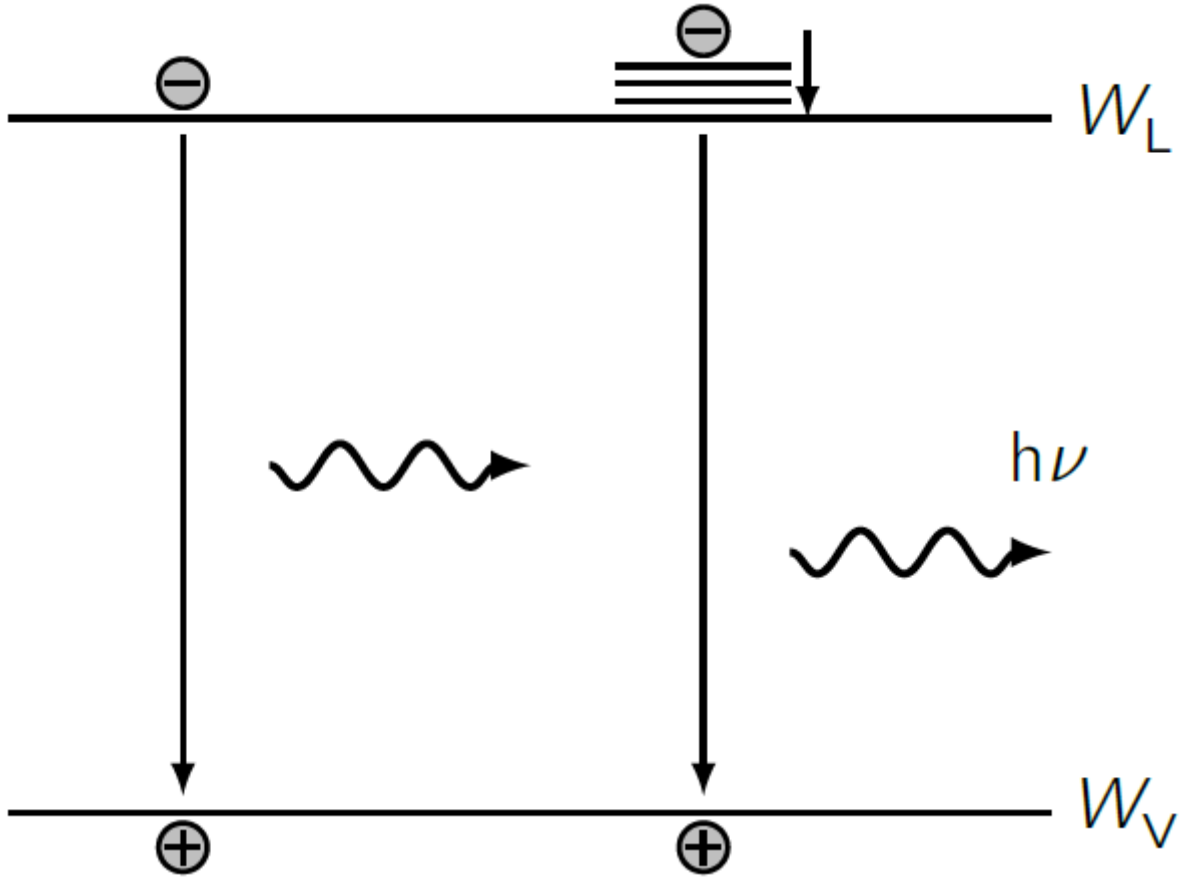




Schaltungen mit Dioden

- LED:





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Shockley Bedingungen

- **kein Spannungsabfall über den Bahngebieten**

➢ gesamter Spannungsabfall über RLZ

➢ Bahngebiete widerstandslos, ideal leitend

- **keine Generation/Rekombination von Ladungsträgern in RLZ**

➢ kein Verlust (in=out)

- **schwache Injektion**

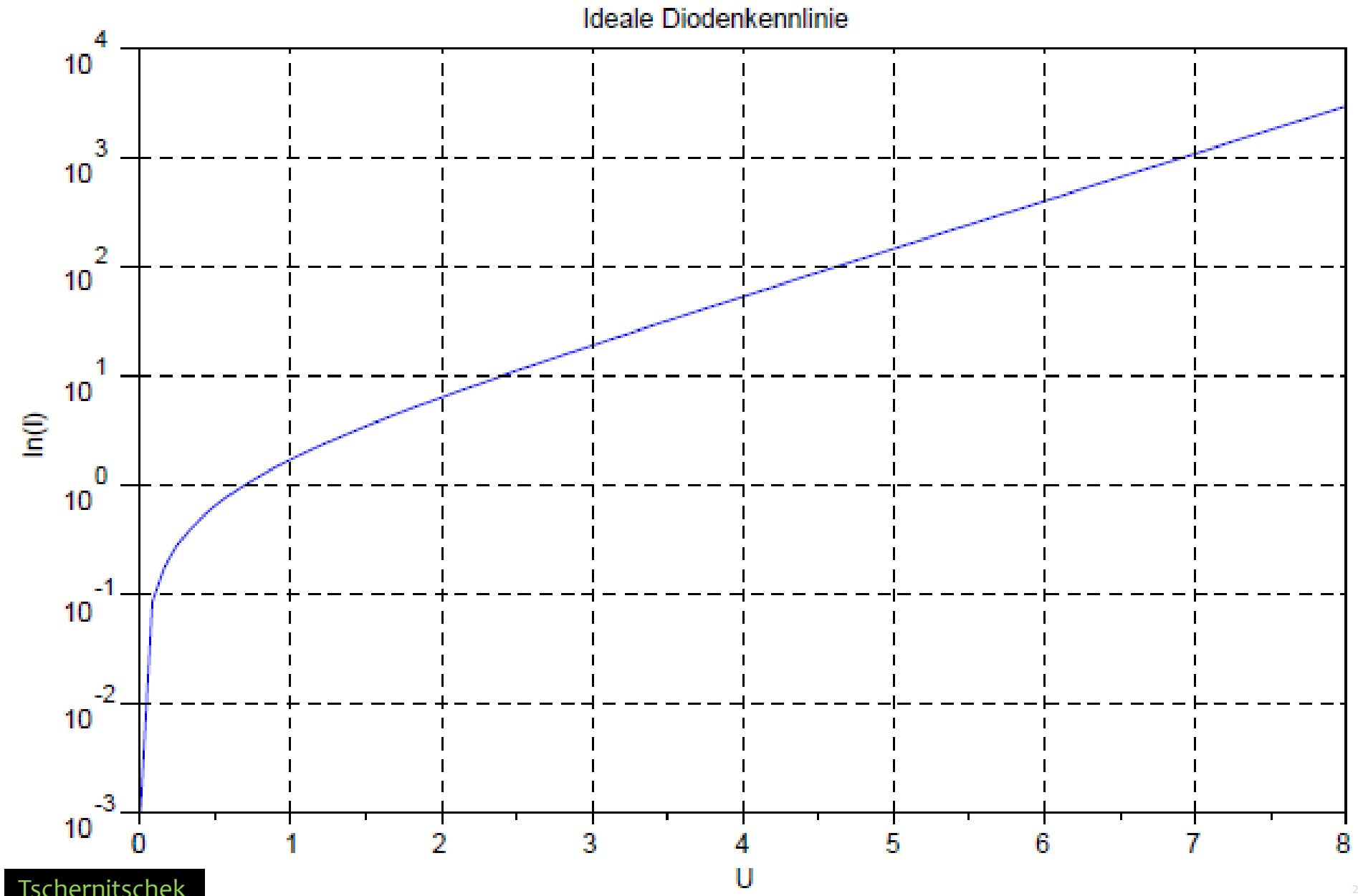
➢ Niveau Minoritäten trotz Injektion deutlich unter Majoritäten

- **abrupter pn-Übergang**

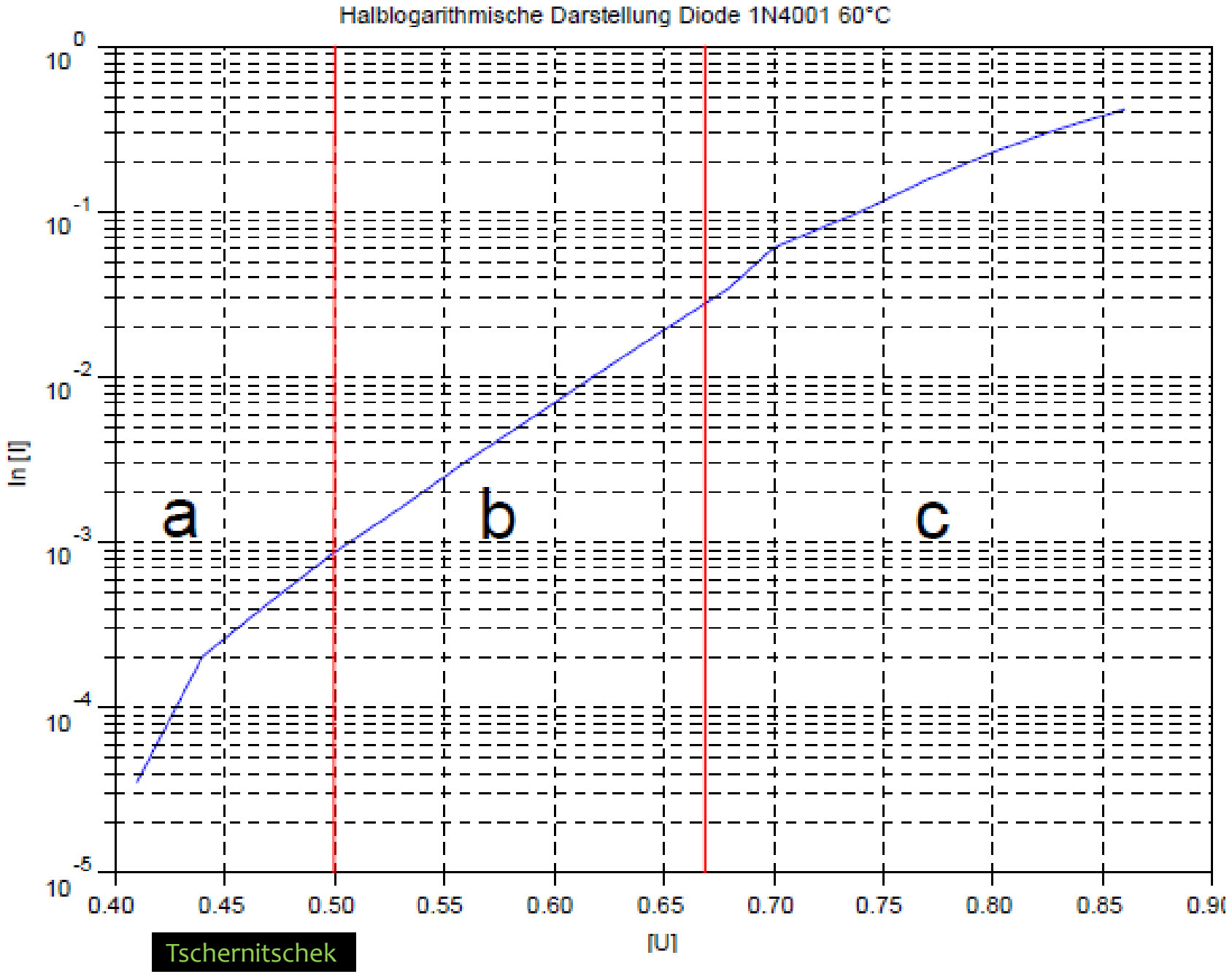
➢ konstante Konzentration Akzeptoren /Donatoren in Bahngebieten bis zum Übergang

- **keine frei beweglichen Ladungsträger in RLZ**

➢ im TG befinden sich in RLZ nur ortsfeste, positiv geladene Donator- (N_D^+) und negativ Akzeptoratome (N_A^-)



Tschernitschek



Tschernitschek

$$a: I \approx e^{\frac{U}{2U_T}}$$

- Rekombination in RLZ

$$b: I \approx e^{\frac{U}{U_T}}$$

- ideal

$$c: I \approx U$$

- Spannungsabfall über den Bahngebieten