Embedded Systems / Eingebettete Systeme

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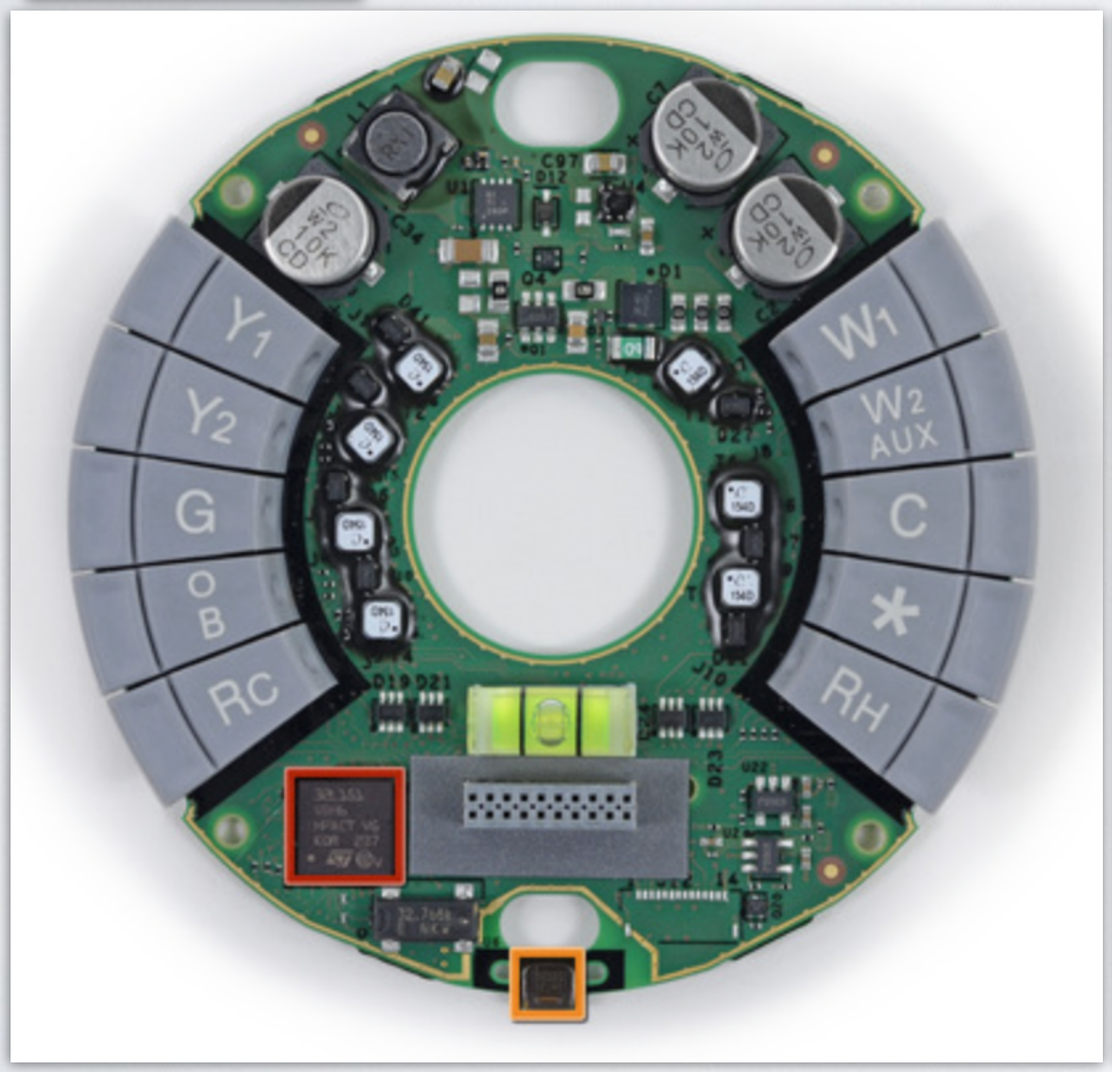
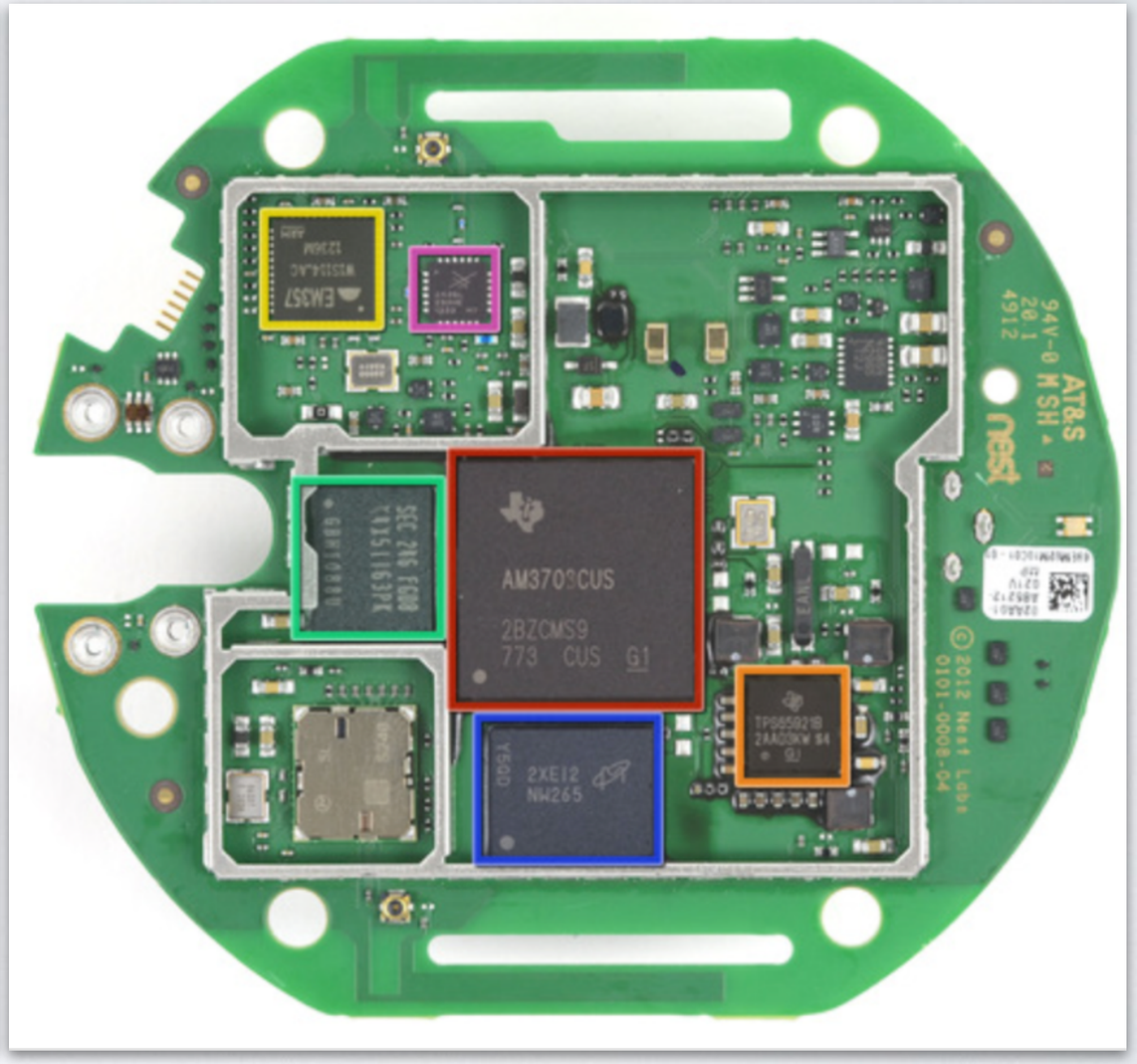
Teardown NEST 2





Quelle: https://www.ifixit.com/Teardown/Nest+Learning+Thermostat+2nd+Generation+Teardown/13818, Zugriff: 13.04.2016

ELEKTROTECHNISCHE GRUNDLAGEN

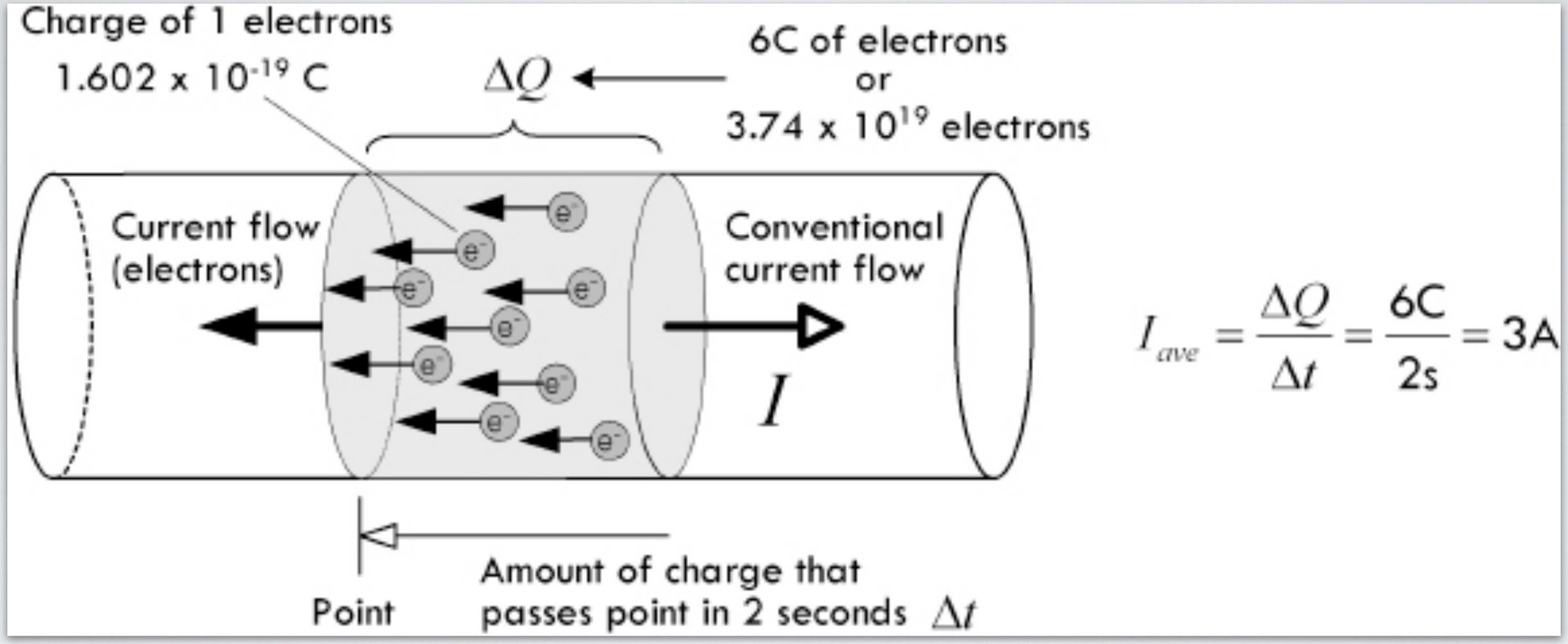
Inhalt heute

- Wiederholung elektrotechnischer Grundlagen
  - Strom, Spannung, Leistung
  - Bauelemente Widerstand, Kondensator, Diode, Transistor

Elektrischer Strom

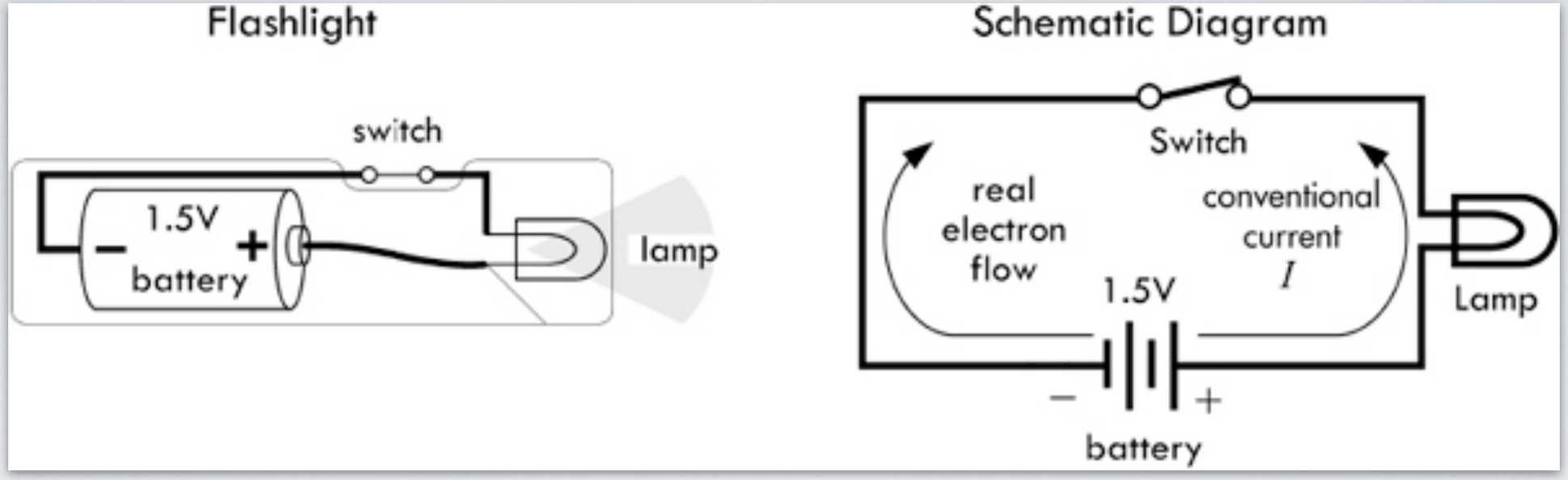
- Ladung eines Elektrons -e = - 1,6022 * 10-^{19} *C*
- Ladung Q = n e
- Elektrischer Strom I = dQ/dt (Ladung pro Zeit)
- Stationärer elektrischer Strom I = Q/t
- Einheit Ampere *A* = *C/s*

Elektrischer Strom: Beispiel



Quelle: P. Scherz (2013)

Elektrische Spannung

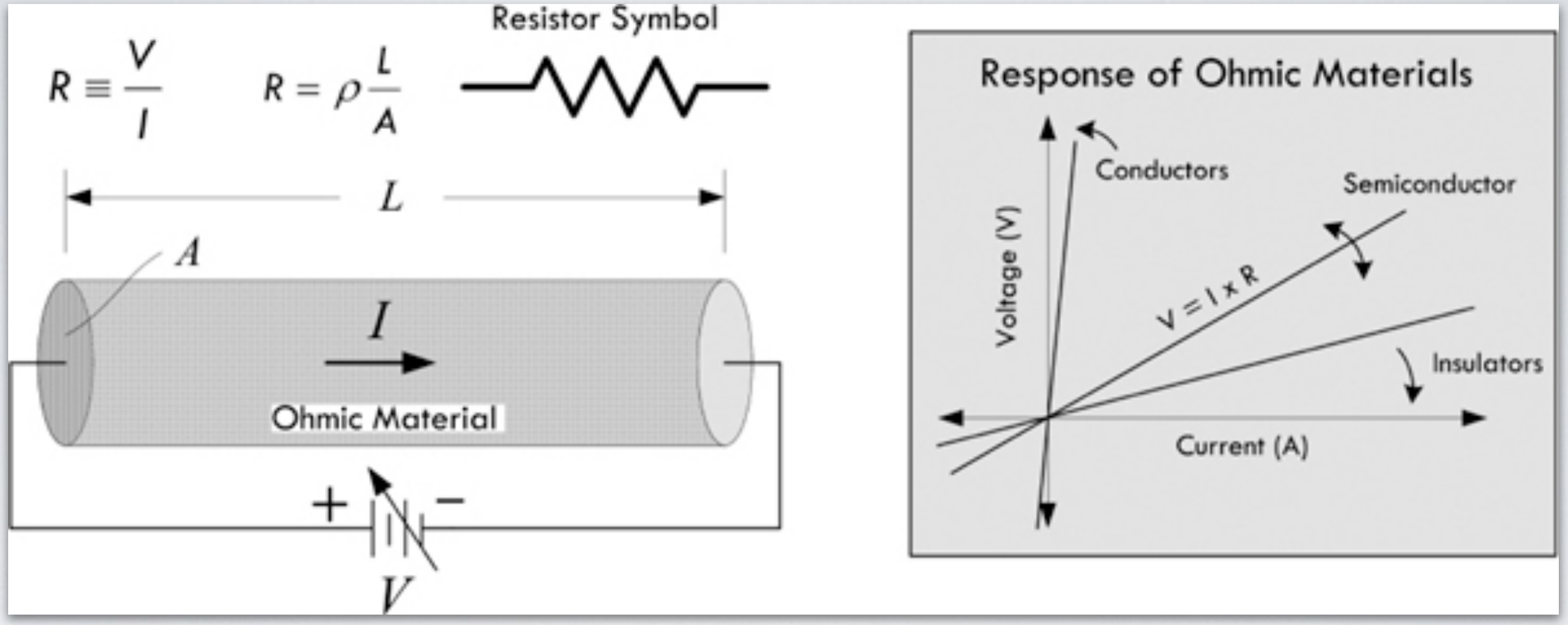


Quelle: P. Scherz (2013)

- Arbeit W_{ab} (zum Transport einer Ladung Q von a nach b)
- Elektrische Spannung $U_{ab} = W_{ab}/Q$
- Leistung $P = dW / dt = U\, dQ / dt = U\, I$
- Einheit der Spannung Volt: $V = J / C = W / A$

Achtung: in den folgenden engl. Abbildungen ist V anstelle von U!

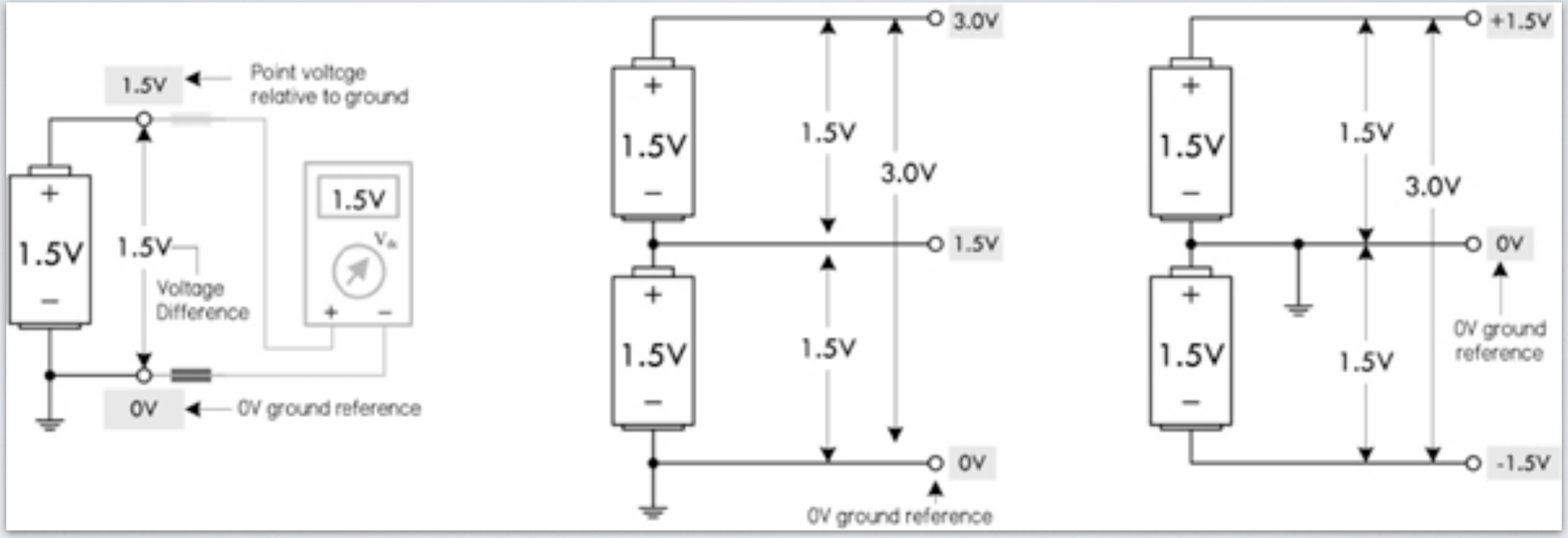
Elektrischer Widerstand und Ohmsches Gesetz



Quelle: P. Scherz (2013)

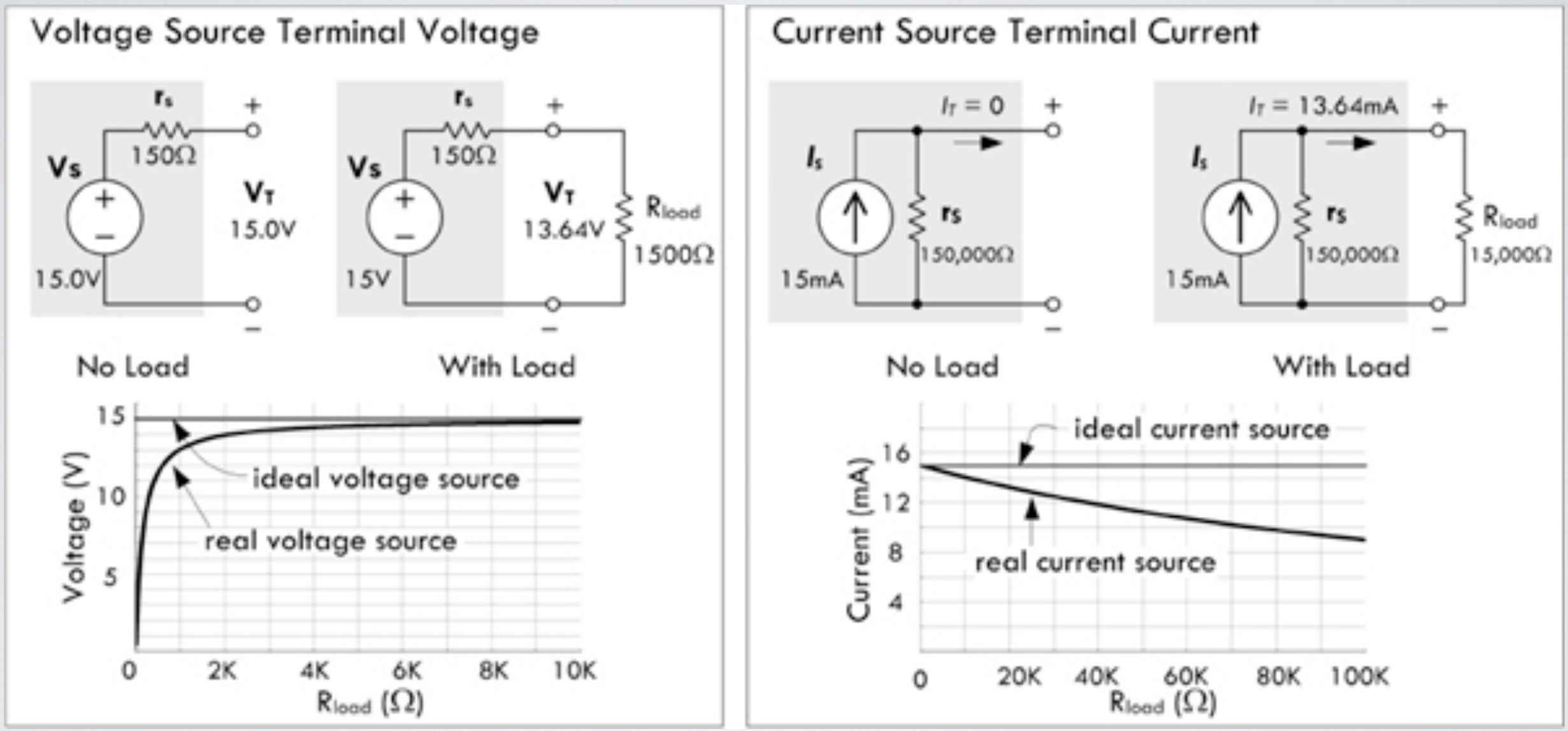
- Für ohmschen Widerstand R = U / I (Ohmsches Gesetz)
- Einheit Widerstand **Ω** [Ohm] = *V / A*

Stromquellen in Schaltung



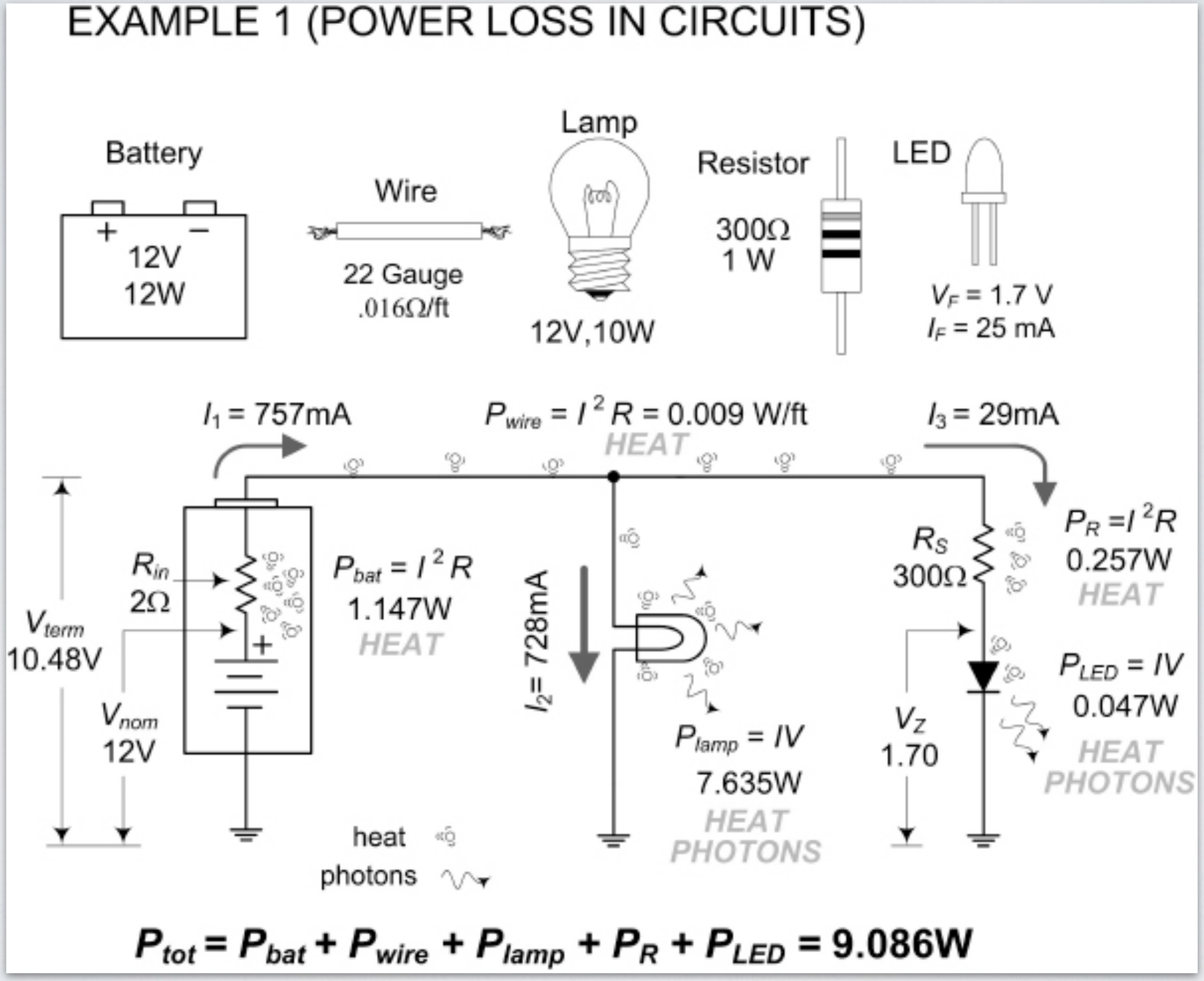
Quelle: P. Scherz (2013)

Stromquellen ideal/real



Quelle: P. Scherz (2013)

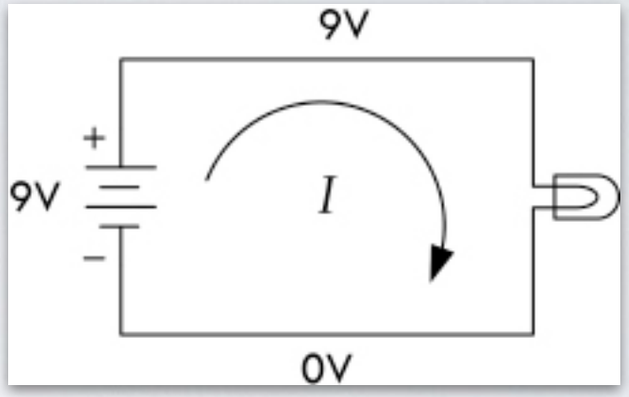
Energieverlust in Schaltungen



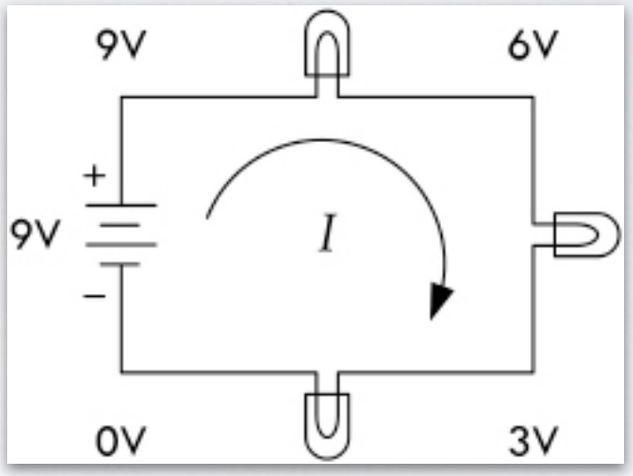
Quelle: P. Scherz (2013)

Elektrische Schaltungen

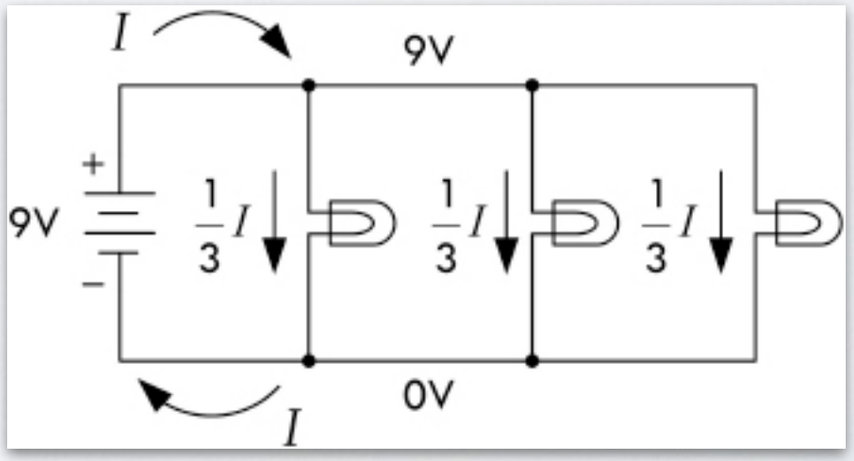
- Grundlegend



- Serienschaltung



- Parallelschaltung

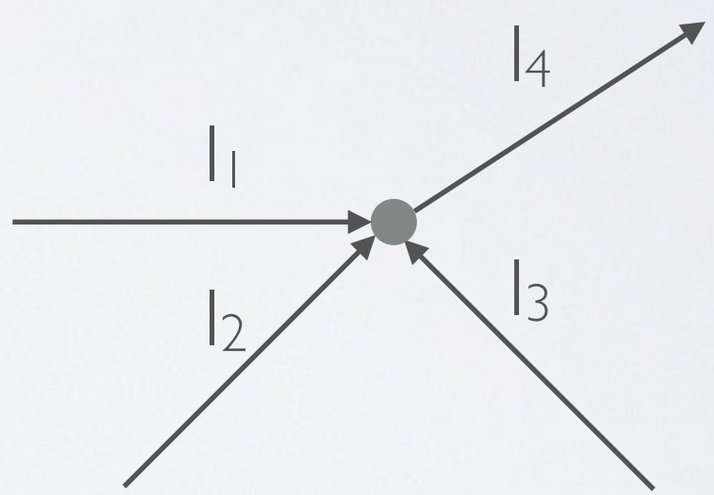


Quelle: P. Scherz (2013)

1. Kirchhoffsche Gesetz

- Knotenregel:
  In einem Knotenpunkt ist die Summe der hineinfließenden Ströme gleich der Summe der abfließenden Ströme.

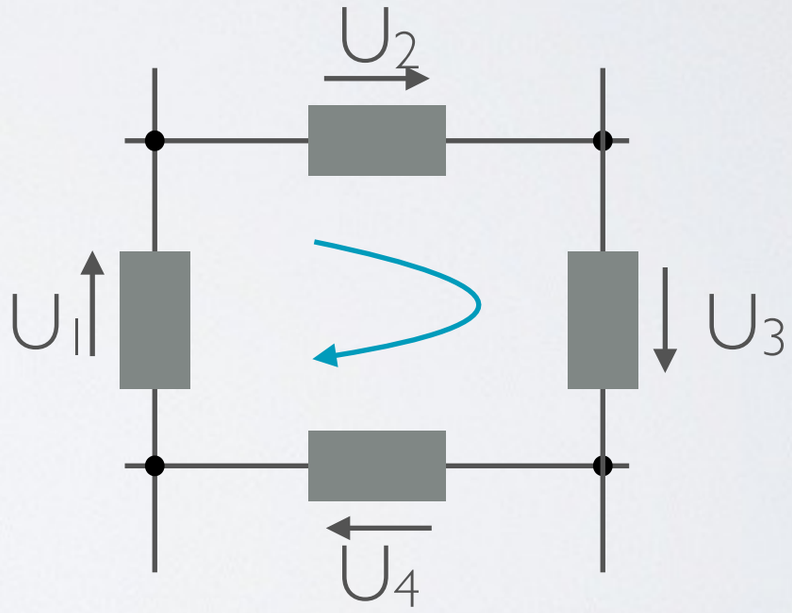
$$\sum_{k=1}^{k=n} I_k = 0$$



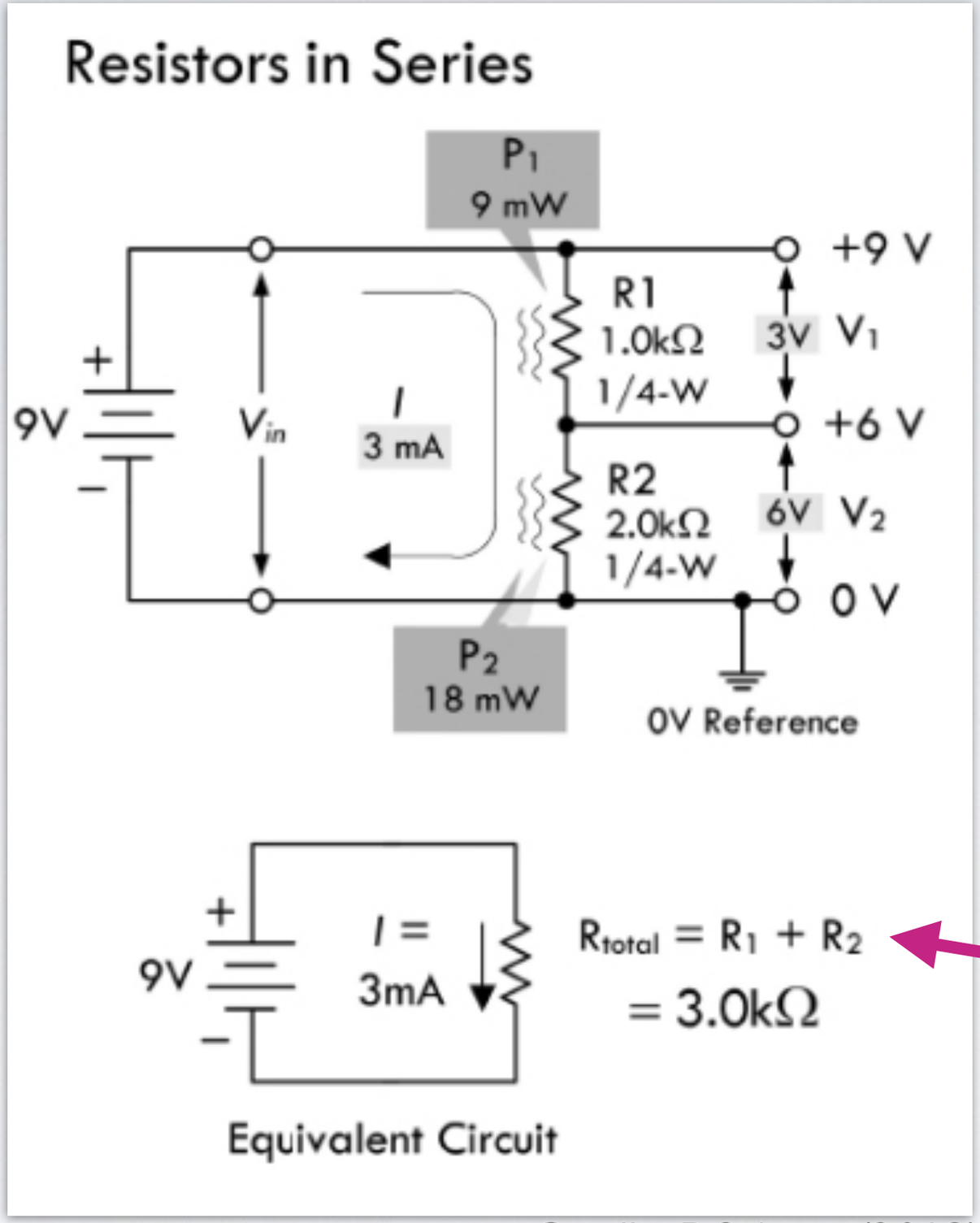
2. Kirchhoffsche Gesetz

- Maschenregel:
  Die Summe der Teilspannungen einer Masche (Umlauf) ist null.

$$\sum_{k=1}^{k=n} U_k = 0$$



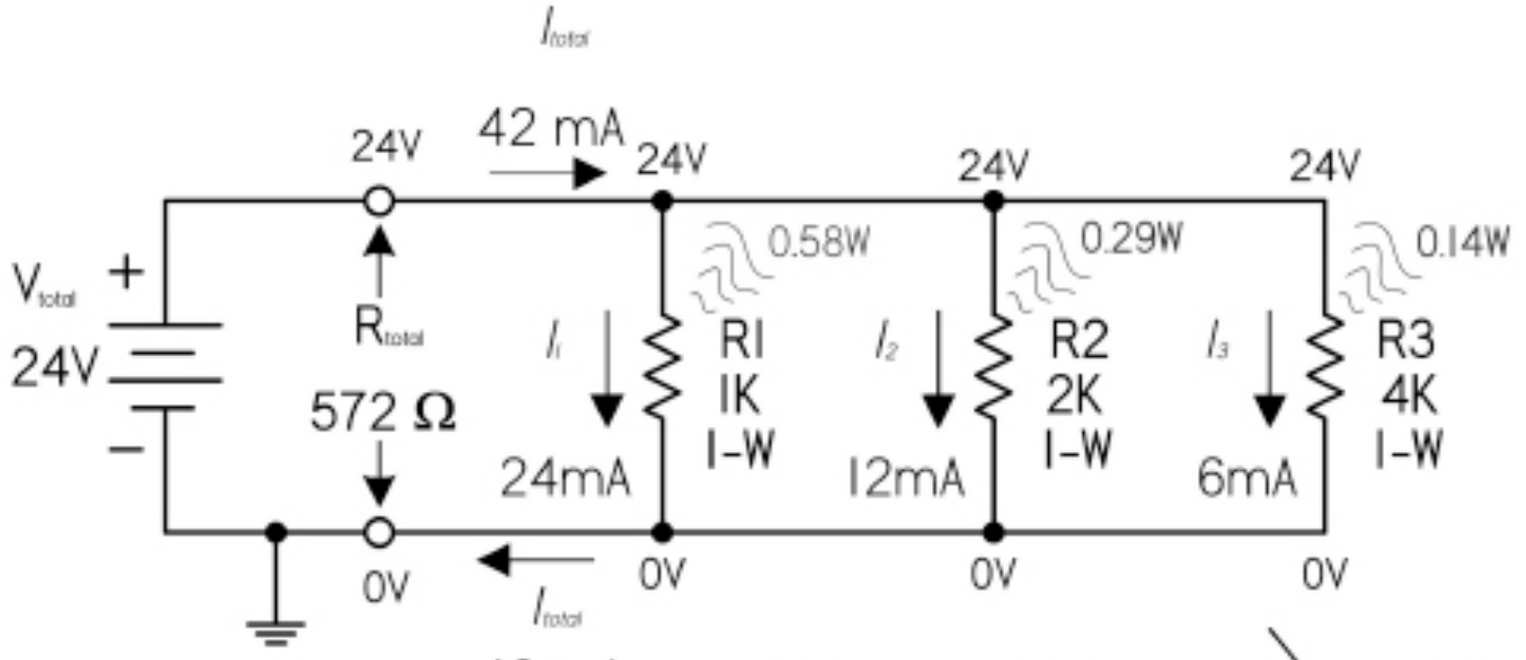
Widerstände: Serienschaltung



Quelle: P. Scherz (2013)

Widerstände seriell / parallel

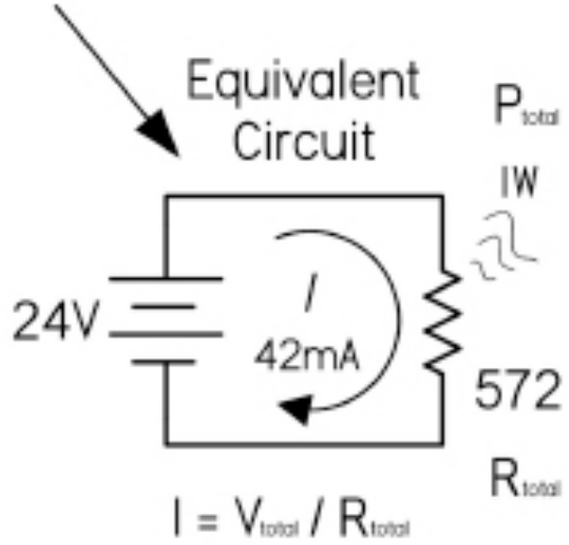
Resistors in Parallel



$P1 = I_1 \times V_1 = 0.58W$

$P2 = I_2 \times V_2 = 0.29W$

$P3 = I_3 \times V_3 = 0.14W$



$$\frac{I}{R_{total}} = \frac{I}{R_1} + \frac{I}{R_2} + \frac{I}{R_3}$$

$I = V_{total} / R_{total}$

$P_{total} = I_{total} \times V_{total}$

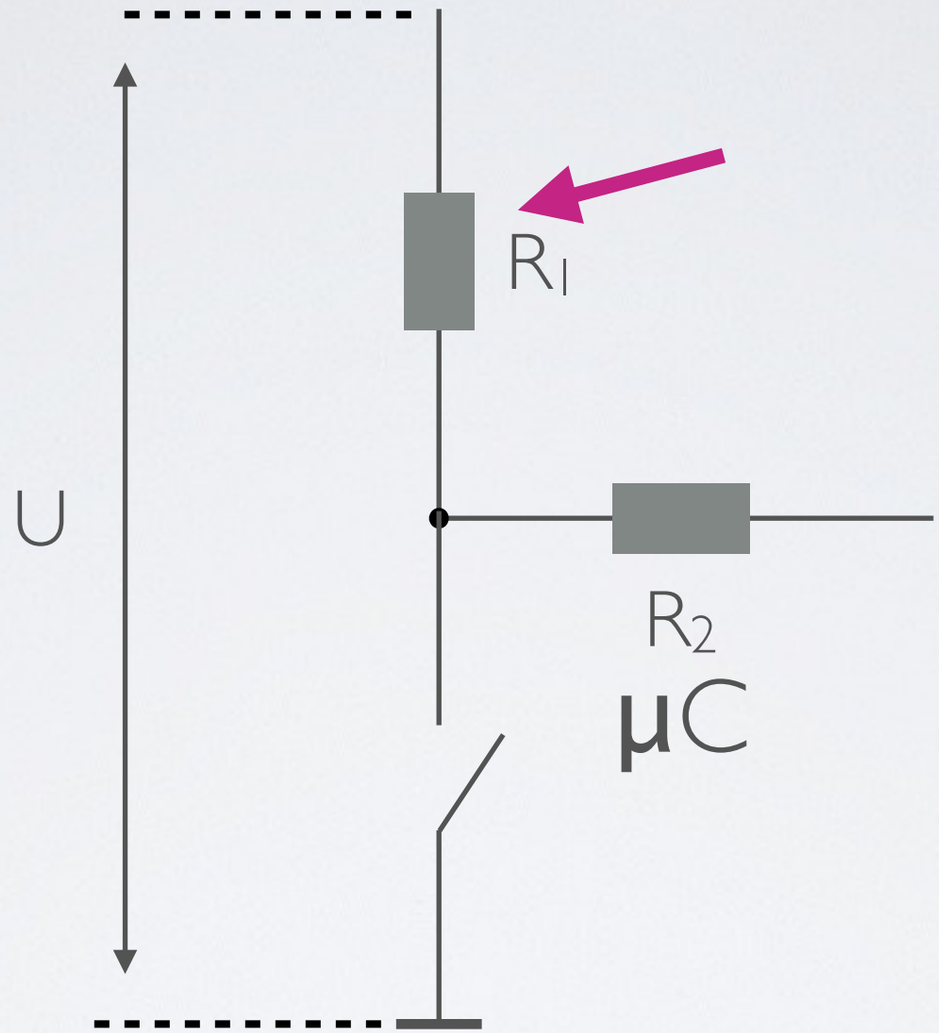
The voltage across each resistor is the same, but the current through each resistor will vary with resistance.

Quelle: P. Scherz (2013)

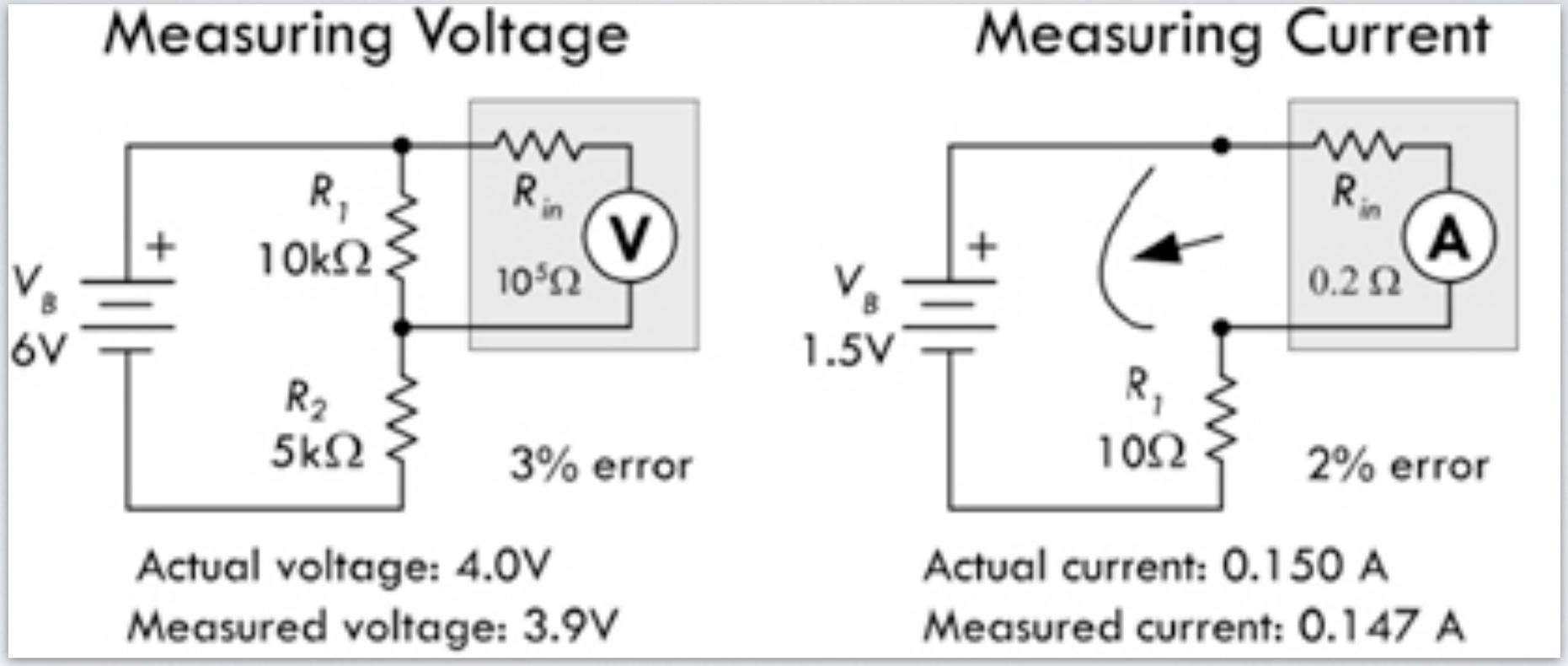
Pull-up und Pull-down

- Widerstände zur Regelung des Pegels bei Schaltern
  - zum Ausgleich von Störsignalen
  - Pull-up-Widerstand für low-aktiv bei geschlossenem Schalter (Widerstand vor µC und Schalter)
  - Pull-down-Widerstand für high-aktiv bei geschlossenem Schalter (Widerstand nach µC und Schalter)

Pull-up ($R_1 < R_2$), Low-active



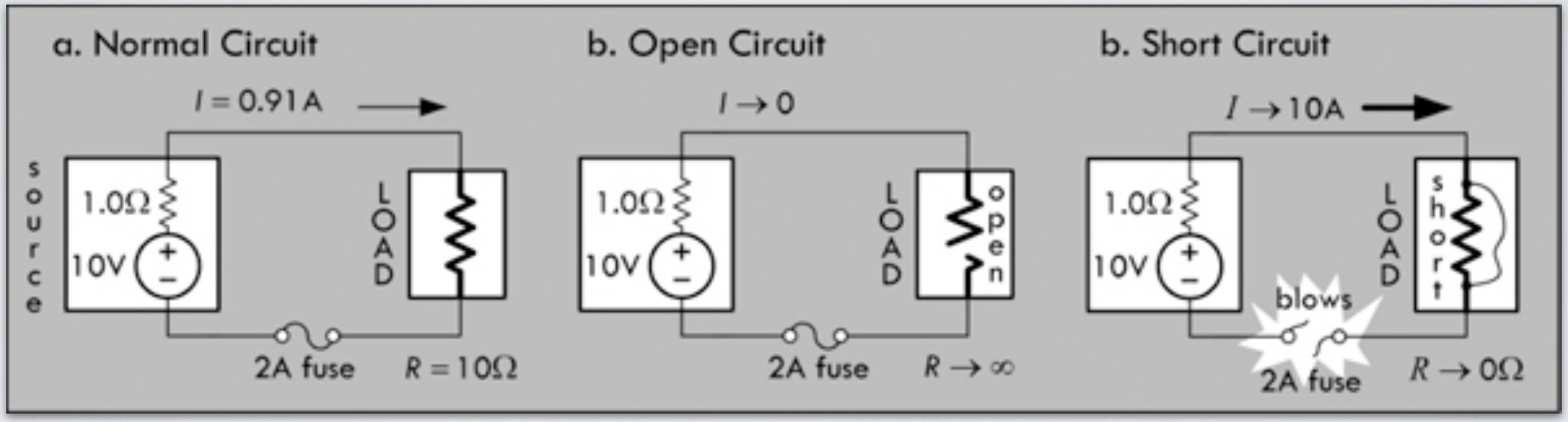
Messen von Spannung und Strom



Quelle: P. Scherz (2013)

- Für Spannung parallel
- Für Strom seriell

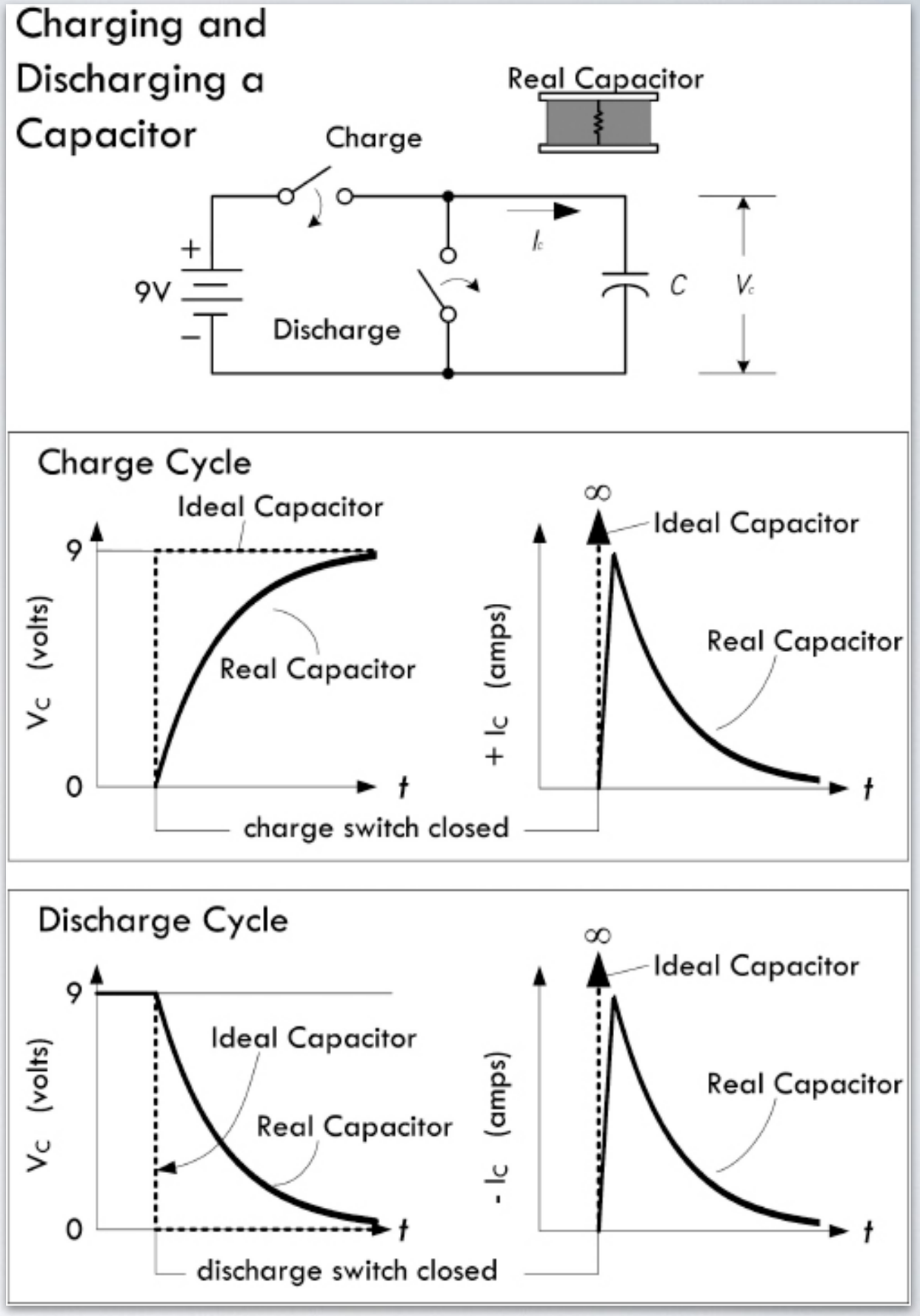
Kurzschluß



Quelle: P. Scherz (2013)

Kondensator

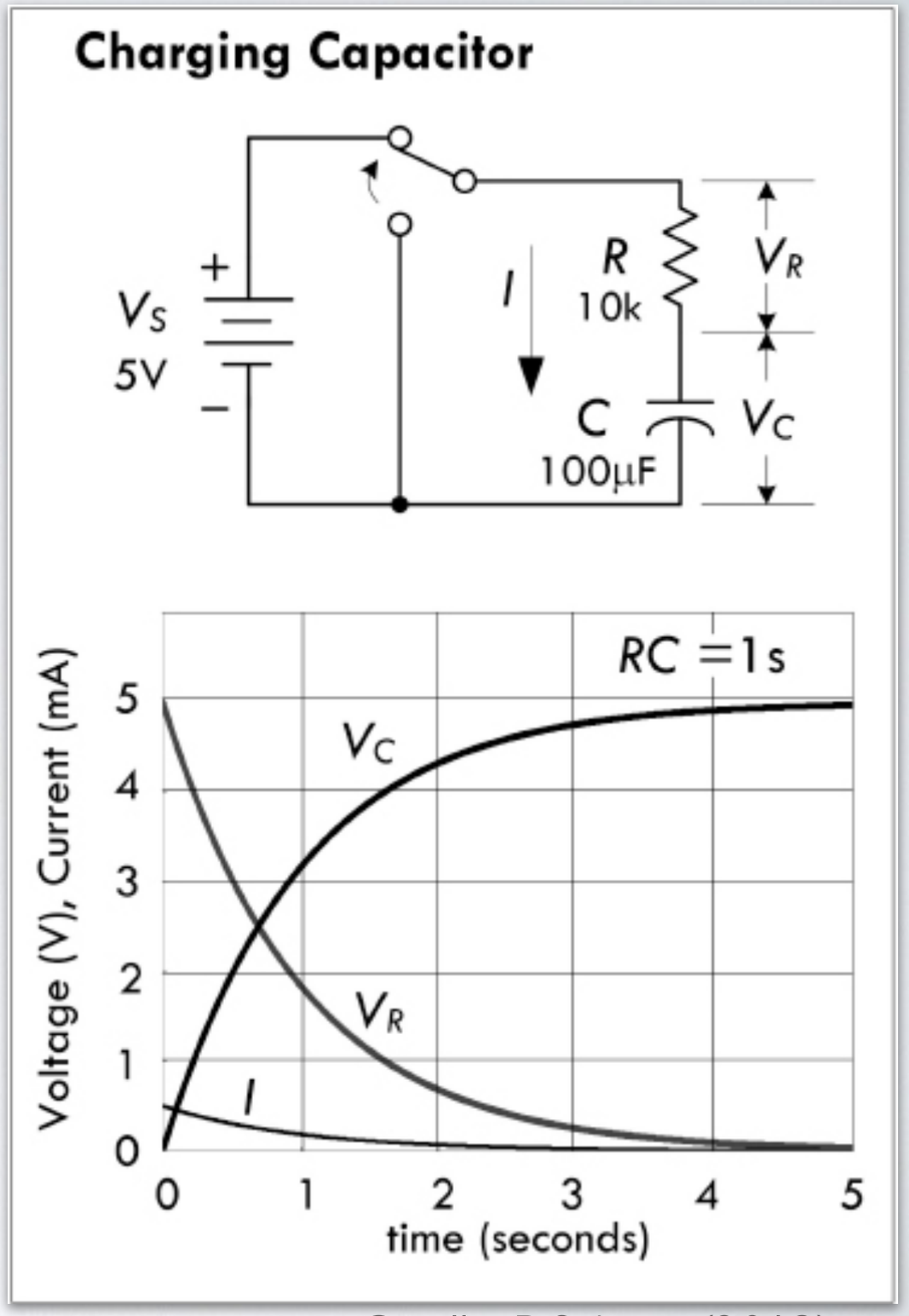
- Lädt und entlädt sich:
- Ladung Q = C * U
- Kapazität C
- Einheit Farad *F = C / V*



Quelle: P. Scherz (2013)

Ladevorgang am Kondensator

- Spannung am Widerstand:
  - $U_R(t) = U_0\, e^{-t/RC}$
- Spannung am Kondensator:
  - $U_C(t) = U_0\, (1-e^{-t/RC})$
- Entladung entsprechend

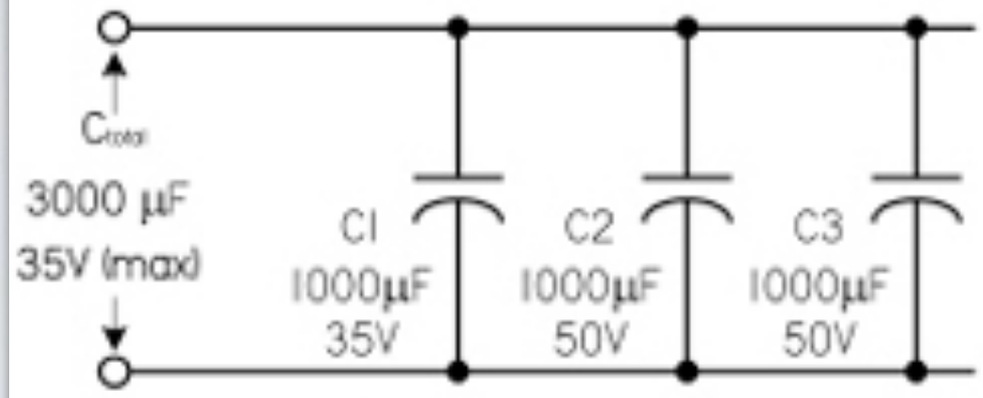


Quelle: P. Scherz (2013)

Kondensatoren parallel / seriell

Capacitors In Parallel

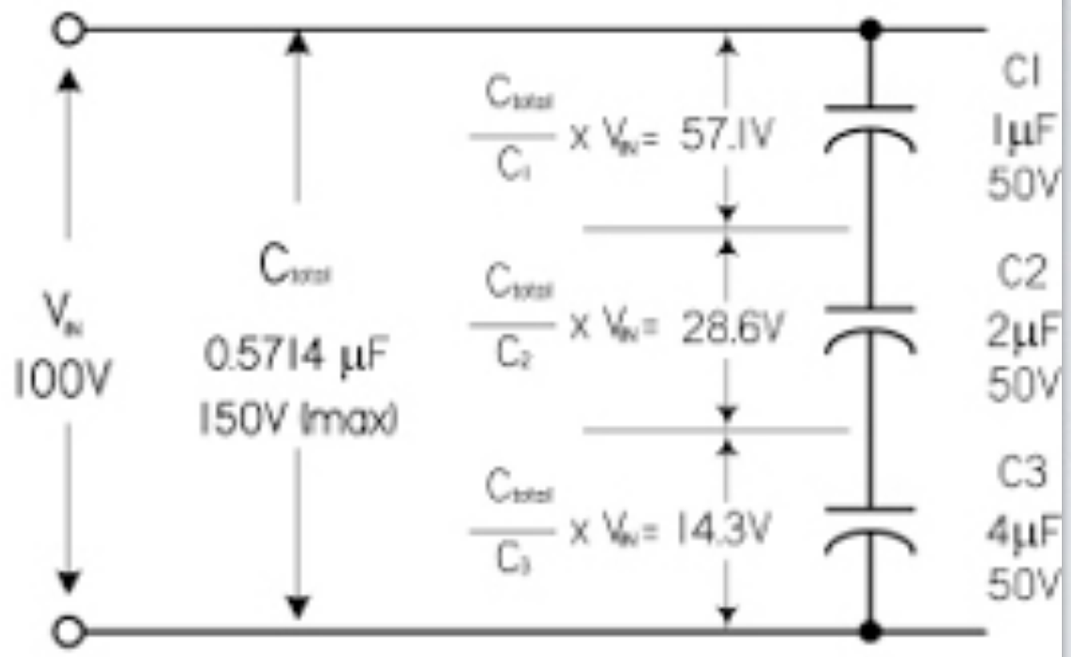
Increases the total capacitance, but limits max. voltage rating to that of smallest rated capacitor.



$$C_{total} = C1 + C2 + C3 + \ldots + C_n$$

Capacitors In Series

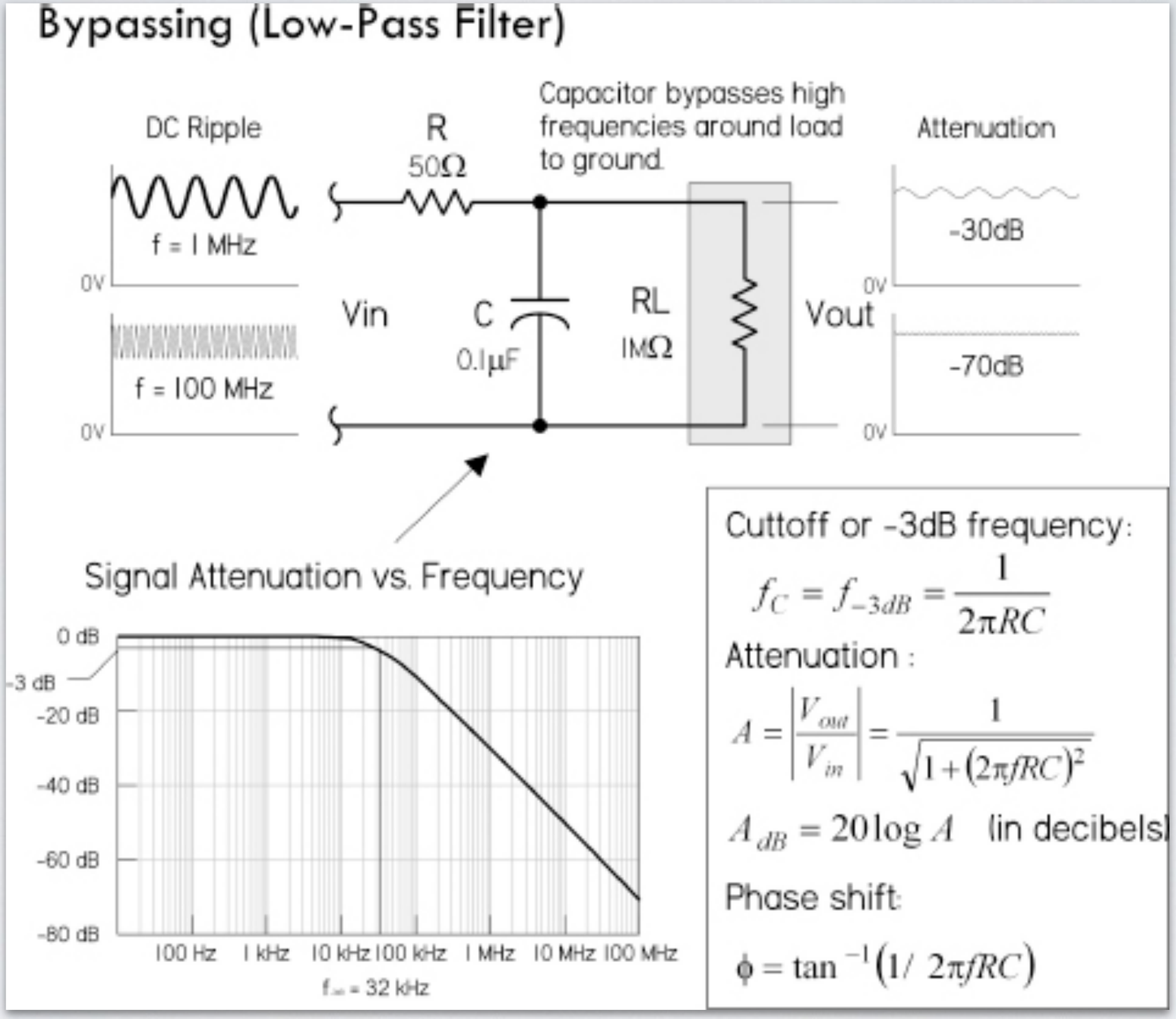
Increases max voltage rating, but decreases capcitance.



$$C_{total} = \frac{1}{1/C1 + 1/C2 + 1/C3 + \ldots + 1/C4}$$

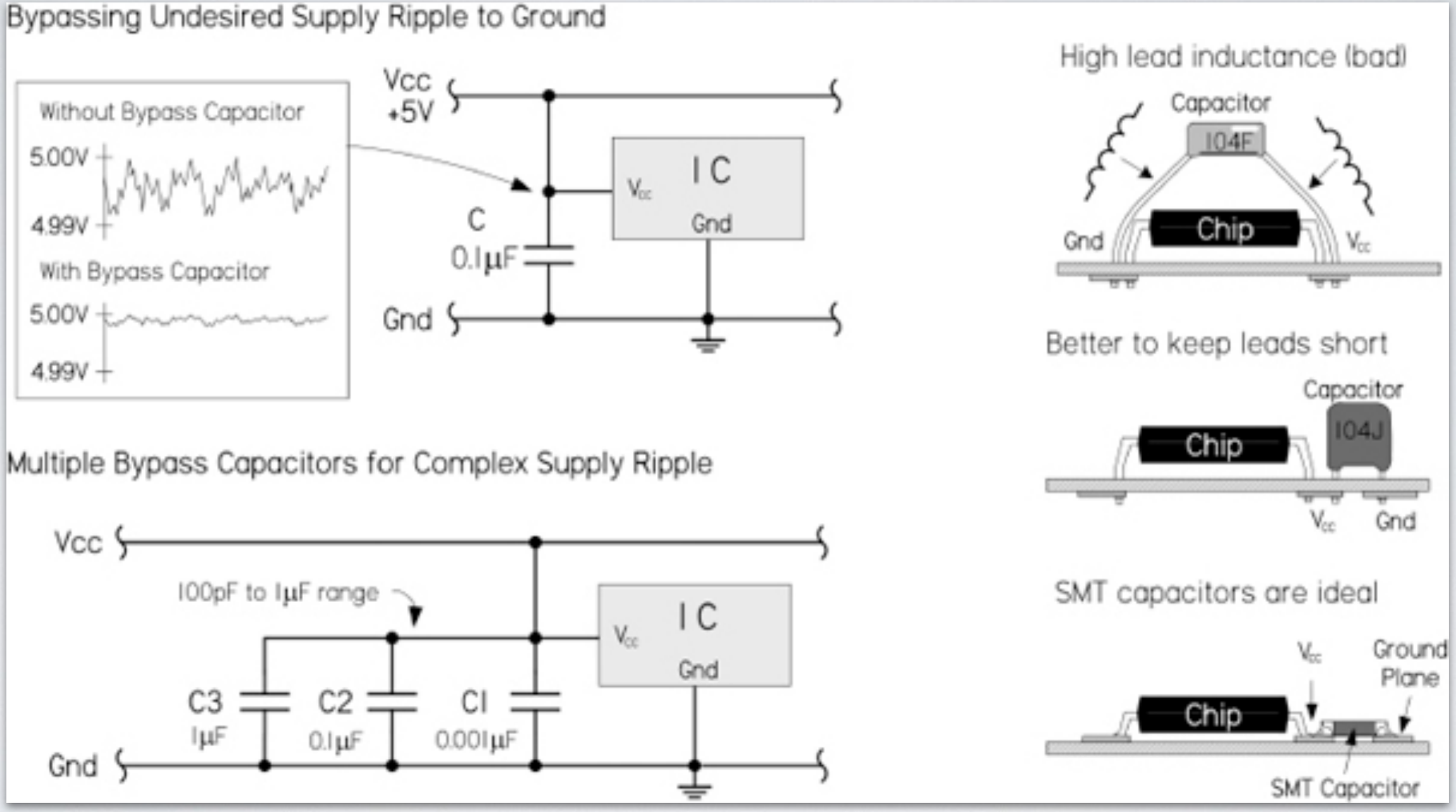
Quelle: P. Scherz (2013)

RC-Tiefpass



Quelle: P. Scherz (2013)

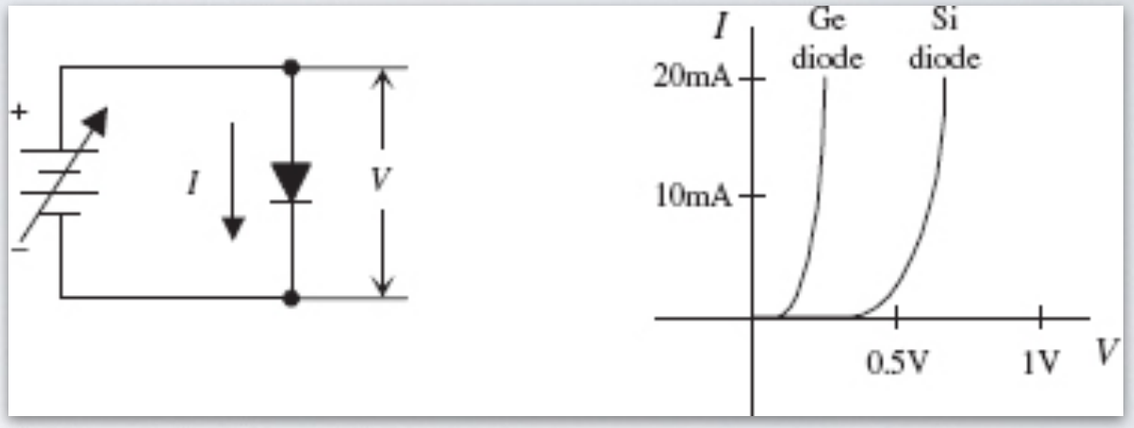
Tiefpass / Schaltungsschutz

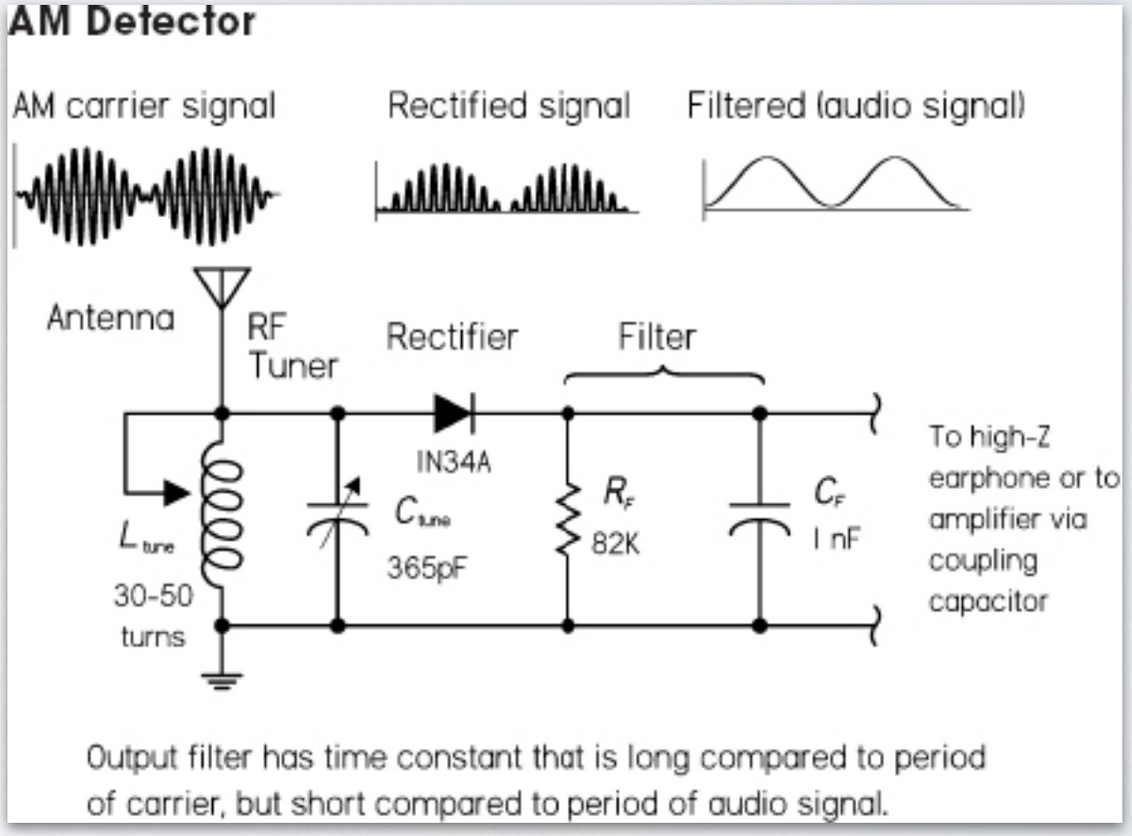


Quelle: P. Scherz (2013)

Diode

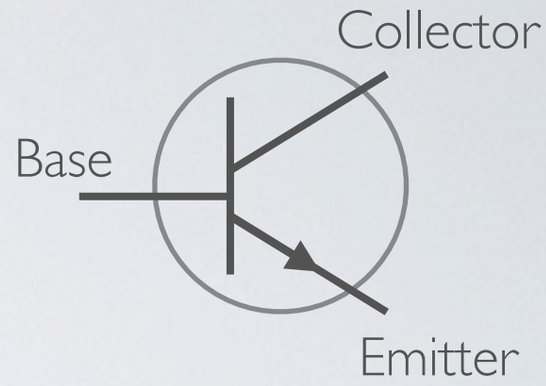
- Lässt Strom nur in einer Richtung durch:
  - von Anode zur Kathode
  - bei Mindestspannung
- LED = Light Emitting Diode





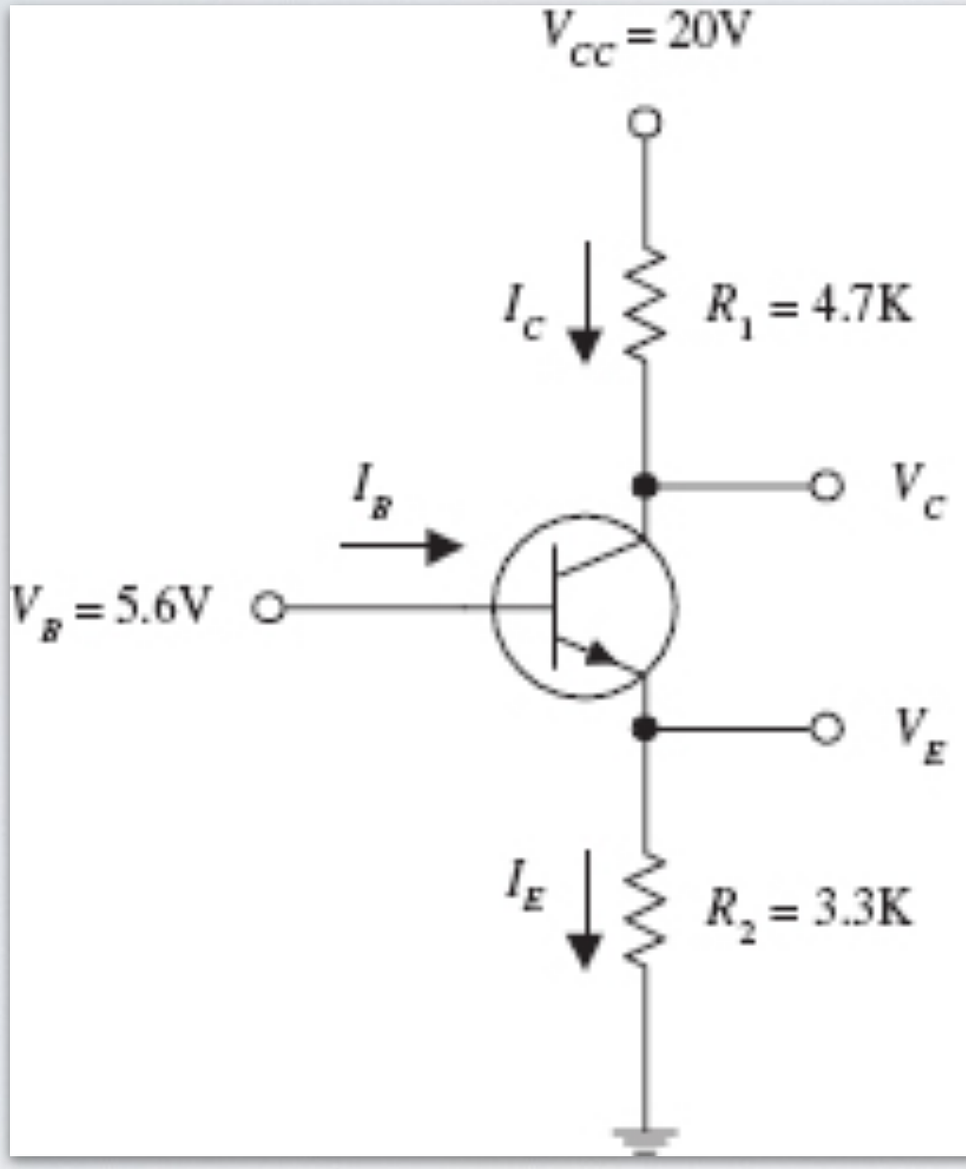
Quelle: P. Scherz (2013)

Transistor (npn)



- Halbleiter anwendbar als Schalter oder Verstärker
- Hier Betrachtung von npn-Transistoren als Schalter:
  - drei Anschlüsse: Base, Collector und Emitter
  - kein Strom an Base: auch kein Strom von Collector zu Emitter
  - Strom über bestimmte Schwelle (z.B. 0,6 V): Strom von Base zu Emitter und Collector zu Emitter
  - Für Anwendung:
    - Spannung an Collector muss größer als Spannung am Emitter sein.
    - Spannung an Base ist (z.B. 0,6 V bei Siliziumtransistoren) größer als die Spannung am Emitter.

Transistor (npn): Beispiel



$$V_E = V_B - 0.6\text{ V}$$

$$V_E = 5.6\text{ V} - 0.6\text{ V} = 5.0\text{ V}$$

$$I_E = \frac{V_E - 0\text{ V}}{R_2} = \frac{5.0\text{ V}}{3300\ \Omega} = 1.5\text{ mA}$$

$$I_B = \frac{I_E}{(1 + h_{FE})} = \frac{1.5\text{ mA}}{(1 + 100)} = 0.015\text{ mA}$$

$$I_C = I_E - I_B \approx I_E = 1.5\text{ mA}$$

$$V_C = V_{CC} - I_C R_1$$

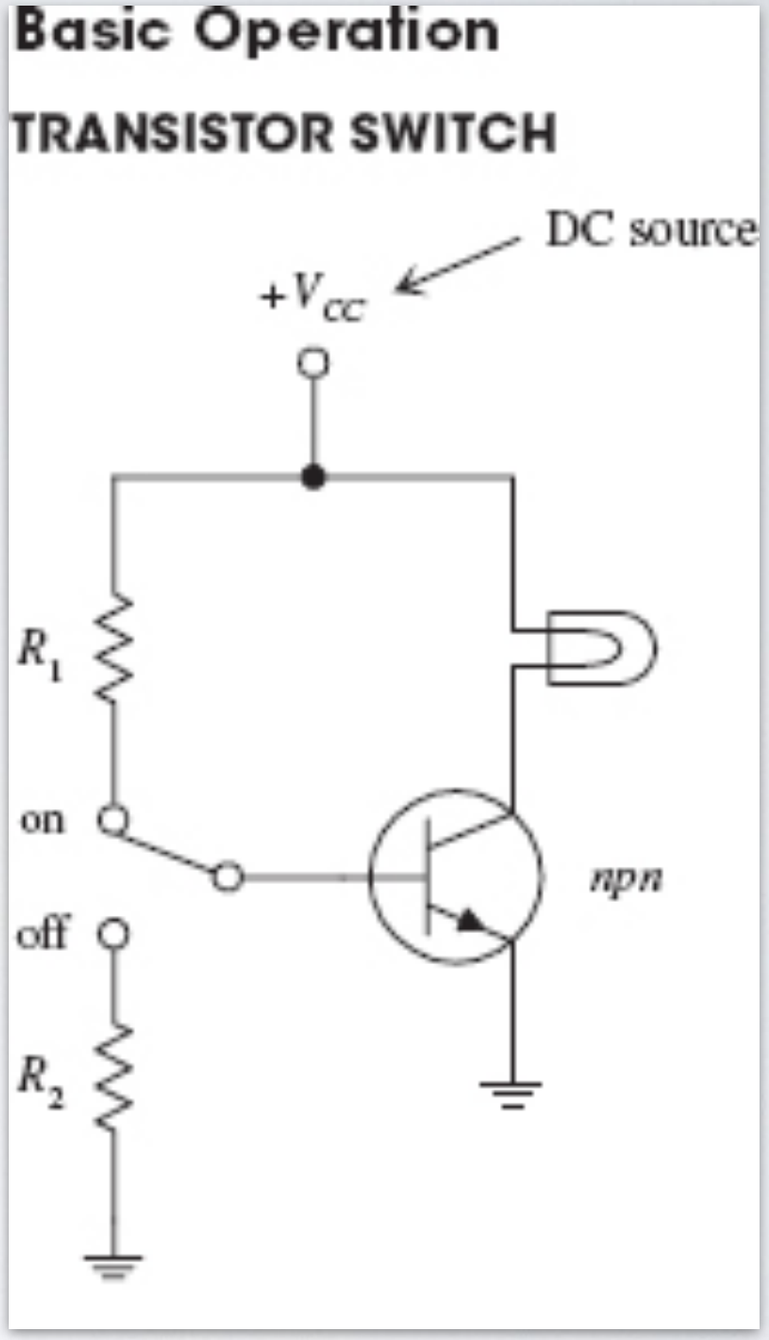
$$V_C = 20\text{ V} - (1.5\text{ mA})(4700\ \Omega)$$

$$V_C = 13\text{ V}$$

Quelle: P. Scherz (2013)

Transistor (npn) als Schalter

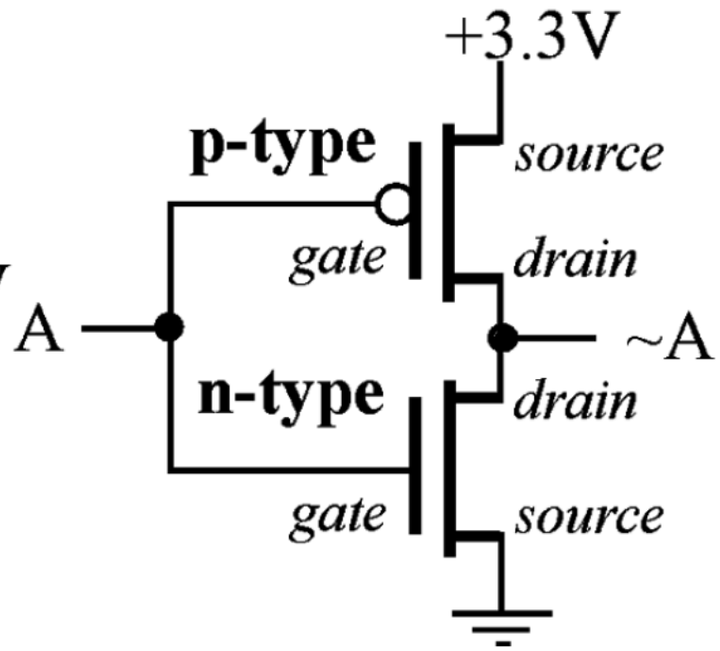
- Der Base-Eingang schaltet den Strom von dem Collector-Eingang zum Emitter-Ausgang.

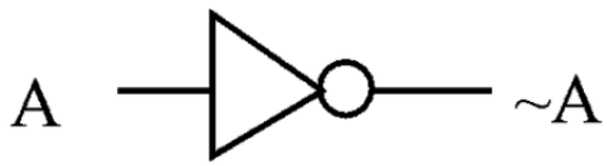


Quelle: P. Scherz (2013)

Digitale Logik

A	p-type	n-type	~A
0 V	active	off	+3.3V
+3.3V	off	active	0V



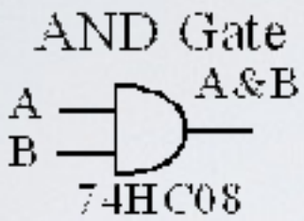


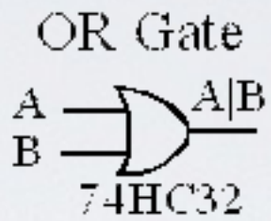
74HC04

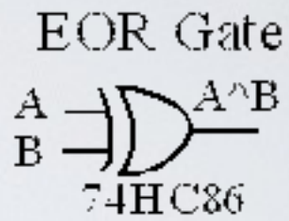
A	~A
0	1
1	0

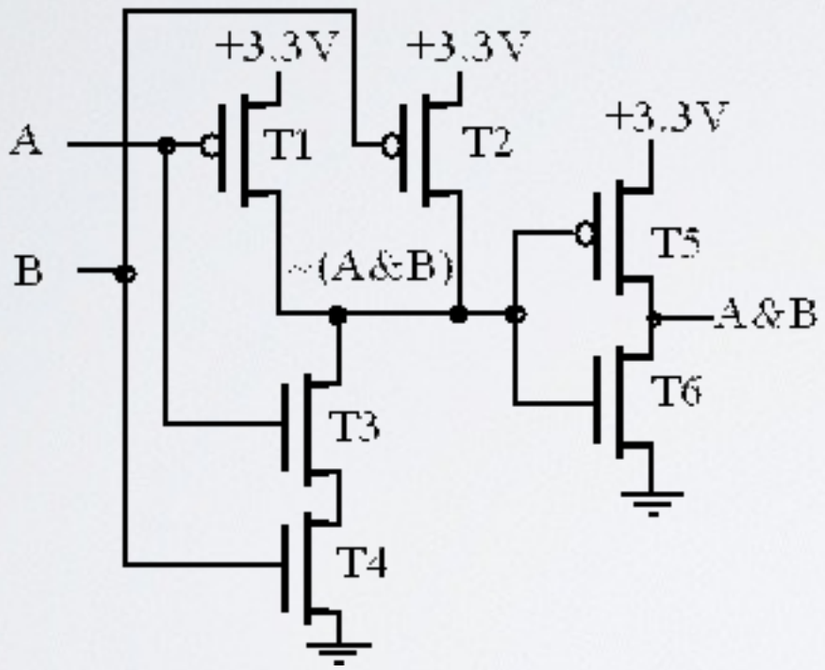
Quelle: J. Valvano (2018)

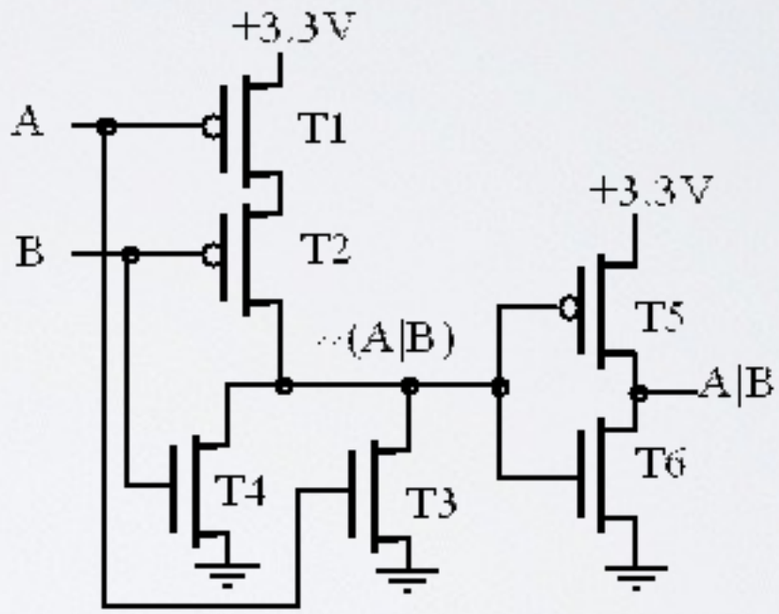
Digitale Logik





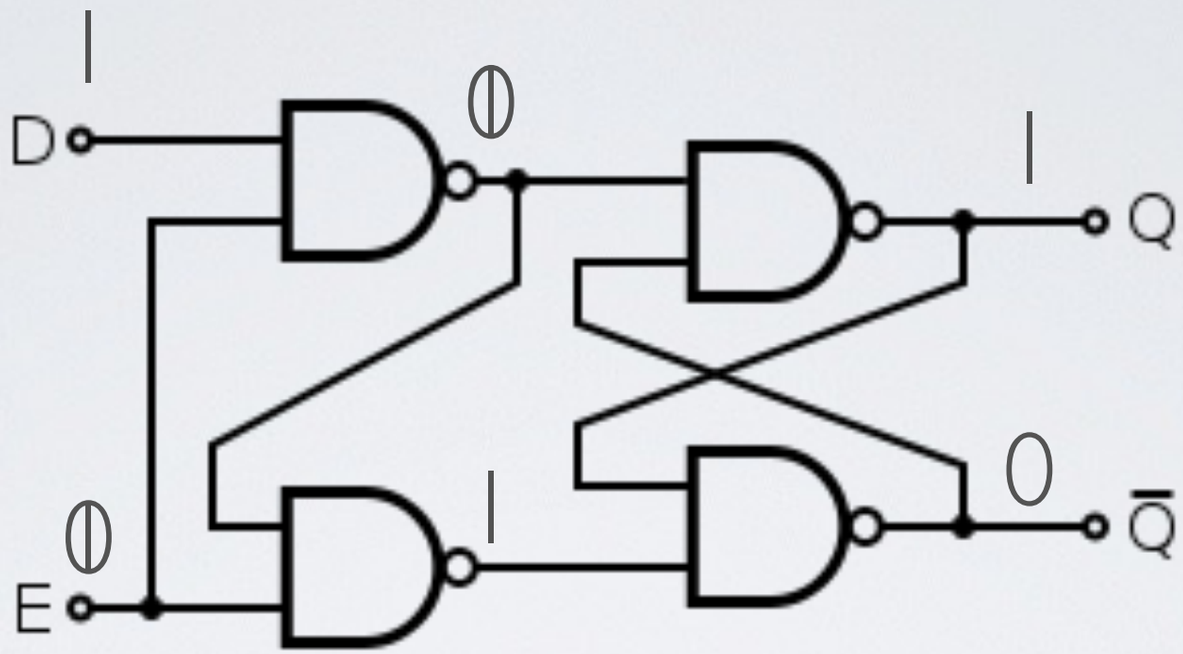






Quelle: J.Valvano (2018)

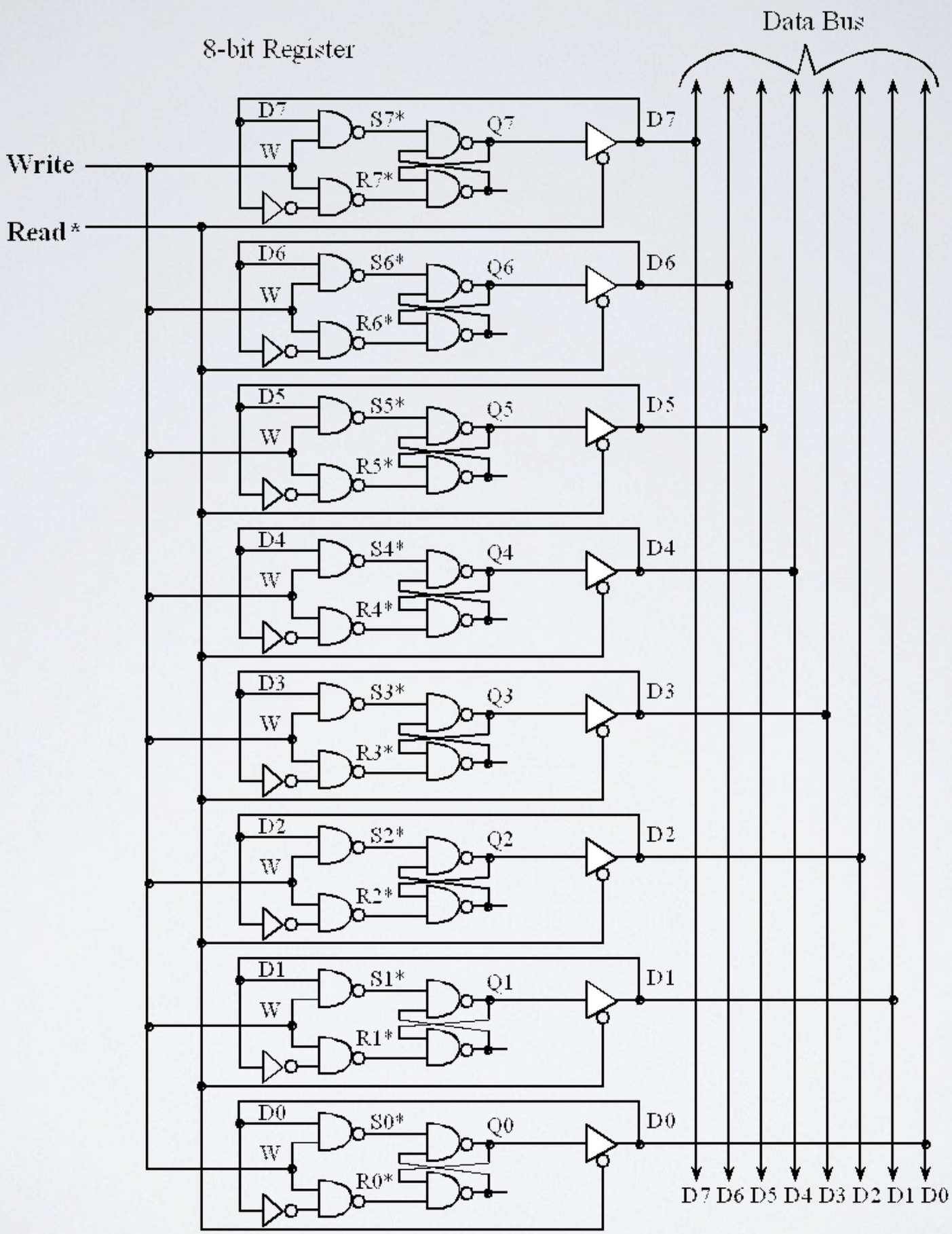
Flip-Flop (Gated D Latch)



Gated D latch truth table

E/C	D		Q	$\overline{Q}$	Comment
0	X		Q_{prev}	$\overline{Q}_{prev}$	No change
1	0		0	1	Reset
1	1		1	0	Set

Quelle: https://en.wikipedia.org/wiki/Flip-flop_(electronics) [05.08.2018]



Quelle: J. Valvano (2018)

Bauelemente im Praktikum (Teil)

Base

1x Arduino
1x USB Cable
1x Breadboard
1x Wiring Set
1x Project Box

Support

8x Resistor 220
4x Resistor 1.1k
4x Resistor 10k
4x Resistor 100k
1x Resistor 1m
1x Resistor 5,1m
2x Transistor (NPN)
1x Relay
1x MOSFET (Power)
2x Diode (Rectifier)
1x Diode (Zener)

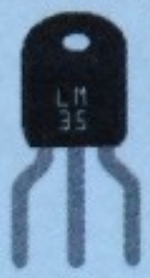
Outputs

1x Servo Motor
1x LED RGB
2x LED green
2x LED red
2x LED yellow
1x Piezo Buzzer

Inputs

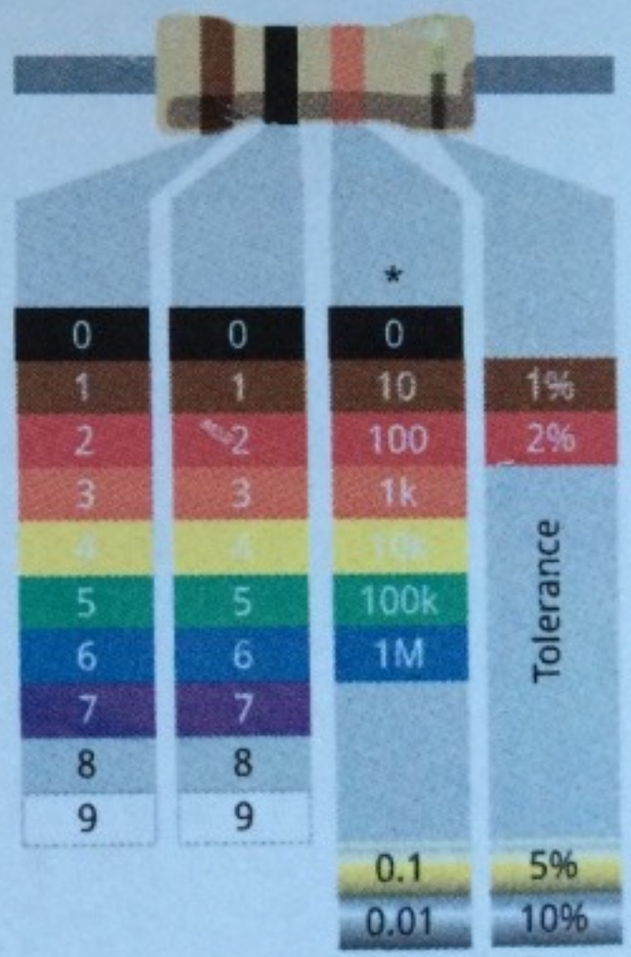
1x Rotary Knob (Potentiometer)
2x Push-Button
1x Tilt Sensor
1x Light Sensor (LDR)
1x Temperature Sensor

Attention:



The Temperature Sensor looks almost like the Transistors but is labeled with LM35. It's marked with a white dot on top.

Resistor Code

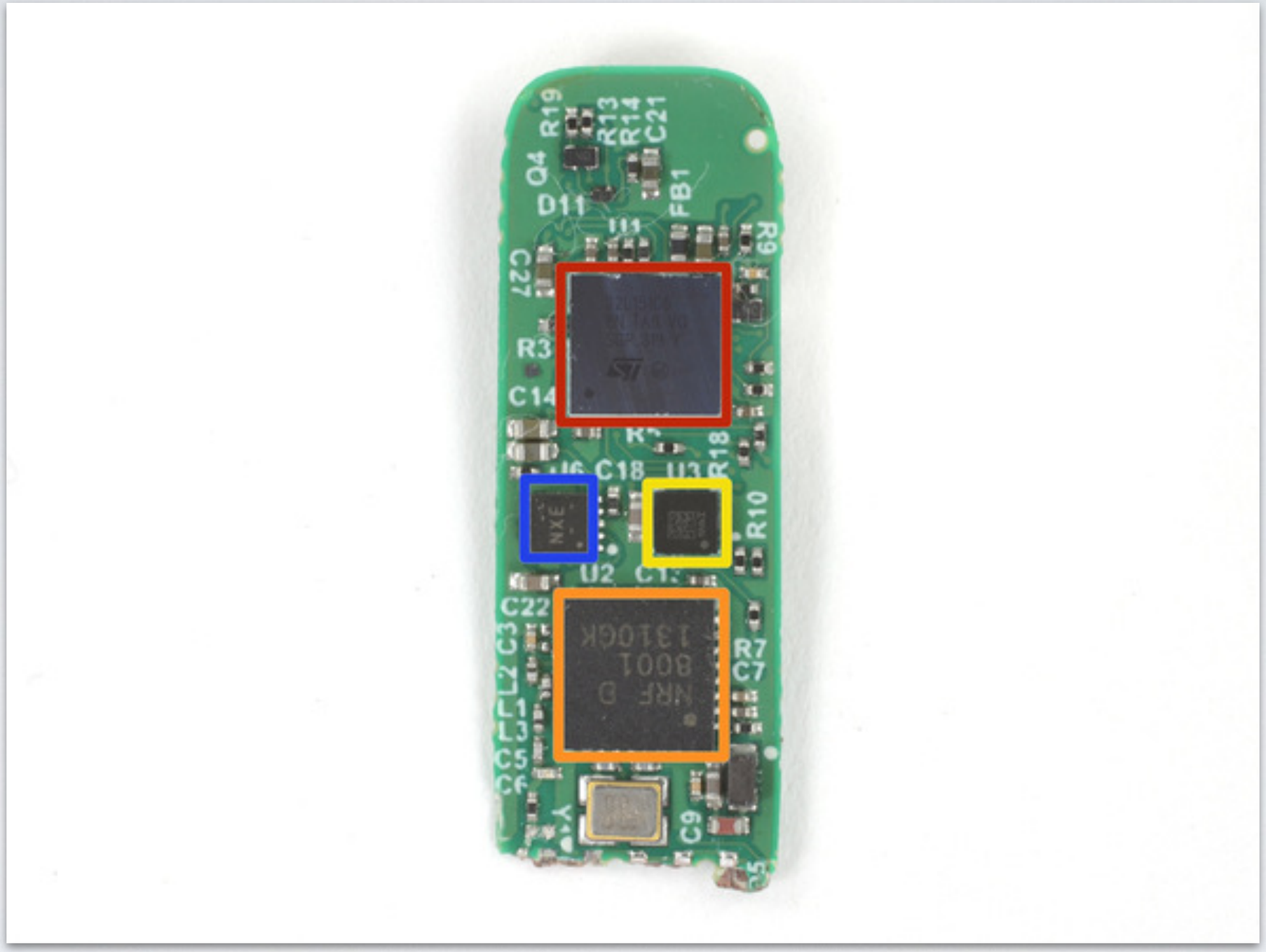


For more information check **http://fritzing.org/starterkit-instructions**

Zusammenfassung

- Kenntnisse über (einige) Grundlagen der Elektrotechnik
  - zum Verständnis von Bauelementen und einfachen Schaltungen
  - für die Anwendung im Praktikum.

Schrittzähler - Teardown



Quelle: https://de.ifixit.com/Teardown/Fitbit+Flex+Teardown/16050, Zugriff: 10.04.2016

Literatur

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