Physical Computing

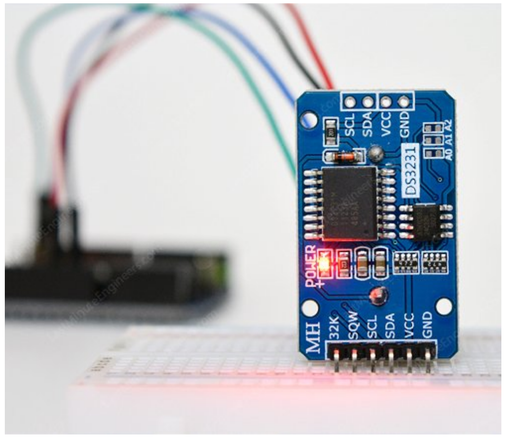
SoSe 2021 – Basics 5

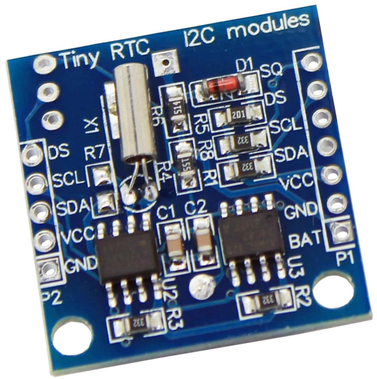
Keine Musterlösung für ein EVA-System

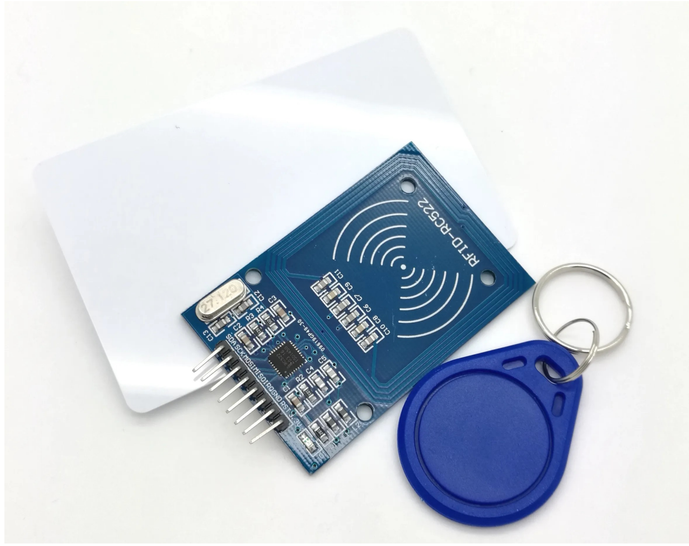
Aufgabe 3

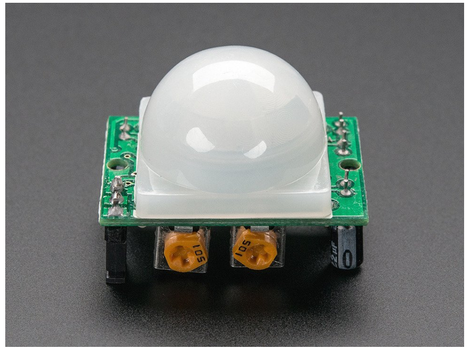
Recap
Halbleiter
Transistoren
Bipolartransistoren
Feldeffekt-Transistoren
Galvanische Trennung
Optokoppler
Relais
(Endlicher) Zustandsautomat

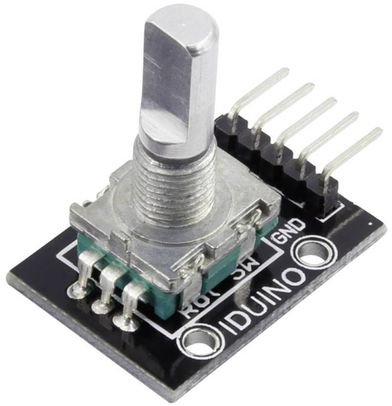
Recap

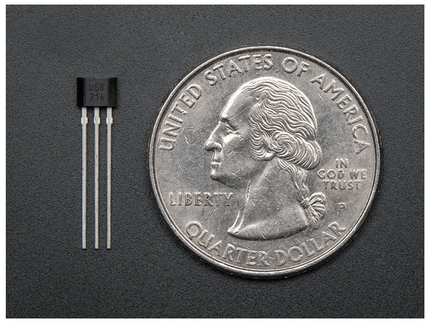


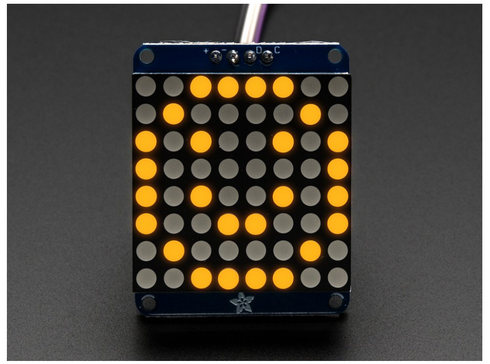




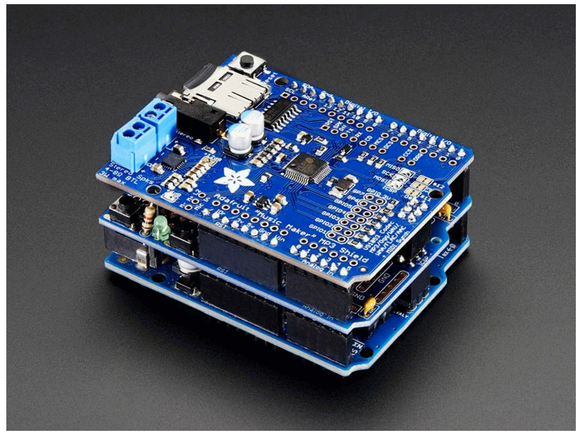


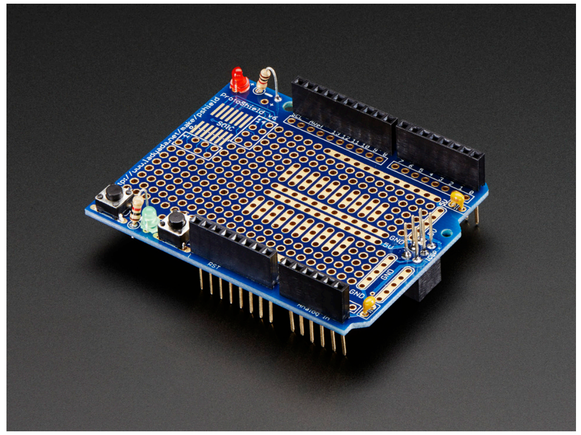


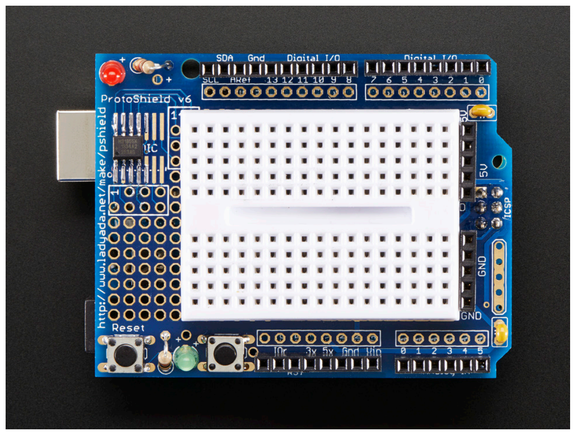


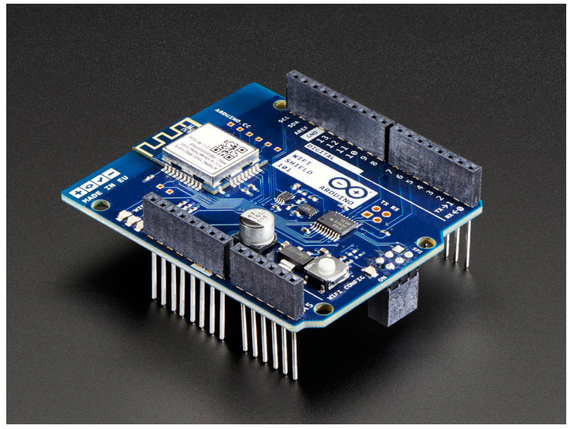


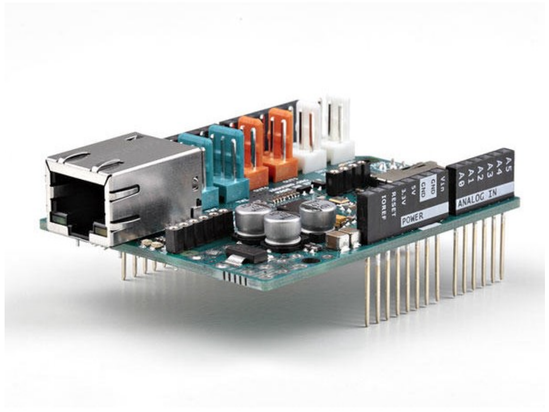
Arduino Bauteile 2

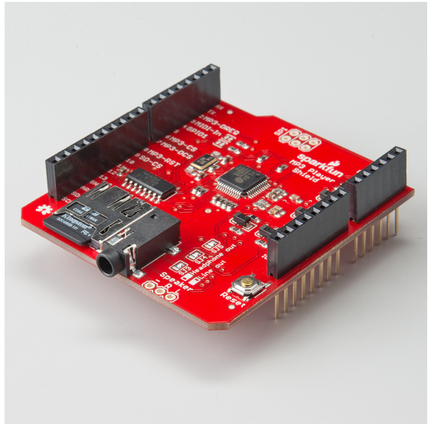


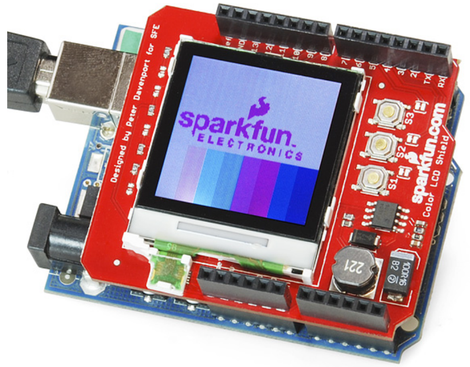


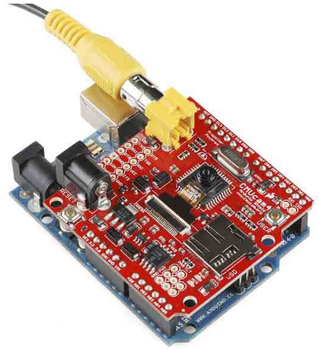






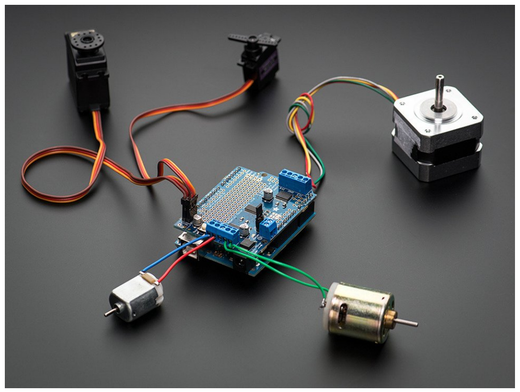


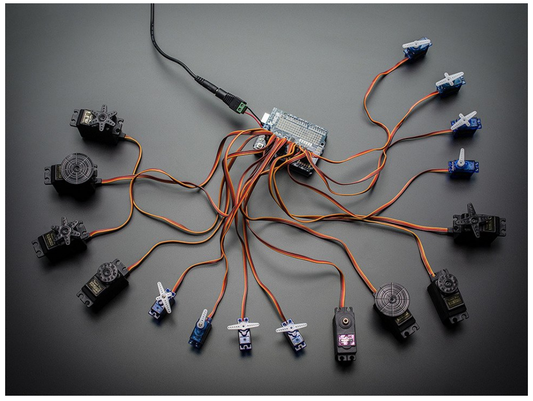


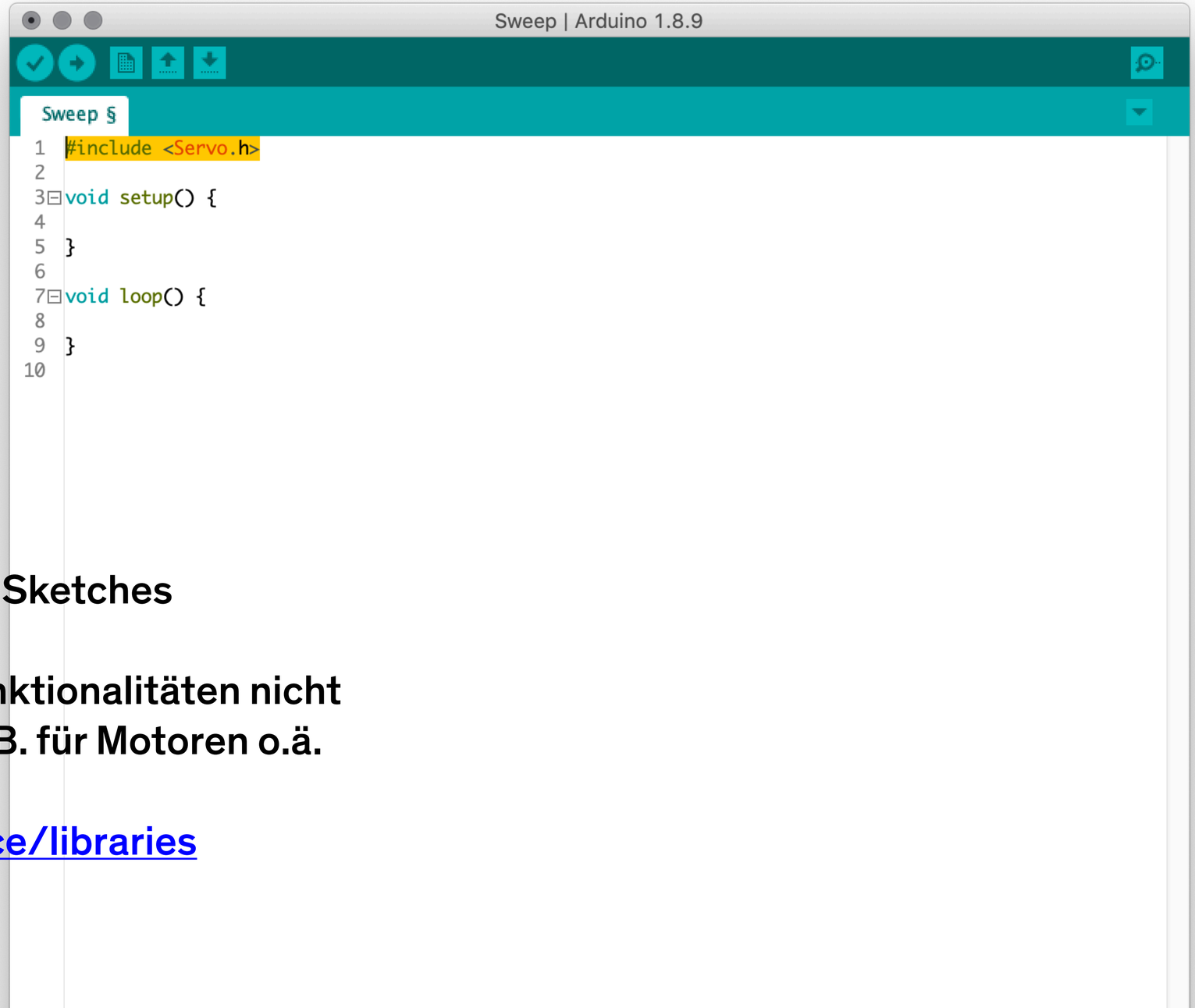


Platinen, die auf das Arduino Board gesteckt werden können und die Funktionalität des Arduino erweitern

Shields







– Bieten zusätzliche Funktionalität für Sketches
– Sind in C/C++ geschrieben
– Erleichtern das Arbeiten, da viele Funktionalitäten nicht selbst geschrieben werden müssen, z.B. für Motoren o.ä.
– https://www.arduinolibraries.info/
– https://www.arduino.cc/en/reference/libraries

Bibliotheken

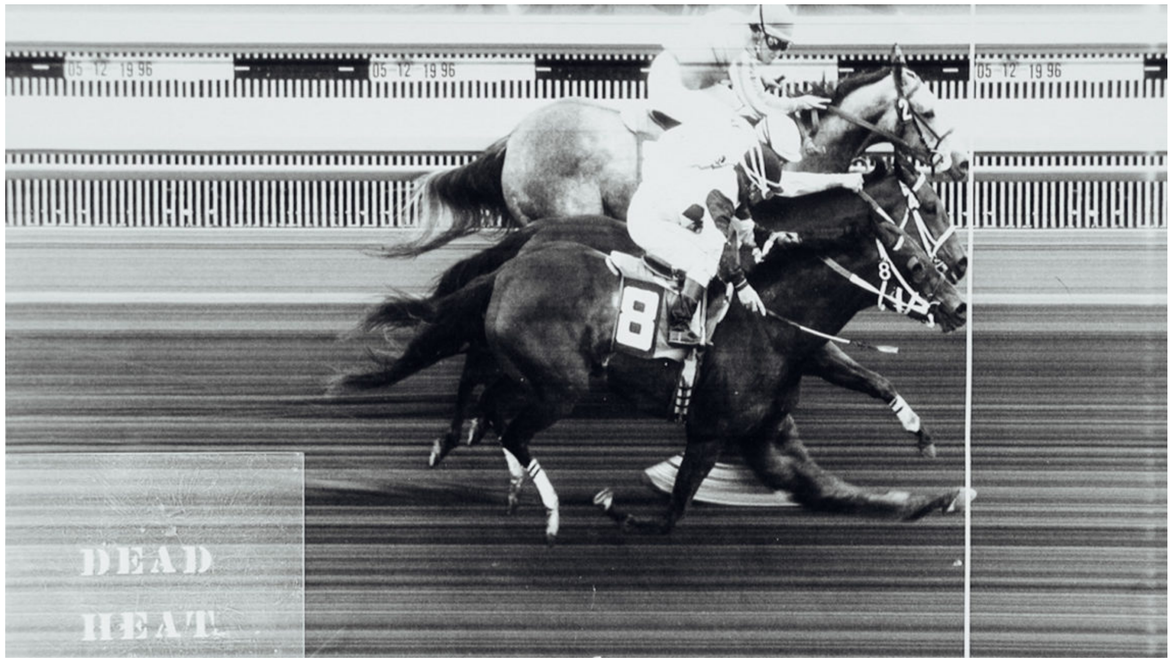
millis()

- Gibt die Anzahl der Millisekunden seit dem Programmstart zurück
- long timestamp = millis() // (Messpunkt)
- Zeitdifferenz mit aktuellen millis() gegen unser Mess-interval abgleichen

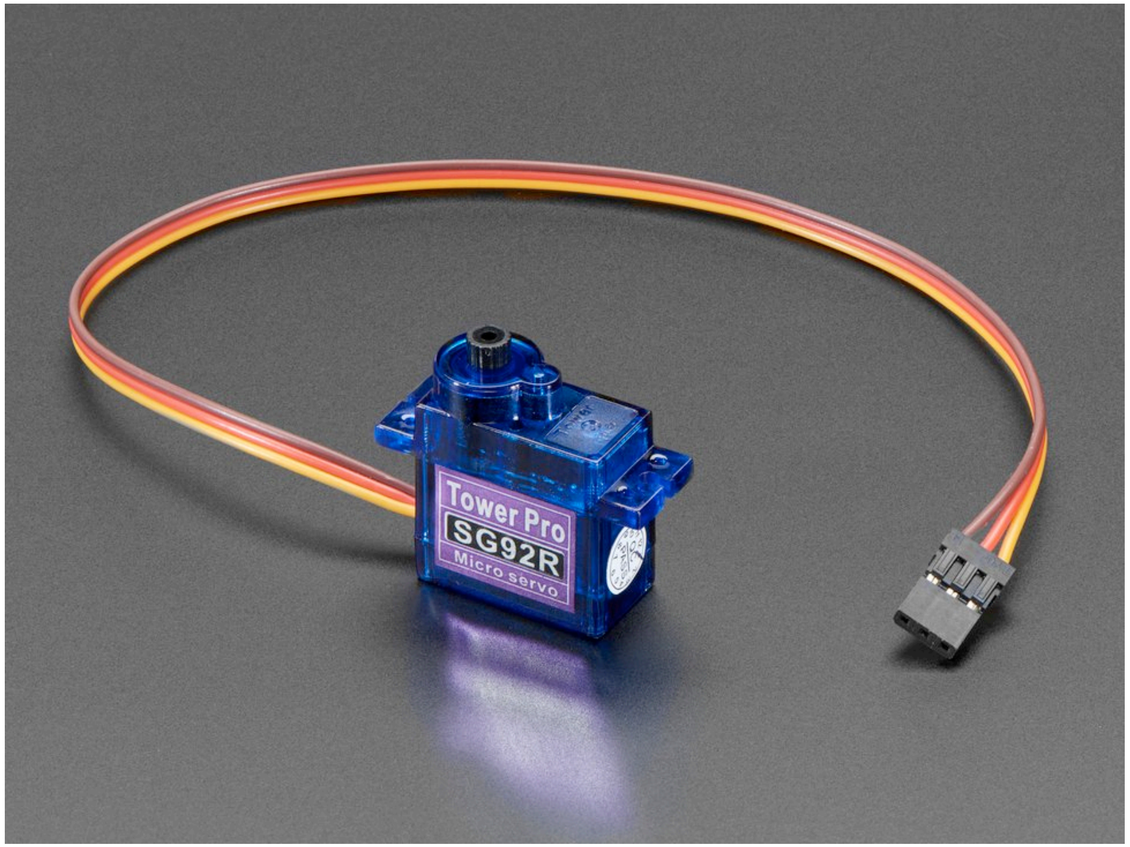
```
long timestamp = 0;
long interval = 1000;

void setup() {
}

void loop() {
  if(millis() - timestamp > interval) {
    timestamp = millis();
    // unser zeitsensibler code
  }
}
```



Multitasking



2 Drehrichtungen

Rotation zwischen 0° und 180°

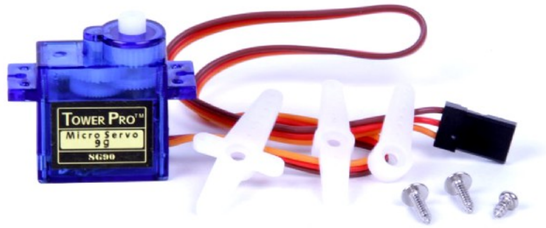
Enthält Zahnräder und eine Welle

Genaue Positionierung über IC + Potentiometer

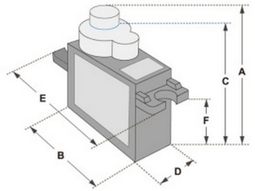
Kann direkt an den Arduino angeschlossen werden

Besser: Servomotor an separate Spannungsversorgung

SERVO MOTOR SG90 DATA SHEET

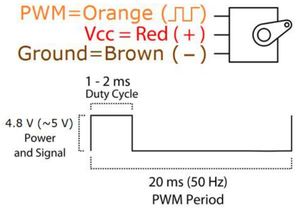


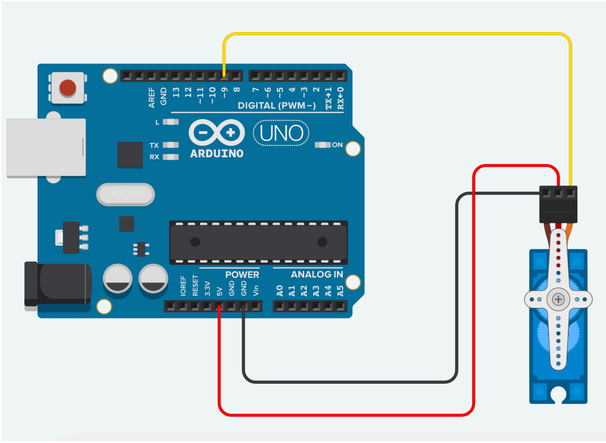
Tiny and lightweight with high output power. Servo can rotate approximately 180 degrees (90 in each direction), and works just like the standard kinds but smaller. You can use any servo code, hardware or library to control these servos. Good for beginners who want to make stuff move without building a motor controller with feedback & gear box, especially since it will fit in small places. It comes with a 3 horns (arms) and hardware.



Dimensions & Specifications
A (mm) : 32
B (mm) : 23
C (mm) : 28.5
D (mm) : 12
E (mm) : 32
F (mm) : 19.5
Speed (sec) : 0.1
Torque (kg-cm) : 2.5
Weight (g) : 14.7
Voltage : 4.8 - 6

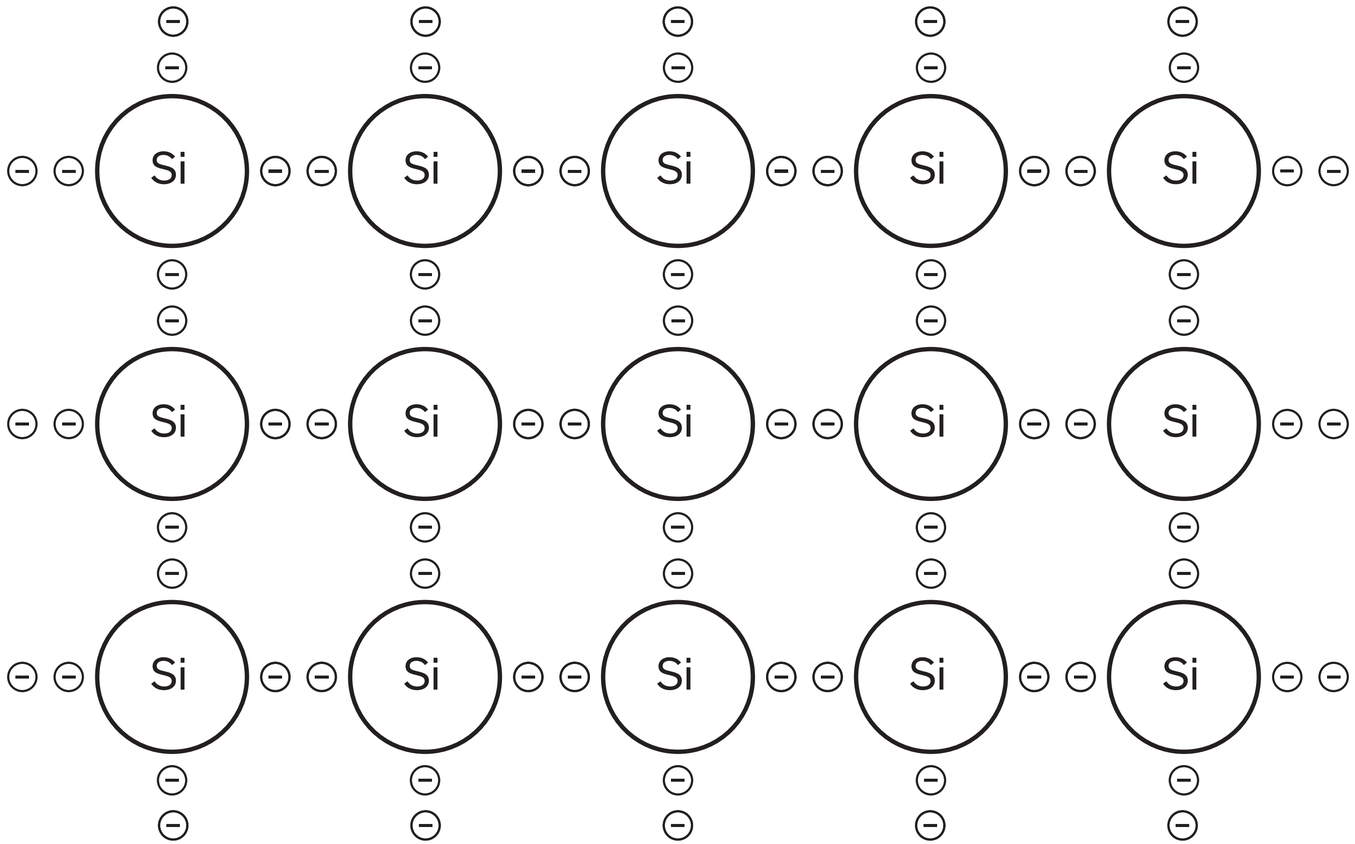
Position "0" (1.5 ms pulse) is middle, "90" (~2ms pulse) is middle, is all the way to the right, "-90" (~1ms pulse) is all the way to the left.





Workshop Servos

Halbleiter



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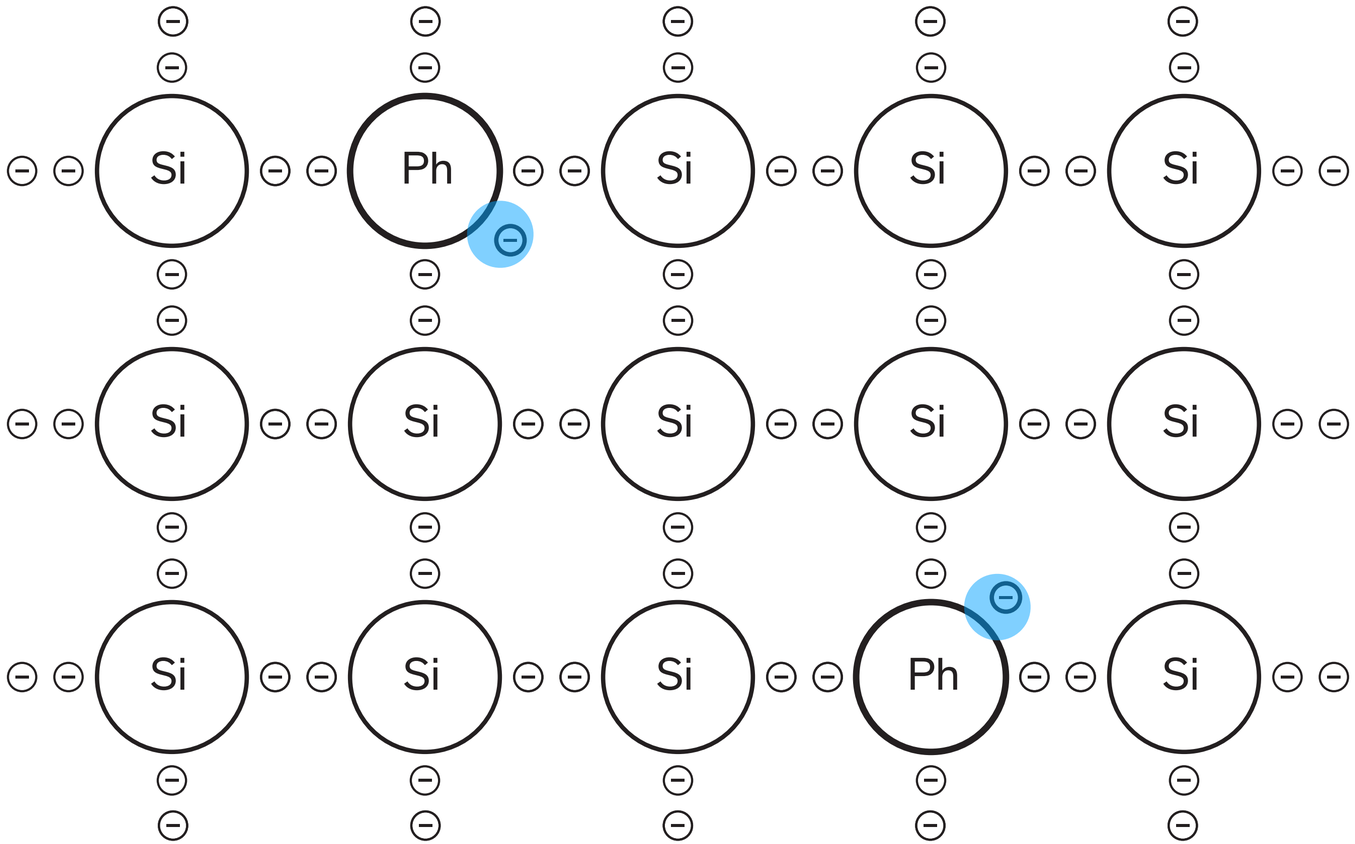
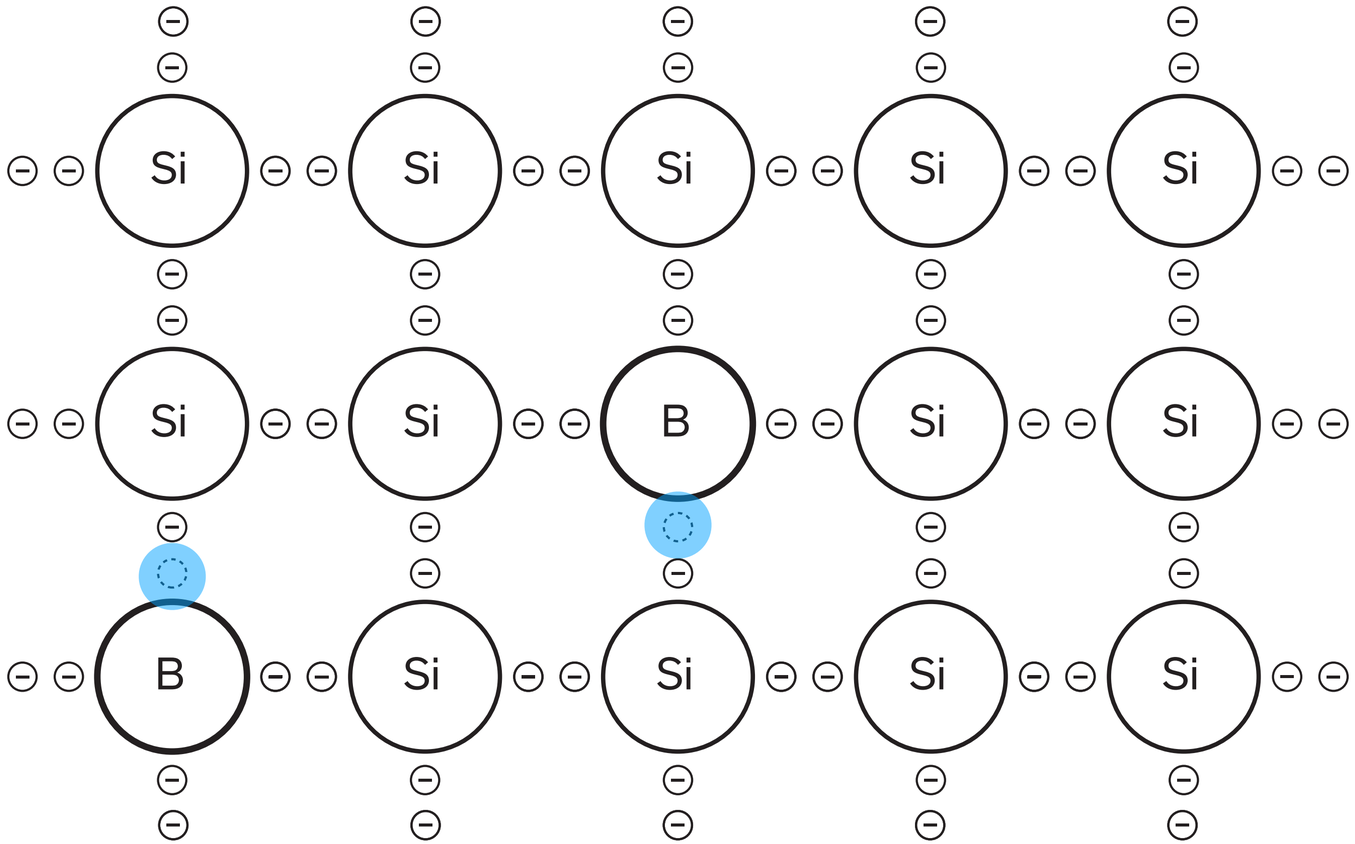
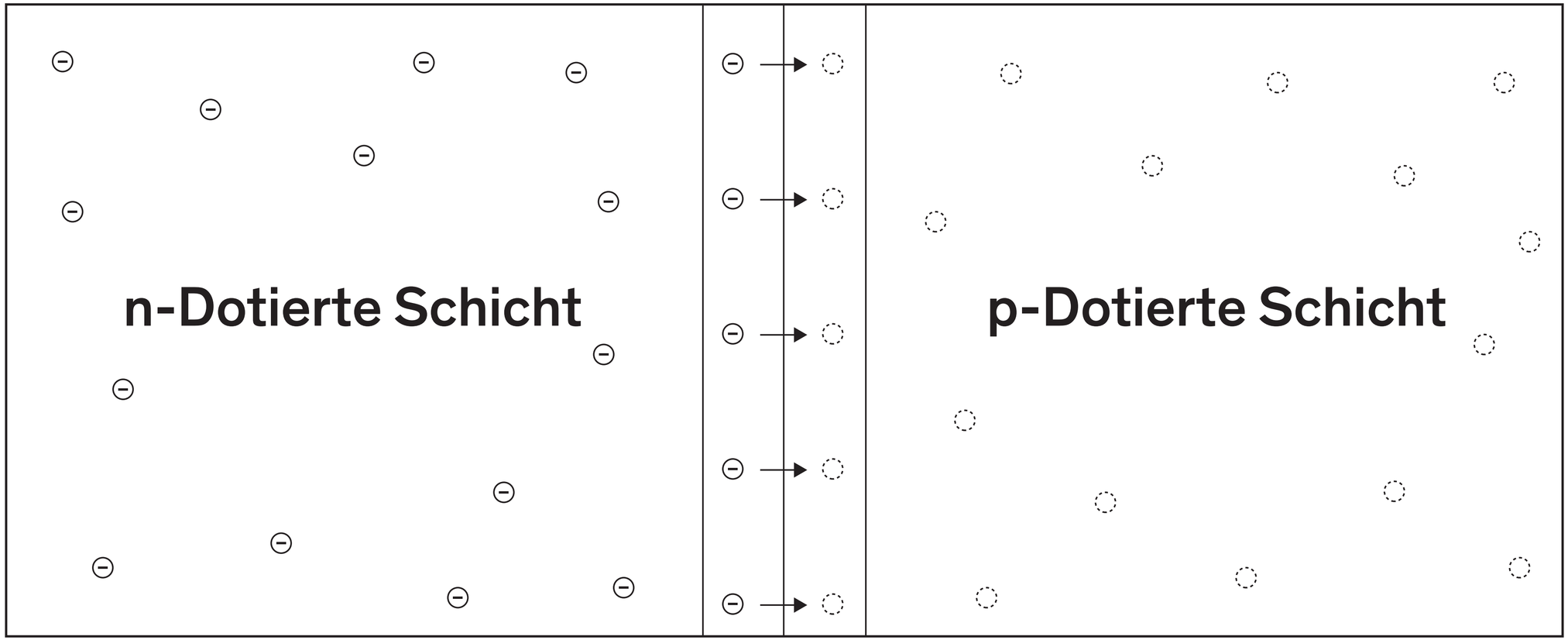


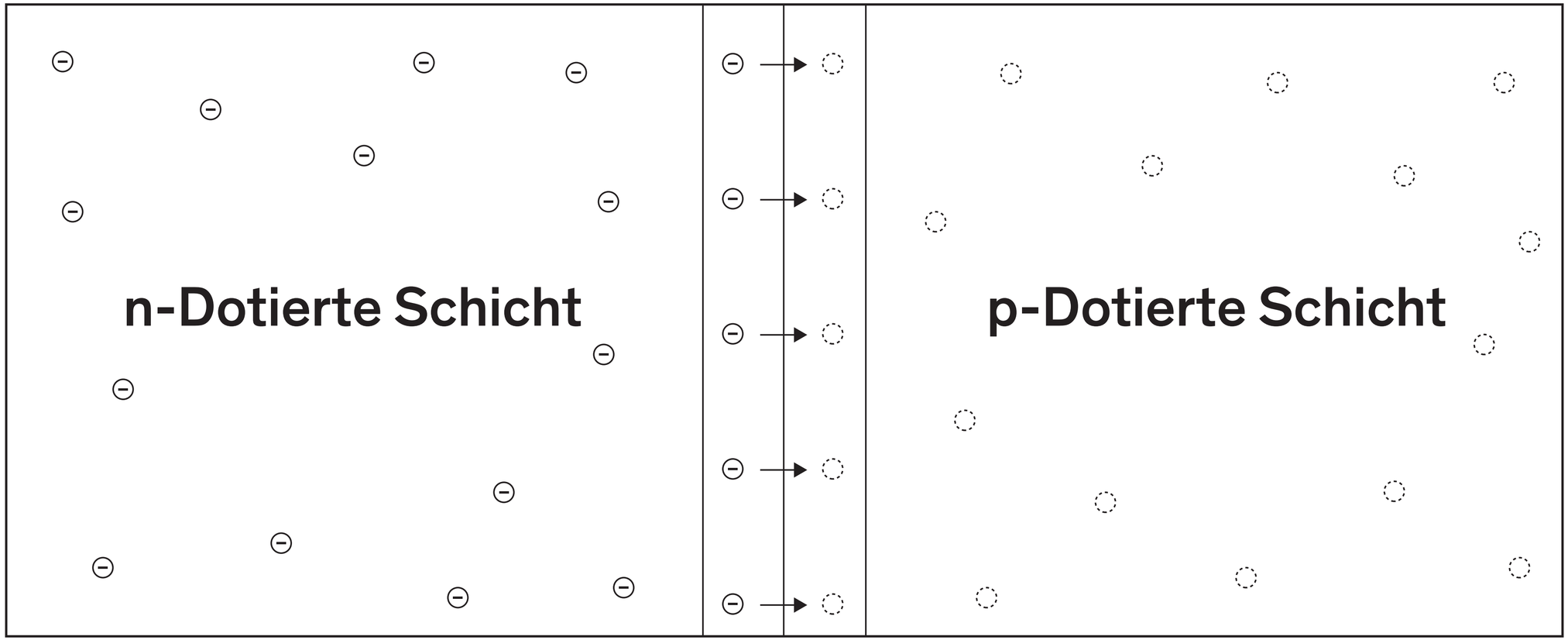
n-Dotierung



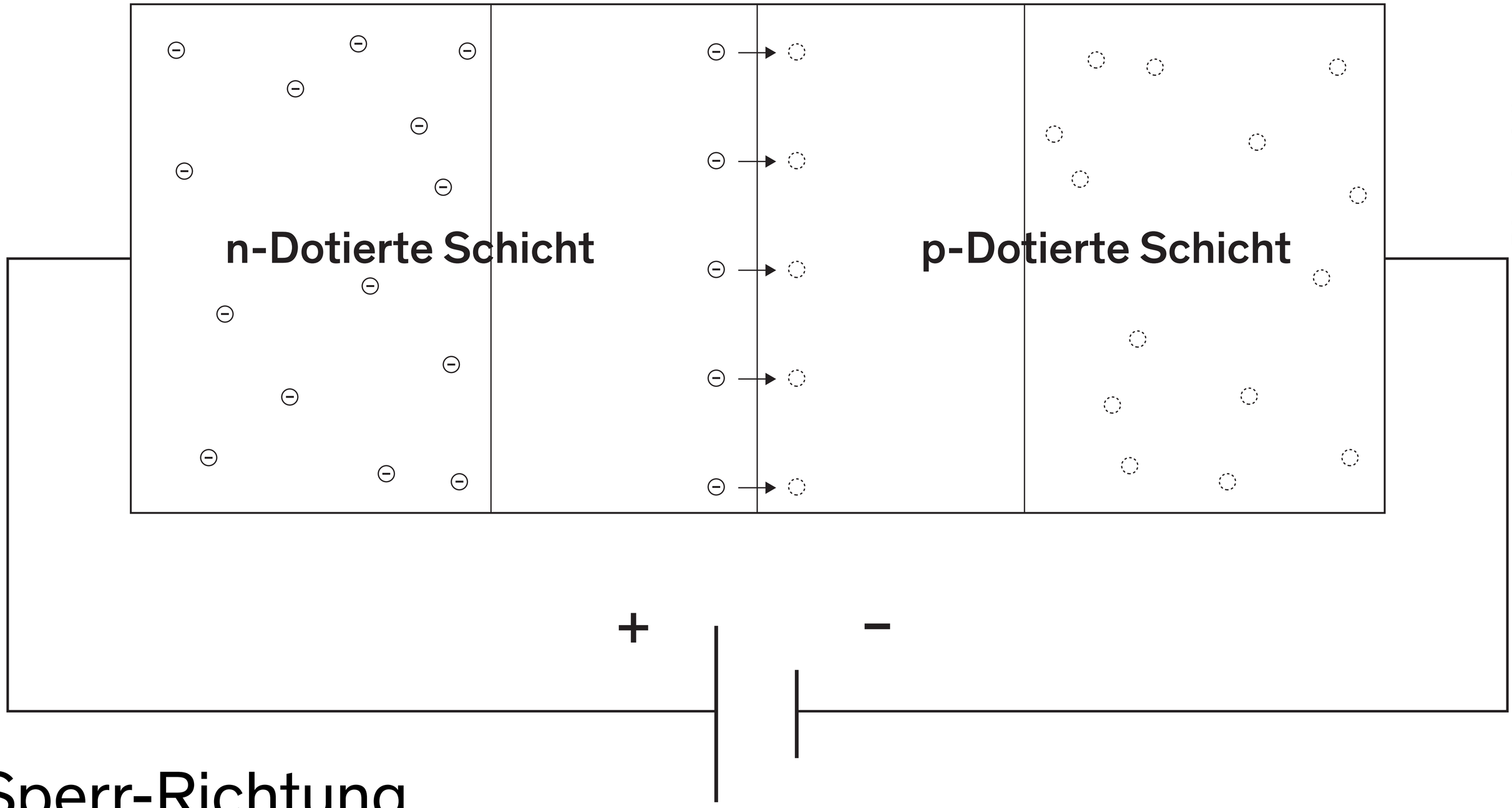
p-Dotierung



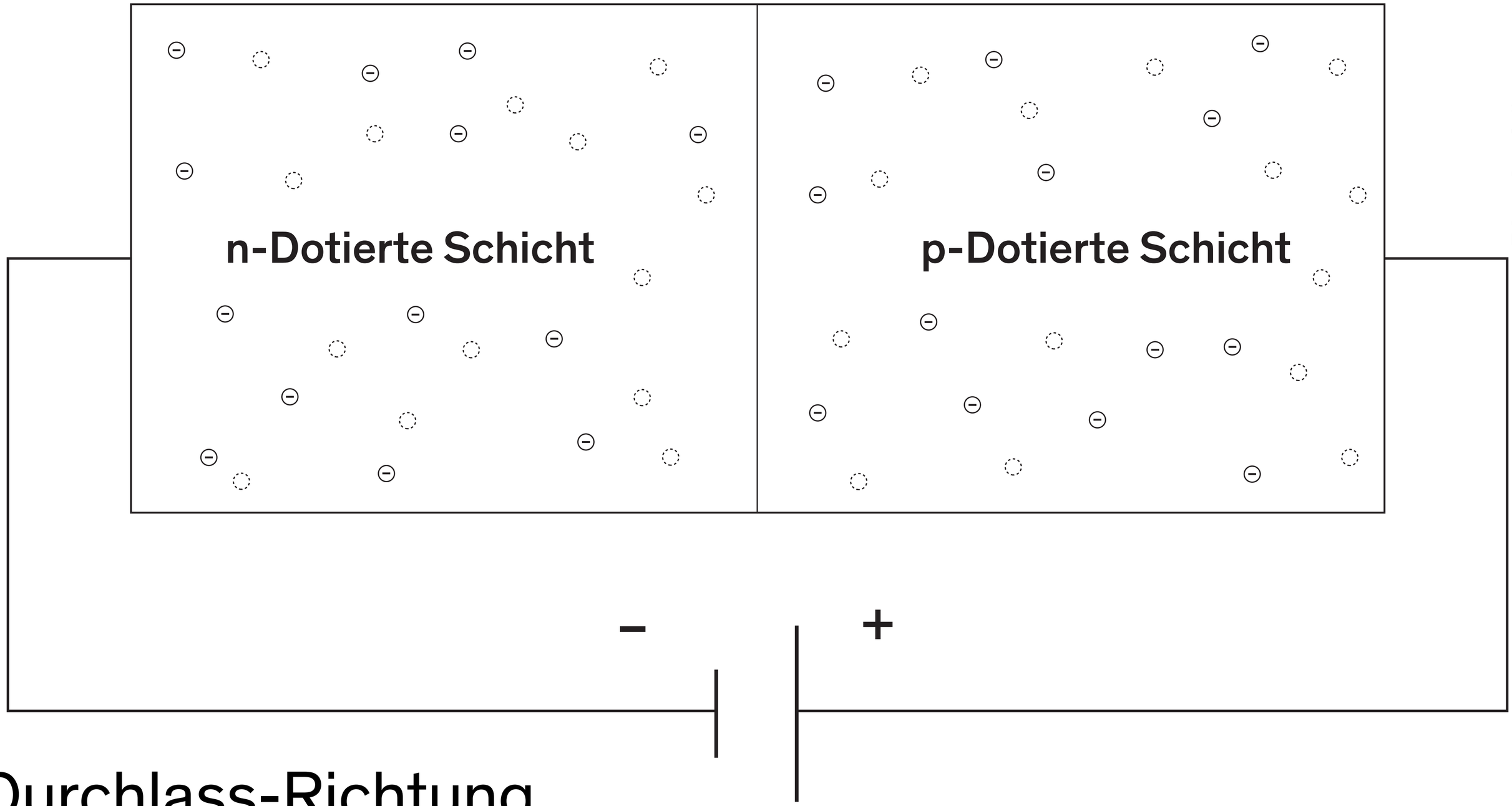
n-p-Übergang



Durchlass- und Sperr-Richtung



Sperr-Richtung



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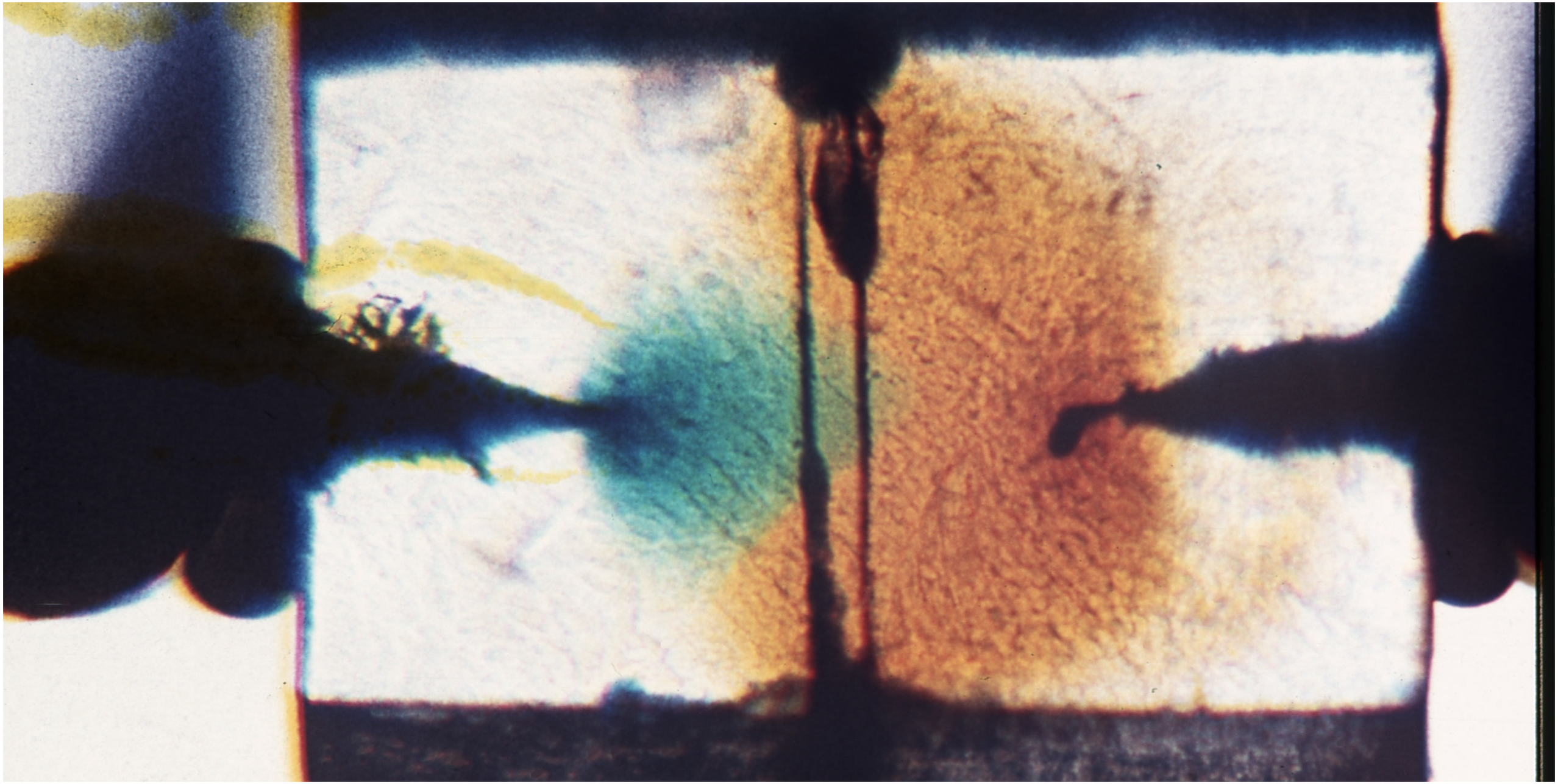
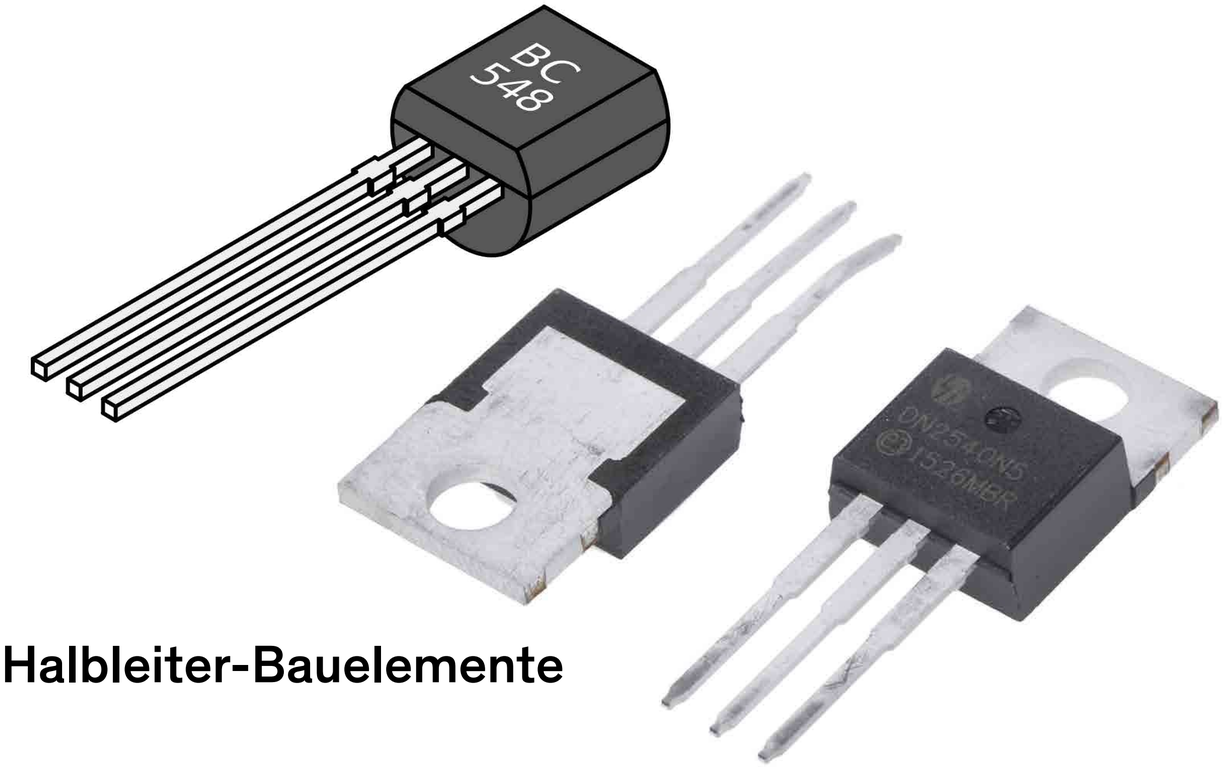


n-P-Übergänge

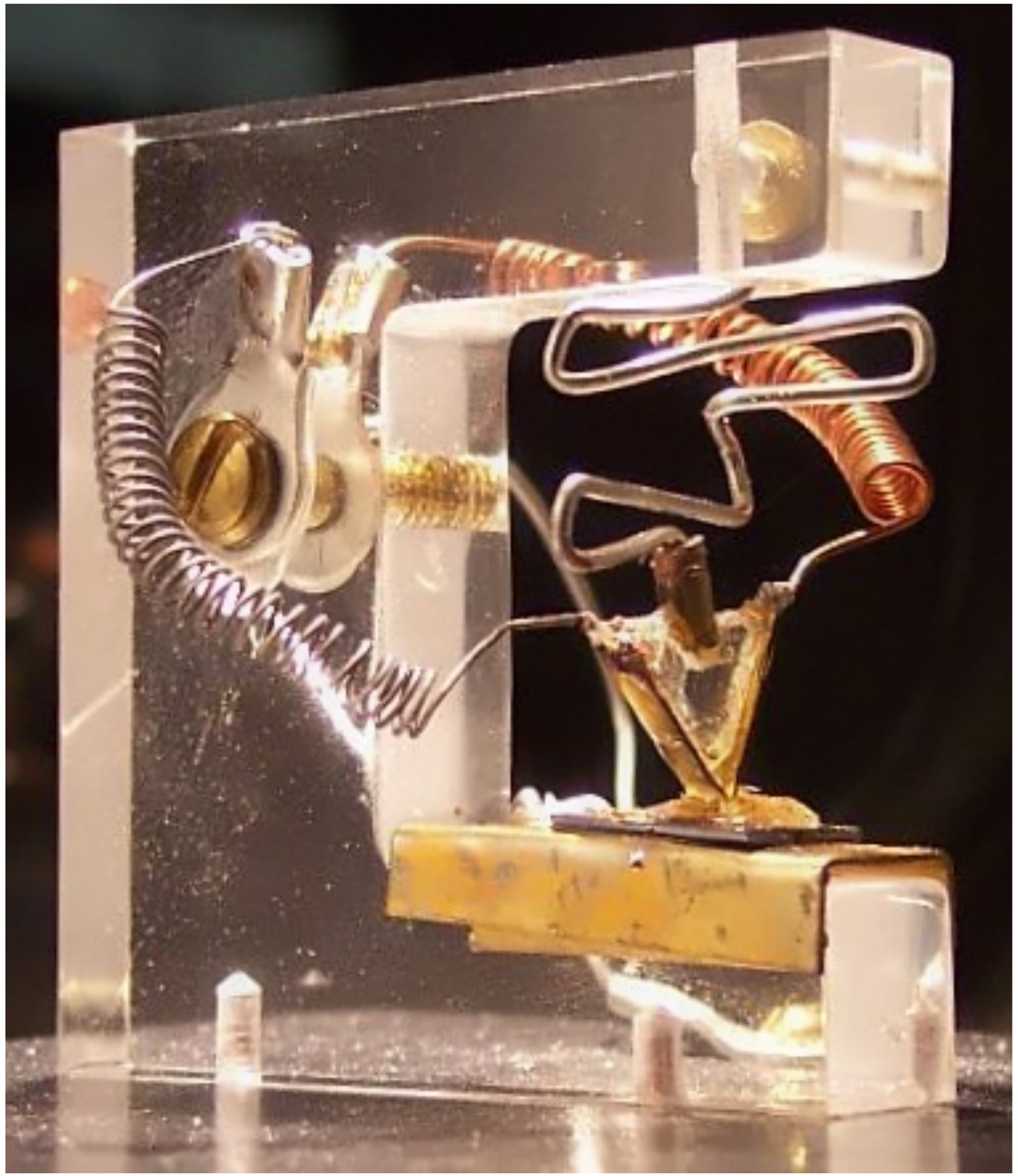


Halbleiter-Bauelemente

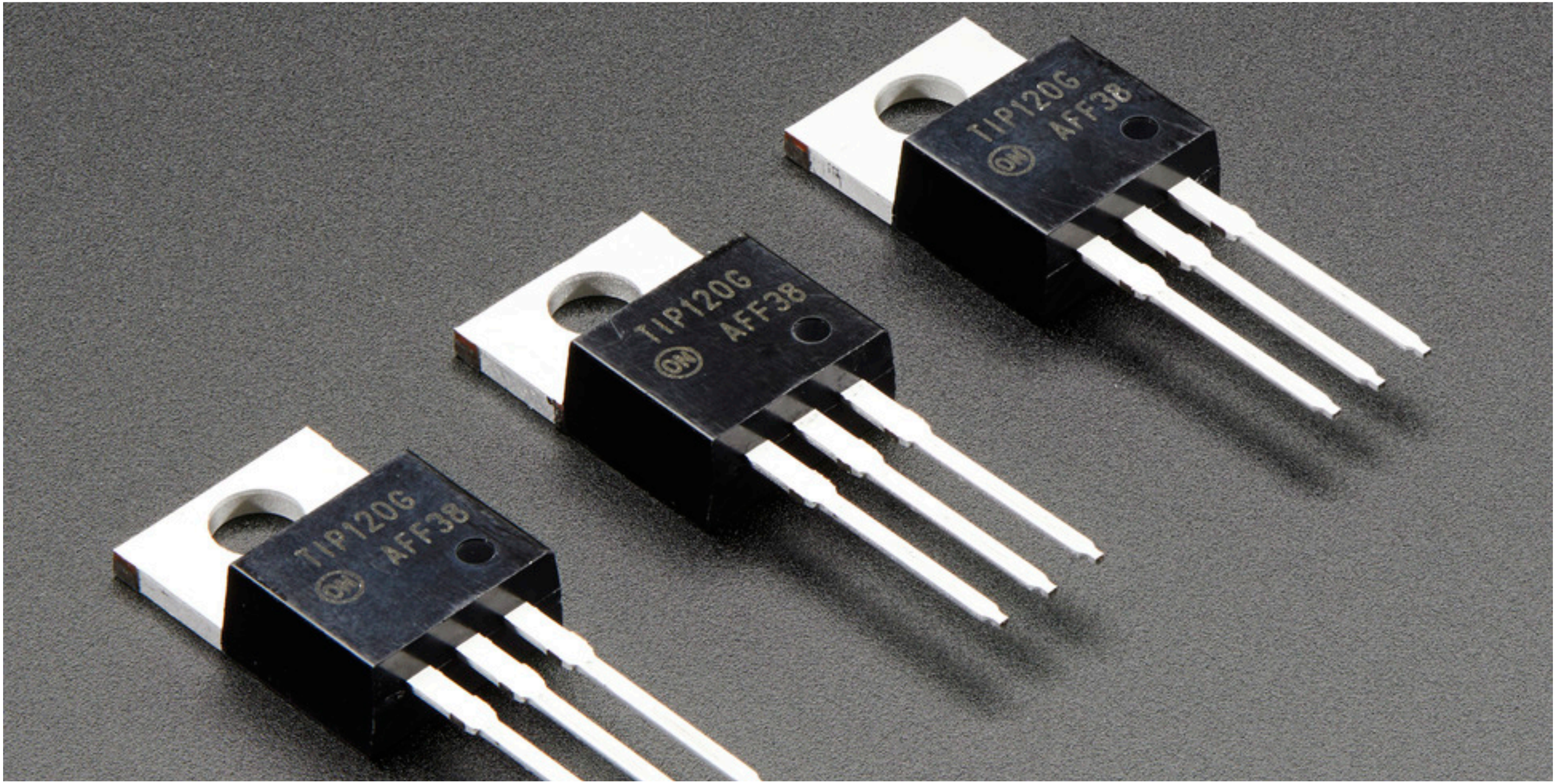
"Elektronischer Schalter"

Steuern und Verstärken von Strömen

Verschiedene Arten:
– Bipolare Transistoren
– Feldeffekttransistoren



Transistoren

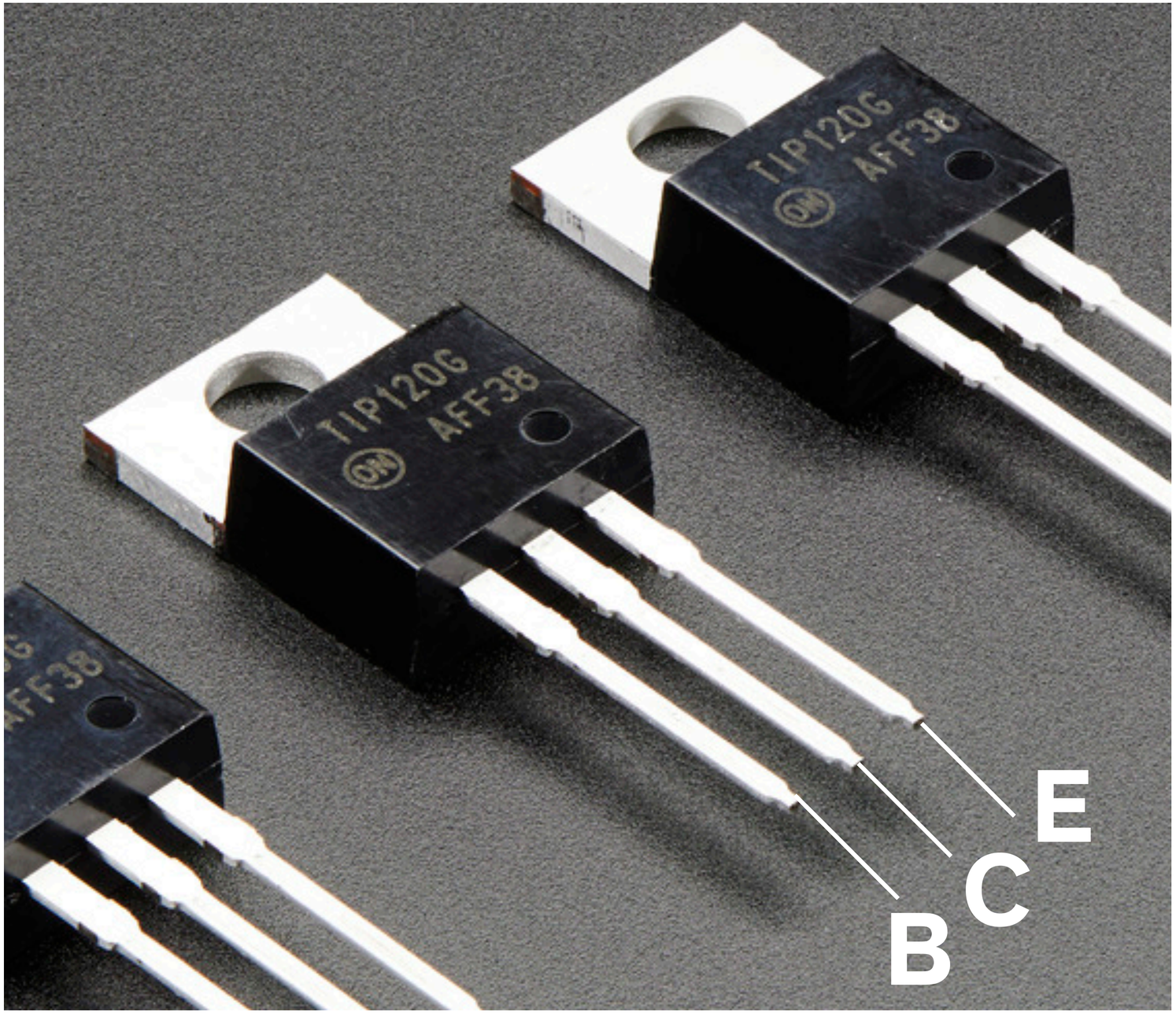


Bipolartransistoren

Bipolartransistoren

"Stromgetrieben"

Standard-Transistor, ausreichend für die meisten Projekte



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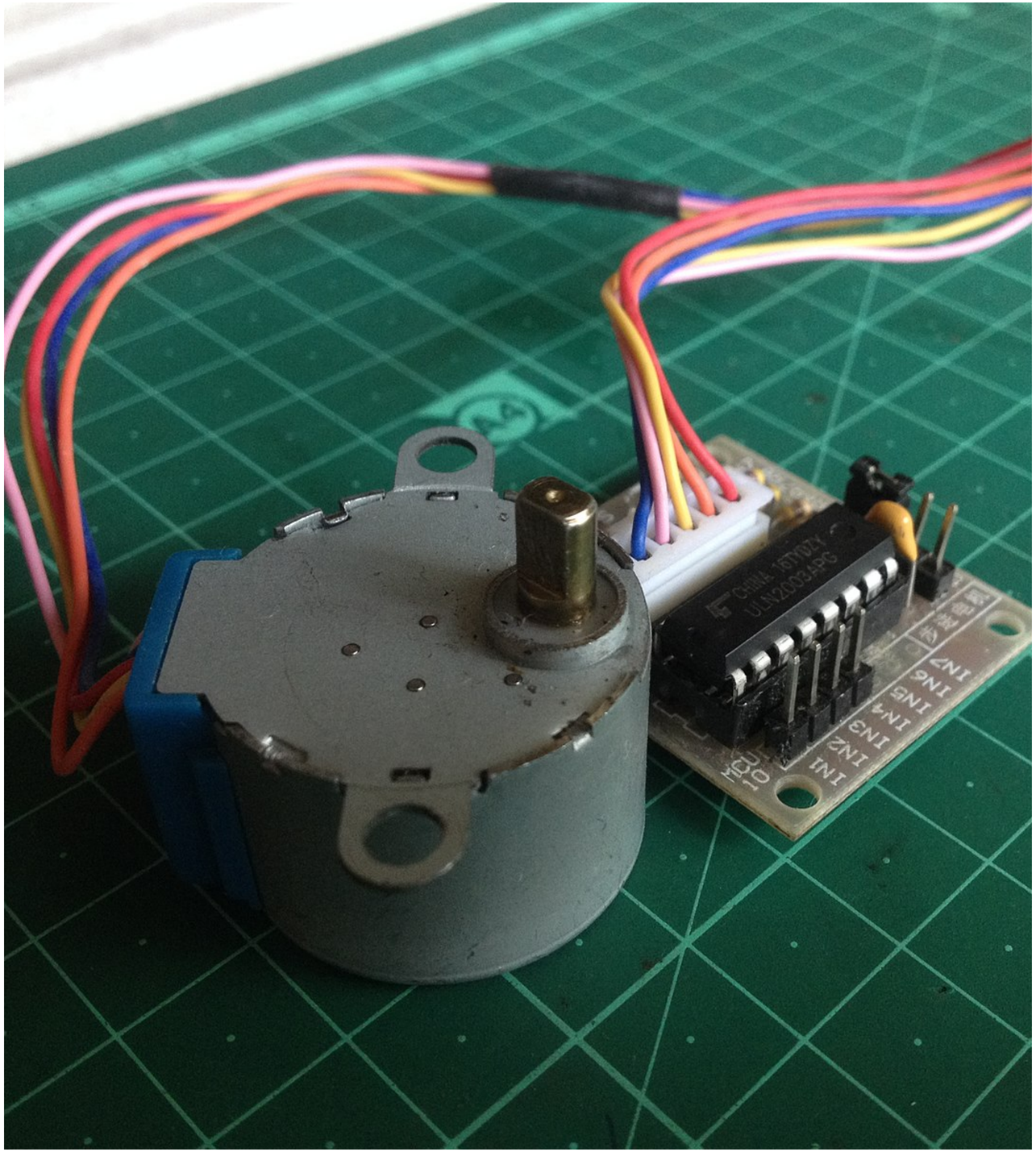
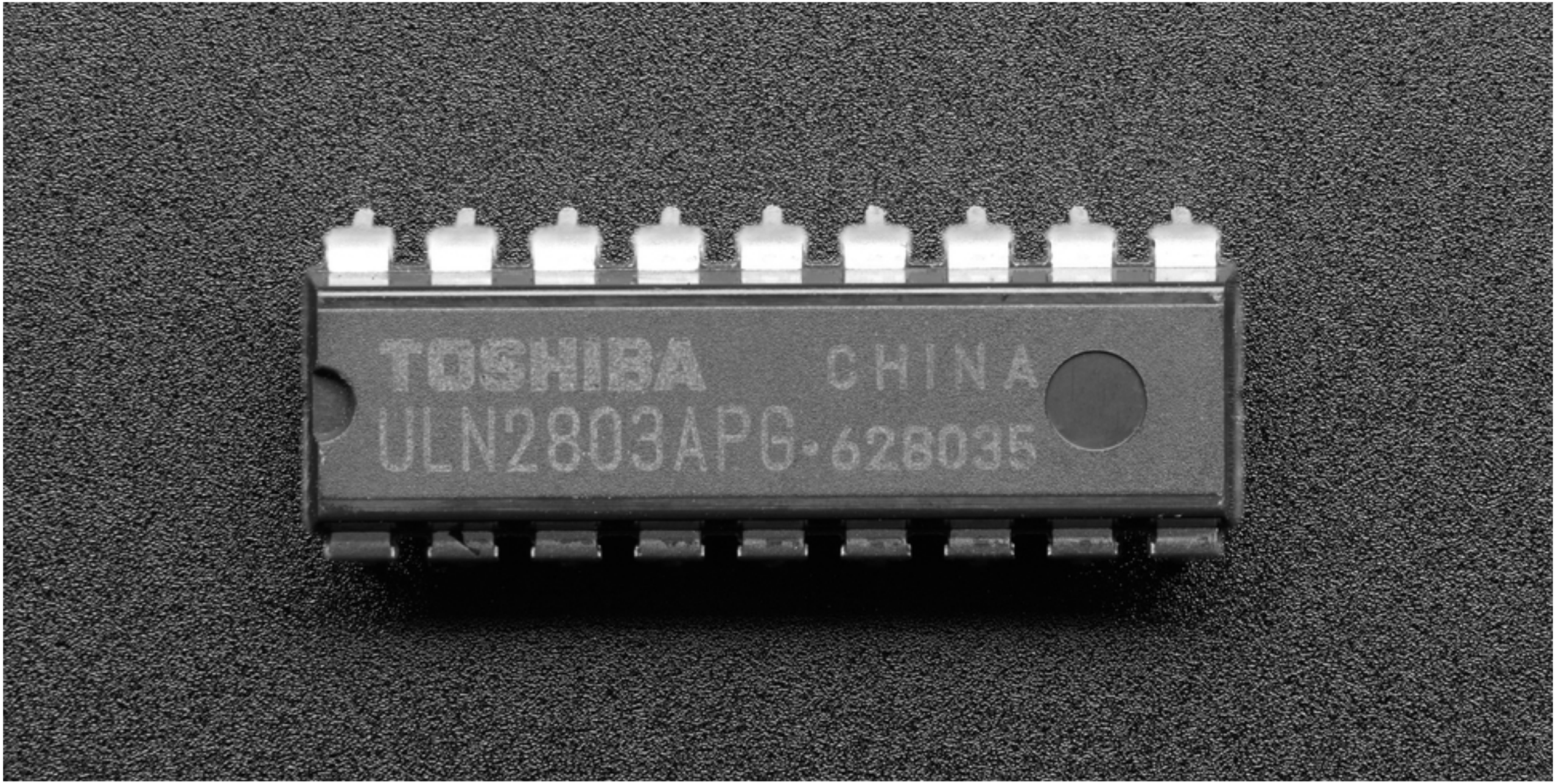
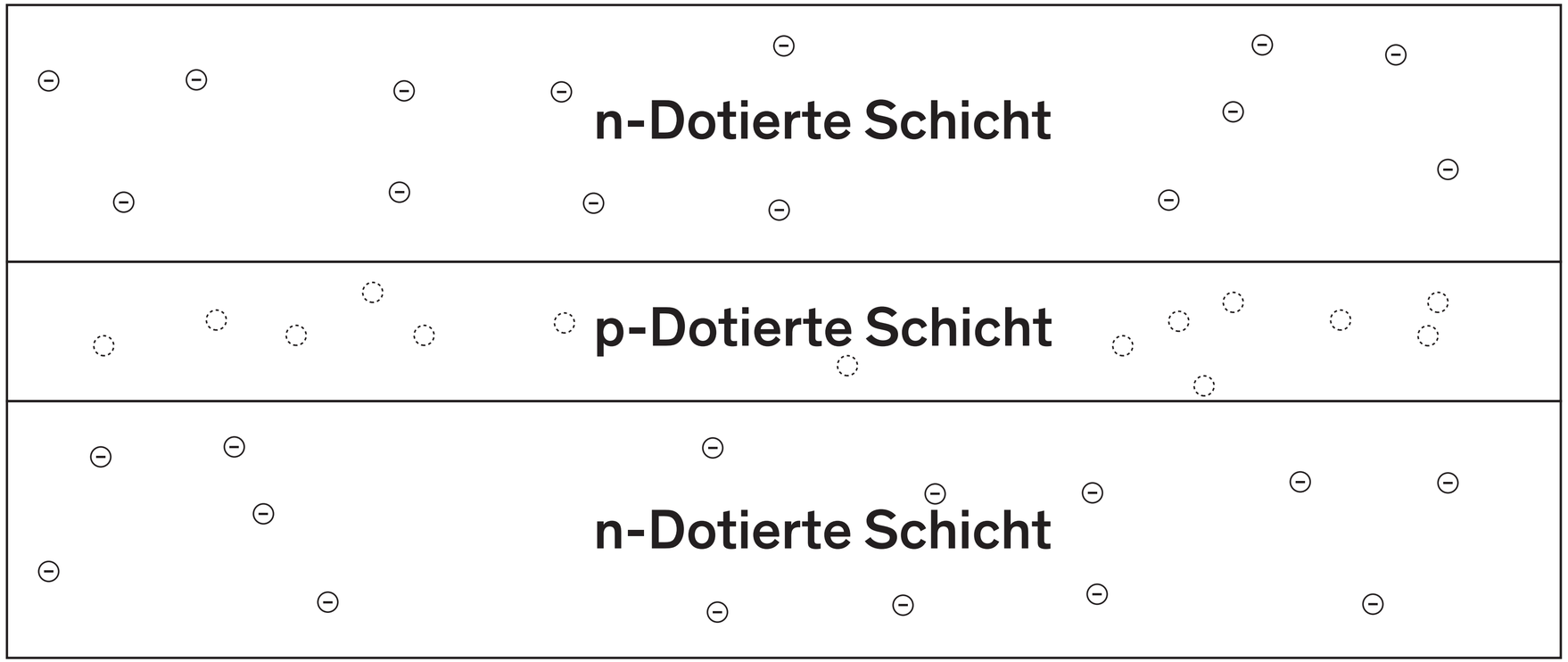




Bipolartransistoren

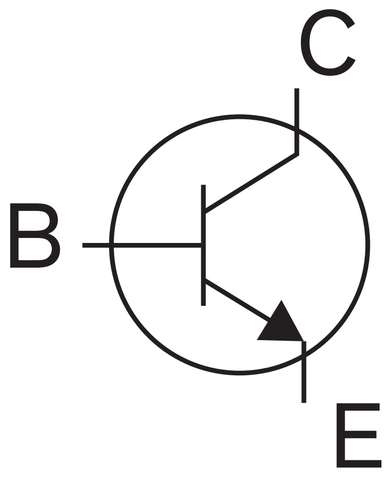


Kollektor (C)

Basis (B)

Emitter (E)

npn-Transistoren

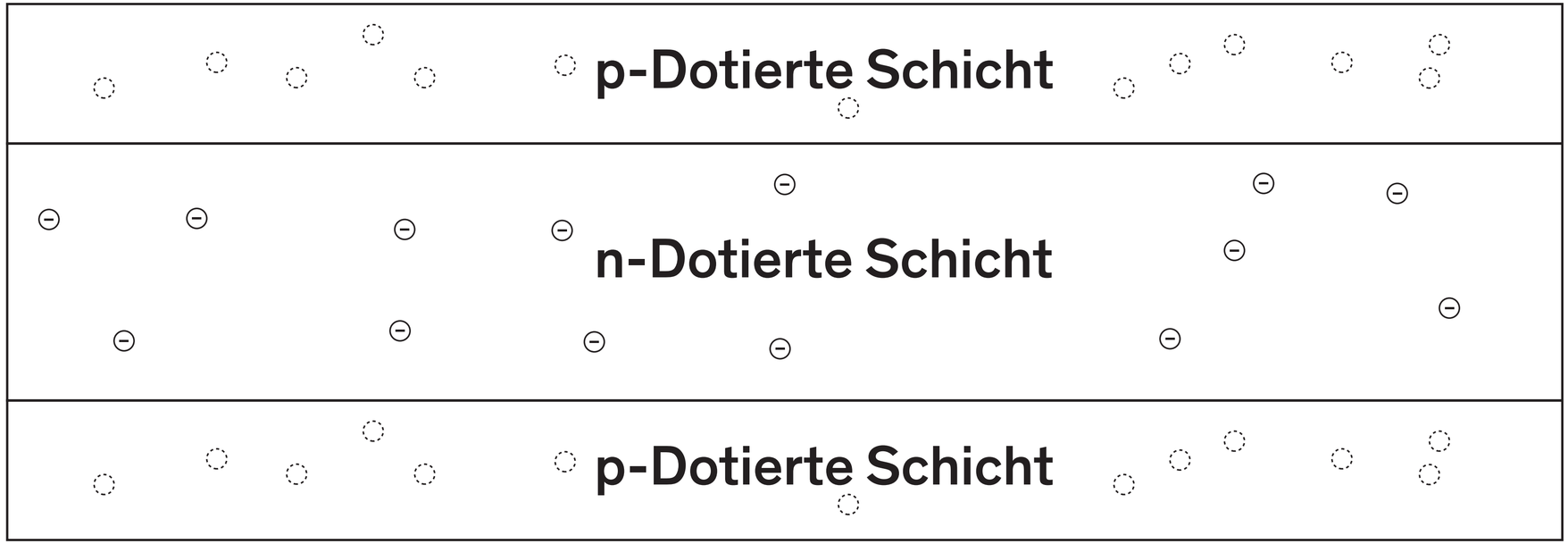


Kollektor (C)

Basis (B)

Emitter (E)

npn-Transistoren

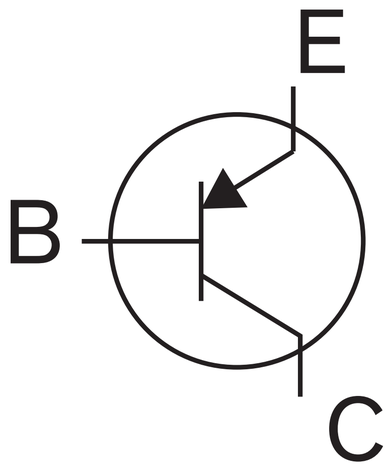


Emitter (E)

Basis (B)

Collector (C)

pnp-Transistoren

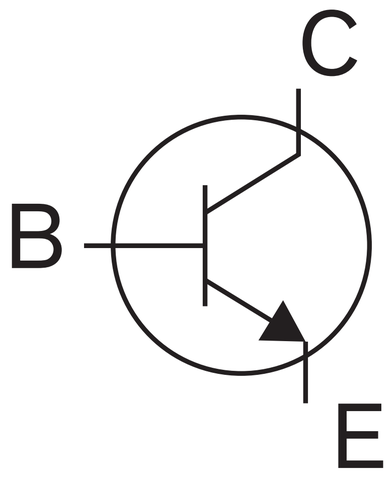


Emitter (E)

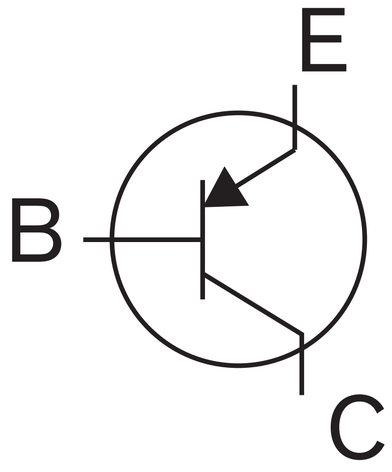
Basis (B)

Collector (C)

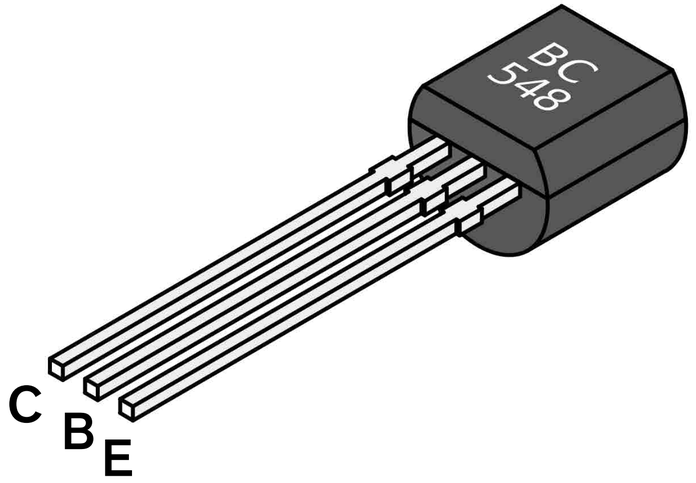
pnp-Transistoren



npn-Transistor



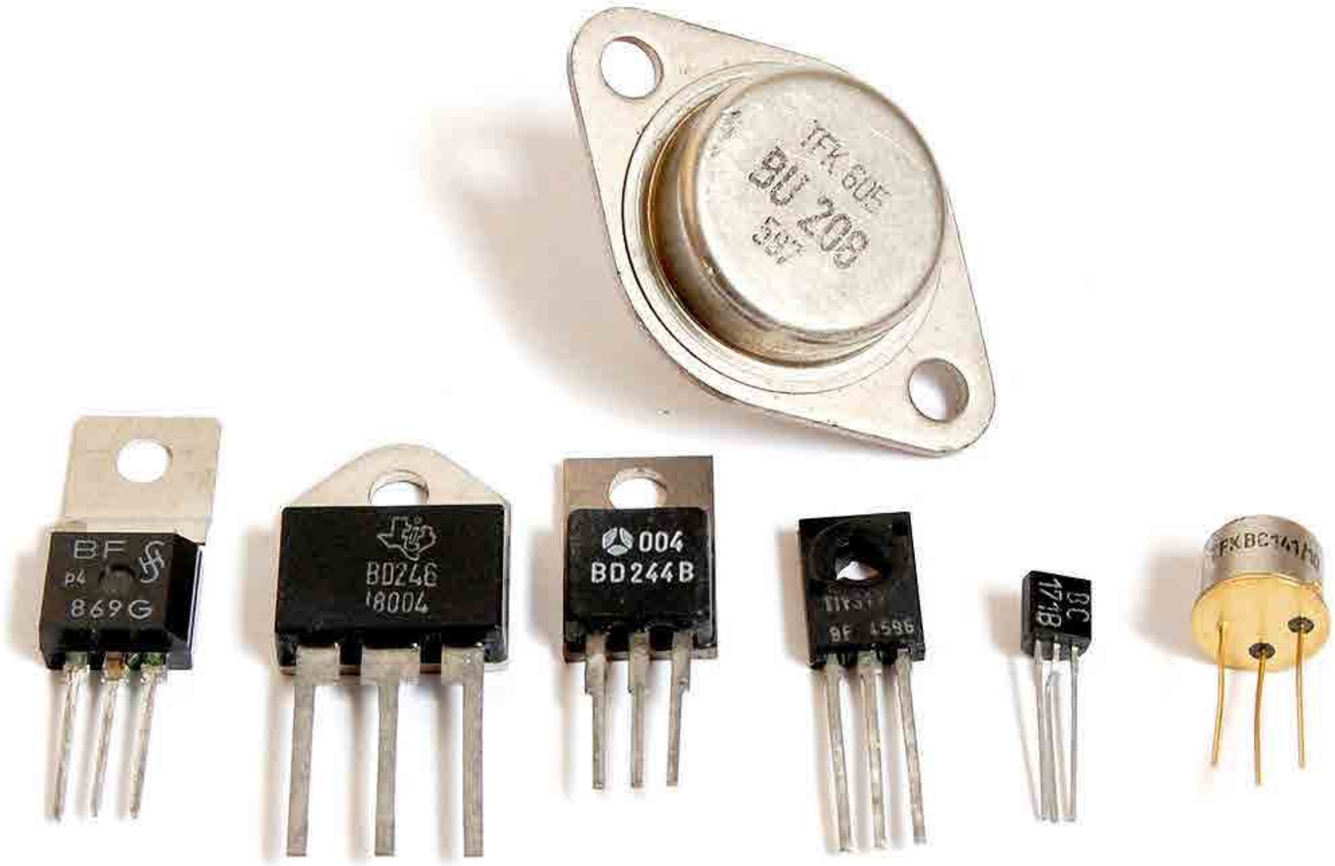
pnp-Transistor



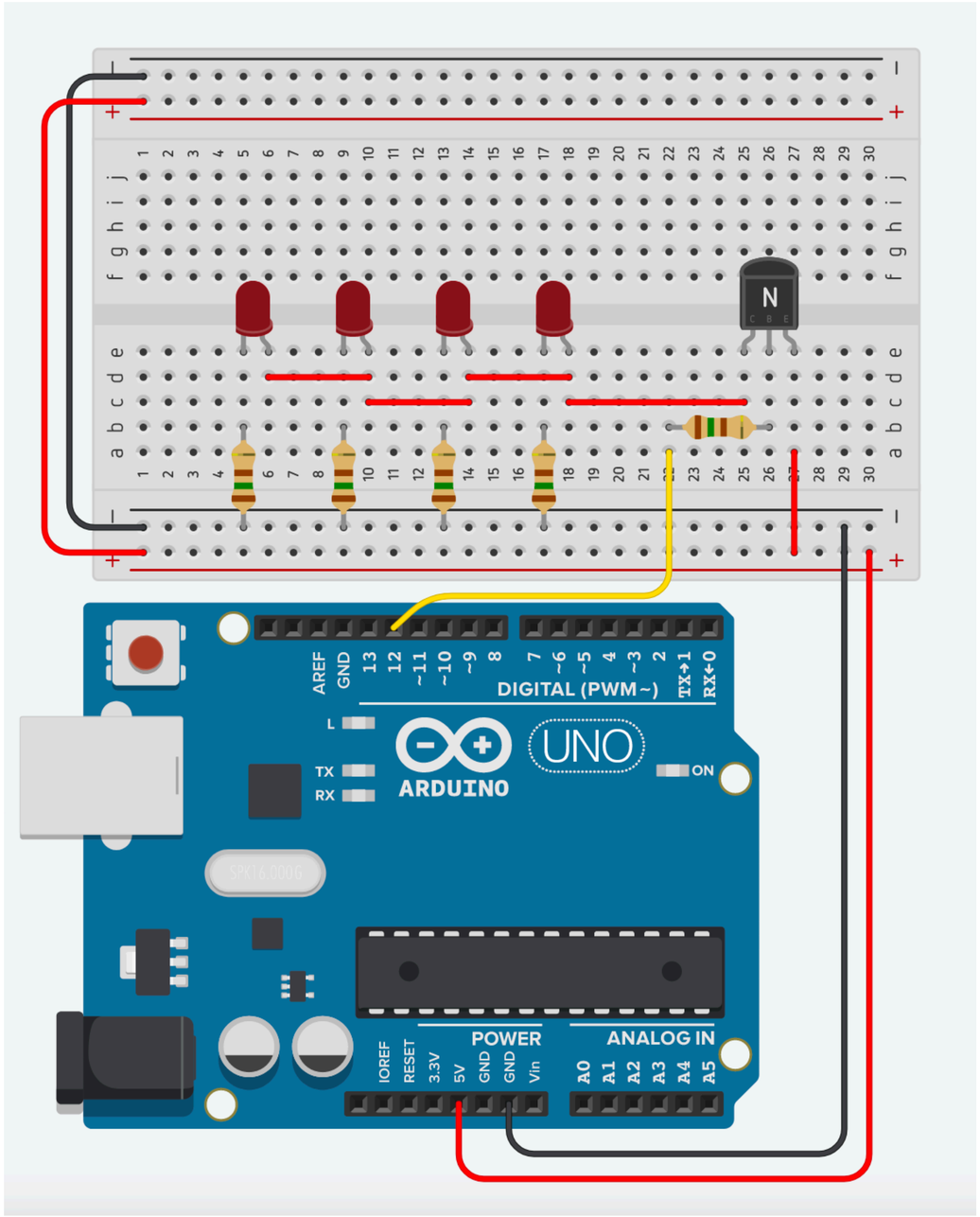
Kein Strom an Basis B → Transistor sperrt = Unendlich großer Widerstand

Strom an Basis B → Transistor leitet = Elektrisch regelbar, sehr kleiner Widerstand

Bipolartransistoren



Bipolartransistoren

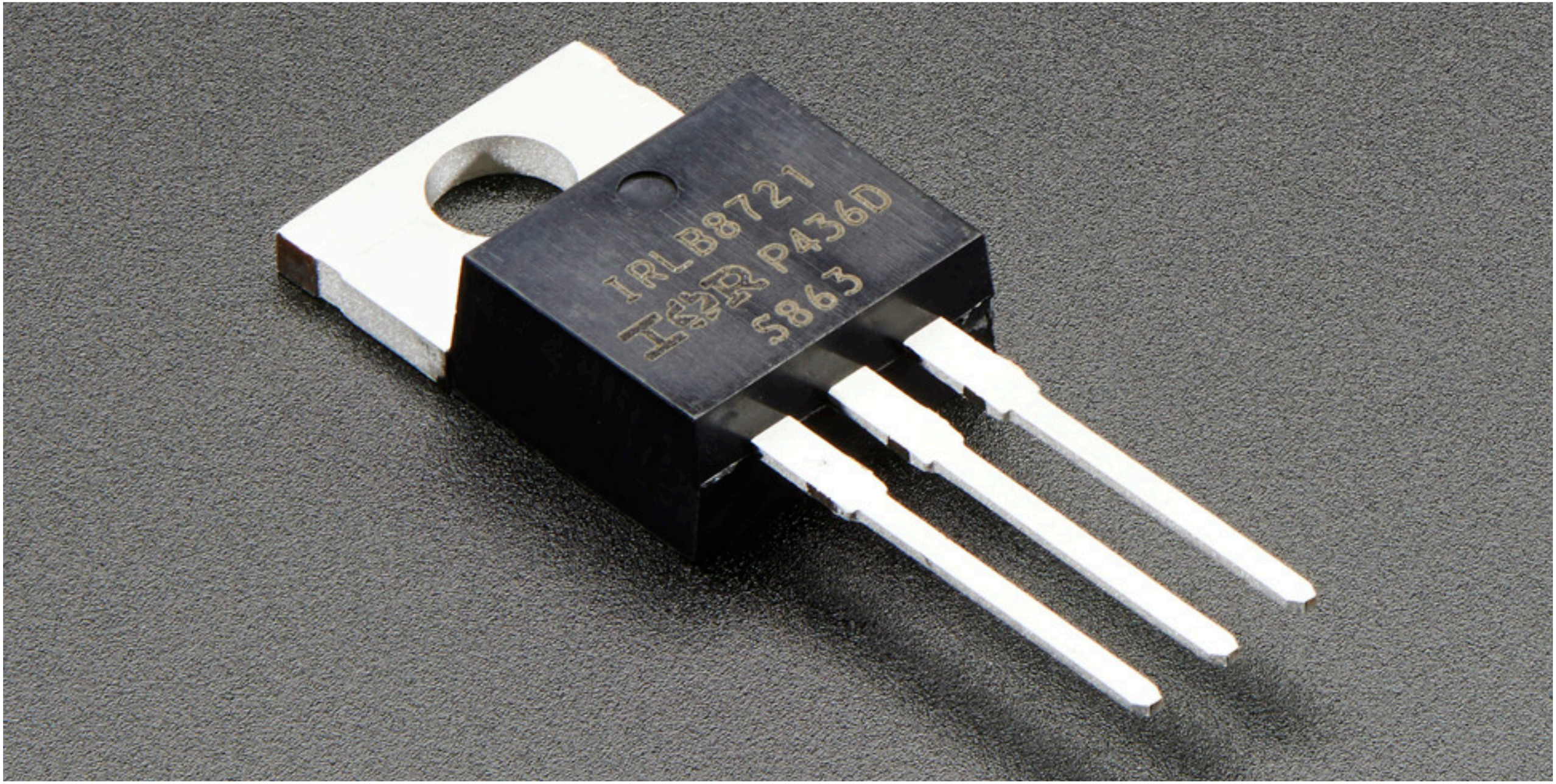



```
#define PIN_CONTROL_OUTPUT 0
void setup() {
 pinMode(PIN_CONTROL_OUTPUT, OUTPUT);
}

void loop() {
  digitalWrite(PIN_CONTROL_OUTPUT, HIGH);
  delay(500);
  digitalWrite(PIN_CONTROL_OUTPUT, LOW);
  delay(500);
}
```

Bipolartransistoren

https://rotering-net.de/tut/arduino/led-mit-transistor-steuern.html

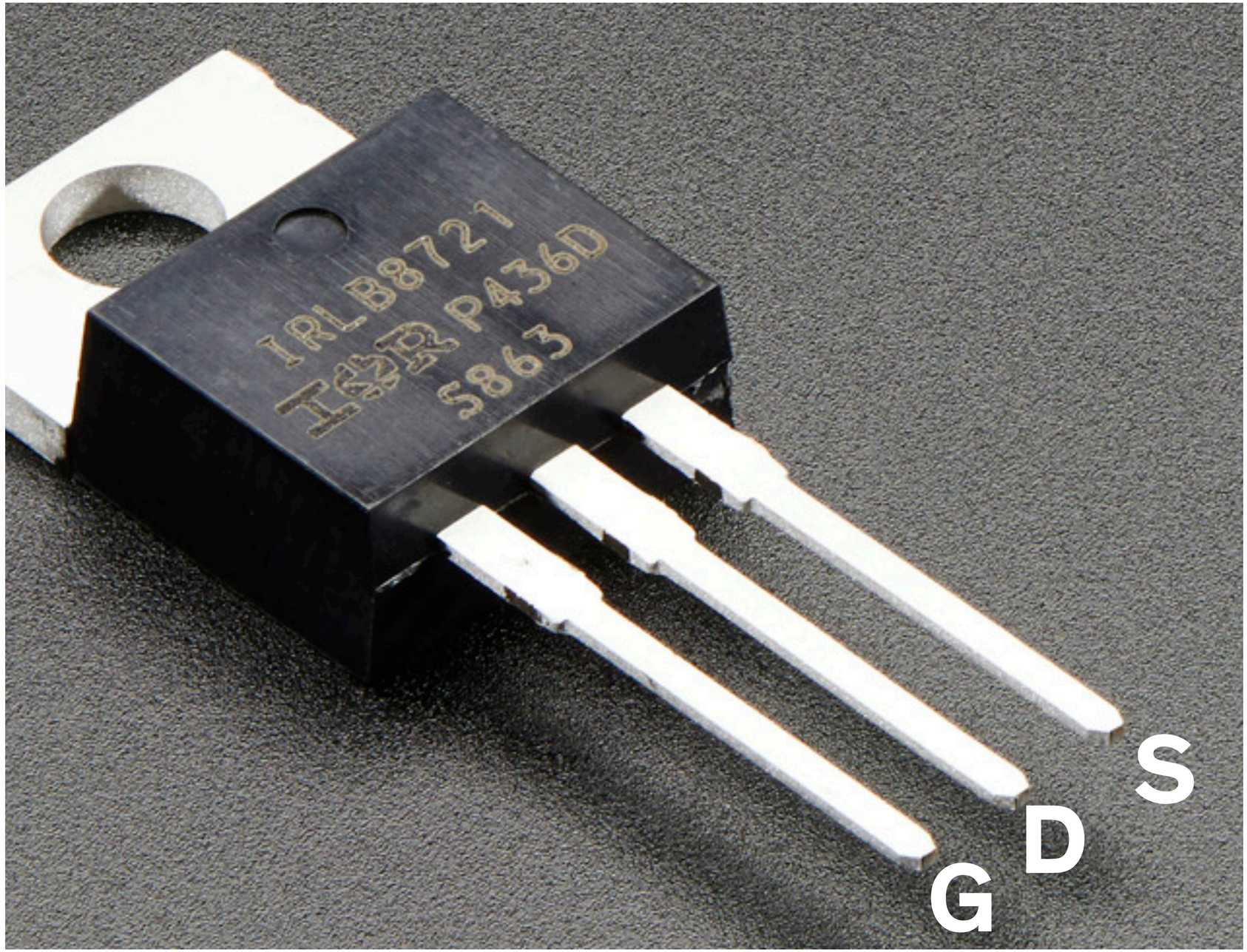


Feldeffekt-Transistoren

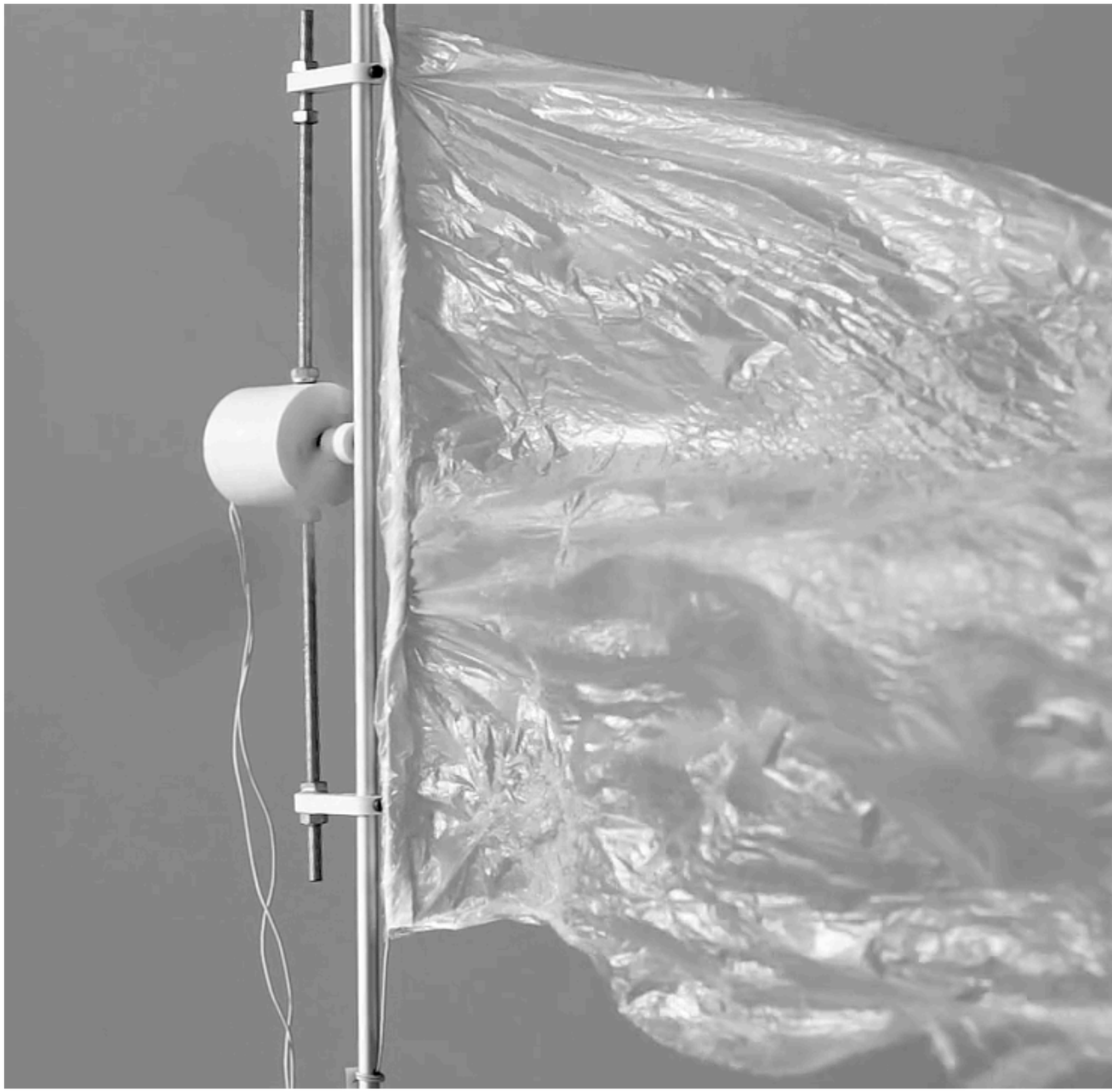
"Spannungsgetrieben"

Für anspruchsvolle Anwendungen

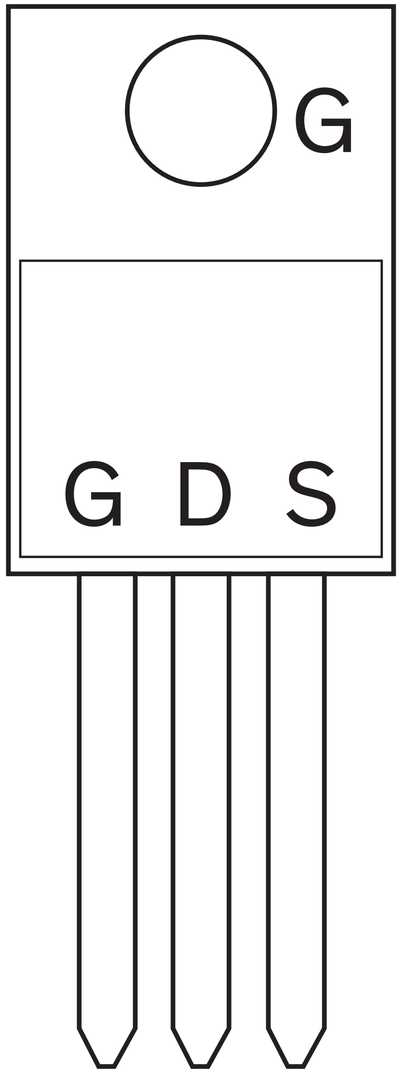
Mit speziellen Bauformen können große Spannungen und Ströme geschalten werden



Feldeffekt-Transistoren



Feldeffekt-Transistoren



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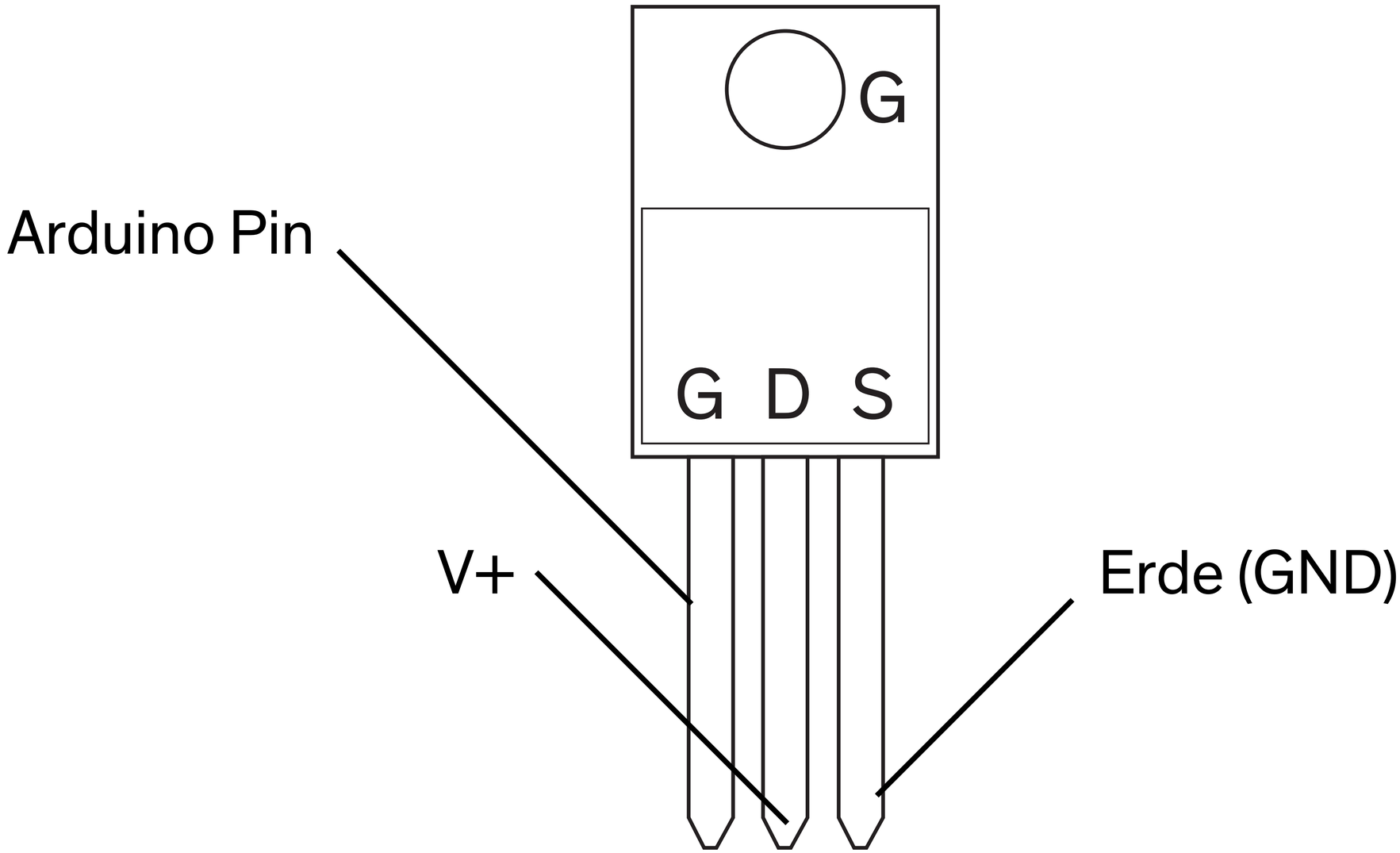
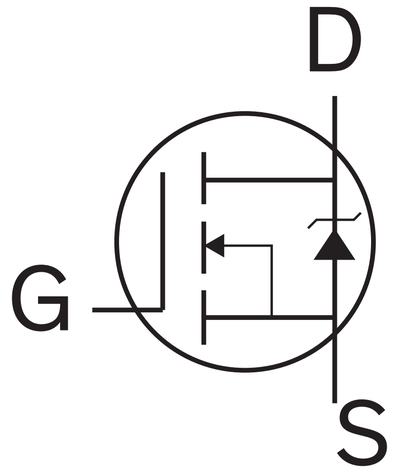


Feldeffekt-Transistoren

IRLZ44N
IRL540N
IRLZ24N

IRF522
IRF540
IRF3205



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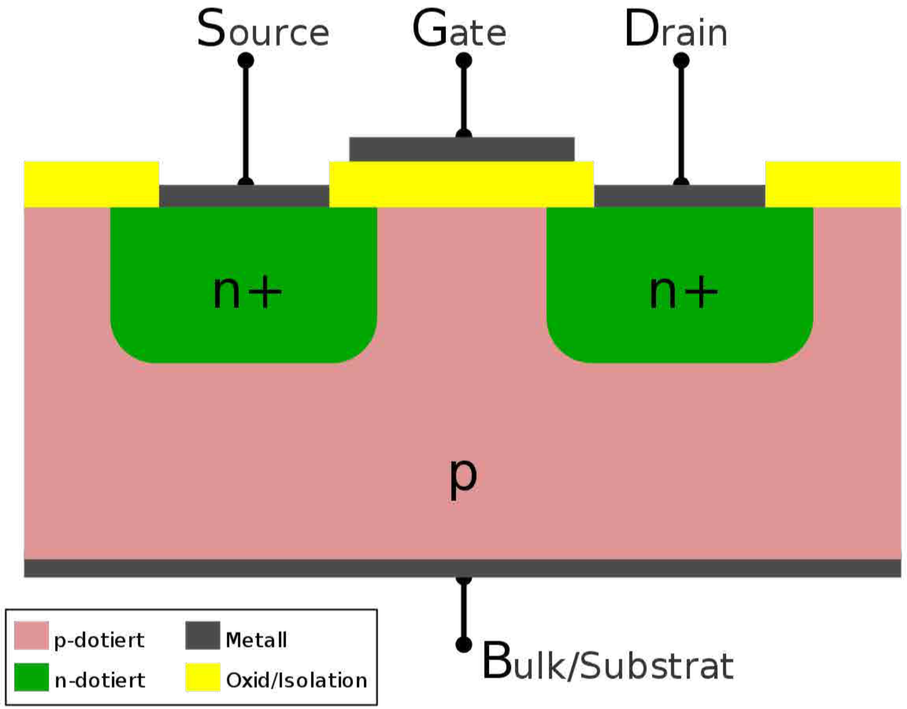
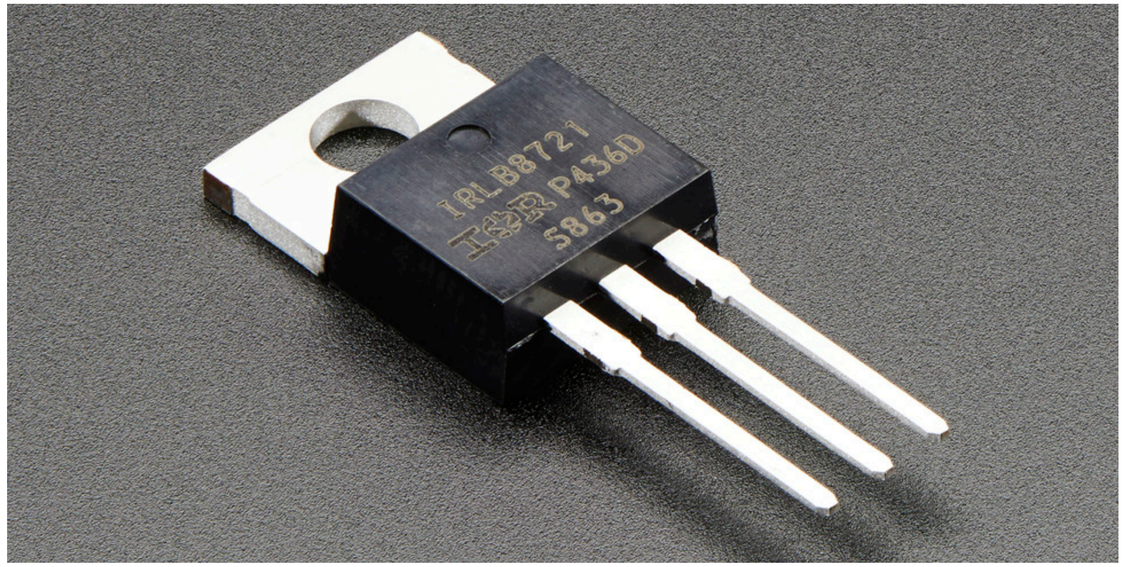
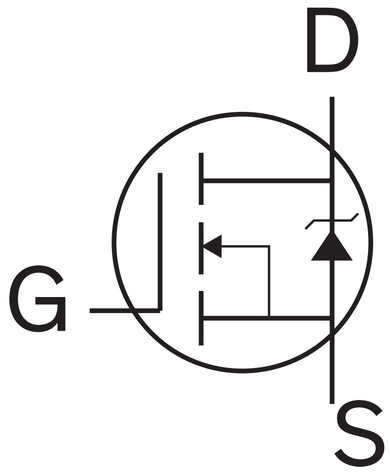






Kein Spannung am Gate G → Transistor sperrt = Unendlich großer Widerstand

Spannung am Gate G → Transistor leitet = Elektrisch regelbar, sehr kleiner Widerstand

Feldeffekt-Transistoren

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS} @ 10V	47	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS} @ 10V	33	
I_{DM}	Pulsed Drain Current ①	160	
P_D @T_C = 25°C	Power Dissipation	110	W
	Linear Derating Factor	0.71	W/°C
V_{GS}	Gate-to-Source Voltage	±16	V
E_{AS}	Single Pulse Avalanche Energy ②	210	mJ
I_{AR}	Avalanche Current①	25	A
E_{AR}	Repetitive Avalanche Energy①	11	mJ
dv/dt	Peak Diode Recovery dv/dt ③	5.0	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to + 175	°C
	Soldering Temperature, for 10 seconds	300 (1.6mm from case)	
	Mounting torque, 6-32 or M3 screw.	10 lbf•in (1.1N•m)	

Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	——	——	1.4	°C/W
$R_{\theta CS}$	Case-to-Sink, Flat, Greased Surface	——	0.50	——	
$R_{\theta JA}$	Junction-to-Ambient	——	——	62	

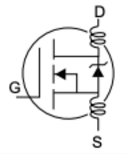
Feldeffekt-Transistoren

IRLZ44N

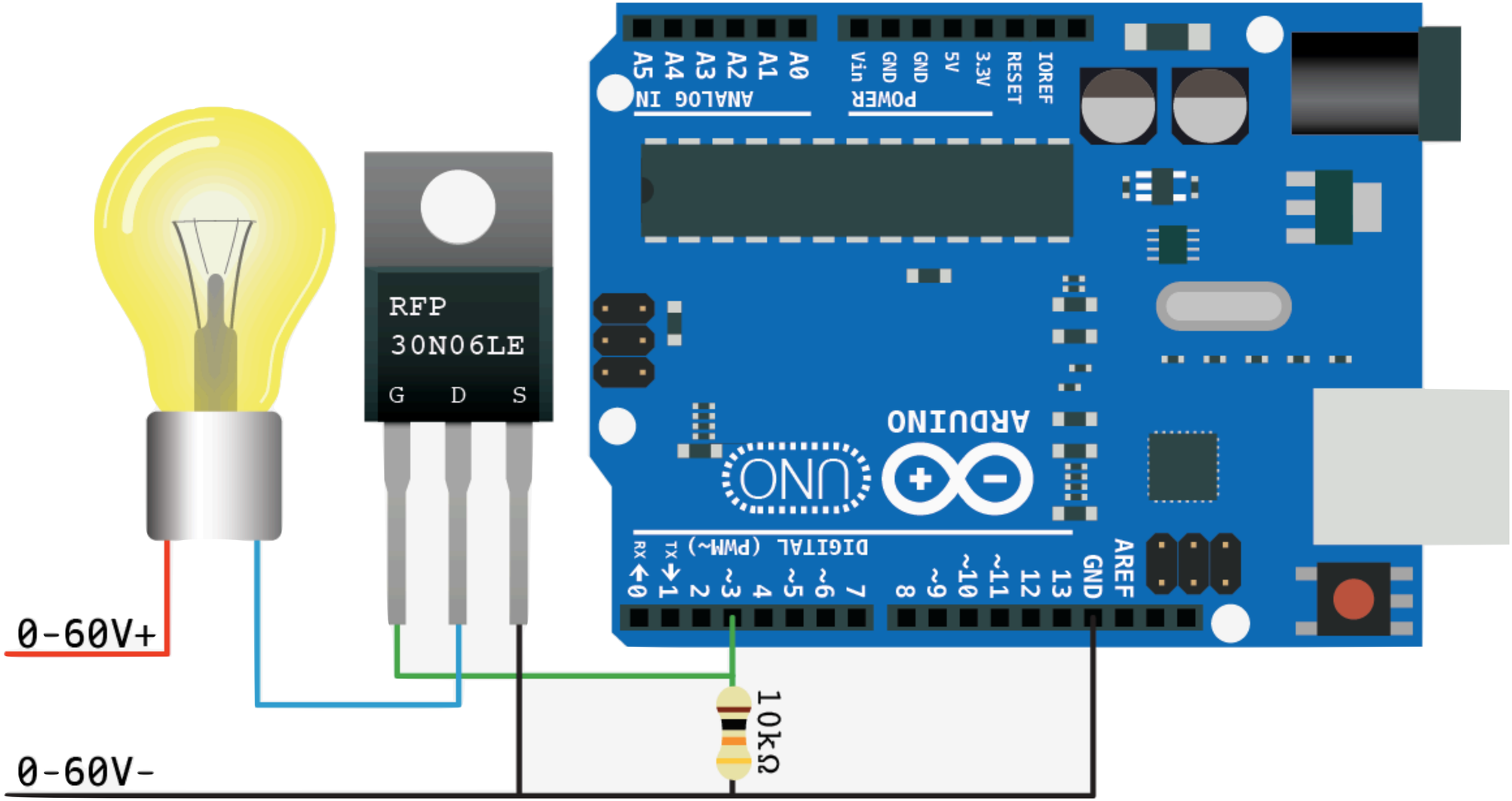
International
IOR Rectifier

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)DSS}$	Drain-to-Source Breakdown Voltage	55	—	—	V	V_{GS} = 0V, I_D = 250µA
$\Delta V_{(BR)DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	—	0.070	—	V/°C	Reference to 25°C, I_D = 1mA
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	—	—	0.022	Ω	V_{GS} = 10V, I_D = 25A ④
		—	—	0.025		V_{GS} = 5.0V, I_D = 25A ④
		—	—	0.035		V_{GS} = 4.0V, I_D = 21A ④
$V_{GS(th)}$	Gate Threshold Voltage	1.0	—	2.0	V	V_{DS} = V_{GS}, I_D = 250µA
g_{fs}	Forward Transconductance	21	—	—	S	V_{DS} = 25V, I_D = 25A
I_{DSS}	Drain-to-Source Leakage Current	—	—	25	µA	V_{DS} = 55V, V_{GS} = 0V
		—	—	250		V_{DS} = 44V, V_{GS} = 0V, T_J = 150°C
I_{GSS}	Gate-to-Source Forward Leakage	—	—	100	nA	V_{GS} = 16V
	Gate-to-Source Reverse Leakage	—	—	-100		V_{GS} = -16V
Q_g	Total Gate Charge	—	—	48	nC	I_D = 25A
Q_{gs}	Gate-to-Source Charge	—	—	8.6		V_{DS} = 44V
Q_{gd}	Gate-to-Drain ("Miller") Charge	—	—	25		V_{GS} = 5.0V, See Fig. 6 and 13 ④
$t_{d(on)}$	Turn-On Delay Time	—	11	—	ns	V_{DD} = 28V
t_r	Rise Time	—	84	—		I_D = 25A
$t_{d(off)}$	Turn-Off Delay Time	—	26	—		R_G = 3.4Ω, V_{GS} = 5.0V
t_f	Fall Time		15			R_D = 1.1Ω, See Fig. 10 ④
L_D	Internal Drain Inductance	—	4.5	—	nH	Between lead, 6mm (0.25in.)
L_S	Internal Source Inductance	—	7.5	—		from package and center of die contact
C_{iss}	Input Capacitance	—	1700	—	pF	V_{GS} = 0V
C_{oss}	Output Capacitance	—	400	—		V_{DS} = 25V
C_{rss}	Reverse Transfer Capacitance	—	150	—		f = 1.0MHz, See Fig. 5



Feldeffekt-Transistoren



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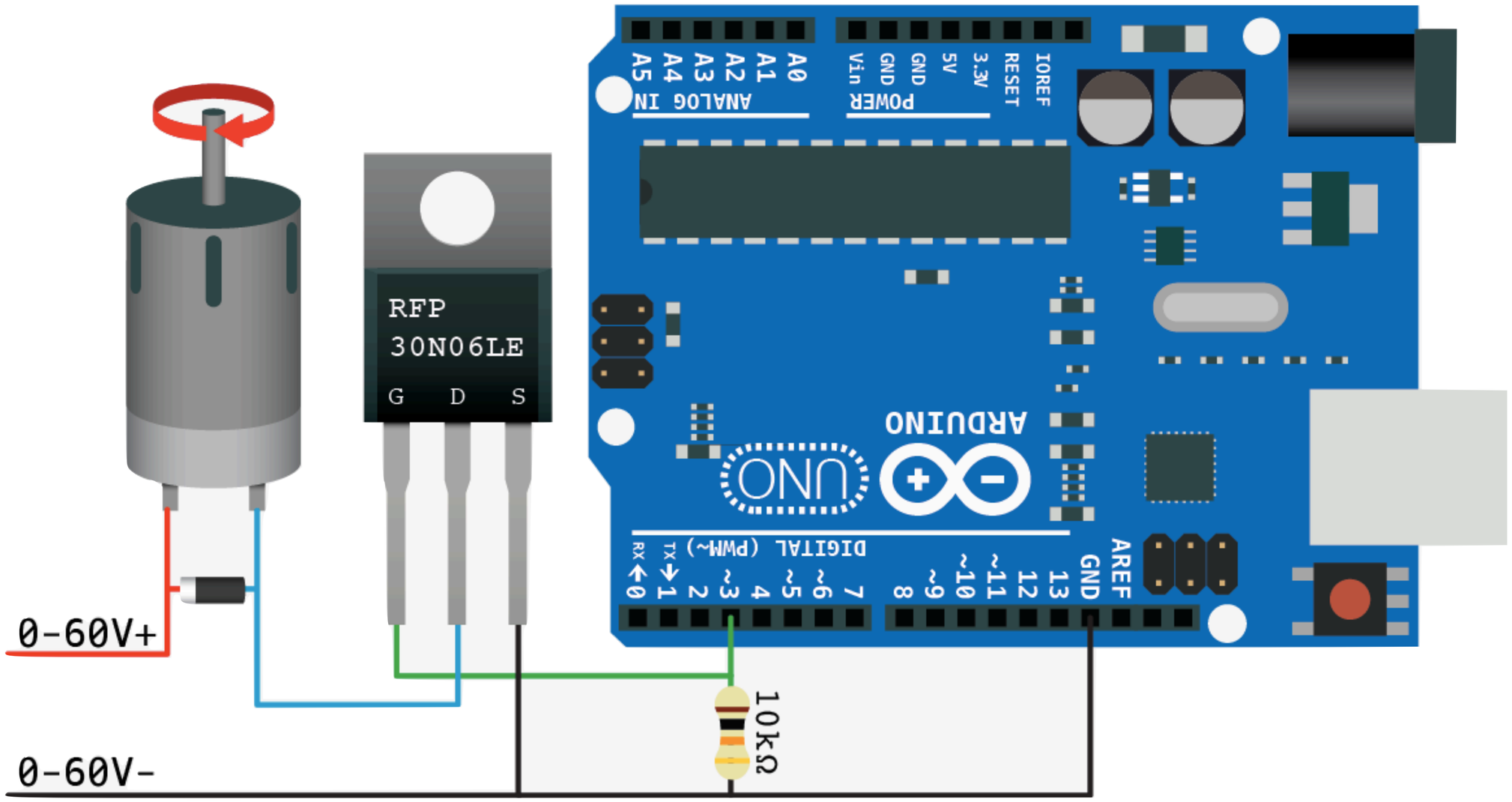

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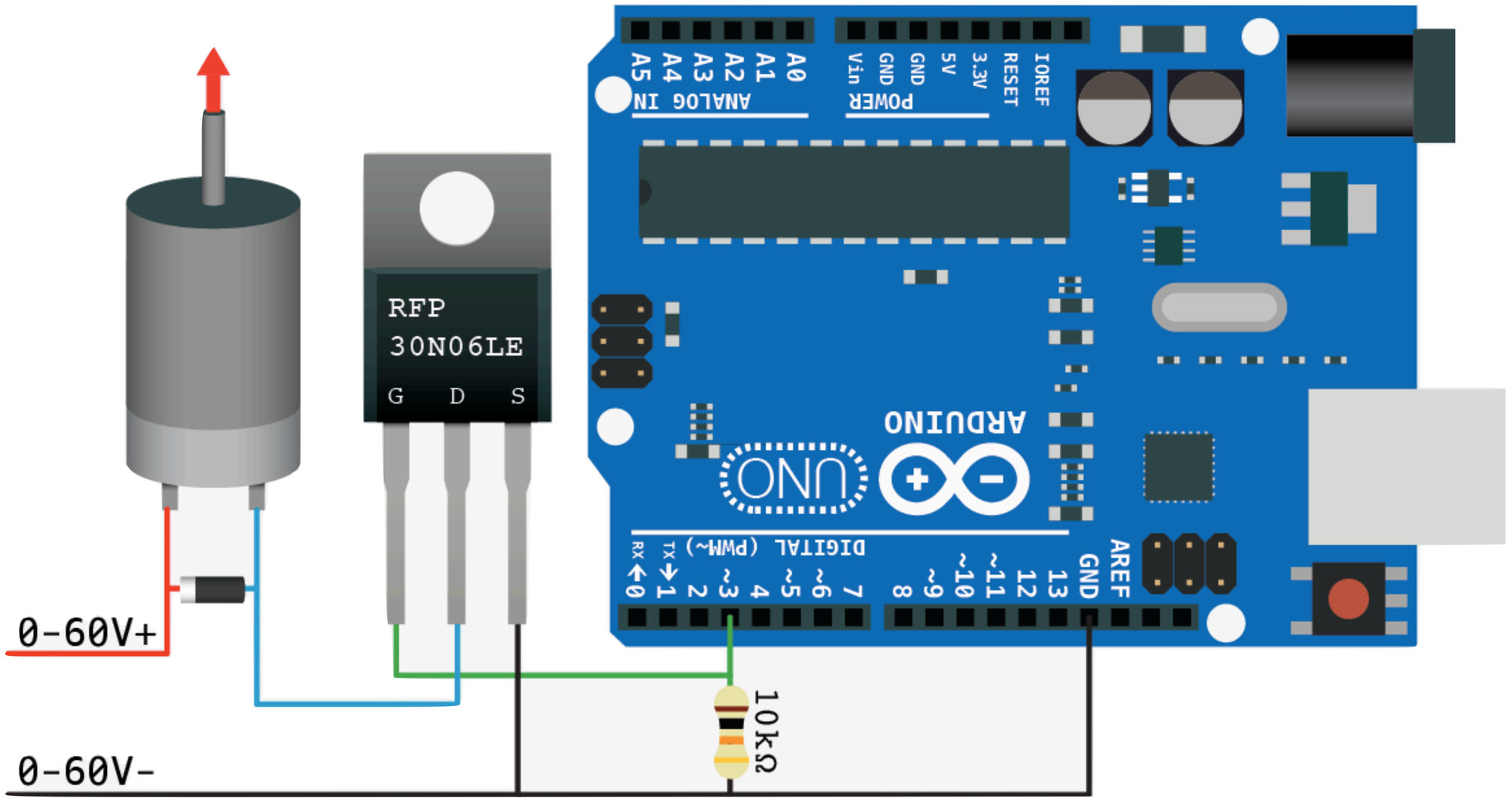

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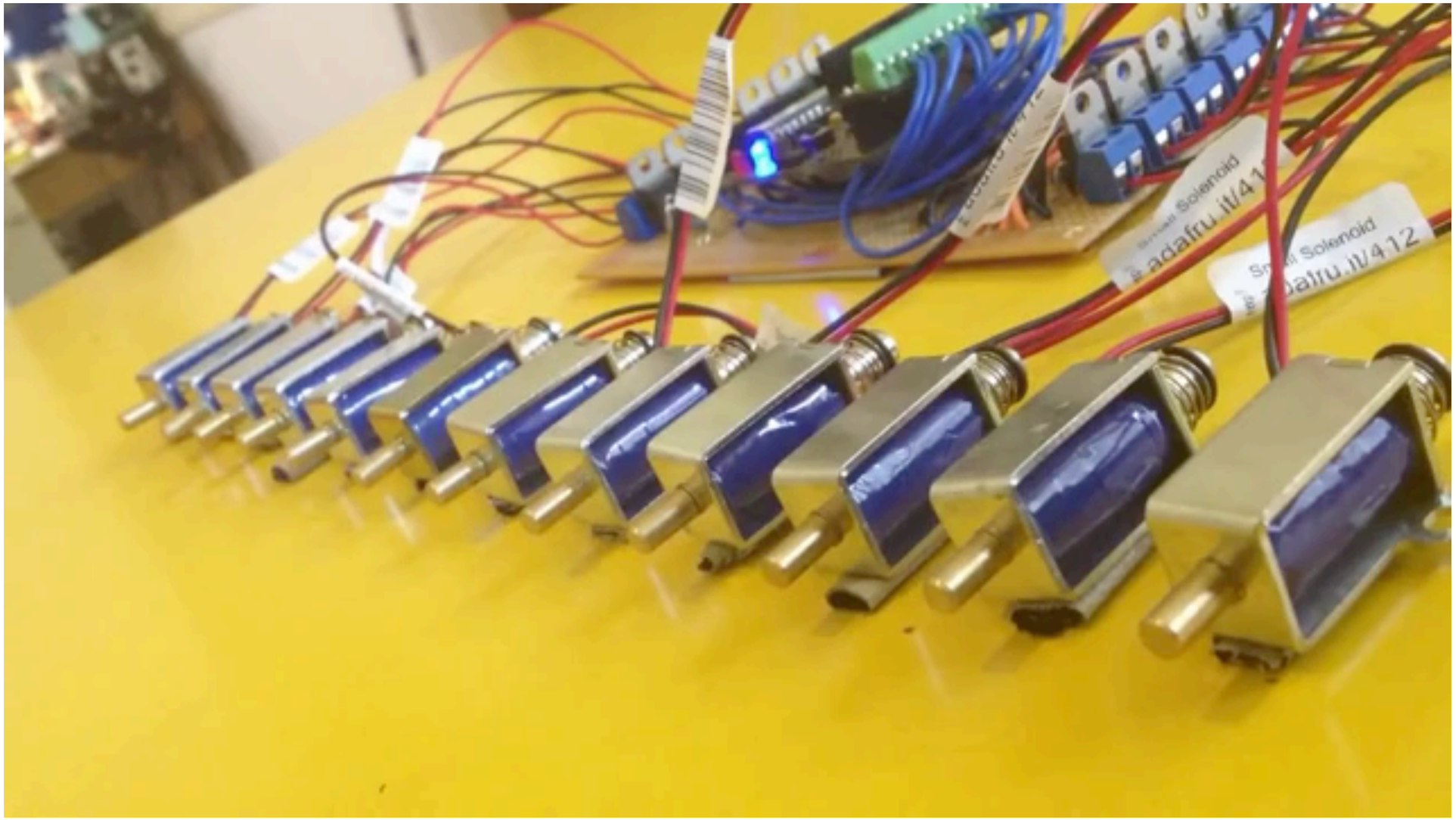

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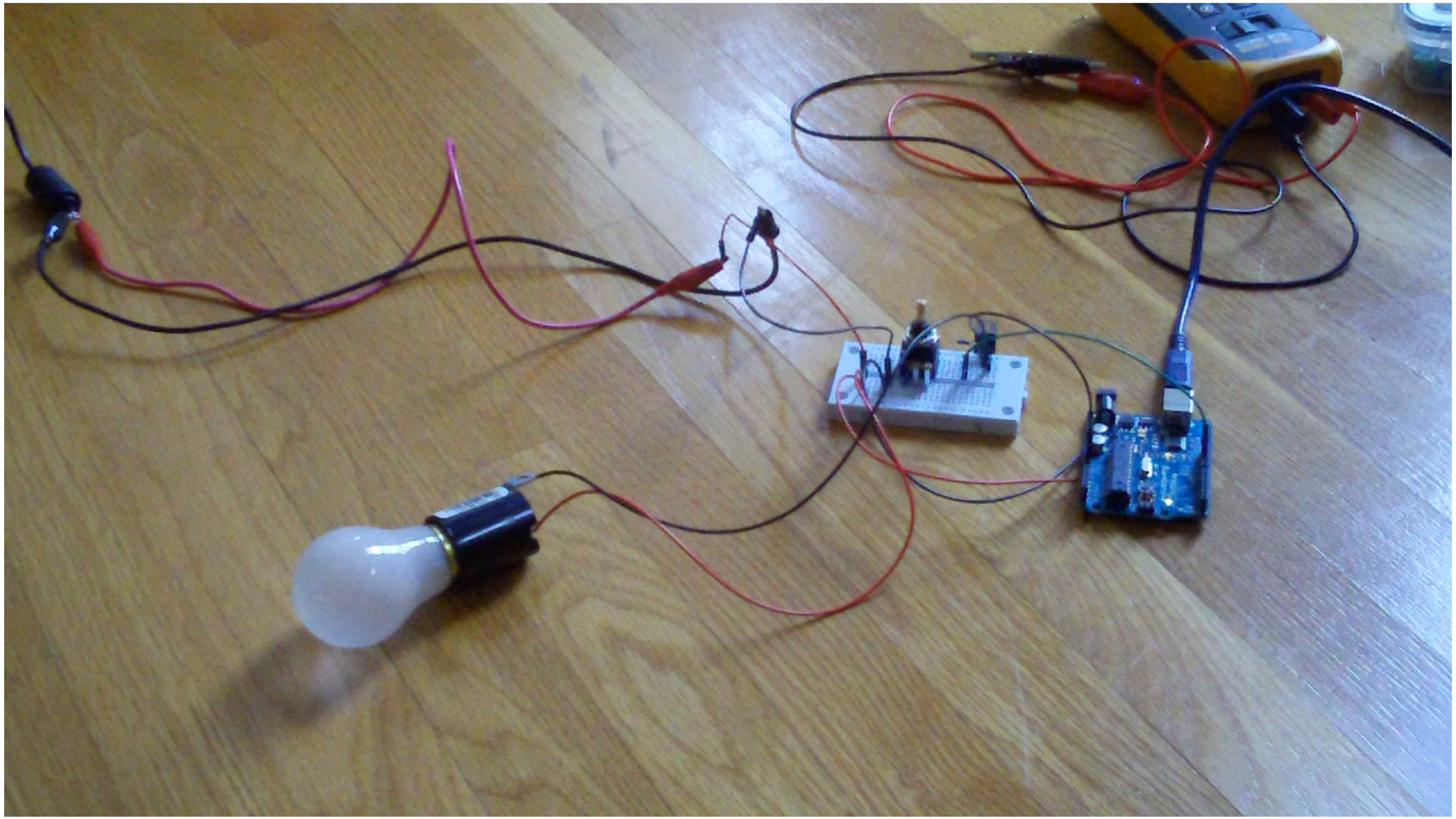
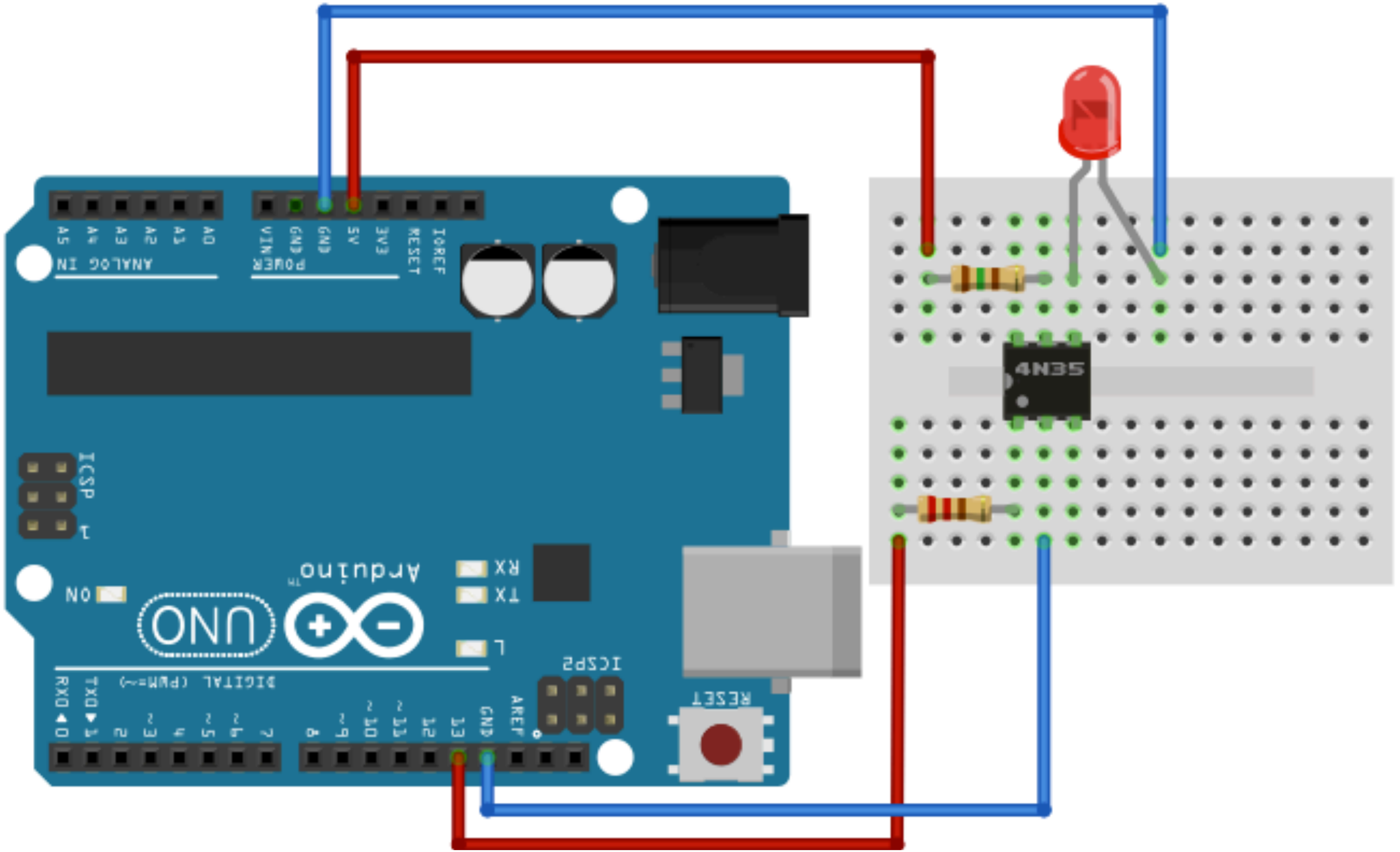


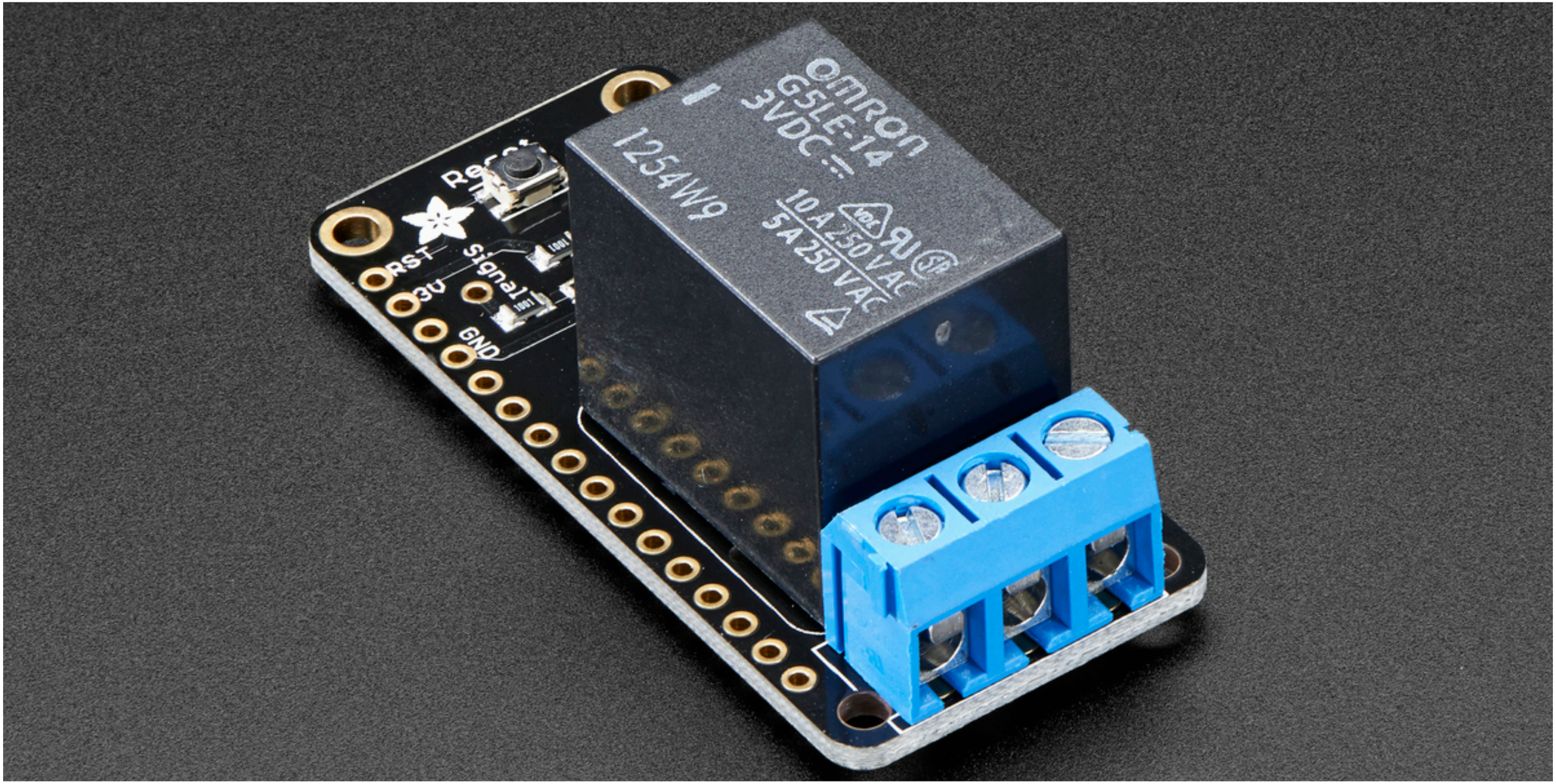
Feldeffekt-Transistoren

Masseschleifen / "Brummschleifen"
Sicherheit
Schutzmaßnahme
Vermeidung von Potentialverschiebungen

Galvanische Trennung



Optokoppler


omron
G5LE-14
3VDC
1254W9
10A 250 VAC
5A 250 VAC
RST
3V
Signal
GND

Relais

(Finite) State Machine

(Endlicher) Zustandsautomat

Vereinfacht die Darstellung komplexer Abläufe

Verhindert "Spaghetti-Code"

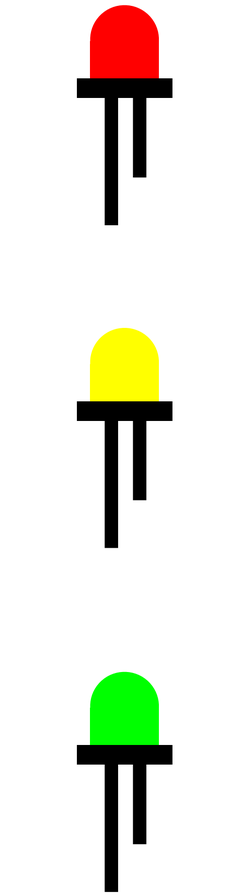
Definierte Programmzustände

Einfache Nachvollziehbarkeit

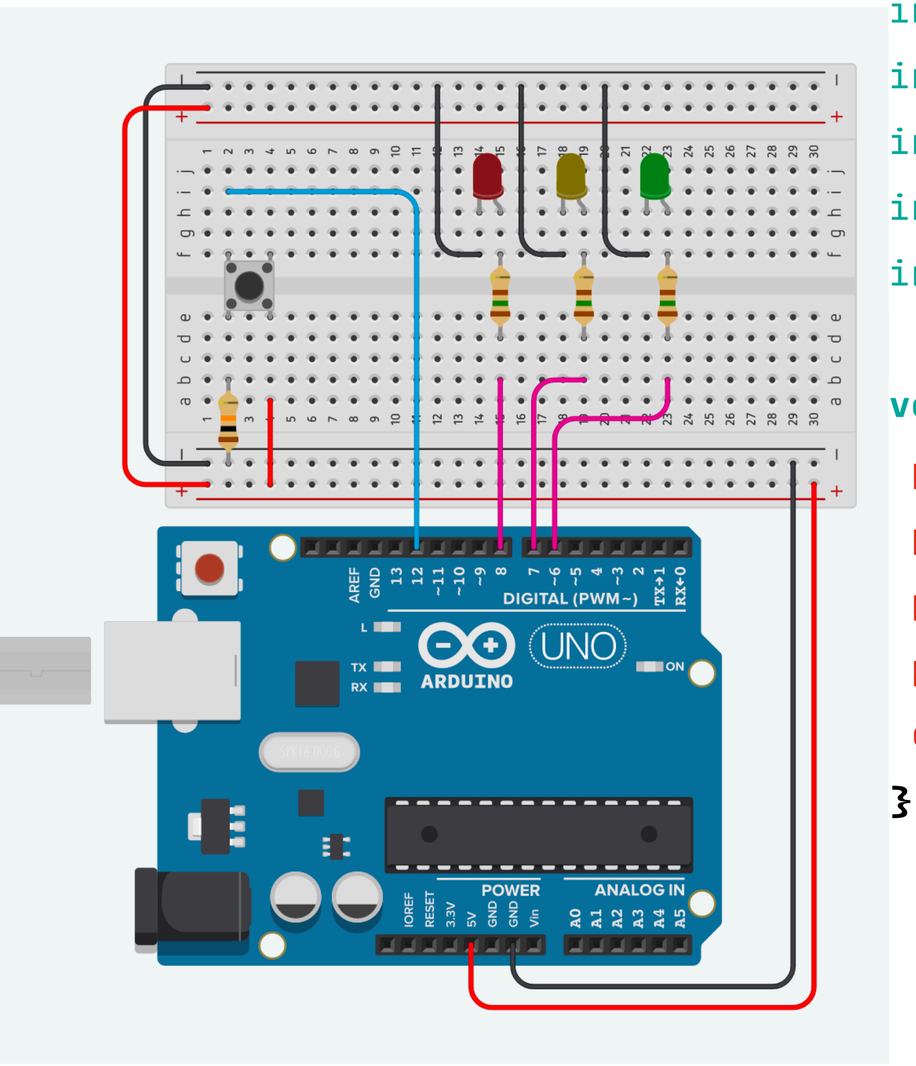
(Endlicher) Zustandsautomat

Beispiel – Fußgängerampel

"Wenn der Knopf gedrückt wird, soll die Ampel nach 3 Sekunden von Grün auf Gelb wechseln. Nach weiteren 3 Sekunden auf Rot. Nach 5 Sekunden soll sie zurück auf Gelb und nach weiteren 3 Sekunden wieder auf Grün wechseln"



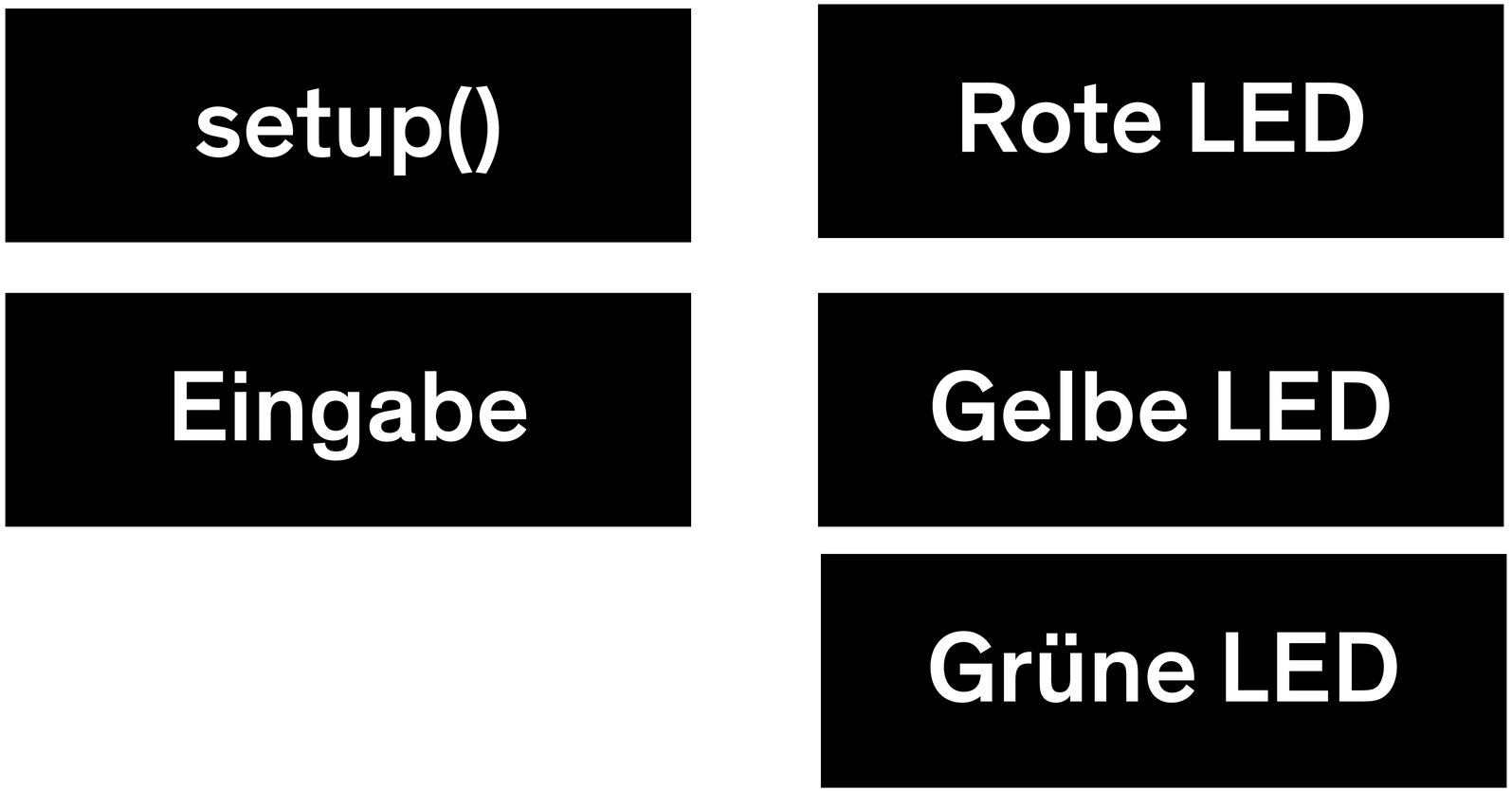
(Endlicher) Zustandsautomat




```
int buttonPin = 12;
int redLED = 8;
int yellowLED = 7;
int greenLED = 6;
int buttonState = 0;

void setup() {
 pinMode(buttonPin, INPUT);
 pinMode(redLED, OUTPUT);
 pinMode(yellowLED, OUTPUT);
 pinMode(greenLED, OUTPUT);
 digitalWrite(greenLED, HIGH);
}
```

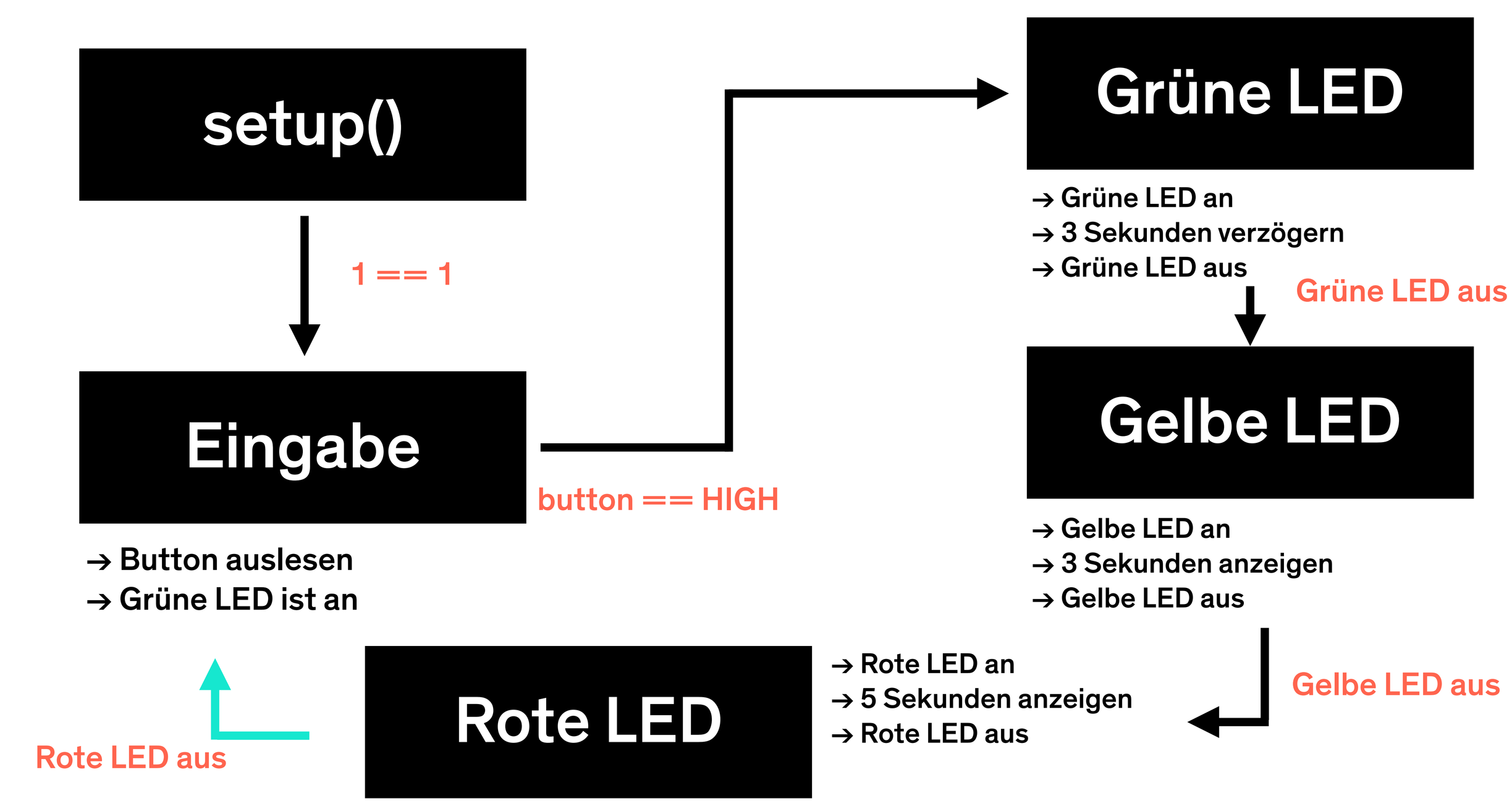
```
void loop() {
  buttonState = digitalRead(buttonPin);
  if(buttonState == 1){

    delay(3000);
    digitalWrite(greenLED, LOW);
    digitalWrite(yellowLED, HIGH);

    delay(3000);
    digitalWrite(yellowLED, LOW);
    digitalWrite(redLED, HIGH);

    delay(5000);
    digitalWrite(redLED, LOW);
    digitalWrite(yellowLED, HIGH);

    delay(3000);
    digitalWrite(yellowLED, LOW);
    digitalWrite(greenLED, HIGH);
  }
}
```

(Endlicher) Zustandsautomat

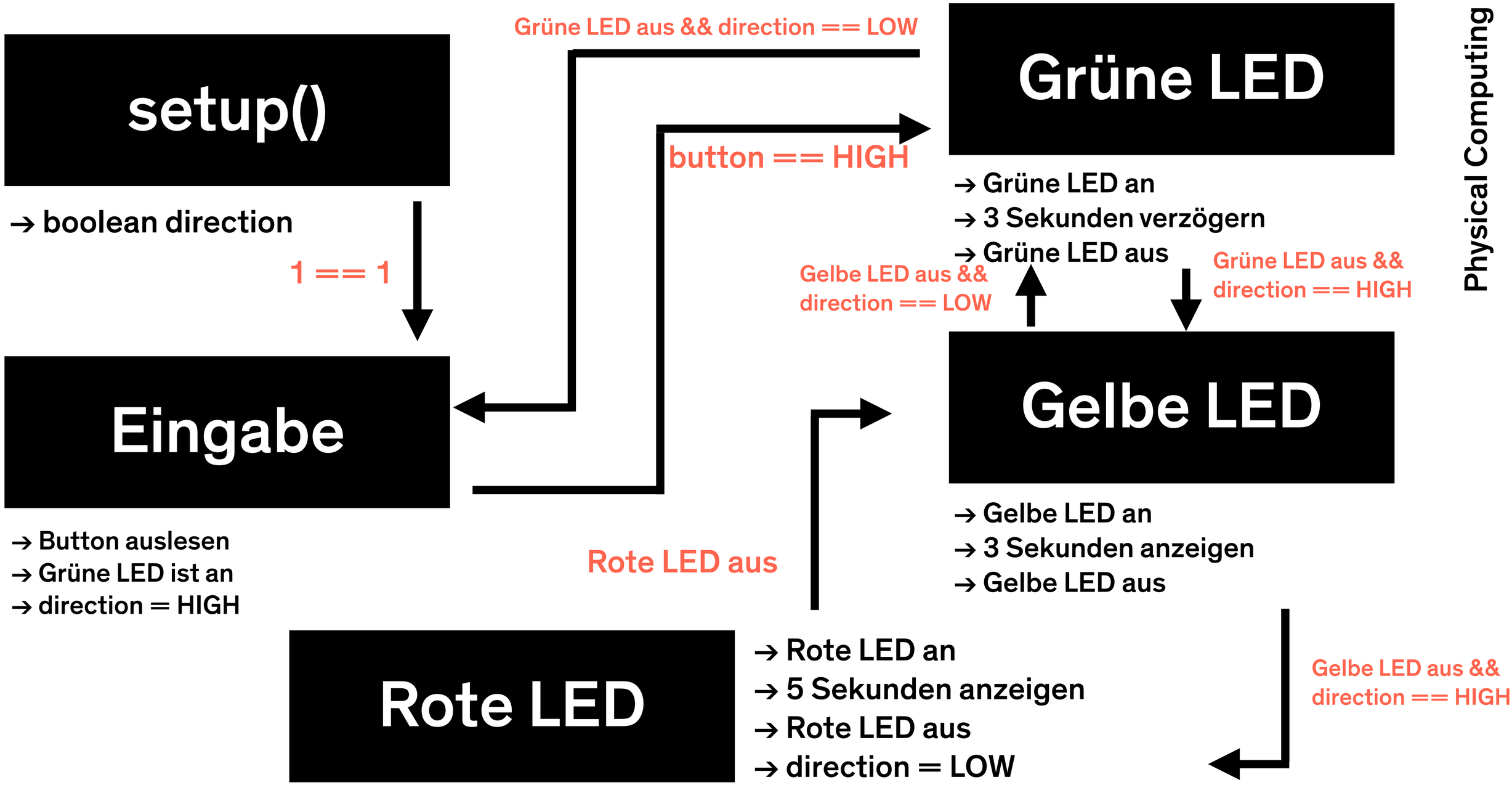


(Endlicher) Zustandsautomat

(Endlicher) Zustandsautomat



(Endlicher) Zustandsautomat



(Endlicher) Zustandsautomat

```
int buttonPin = 12;
int redLED = 8;
int yellowLED = 7;
int greenLED = 6;
int buttonState = 0;
#define EINGABE     0
#define GRUENE_LED  1
#define GELBE_LED   2
#define ROTE_LED    3
bool direction;
int state = EINGABE;

void setup() {
 pinMode(buttonPin, INPUT);
 pinMode(redLED, OUTPUT);
 pinMode(yellowLED, OUTPUT);
 pinMode(greenLED, OUTPUT);
 digitalWrite(greenLED, HIGH);
}
```

```
void loop() {
  switch(state) {
    case EINGABE:
      buttonState = digitalRead(buttonPin);
      digitalWrite(greenLED, LOW);
      direction = HIGH;
      if(buttonState == 1){
        state = GRUENE_LED;
      }
    break;
    case GRUENE_LED:
      digitalWrite(greenLED, HIGH);
      delay(3000);
      digitalWrite(greenLED, LOW);
      if(direction == HIGH) {
        state = GELBE_LED;
      } else {
        state = EINGABE;
      }
    break;
```

```
 case GELBE_LED:
   digitalWrite(yellowLED, HIGH);
   delay(3000);
   digitalWrite(yellowLED, LOW);
   if(direction == HIGH) {
     state = ROTE_LED;
   } else {
     state = GRUENE_LED;
   }
 break;
 case ROTE_LED:
   digitalWrite(redLED, HIGH);
   delay(5000);
   digitalWrite(redLED, LOW);
   direction = LOW;
   state = GELBE_LED;
break;
```

(Endlicher) Zustandsautomat

Coding Challenge

Baut die Fußgängerampel State-Machine um, sodass sie automatische alle X-Minuten durch die Phasen durchschaltet. Die Start-Lichtphase ist rot.
Benutzt einen Buzzer um die Ampel zu einer "Blindenampel" mit akustischem Signal umzubauen.
Rot → Auffindesignal (Langsames Piepen)
Grün → Freigabesignal (Schnelles Piepen)

Keine Abgabe https://www.absv.de/die-blindenampel

Aufgabe 4

Sucht nach Prozessen bei denen Synchronisierungs-Momente auftreten.
Beobachtet und beschäftigt euch mit eurer Umwelt / Umfeld.

Paare im Gleichschritt, Pendel die sich spontan syncen, Gerichte Kochen,
Hunde die bei Polizei-Sirenen mitbellen, Gesundheitsbereich, Öffentliche Orte, Mikro / Makro etc.

Versucht euch in Prozesse reinzudenken.
Versucht diese Prozesse zu abstrahieren.
Kann ein Prozess in ein EVA-System übersetzt werden?
Versucht ein Produkt aus der Recherche und den Beobachtungen abzuleiten
Was kann dieses Produkt lösen? (Designfrage)

Aufgabe 4 – Bis 04.06.2021

– min. 3 Ideen je Studierender
– Titel für Ideen
– Designfrage
– Kurze Beschreibung
– Skizzen / Scribbles / Recherche
– Technische Idee (Welche Bauteile?)
– Name, Matrikelnummer
– Aufgabe, Datum

– Abgabe auf Incom als PDF im "Abgabe" Ordner

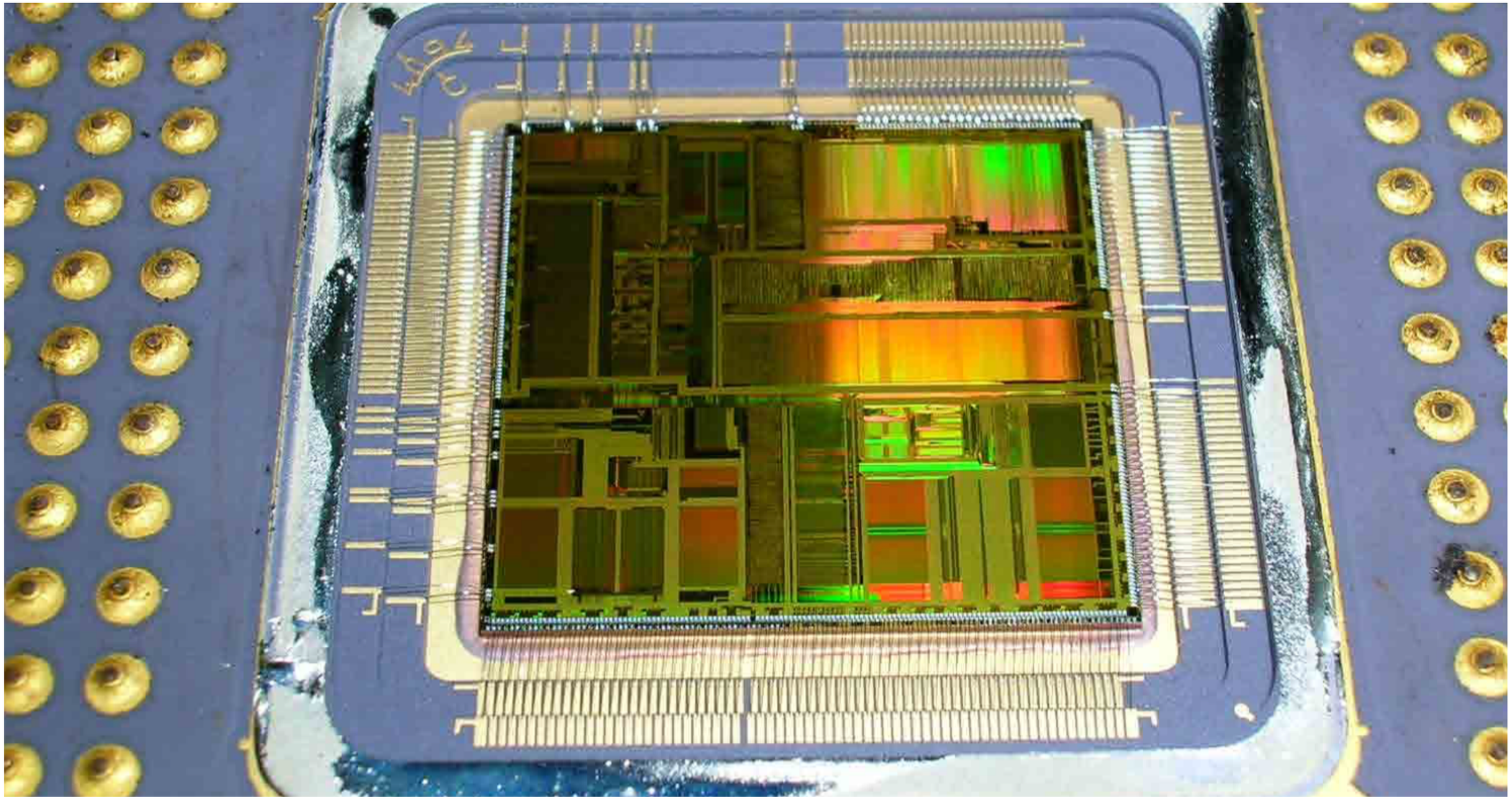
Fragt gerne im Tutorium bei Christoph falls ihr Fragen zu Bauteilen habt oder ihr unsicher seid wie einfach oder schwer es einzusetzen ist.

Aufgabe 4 – Bis 04.06.2021

– Min. 1 × Eingang, 1 × Verarbeitungsvorgang, 1 × Ausgabe
– Nicht-generisches, innovatives Konzept: Es soll was neues entstehen
– Umsetzung in hoher gestalterischer Qualität: Render / Produktzeichnungen zur Unterstützung, Prototyping von Formen mit gängigen Herstellungsverfahren
– Ergebnis sollte Portfolio-Qualität haben

Voraussetzungen

Fragen?

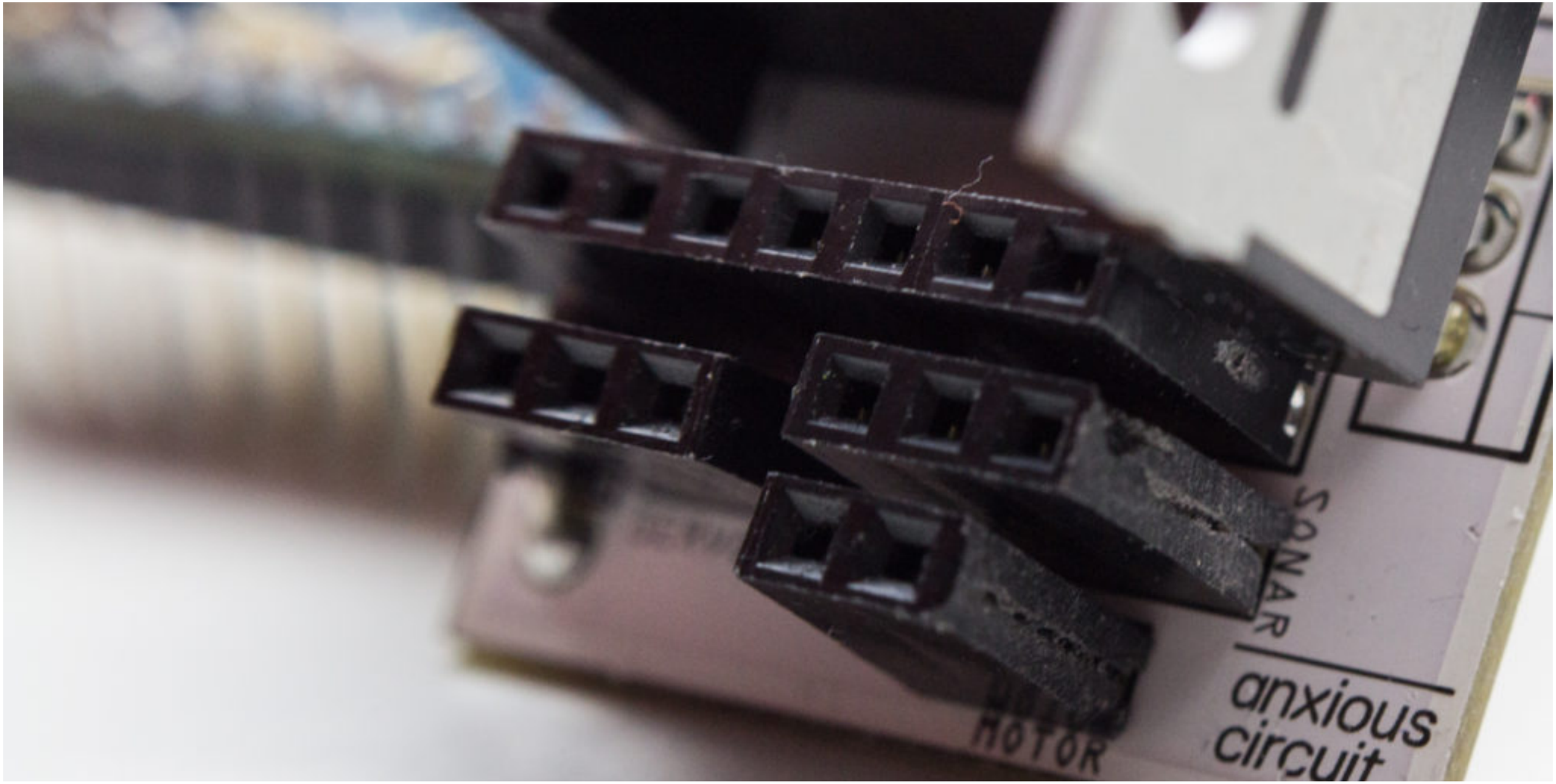


Anwendungsbeispiele

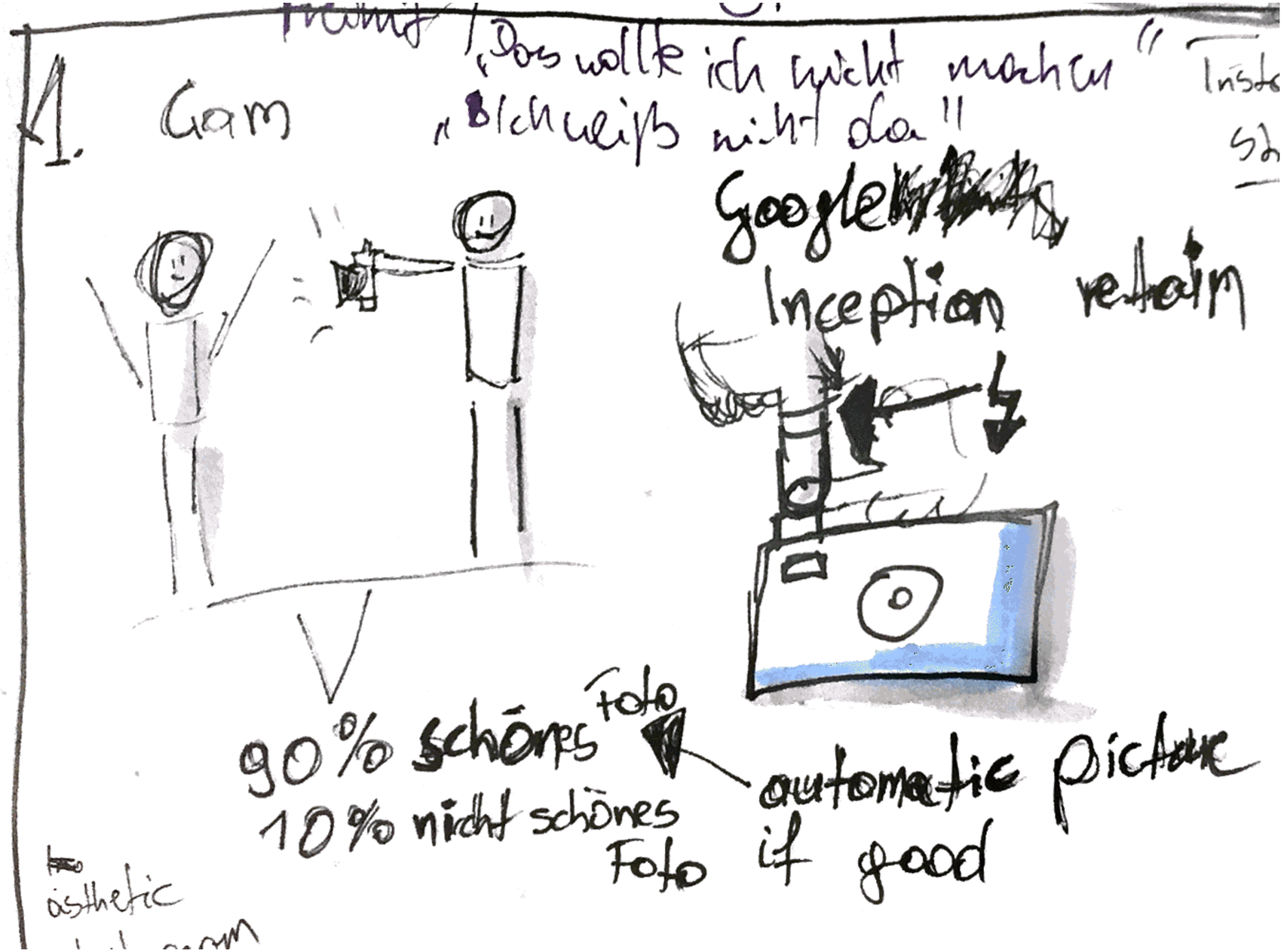
Anxious Lamp

Anxious Lamp

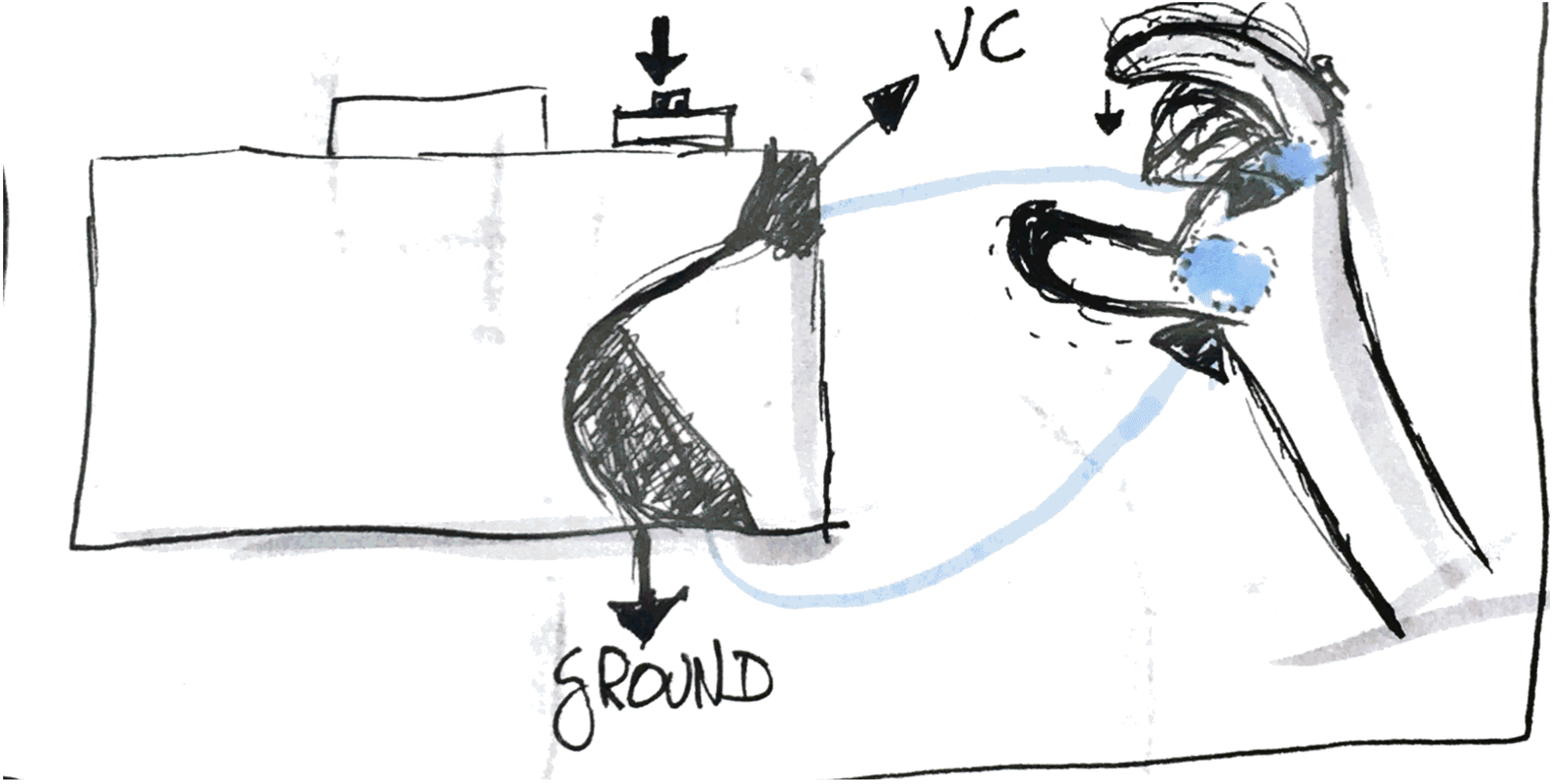
Anxious Lamp



Anxious Lamp



Prosthetic Photographer



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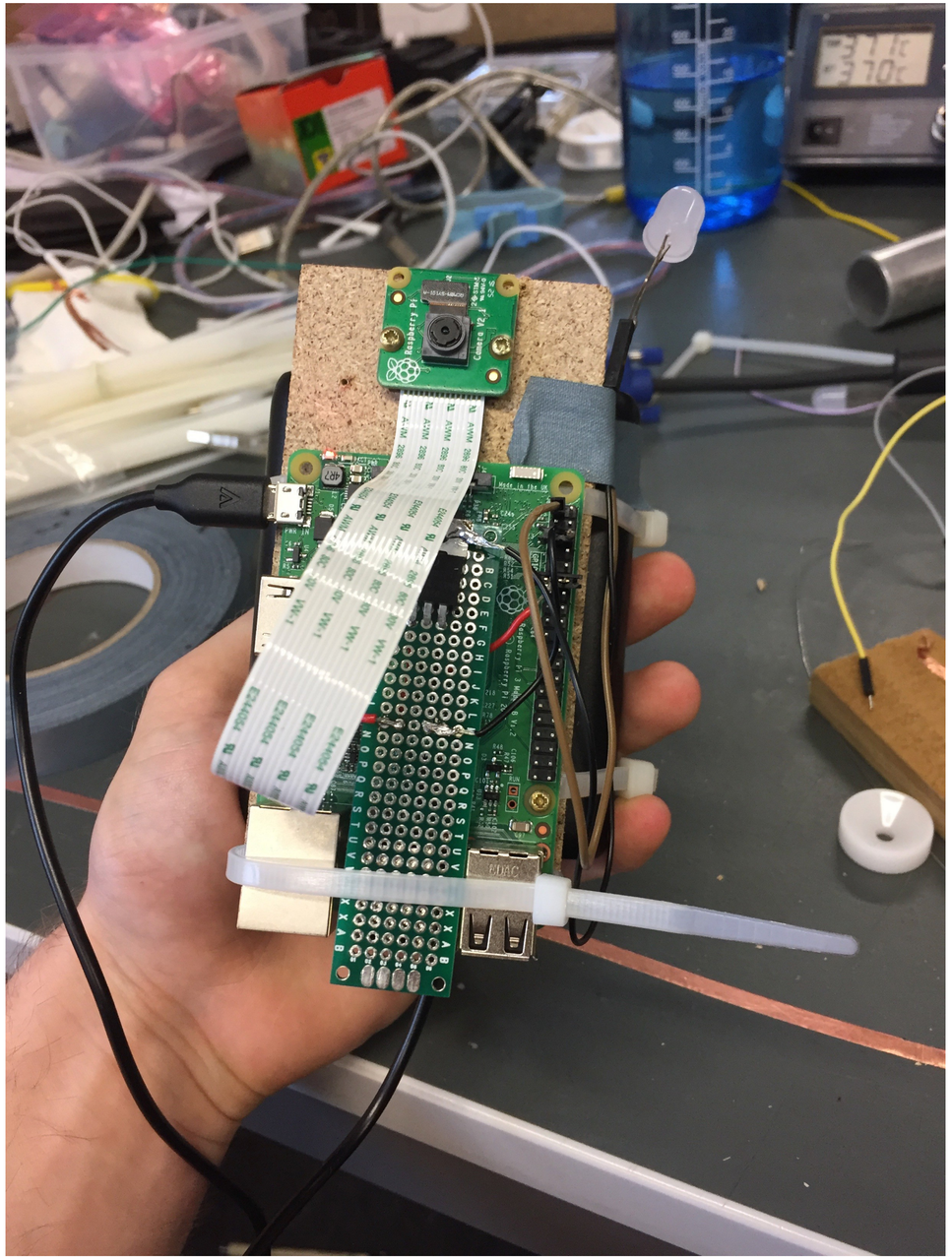
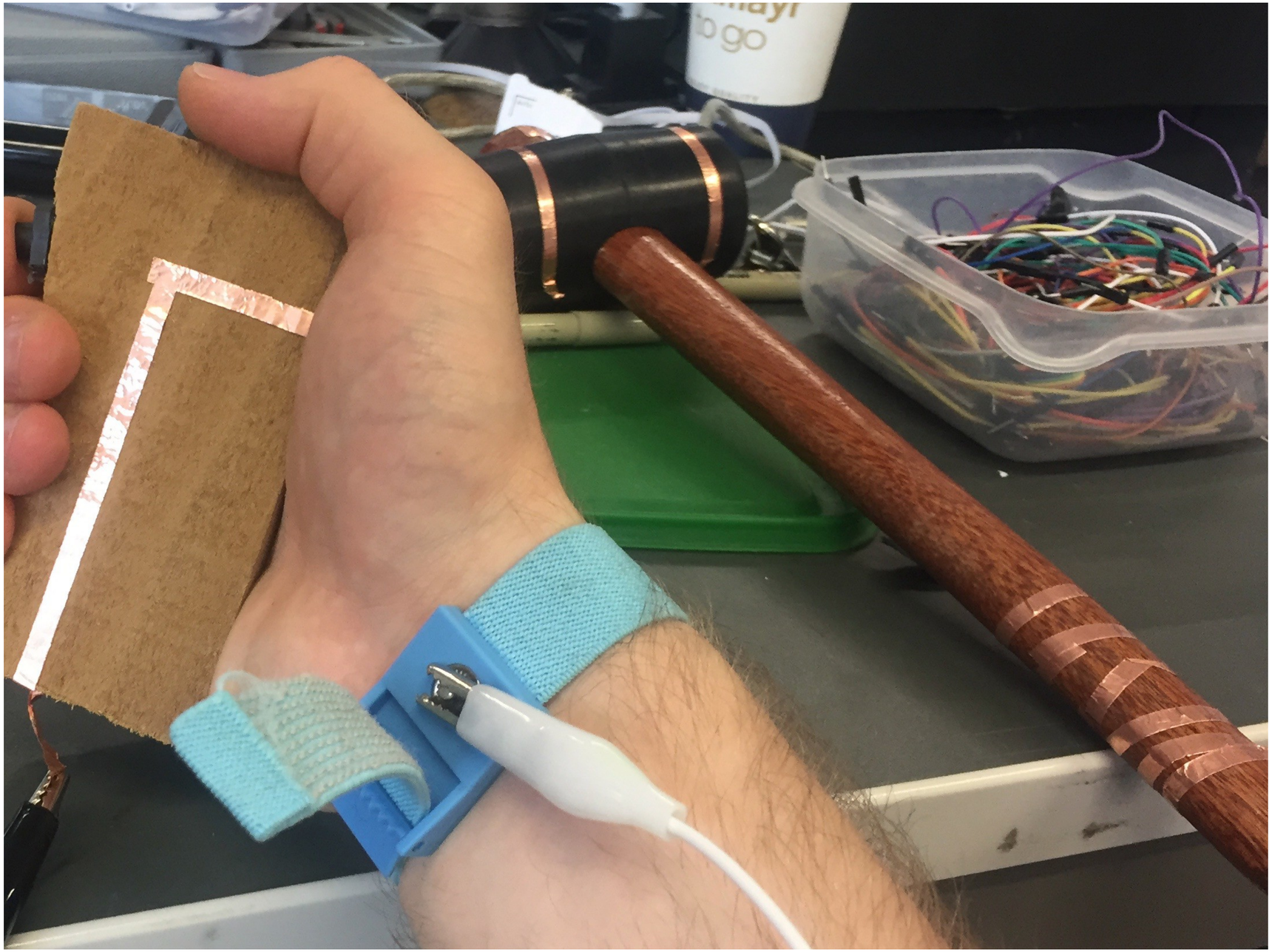
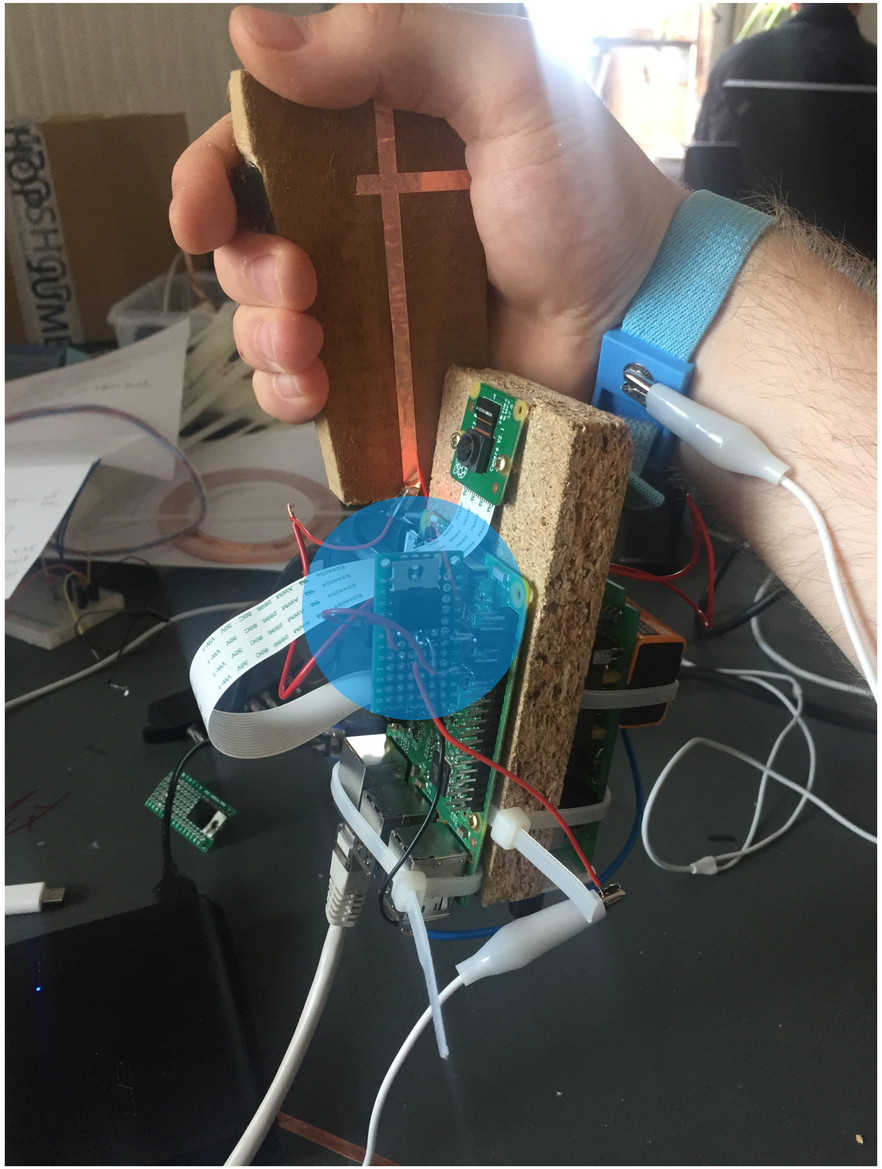


Prosthetic Photographer



Prosthetic Photographer



Prosthetic Photographer

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