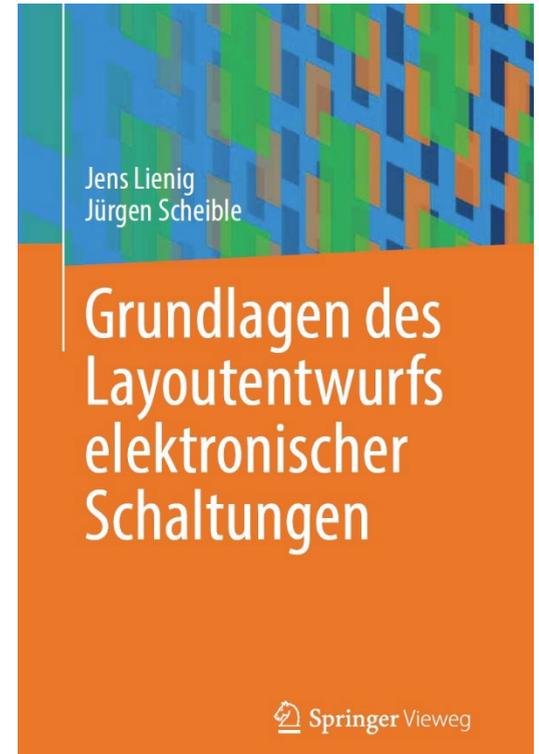
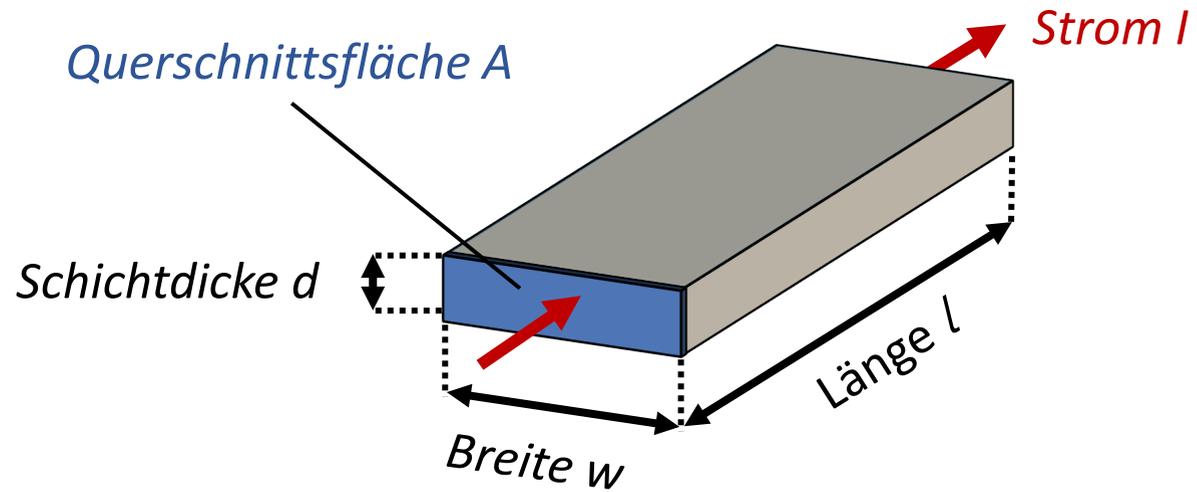
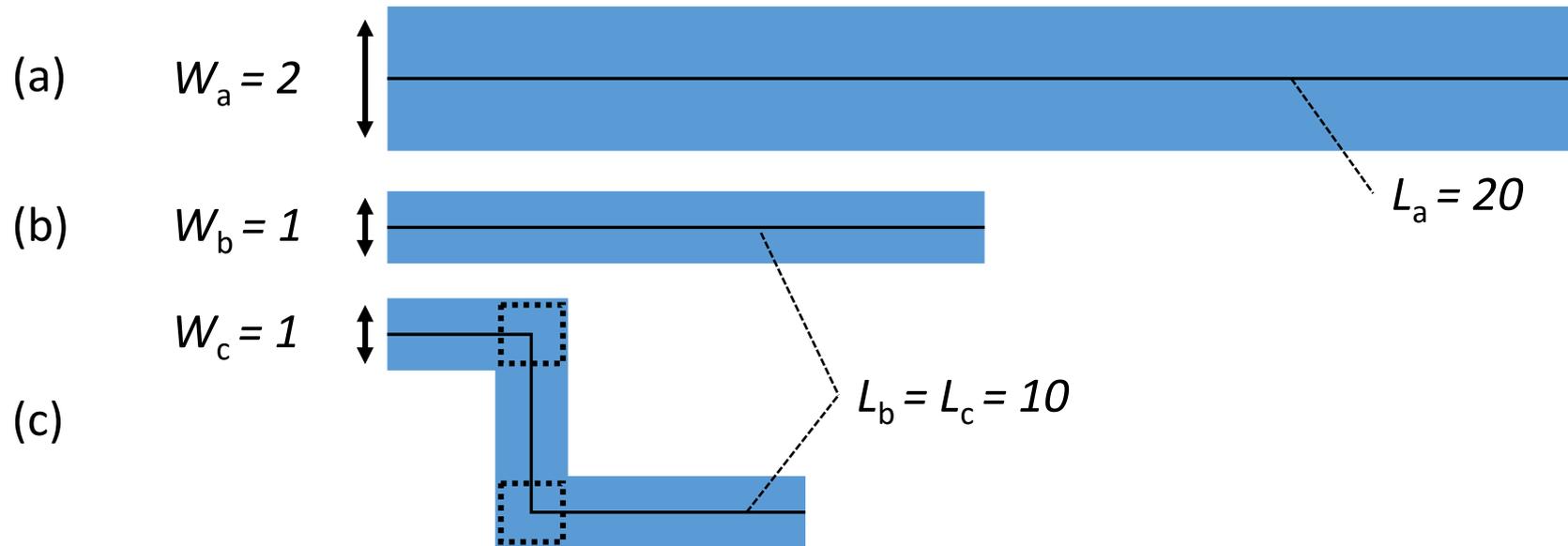


- 6.1 Schichtwiderstand: Rechnen mit Squares
- 6.2 Wannen
- 6.3 Bauelemente: Aufbau, Anschluss und Dimensionierung
- 6.4 Bauelementgeneratoren: Von Parametern zu Layouts
- 6.5 Die Bedeutung der Symmetrie
- 6.6 Matching-Konzepte für den analogen Layoutentwurf

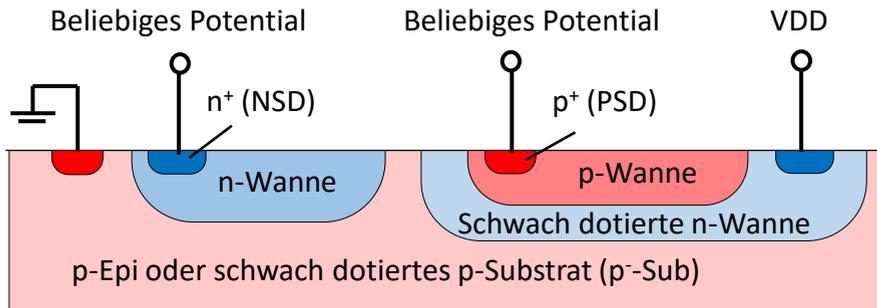




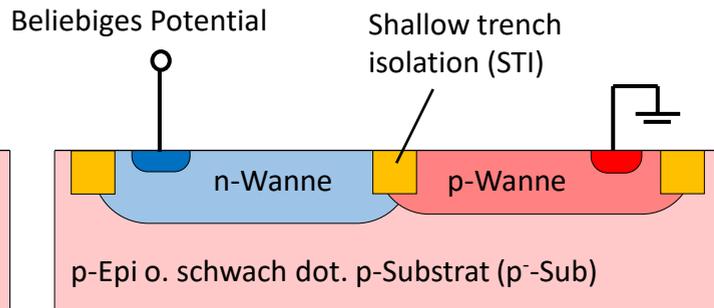


$$R_a = R_b = 10R_{\square}$$

$$R_c = 10R_{\square} - 2R_{\square} / 2 \approx 9R_{\square}$$

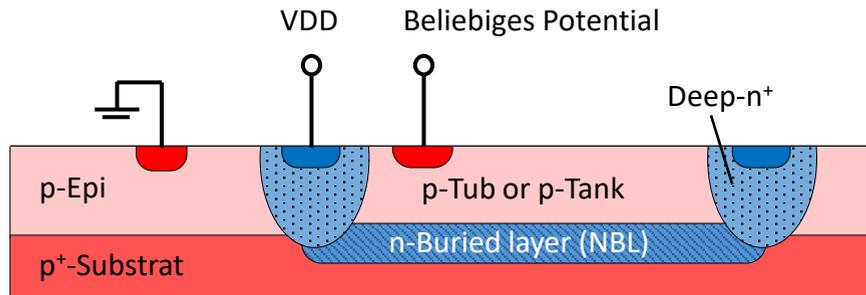


(a)

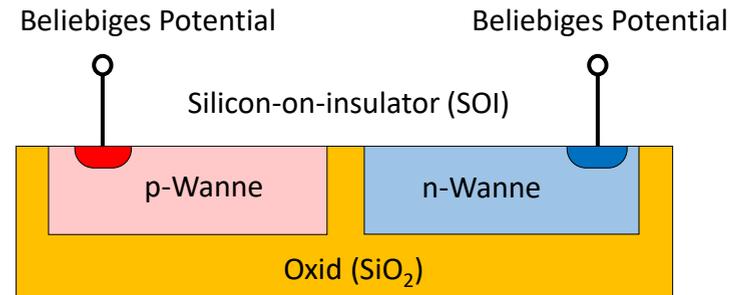


(b)

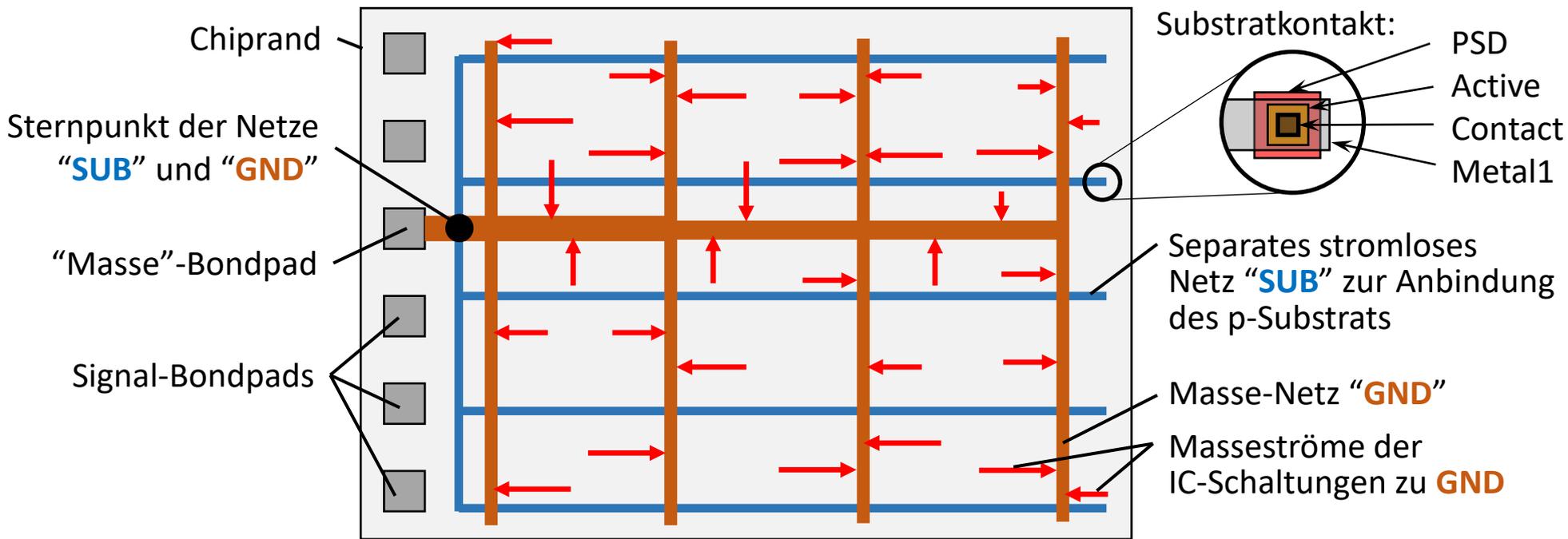
(c)

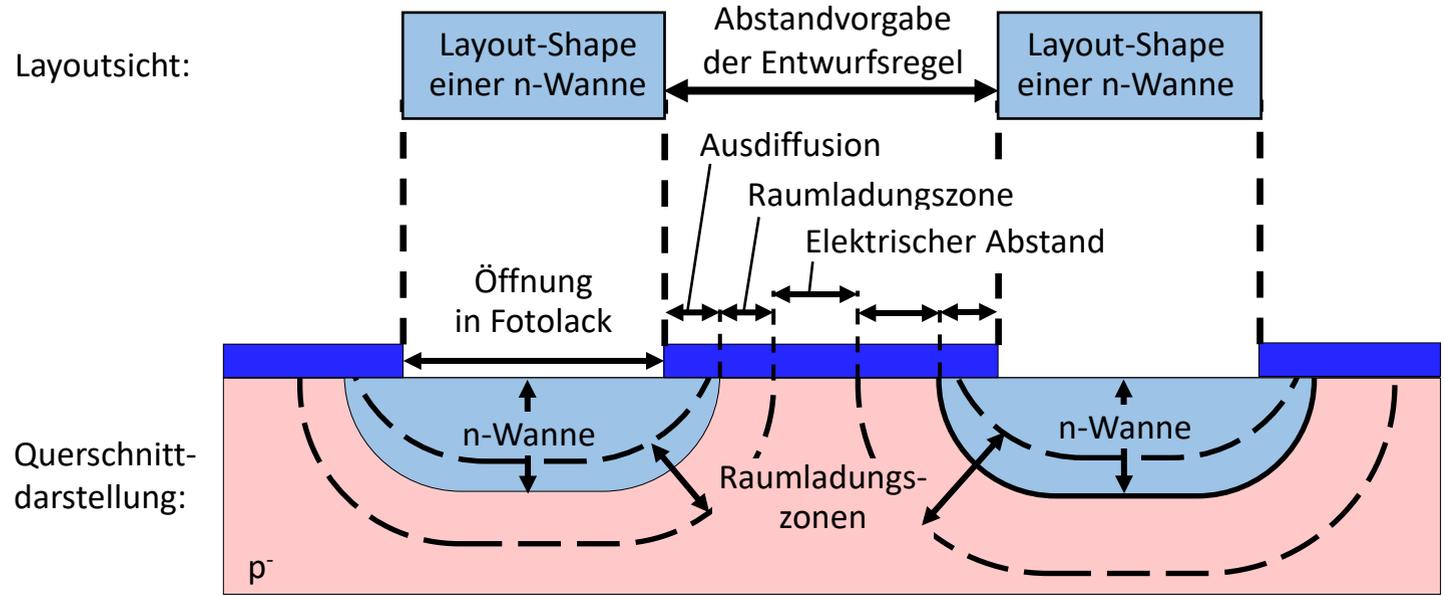


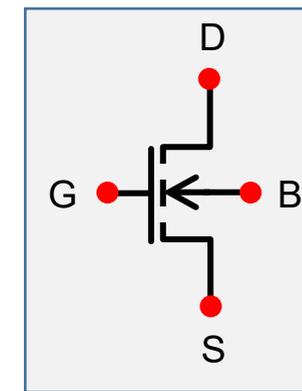
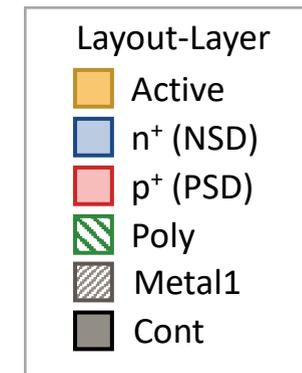
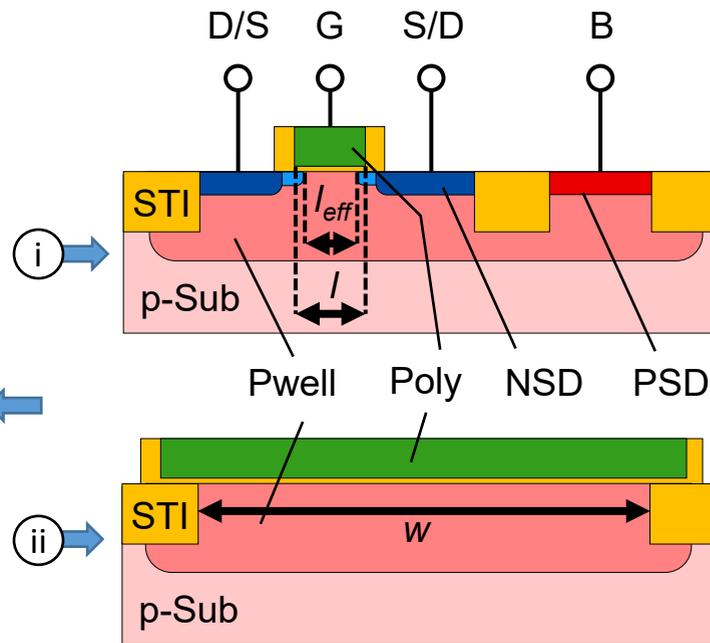
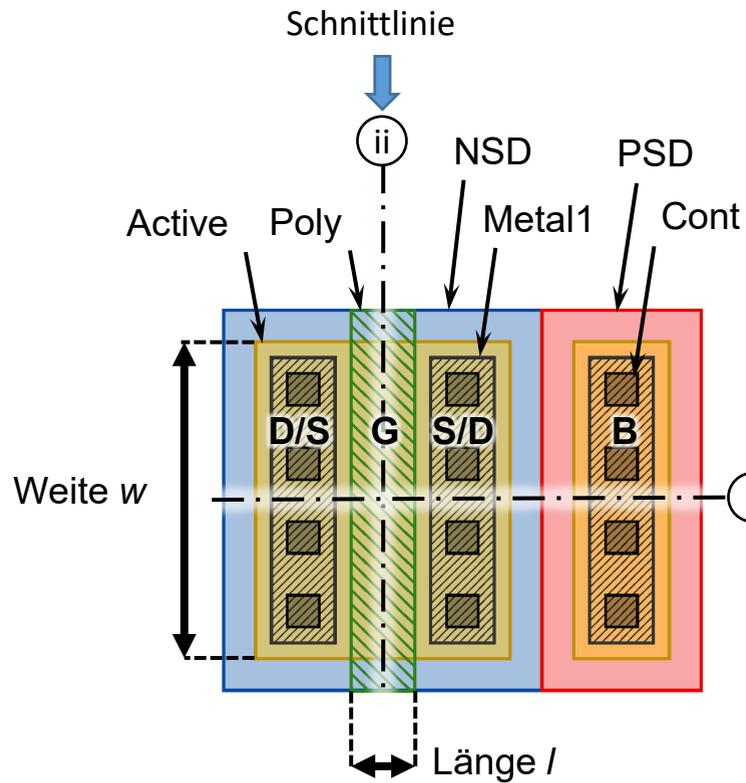
(d)

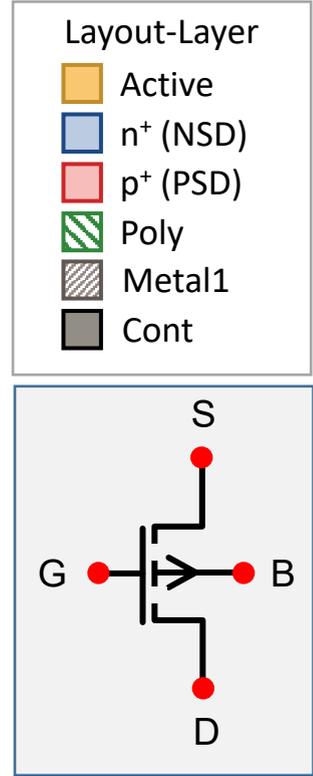
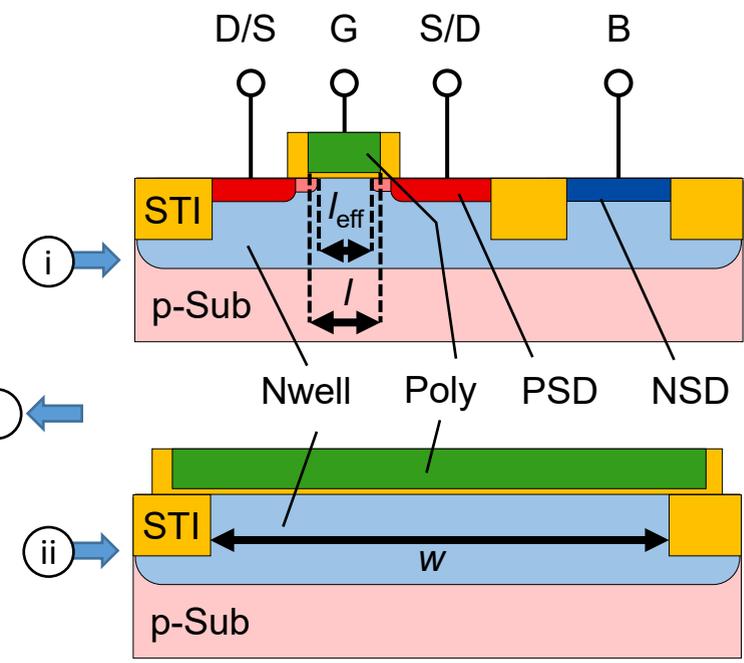
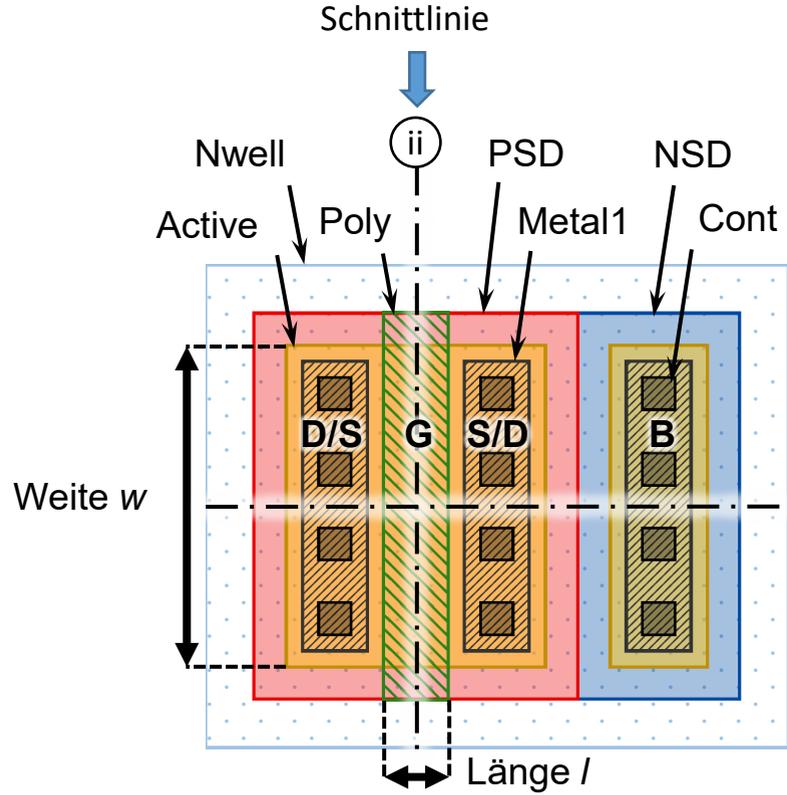


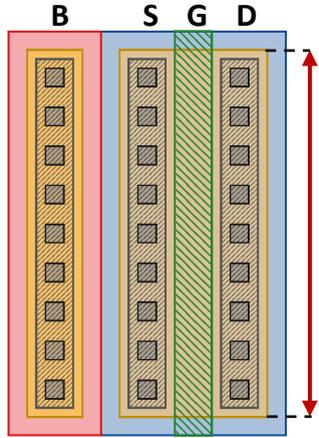
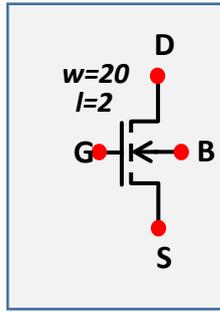
(e)



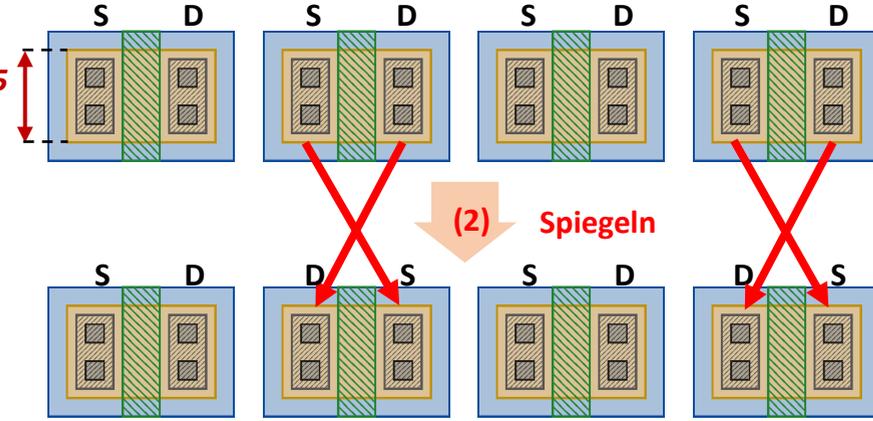




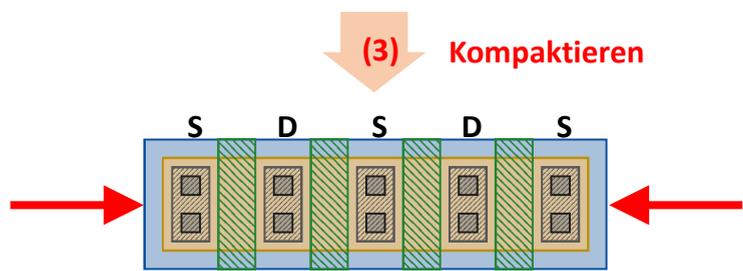




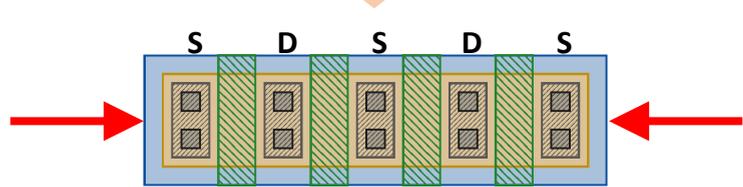
(1) Teilen



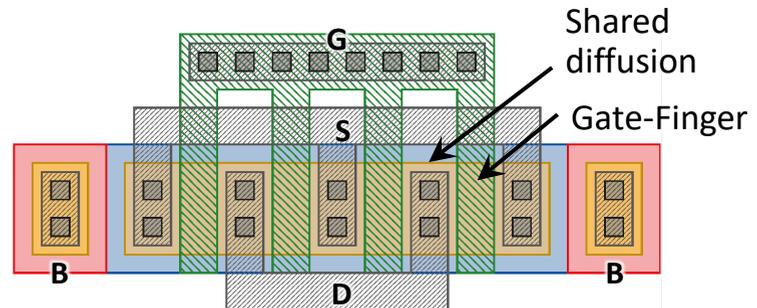
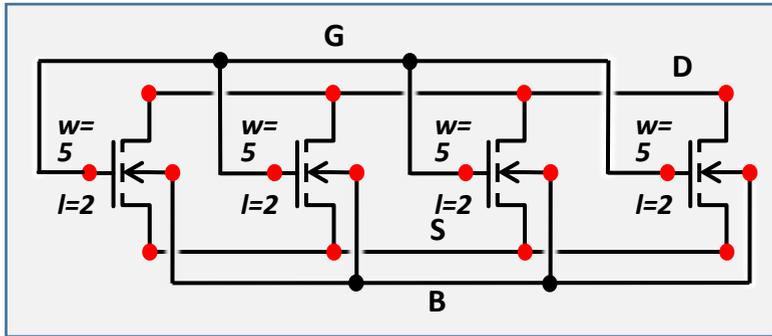
(2) Spiegeln

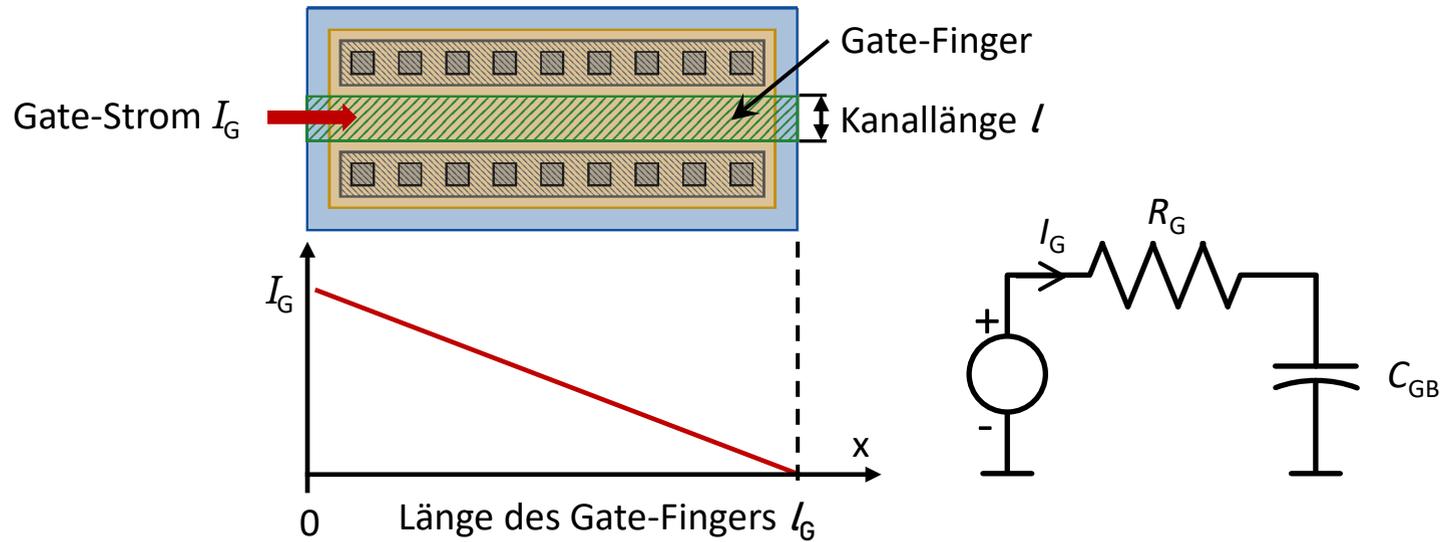


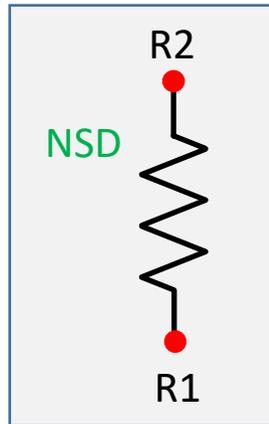
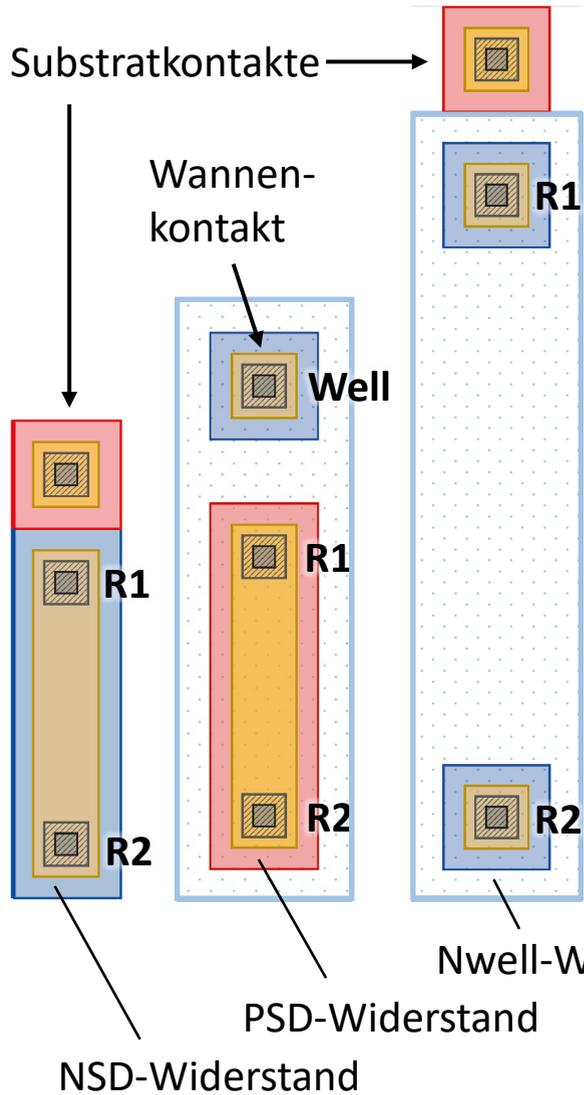
(3) Kompaktieren



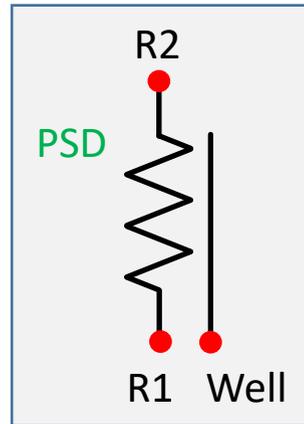
(4) Verdrahten



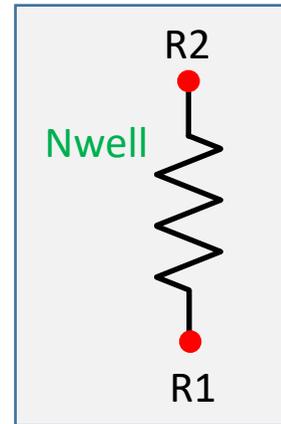




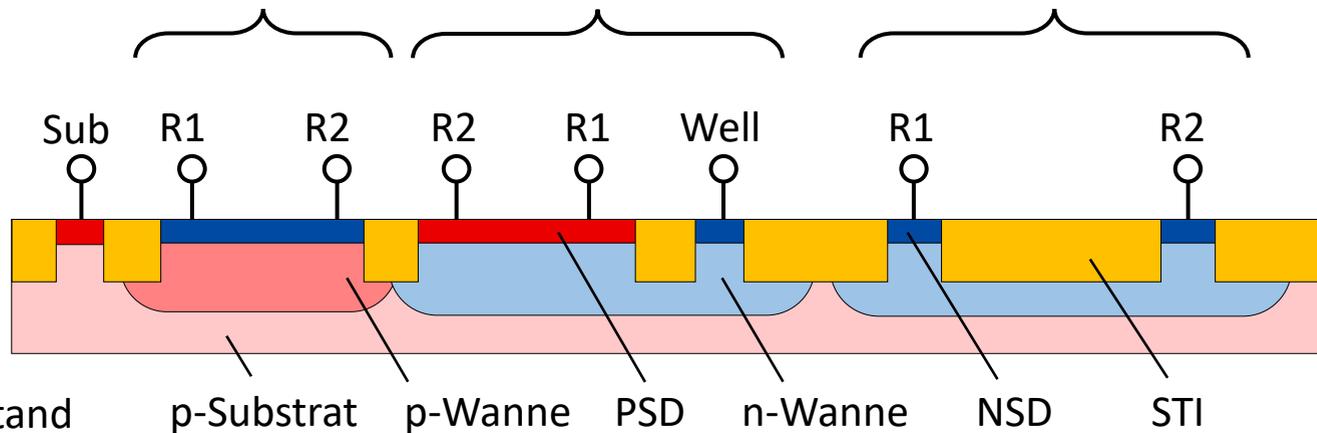
NSD-Widerstand

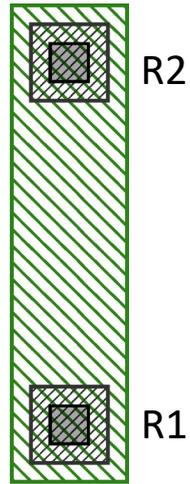


PSD-Widerstand

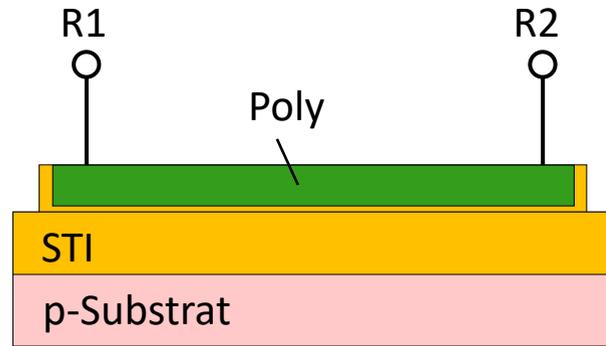


Nwell-Widerstand

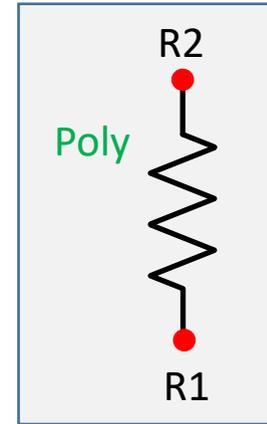




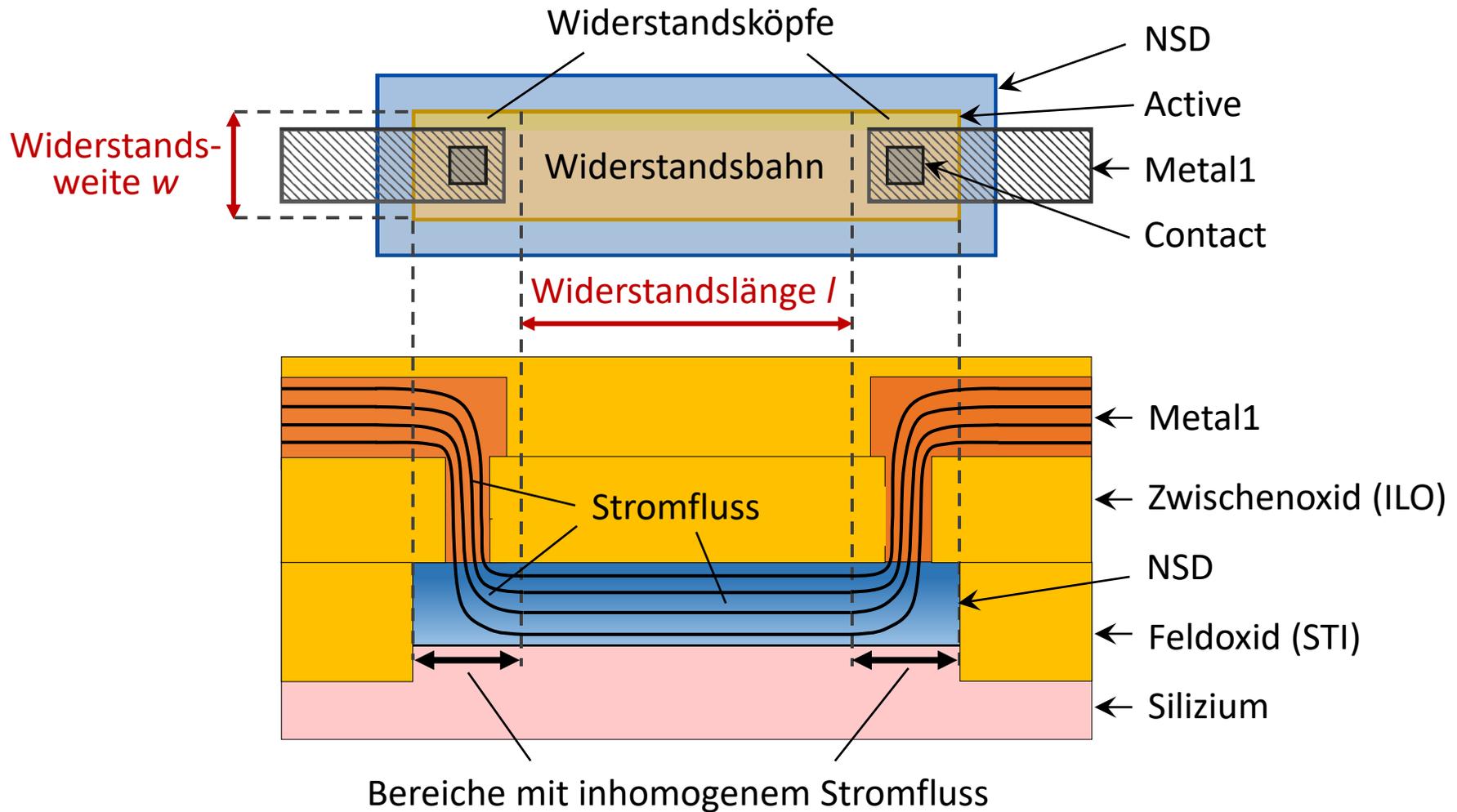
Layout

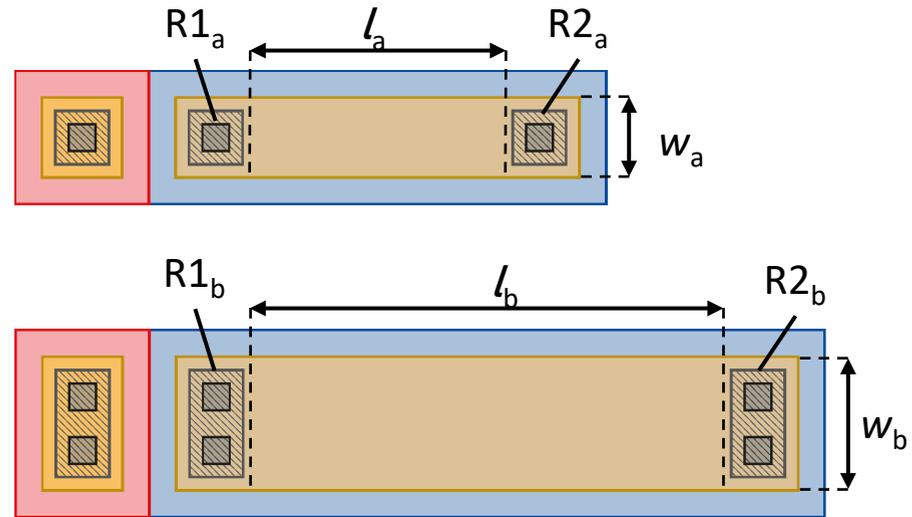


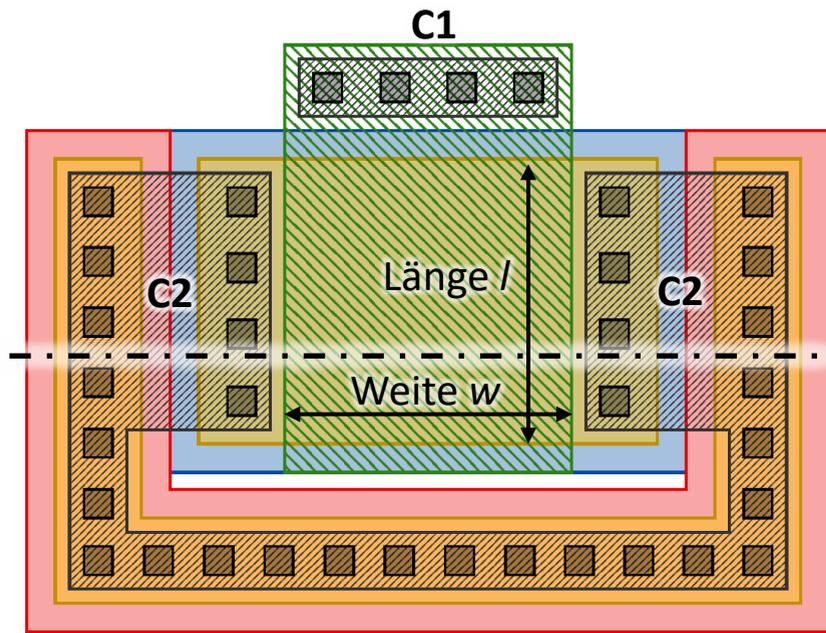
Querschnitt



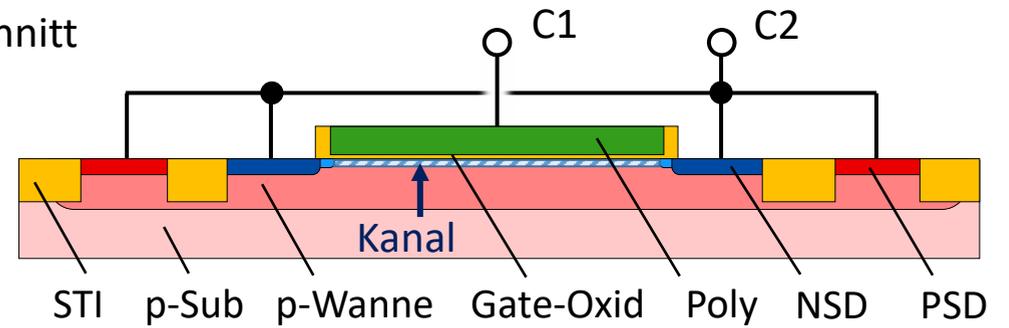
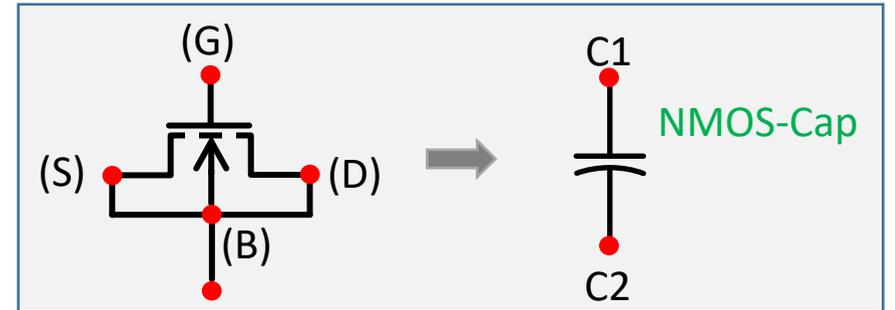
Schaltplansymbol

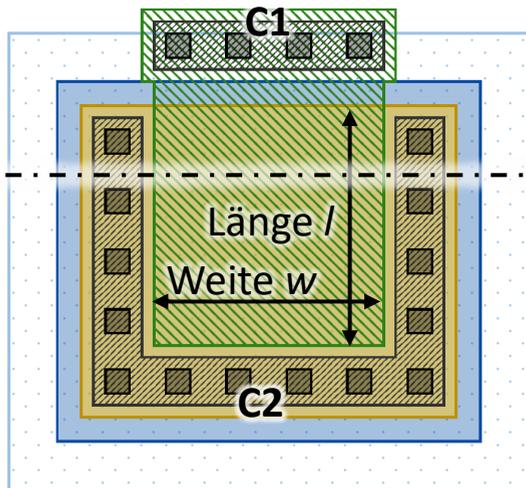




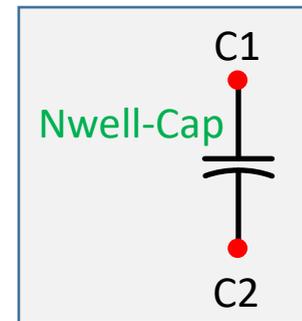
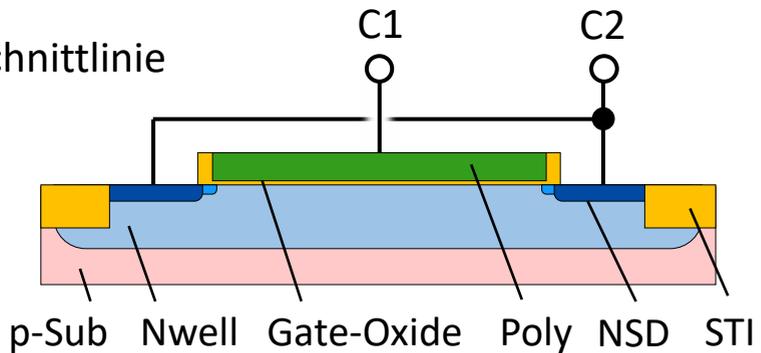


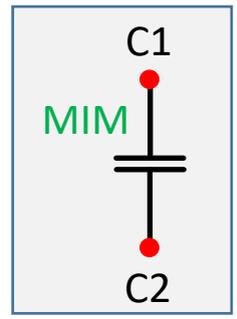
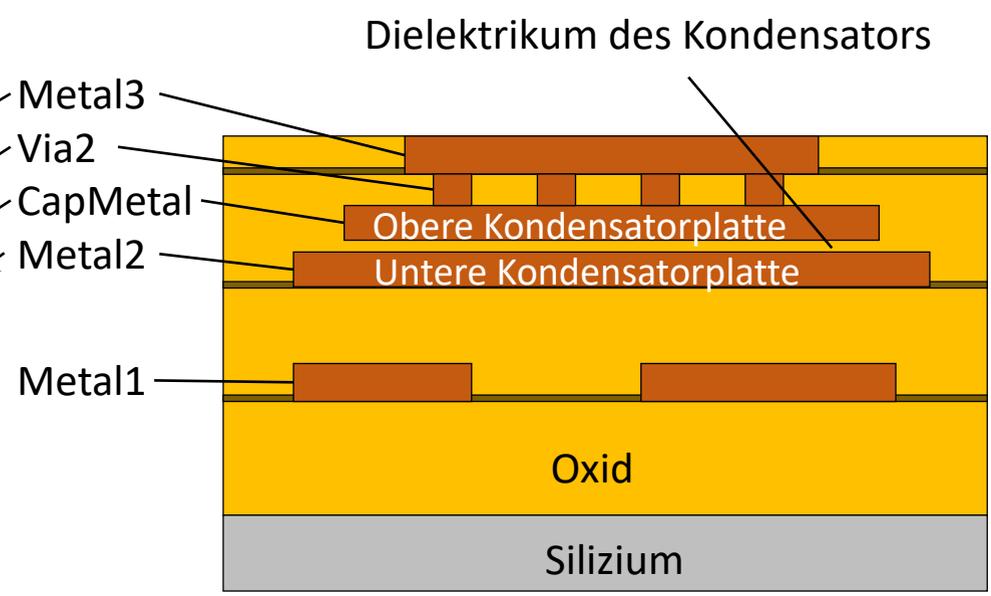
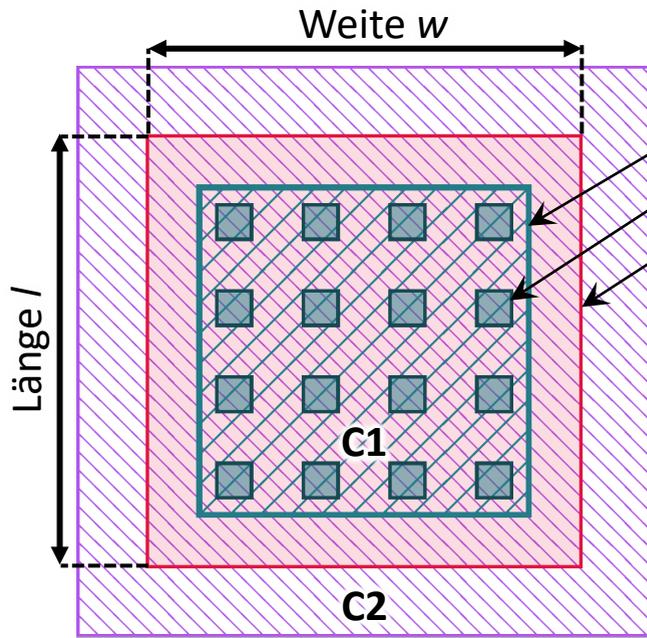
← Schnitt

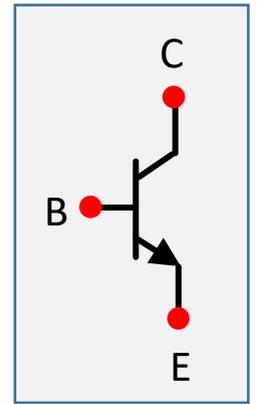
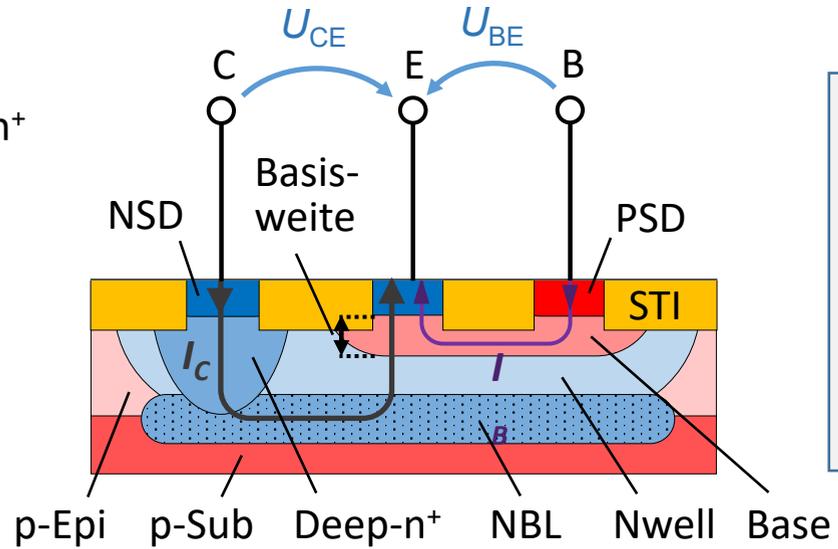
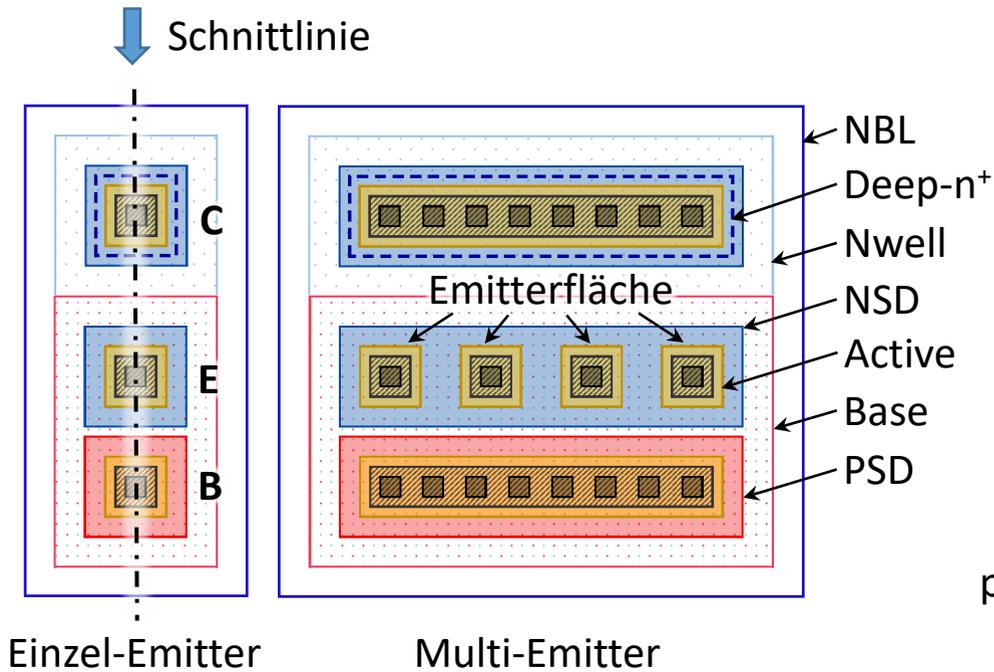


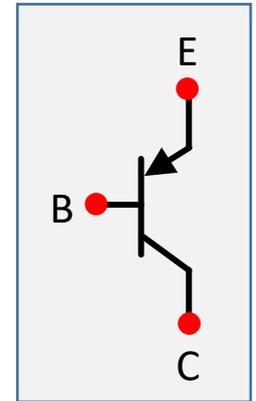
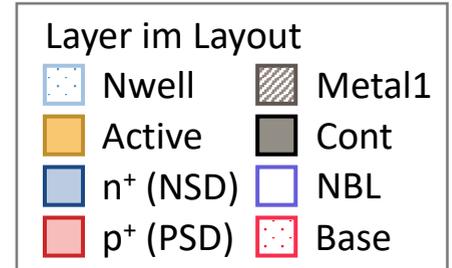
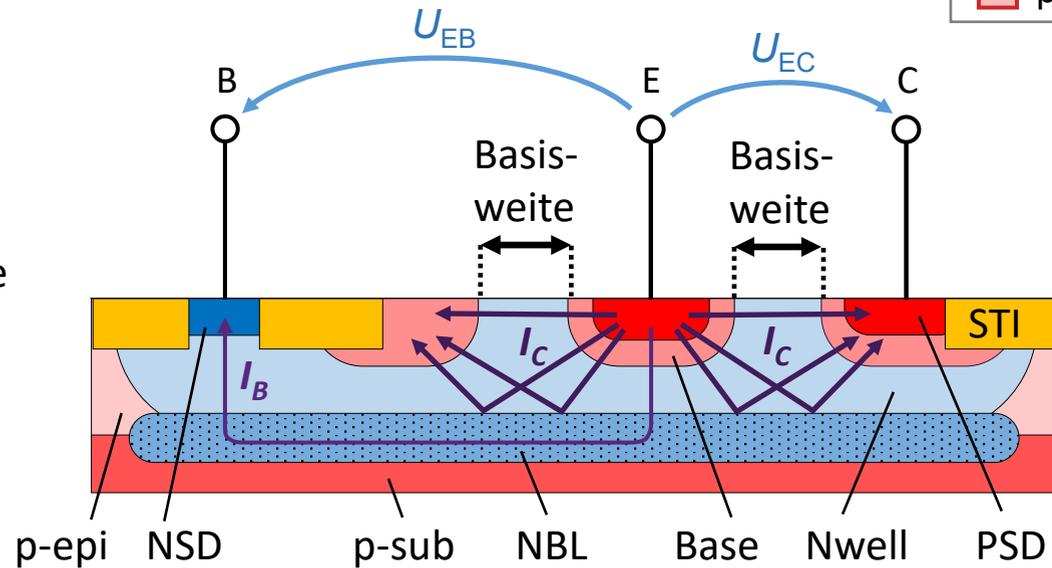
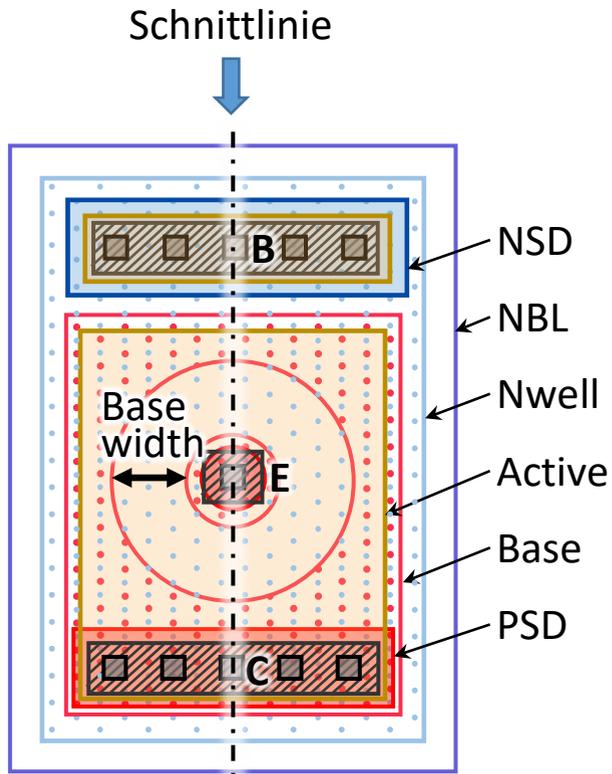


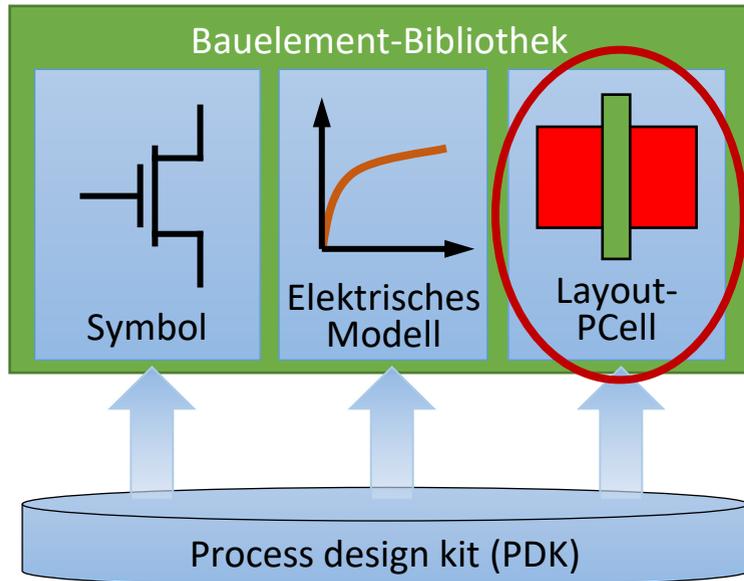
Schnittlinie



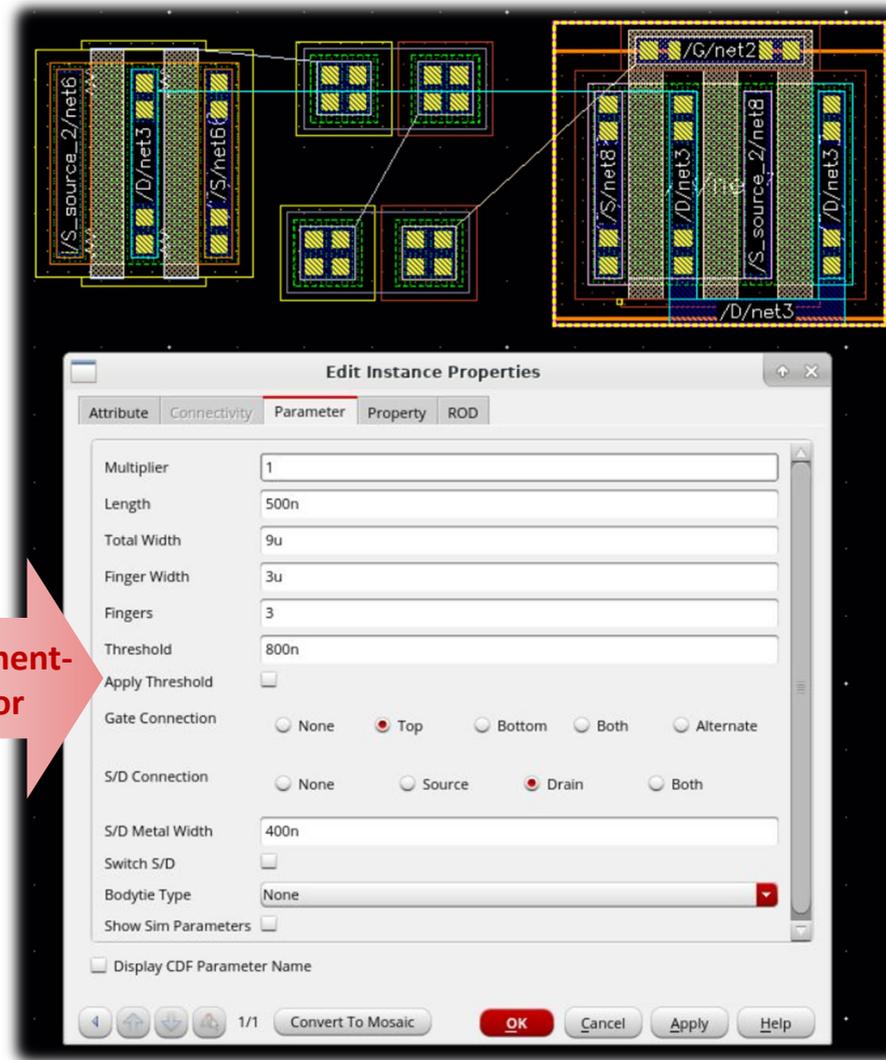








Baelement-generator



Command	Line	Parameters
set	1	Active = list("Oxide" "drawing"), Poly = list("Poly" "drawing"), NSD = list("Nimp" "drawing"), PSD = list("Pimp"
block	2	"Create initial shapes."
group	3	Shapes "nil"
group	4	Core -
rectangle	5	Active {-0.6:0.0, 0.78:0.0, 0.78:1.0, -0.6:1.0}
rectangle	6	Poly {0.0:-0.205, 0.18:-0.205, 0.18:1.205, 0.0:1.205}
rectangle	7	NSD {-0.8:-0.2, 0.98:-0.2, 0.98:1.2, -0.8:1.2}
rectangle	8	Metal1 {0.28:0.1, 0.68:0.1, 0.68:0.9, 0.28:0.9}
rectangle	9	Metal1 {-0.5:0.1, -0.1:0.1, -0.1:0.9, -0.5:0.9}
group	10	BulkLeft "nil"
rectangle	11	Active {-1.6:0.0, -1.0:0.0, -1.0:1.0, -1.6:1.0}
rectangle	12	PSD {-1.8:-0.2, -0.8:-0.2, -0.8:1.2, -1.8:1.2}
rectangle	13	Metal1 {-1.5:0.1, -1.1:0.1, -1.1:0.9, -1.5:0.9}
group	14	BulkRight "nil"
rectangle	15	Active {1.18:0.0, 1.78:0.0, 1.78:1.0, 1.18:1.0}
rectangle	16	PSD {0.98:-0.2, 1.98:-0.2, 1.98:1.2, 0.98:1.2}
rectangle	17	Metal1 {1.28:0.1, 1.68:0.1, 1.68:0.9, 1.28:0.9}
block	18	"Stretch transistor channel."
set	19	fFingerWidth = width - 1
set	20	fLength = length - 0.18
stretch	21	{Group Shapes} east <fLength:0 R0>
stretch	22	{Group Shapes} north <0:fFingerWidth R0>
block	23	"Create fingers through duplication."
set	24	fPitch = 0
repeat	25	"finger" [f: fingers - 1]
set	26	fPitch = (finger+1)*(0.78+fLength)
copy	27	{Group Core} <fPitch:0 R0> "t" "t" - must
move	28	{Group BulkRight} <fPitch:0 R0>
merge	29	{F: {append (group ("Core")) (layer evalstring("Active")) (layer evalstring("NSD"))}}
block	30	"Keep or delete bulks."
unless	31	[f: leftBulk]
delete	32	{Group BulkLeft}
unless	33	[f: rightBulk]
delete	34	{Group BulkRight}
block	35	"Create contact holes."
rectangle	36	oCont Cont {0.0:-0.5, 0.2:-0.5, 0.2:-0.3, 0.0:-0.3}
fill	37	{Name oCont} {F: {append (layer evalstring("Metal1"))} [f: 0.4] [f: 0.4] "nil" [f: 0.1] "distribute" "distribute"}
delete	38	{Name oCont}

Gruppenname

Layername {Koordinaten $x_1:y_1, x_2:y_2, x_3:y_3, x_4:y_4$ }

Erzeuge 5 Rechtecke für das Basislayout des MOSFET

Erzeuge 3 Rechtecke für den linken Bulk-Anschluss

Erzeuge 3 Rechtecke für den rechten Bulk-Anschluss

Berechne die Stretch-Länge

Führe Stretch-Operationen aus

{Gruppenname} Richtung
<x_Wert:y_Wert Rotation>

Kopiere (fingers-1) mal das Basislayout des MOSFET mit (fPitch) in x-Richtung

Schiebe rechten Bulk (fPitch) in x-Richtung

Lösche Bulk-Anschlüsse abhängig von den Werten von „leftBulk“ und „rightBulk“

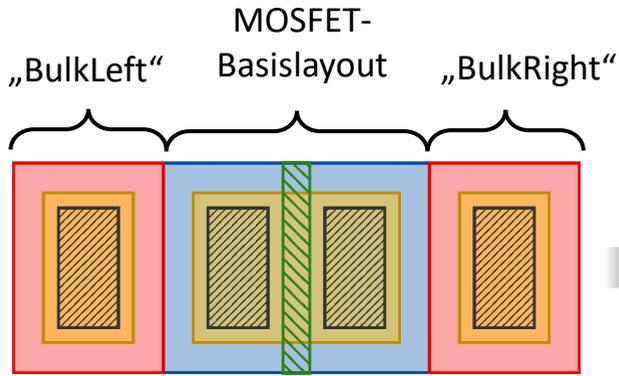
Erzeuge ein Muster-Kontaktloch

Fülle Metal1 komplett mit diesem Kontaktloch

Lösche Muster-Kontaktloch

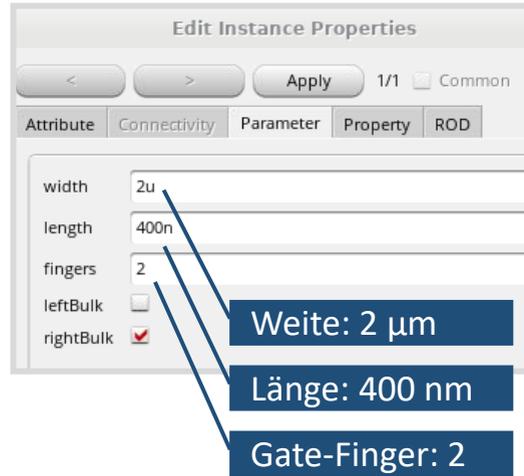
Pitch

Umschließung

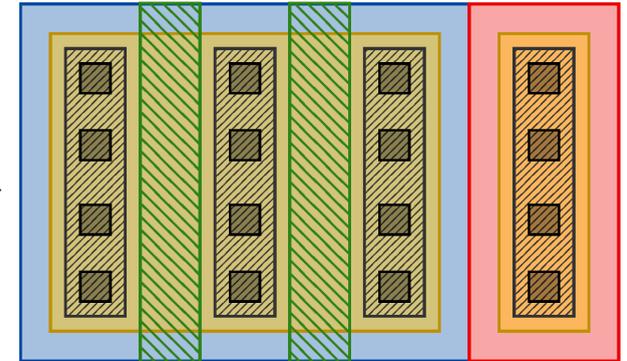


-  Active
-  n⁺ (NSD)
-  p⁺ (PSD)
-  Poly
-  Metal1
-  Cont

Initiales Layout

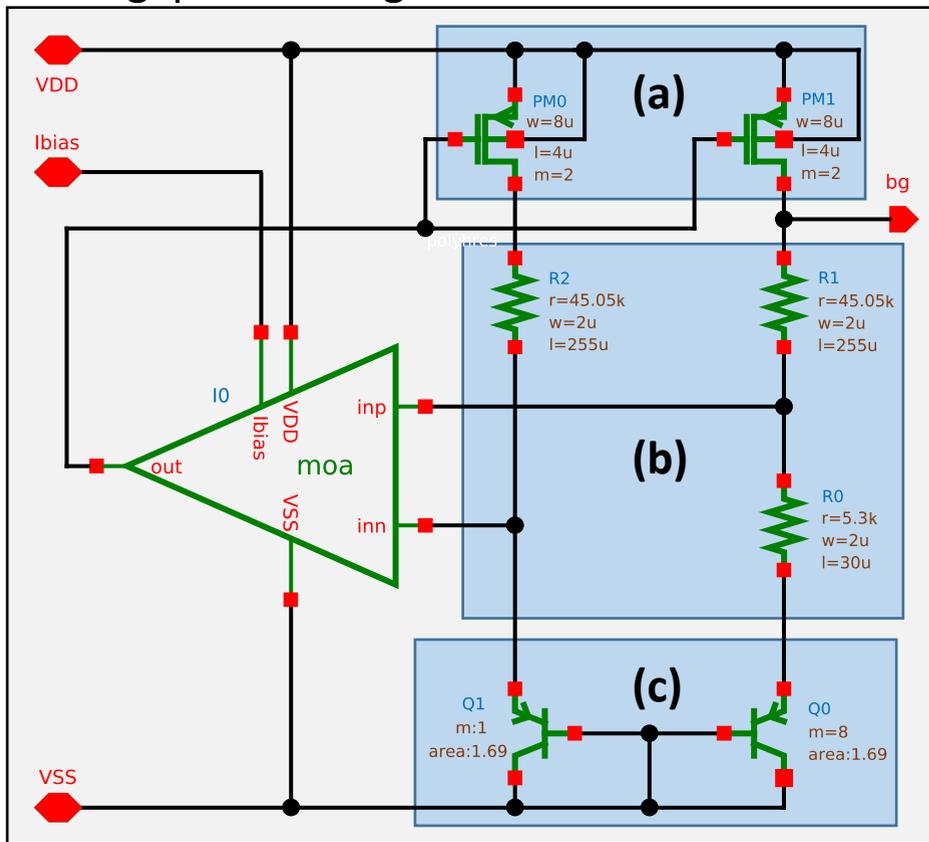


PCell-Menü

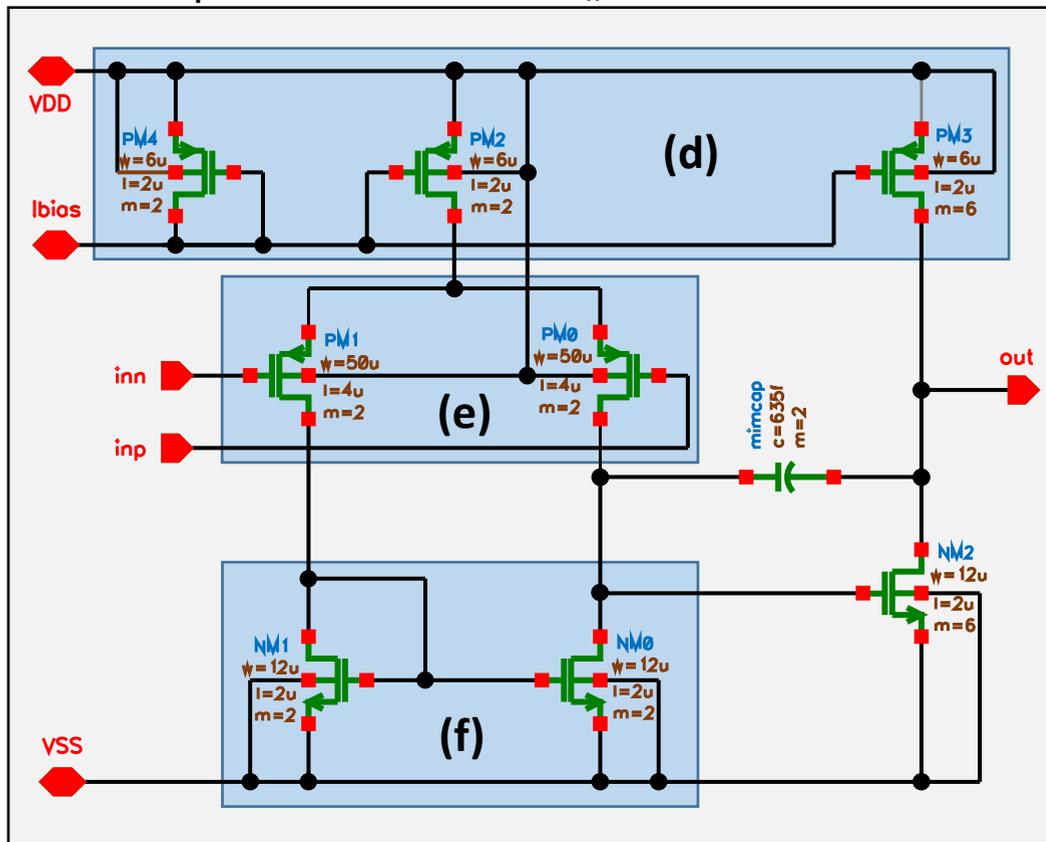


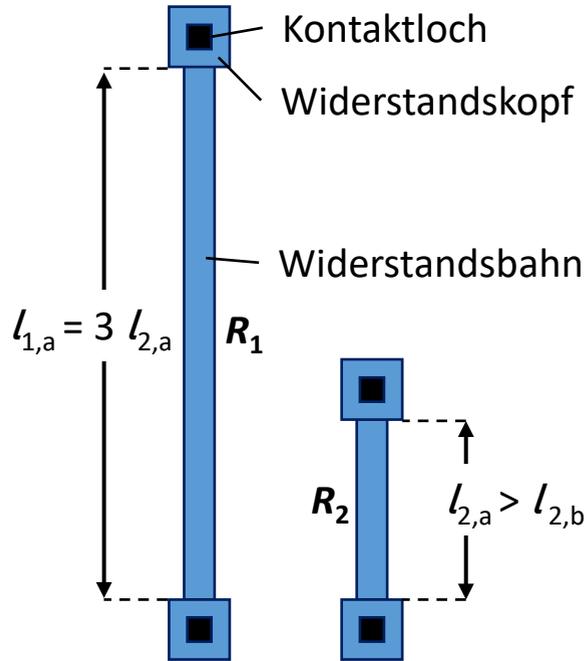
Generierte PCell-Instanz

Bandgap-Schaltung



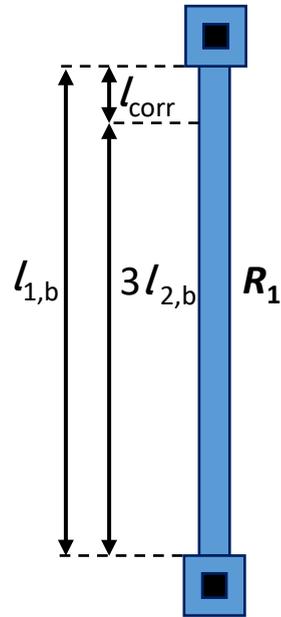
Miller-Operationsverstärker „moa“





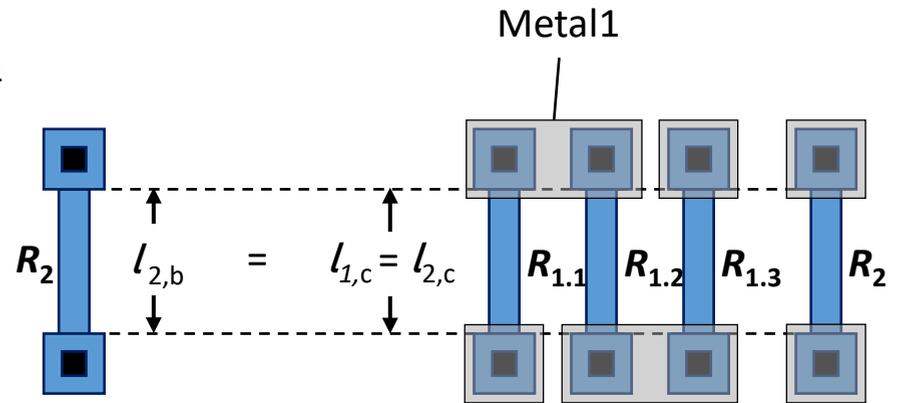
$R_1 < 3R_2 \rightarrow$ **kein Matching!**

(a)



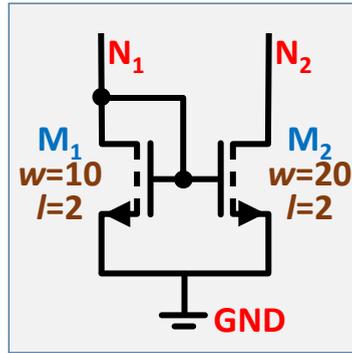
$R_1 \approx 3R_2 \rightarrow$ **schlechtes Matching!**

(b)

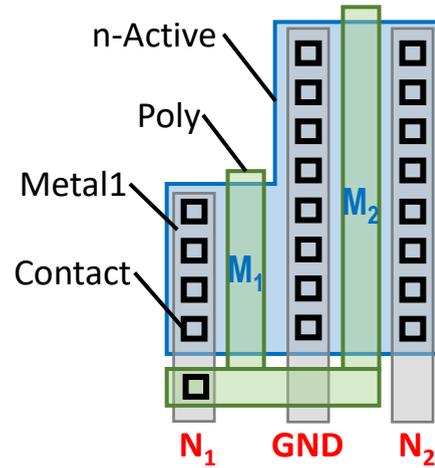


$R_1 = 3R_2 \rightarrow$ **gutes Matching!**

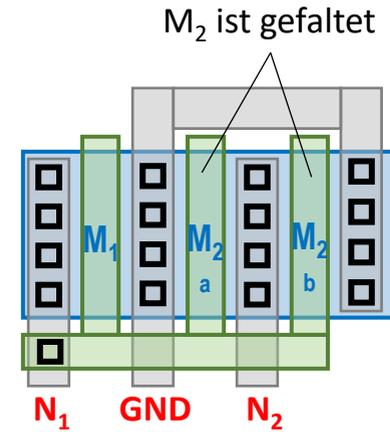
(c)



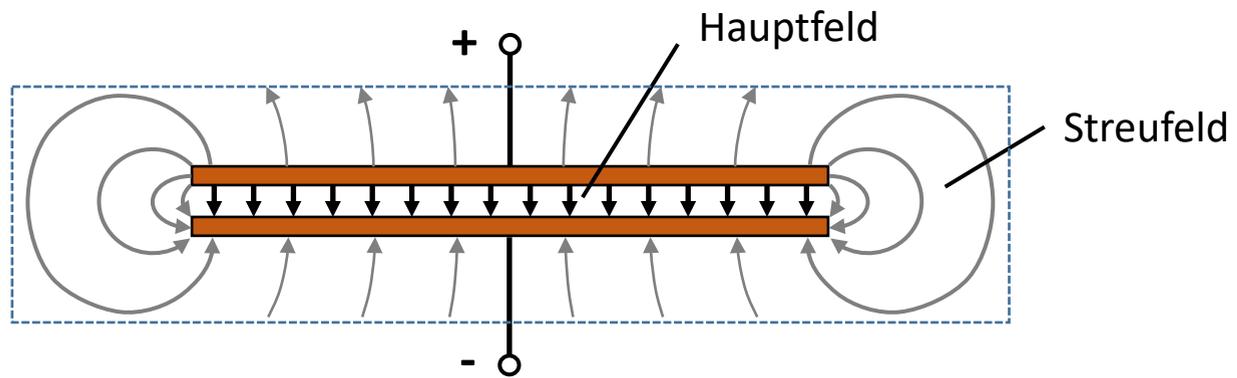
Einfache
Stromspiegelschaltung

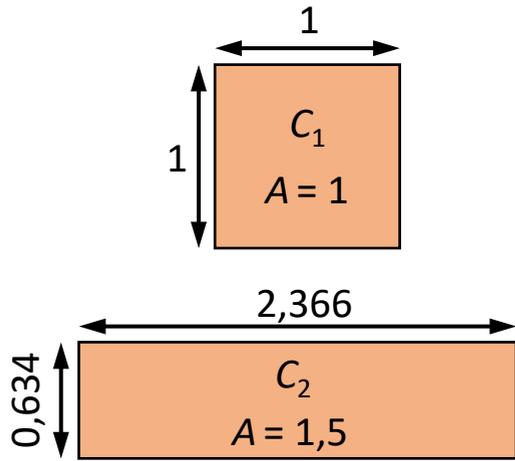


Ohne Splitting (M_2 ungefaltet)
→ schlechtes Matching!

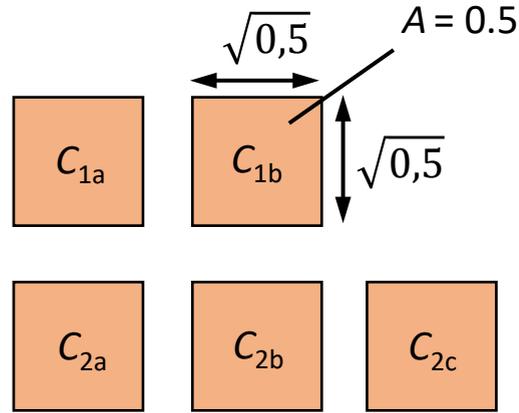


Mit Splitting (M_2 gefaltet)
→ gutes Matching!

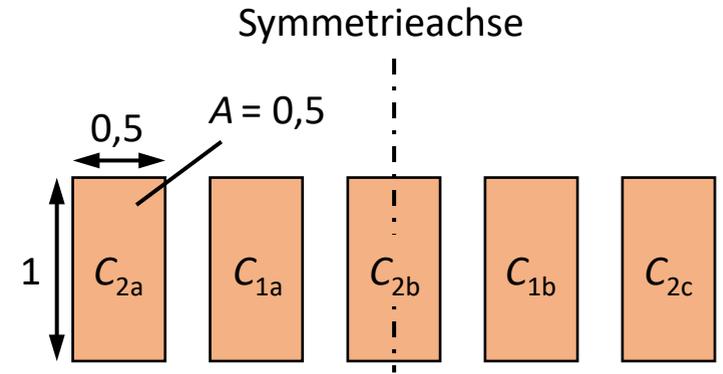




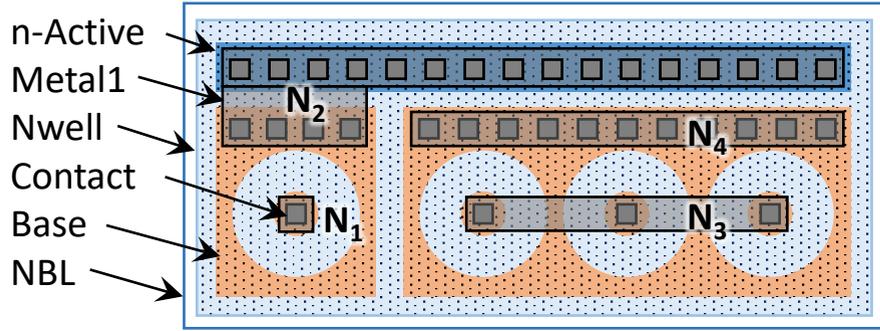
Minimales Matching



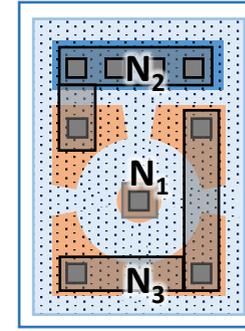
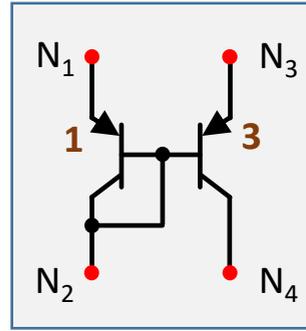
Gutes Matching



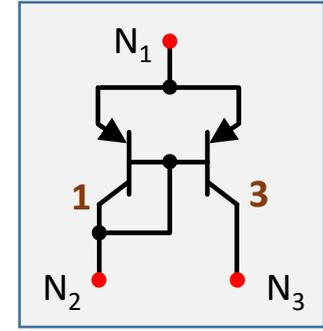
Sehr gutes Matching

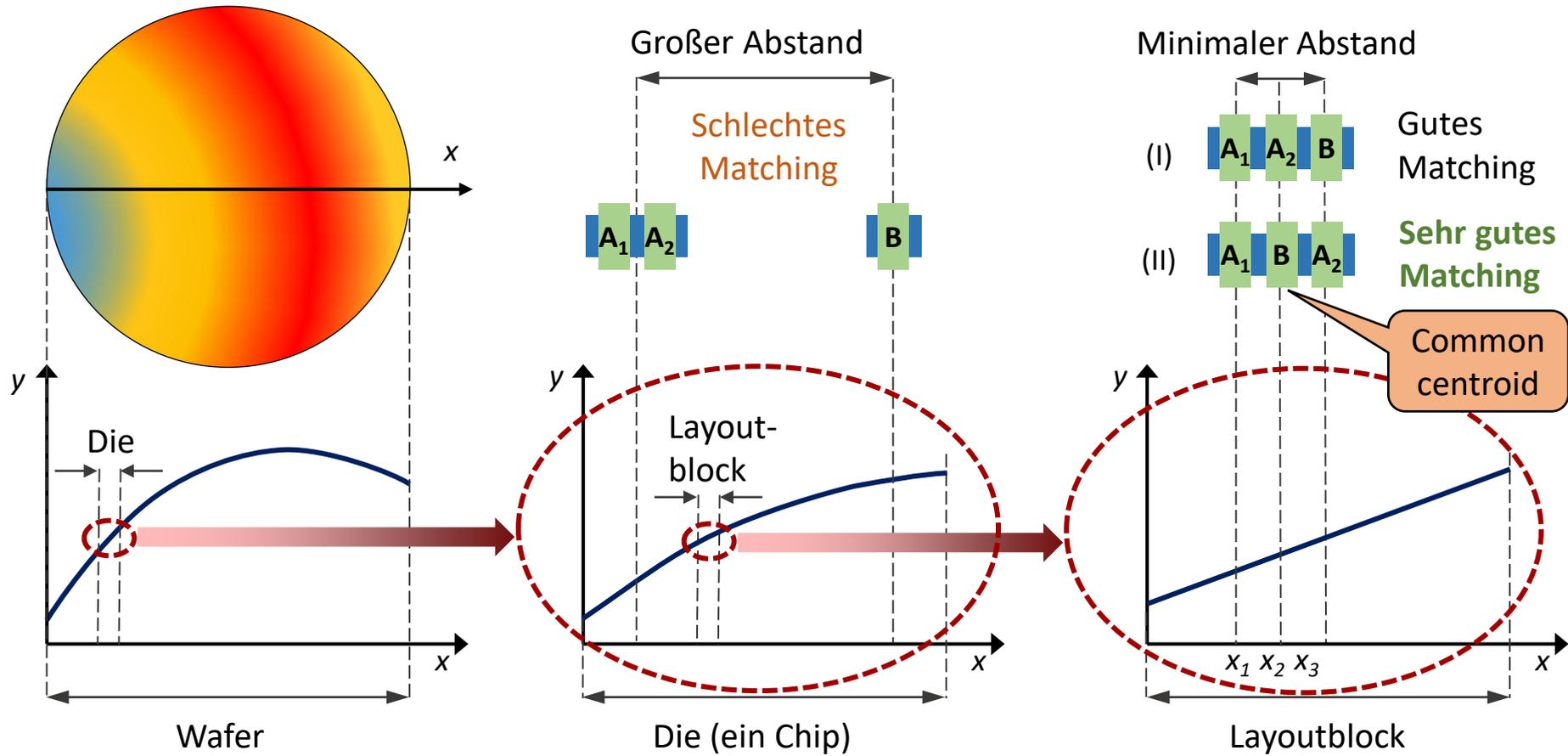


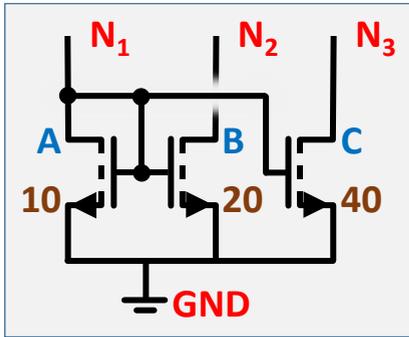
Multi-Emitter PNP-Transistor



Multi-Kollektor PNP-Transistor

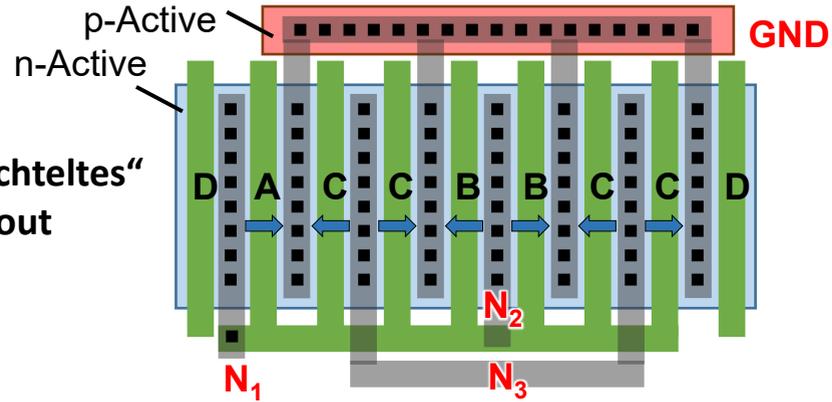




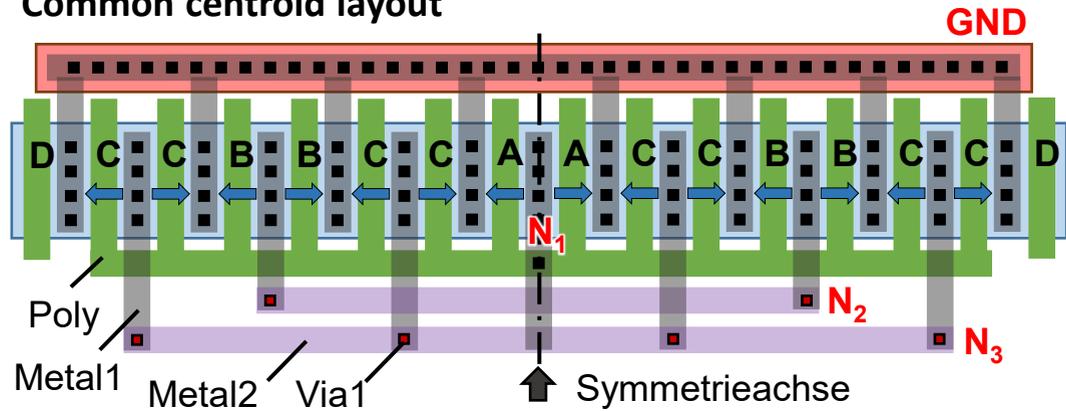


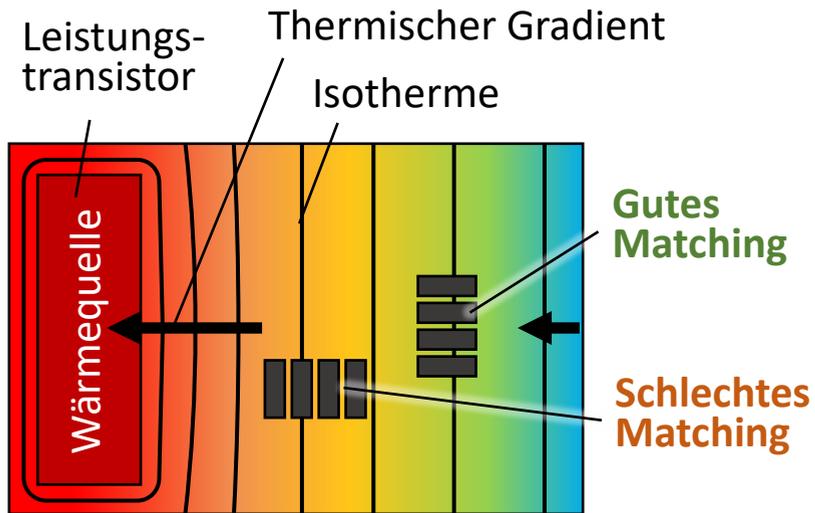
Schaltplan der Stromspiegelschaltung

„Verschachteltes“
Layout

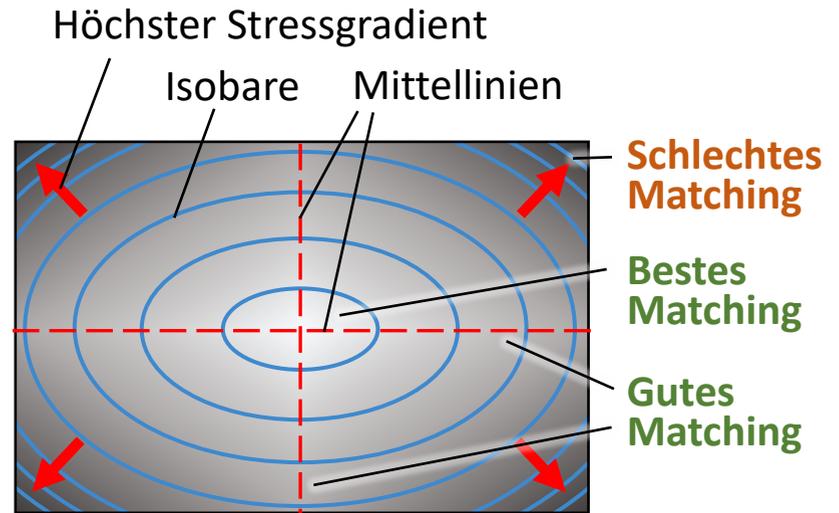


Common centroid layout

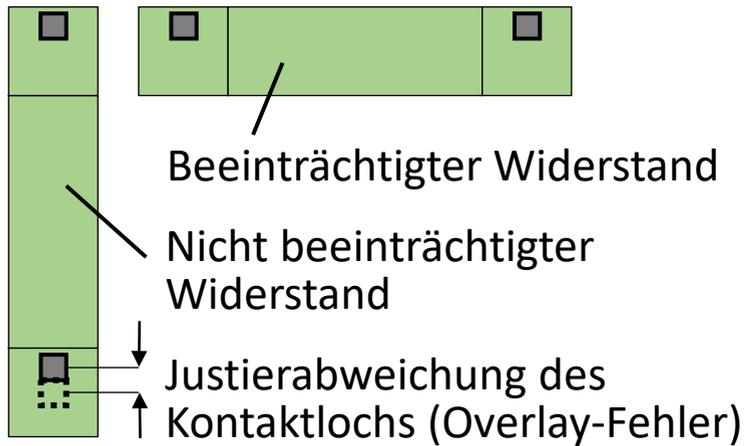




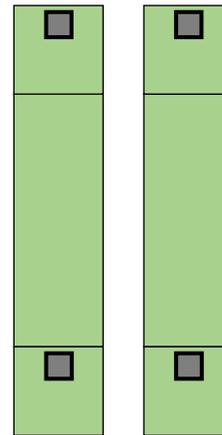
Temperaturverteilung



Verpackungsstress



Schlechtes Matching



Gutes Matching

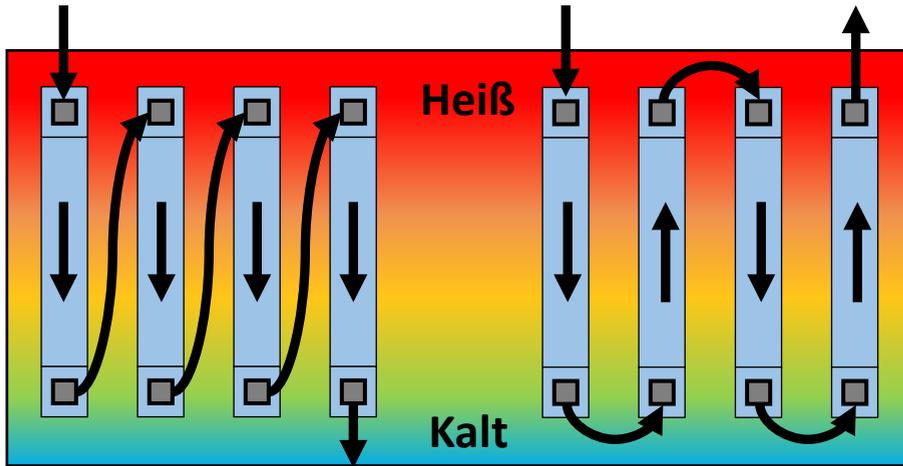


Beide Widerstände sind in gleicher Weise betroffen

Gutes Matching

Paralleler Stromfluss

Antiparalleler Stromfluss

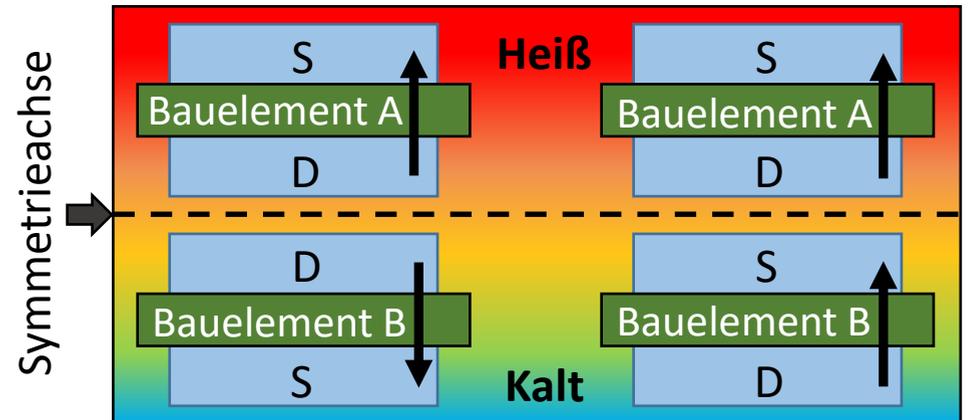


Seebeck-Spannungen werden nicht kompensiert

Seebeck-Spannungen werden kompensiert

Geometrische Symmetrie

“Matching”-Symmetrie



Schlechtes Matching

Gutes Matching