

# Kennliniensimulation

n – Kanal

p - Kanal

Bernhard Wintersperger

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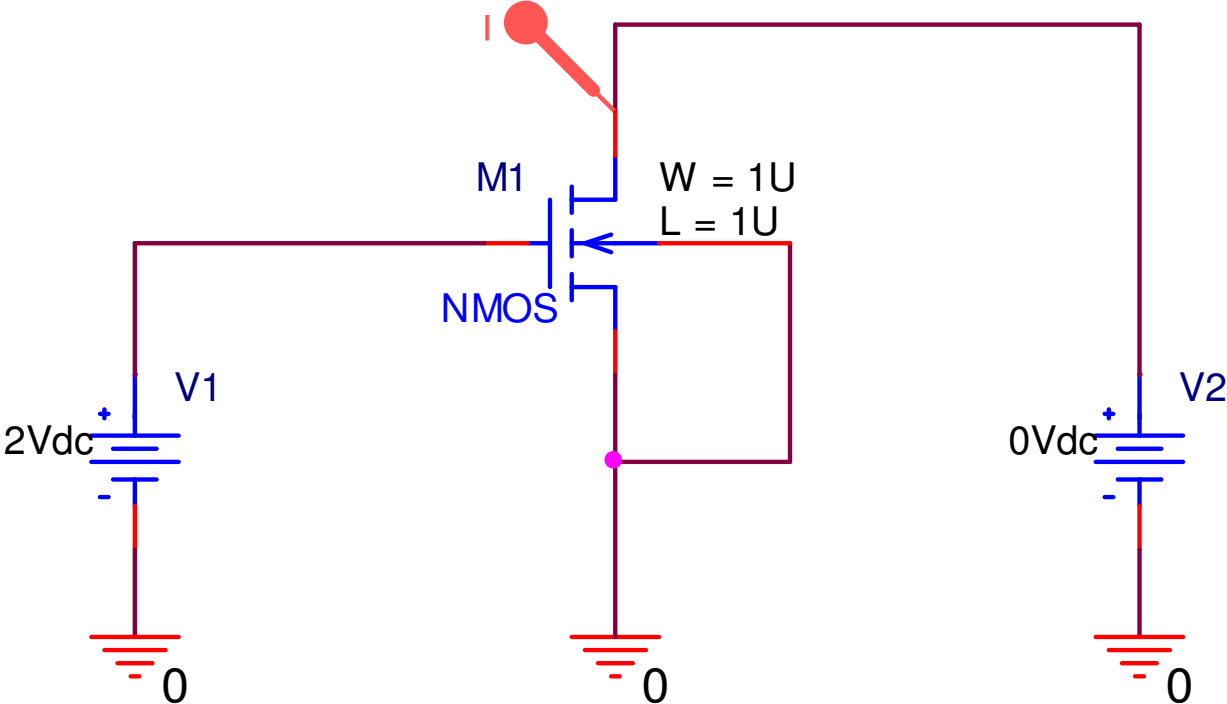
### **Aufgabenstellung:**

Simulation der Ausgangs – und Steuerkennlinien jeweils eines n – und p – Kanal Transistors.

Berechnung der Verstärkung  $\beta$ .

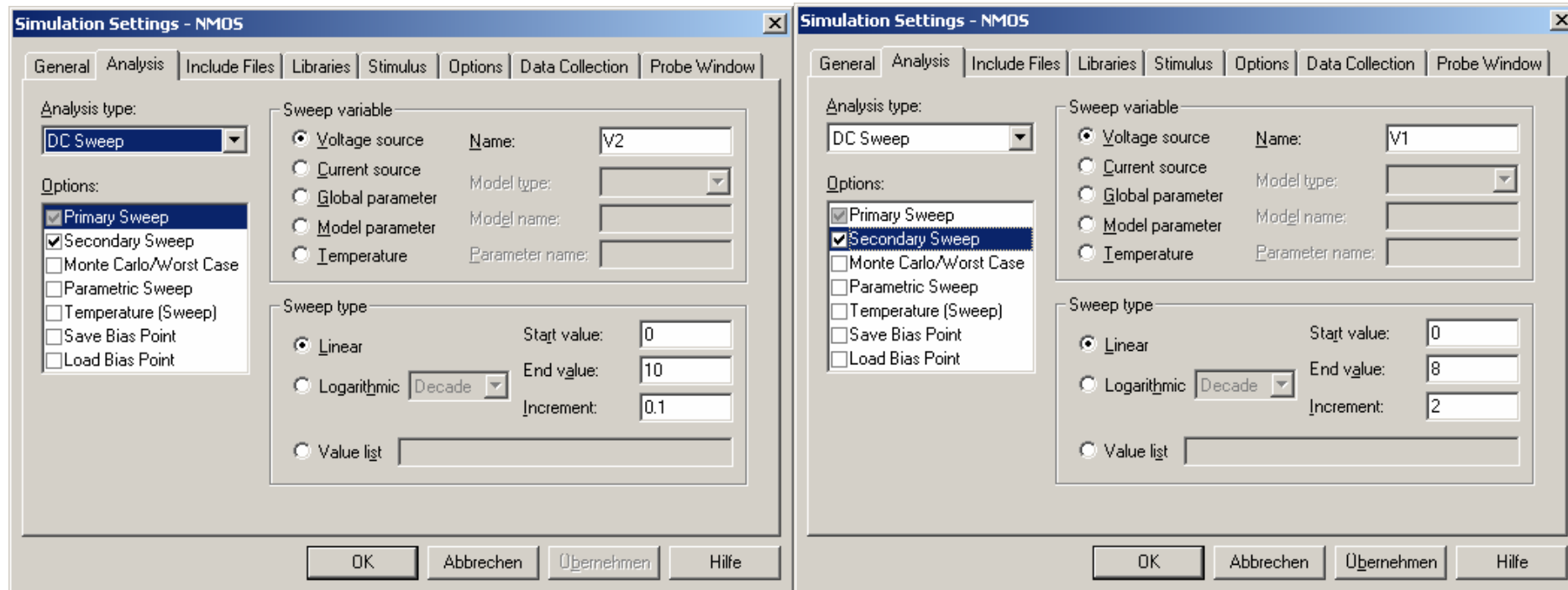
**n – Kanal:**

**Schaltung:**

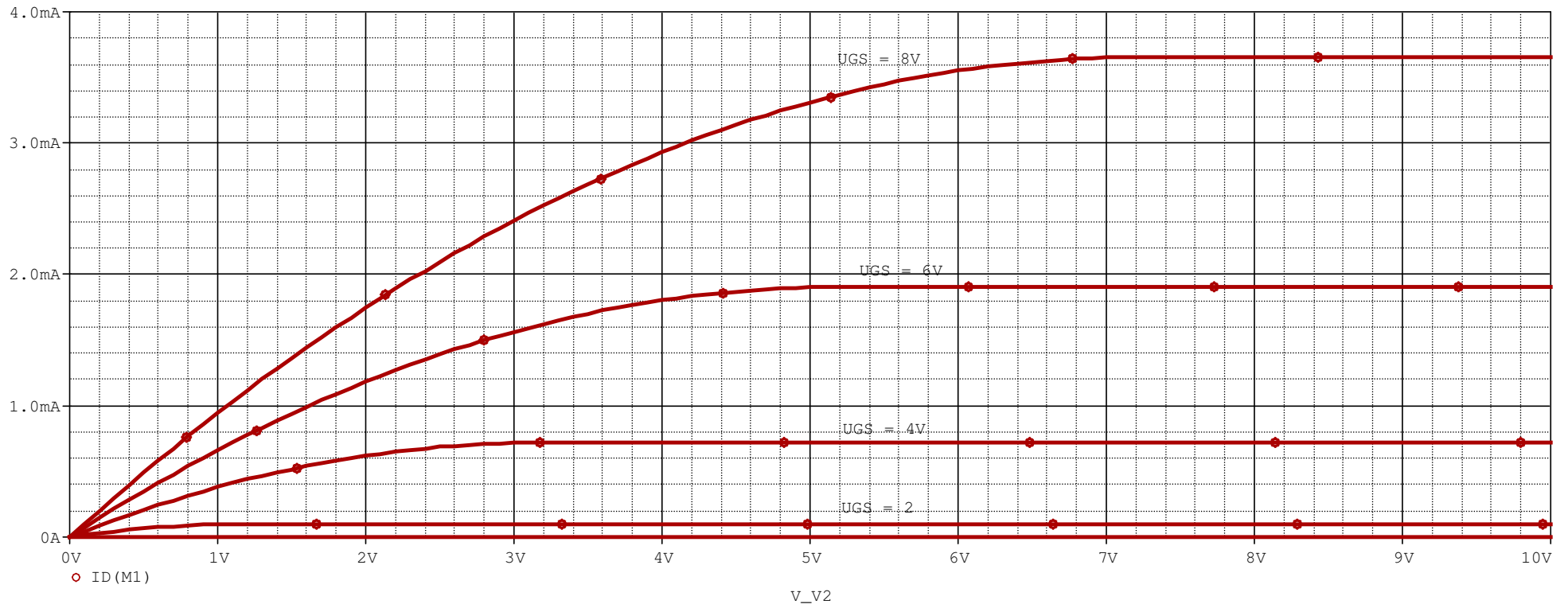


## Ausgangskennlinie:

### Simulationseinstellungen:

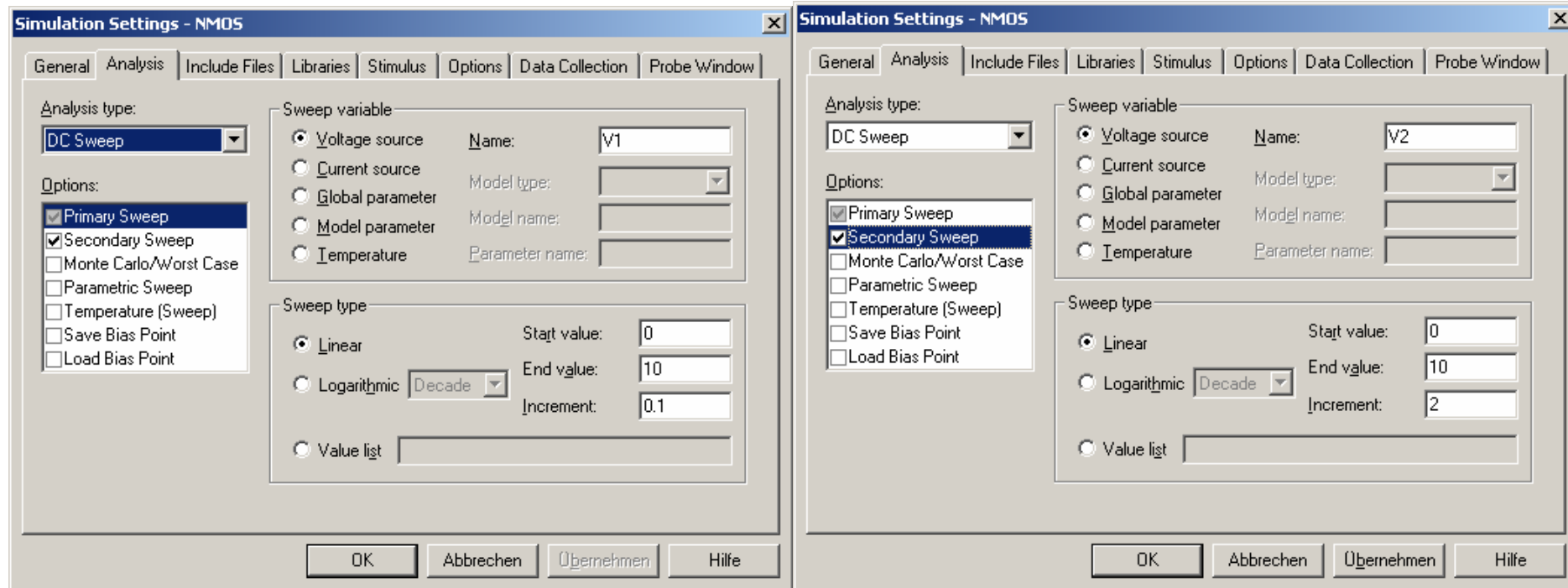


Simulation:

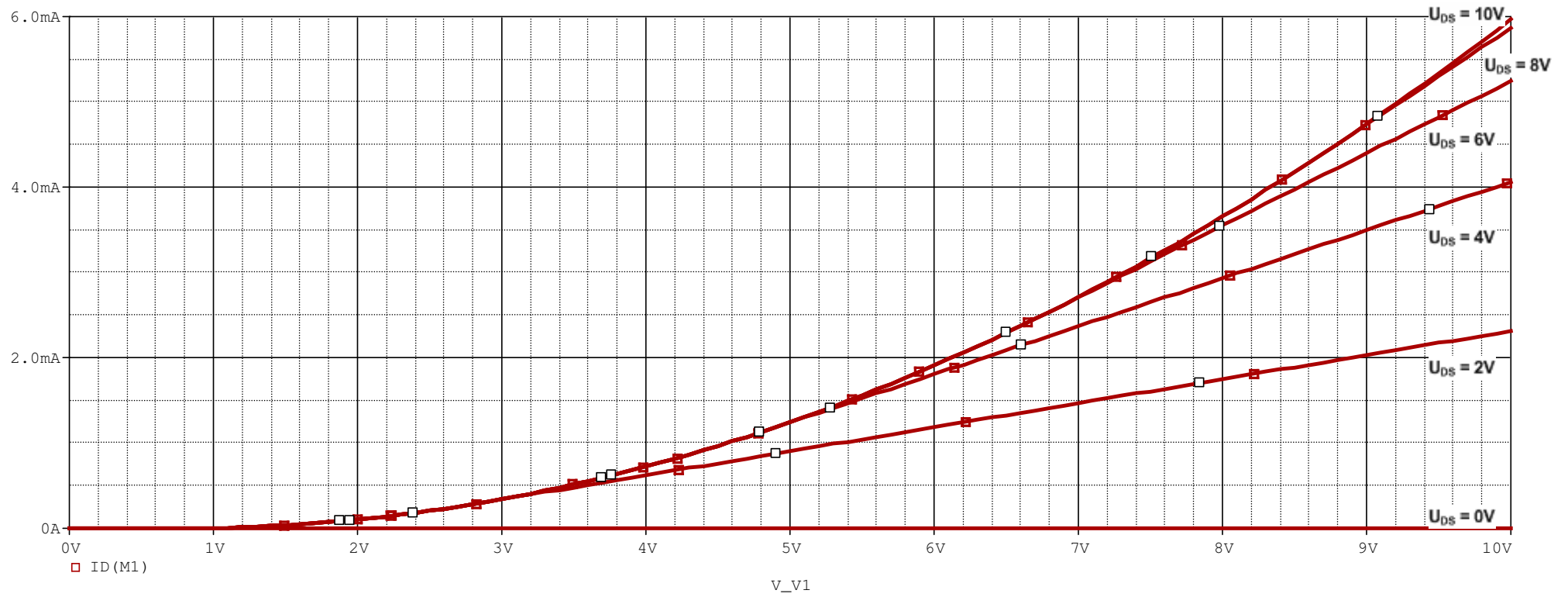


## Steuerkennlinie:

### Simulationseinstellungen:

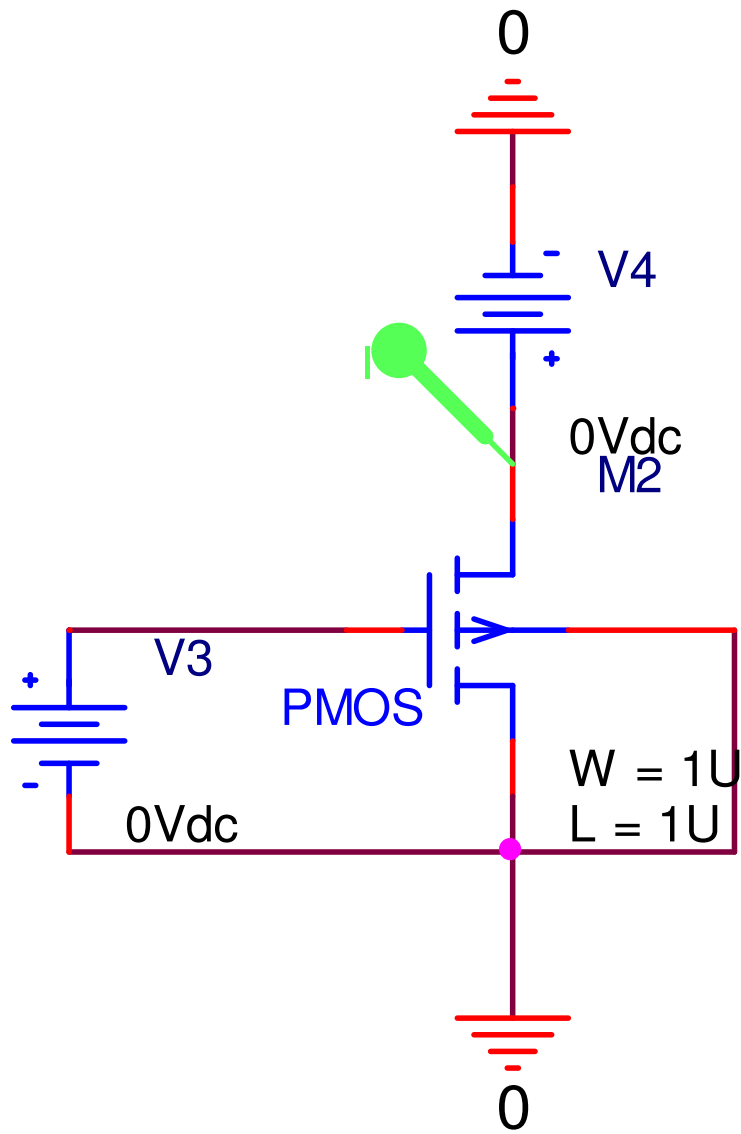


Simulation:



**p – Kanal:**

**Schaltung:**



## Ausgangskennlinie

Simulationseinstellungen:

Simulation Settings - pmos

General Analysis Include Files Libraries Stimulus Options Data Collection Probe Window

Analysis type: DC Sweep

Options:

- Primary Sweep
- Secondary Sweep
- Monte Carlo/Worst Case
- Parametric Sweep
- Temperature (Sweep)
- Save Bias Point
- Load Bias Point

Sweep variable:

- Voltage source Name: V4
- Current source
- Global parameter Model type: [dropdown]
- Model parameter Model name: [text]
- Temperature Parameter name: [text]

Sweep type:

- Linear Start value: 0 End value: -10 Increment: -0.1
- Logarithmic Decade
- Value list [text]

OK Abbrechen Übernehmen Hilfe

Simulation Settings - pmos

General Analysis Include Files Libraries Stimulus Options Data Collection Probe Window

Analysis type: DC Sweep

Options:

- Primary Sweep
- Secondary Sweep
- Monte Carlo/Worst Case
- Parametric Sweep
- Temperature (Sweep)
- Save Bias Point
- Load Bias Point

Sweep variable:

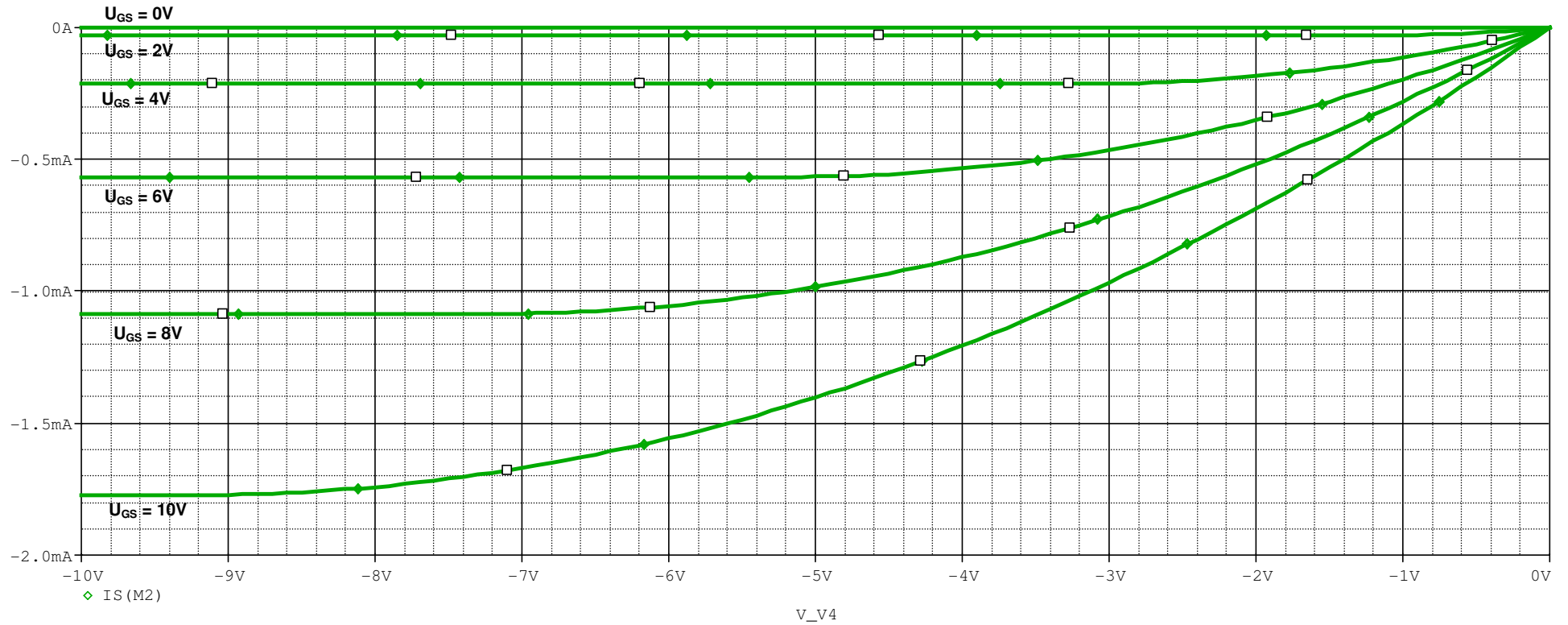
- Voltage source Name: V3
- Current source
- Global parameter Model type: [dropdown]
- Model parameter Model name: [text]
- Temperature Parameter name: [text]

Sweep type:

- Linear Start value: 0 End value: -10 Increment: -2
- Logarithmic Decade
- Value list [text]

OK Abbrechen Übernehmen Hilfe

Simulation:



## Steuerkennlinie:

### Simulationseinstellungen:

**Simulation Settings - pmos**

General Analysis Include Files Libraries Stimulus Options Data Collection Probe Window

Analysis type: DC Sweep

Options:

- Primary Sweep
- Secondary Sweep
- Monte Carlo/Worst Case
- Parametric Sweep
- Temperature (Sweep)
- Save Bias Point
- Load Bias Point

Sweep variable:

- Voltage source Name: V3
- Current source Model type: [ ]
- Global parameter Model name: [ ]
- Model parameter
- Temperature Parameter name: [ ]

Sweep type:

- Linear Start value: 0 End value: -10 Increment: -0.1
- Logarithmic Decade
- Value list [ ]

OK Abbrechen Übernehmen Hilfe

**Simulation Settings - pmos**

General Analysis Include Files Libraries Stimulus Options Data Collection Probe Window

Analysis type: DC Sweep

Options:

- Primary Sweep
- Secondary Sweep
- Monte Carlo/Worst Case
- Parametric Sweep
- Temperature (Sweep)
- Save Bias Point
- Load Bias Point

Sweep variable:

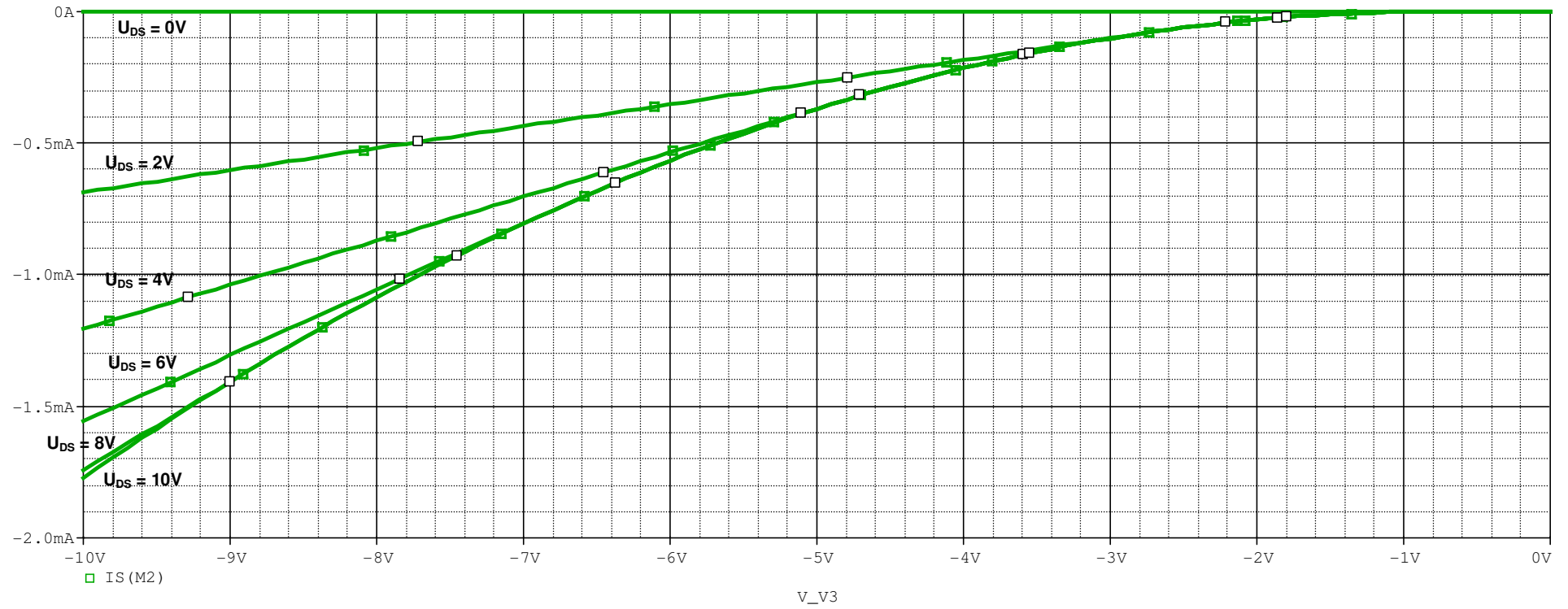
- Voltage source Name: V4
- Current source Model type: [ ]
- Global parameter Model name: [ ]
- Model parameter
- Temperature Parameter name: [ ]

Sweep type:

- Linear Start value: 0 End value: -10 Increment: -2
- Logarithmic Decade
- Value list [ ]

OK Abbrechen Übernehmen Hilfe

Simulation:



## Berechnung von $\beta$ und $U_{Th}$

$$I_{DS} = \frac{\beta}{2} \cdot (U_{Th} - U_{GS})^2$$

$$U_{Th} = \frac{U_{GS1} - \sqrt{U_{GS2}}}{1 - \sqrt{\frac{I_{DS1}}{I_{DS2}}}}$$

Umgeformt:

$$\beta = \frac{2 \cdot I_{DS2}}{(U_{GS2} - U_{Th})^2}$$

### **n - Kanal:**

*Mathematica 5.2:*

`ugs1 = 8;`

`ugs2 = 6;`

`ids1 = 0.00365;`

`ids2 = 0.00190;`

`uth = {(ugs1 -  $\sqrt{\text{ids1}/\text{ids2}} * \text{ugs2}$ ) / (1 - ( $\sqrt{\text{ids1}/\text{ids2}}$ ))}`  
`{0.818927}`

`b = {(2 * ids2) / (ugs2 - uth)2}`  
`{{0.000141561}}`

*Ergebnis:*

$$U_{Th} = 0,818927V$$

$$\beta = 0,000141561 \frac{A}{V^2} = 141,561 \mu \frac{A}{V^2}$$

### **p - Kanal:**

*Mathematica 5.2:*

`ugs1 = 10;`

`ugs2 = 8;`

`ids1 = 0.00178;`

`ids2 = 0.00109;`

`uth = {(ugs1 -  $\sqrt{\text{ids1}/\text{ids2}} * \text{ugs2}$ ) / (1 - ( $\sqrt{\text{ids1}/\text{ids2}}$ ))}`  
`{0.803158}`

`b = {(2 * ids2) / (ugs2 - uth)2}`  
`{{0.0000420894}}`

*Ergebnis:*

$$U_{Th} = 0,803158V$$

$$\beta = 0,0000420894 \frac{A}{V^2} = 42,0894 \mu \frac{A}{V^2}$$