

# Chemisches Analogcomputermodell für ein Flip-Flop

Robert Frank

# Gliederung

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- ▶ 1. Aufgabenstellung
- ▶ 2. NAND Flip-Flop
- ▶ 3. Negation
- ▶ 4. UND-Funktion
- ▶ 5. NAND
- ▶ 6. Flip-Flop



# 1. Aufgabenstellung

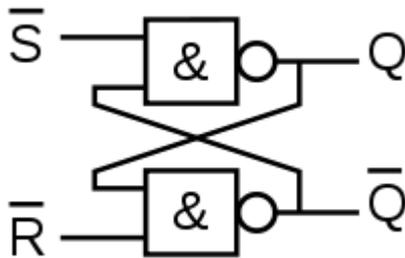
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- ▶ chemisches Analogcomputermodell für ein Flip-Flop
- ▶ Modell aufstellen und Simulationsfallstudien mit Copasi durchführen
- ▶ Genauigkeitsabschätzung: benötigte Modellzeit (in Abhängigkeit der einzelnen  $k$ 's), um Ergebnis auf 5 Dezimalstellen genau zu erhalten



## 2. NAND Flip-Flop

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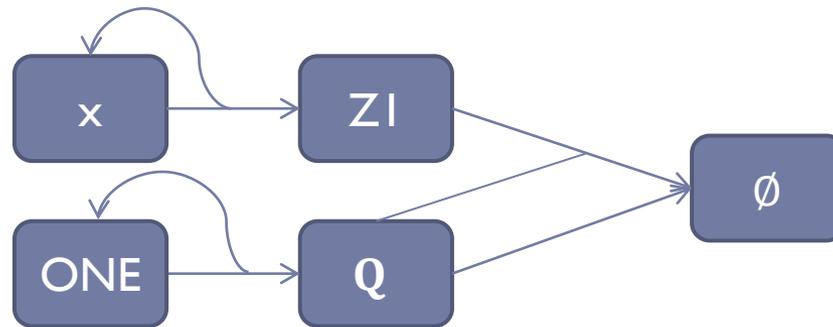
$\bar{S}$	$\bar{R}$	$Q$
1	1	vorheriger Zustand
0	1	1
1	0	0
0	0	$Q = \bar{Q} = 1$ (undefiniert)



# 3. Negation

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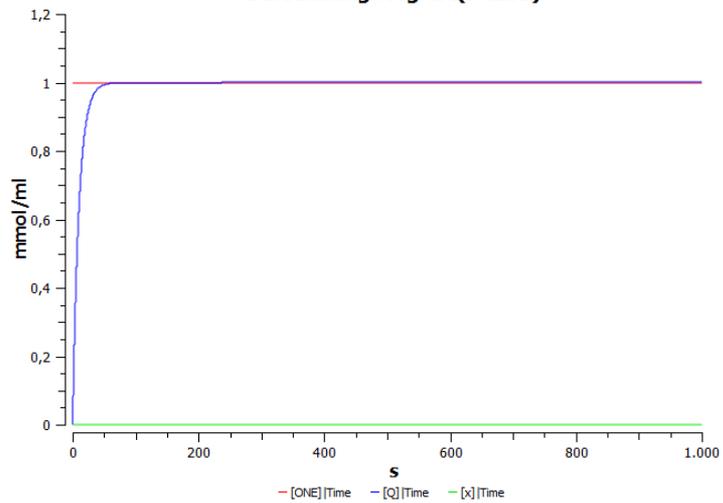
$$\text{NEGATION}(x) = 1 - x$$



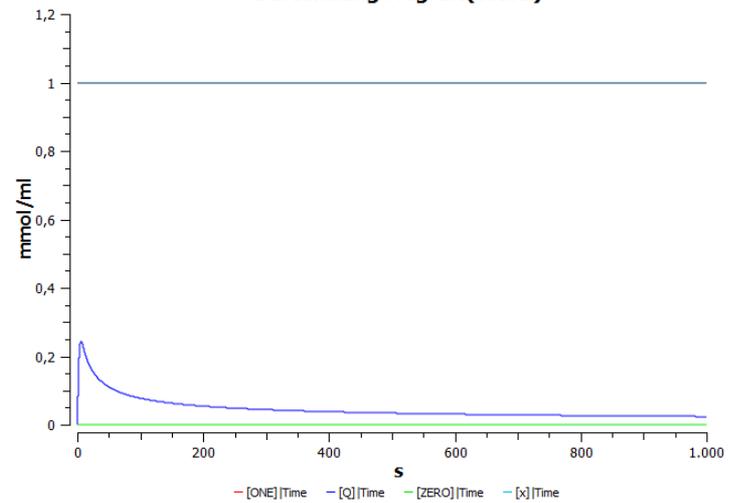
# 3. Negation

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Berechnung Negiert(FALSE)

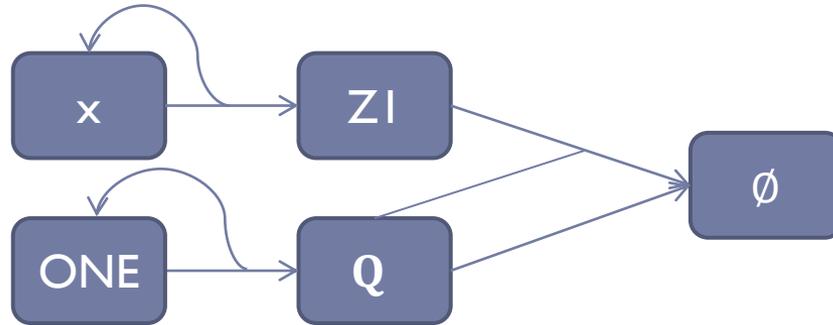


Berechnung Negiert(TRUE)



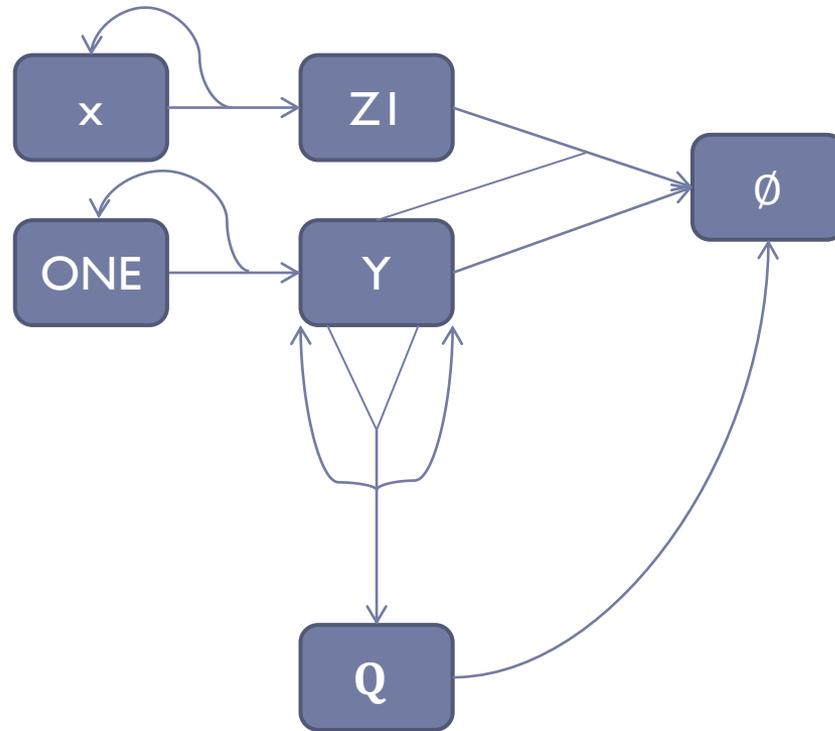
# 3. Negation

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# 3. Negation

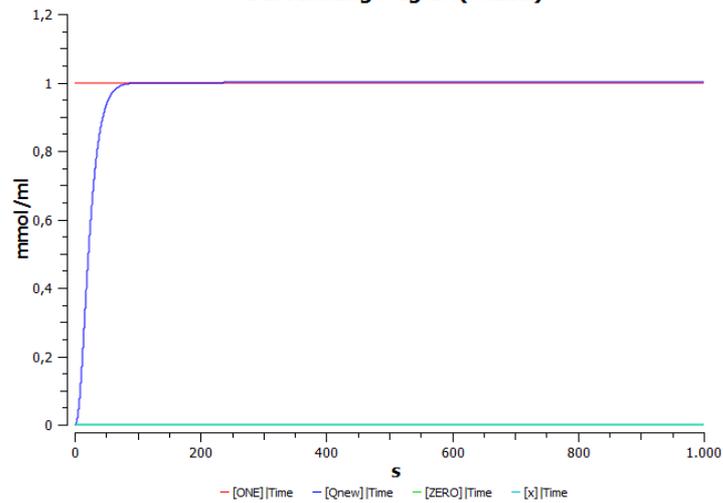
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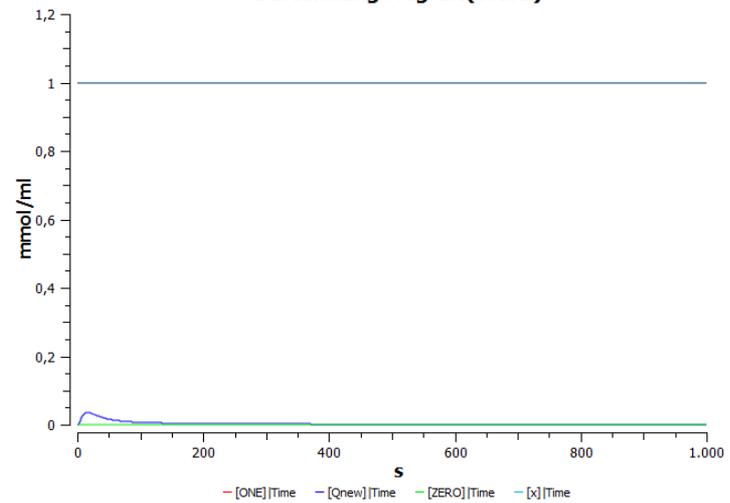
# 3. Negation

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Berechnung Negiert(FALSE)

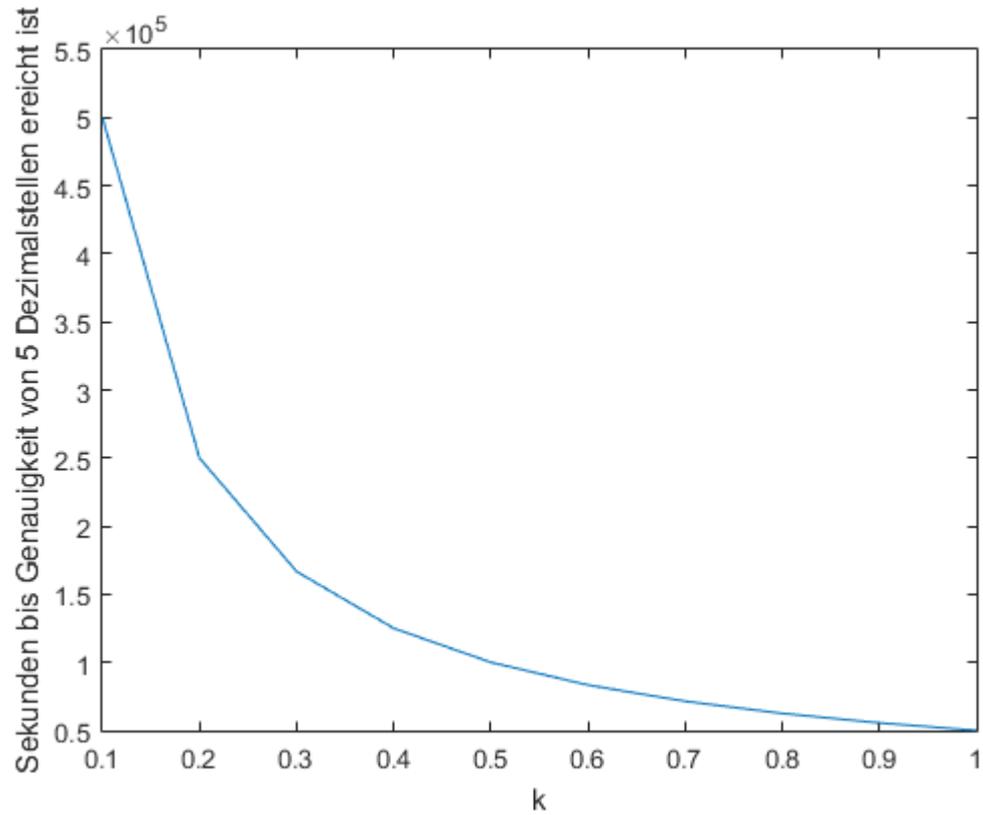


Berechnung Negiert(TRUE)



# 3. Negation

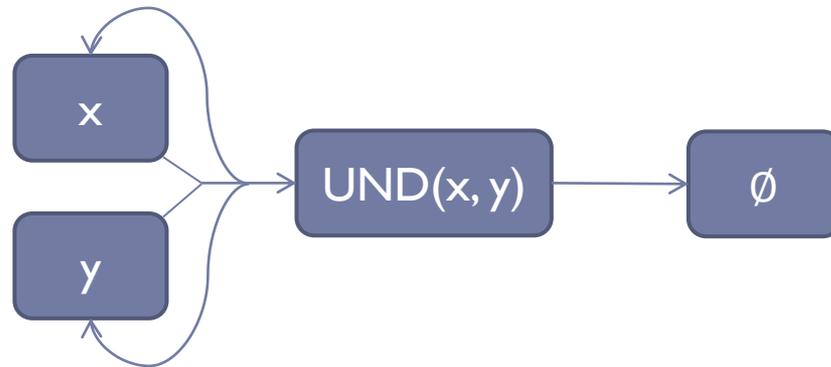
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# 4. UND-Funktion

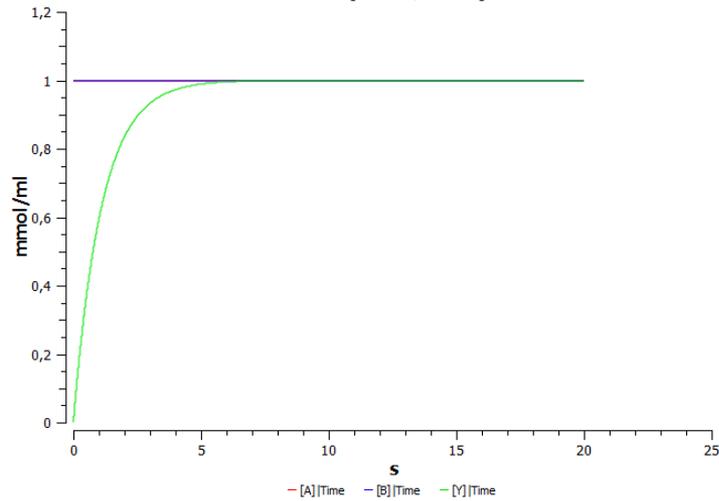
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$$\text{UND}(x, y) = x * y$$

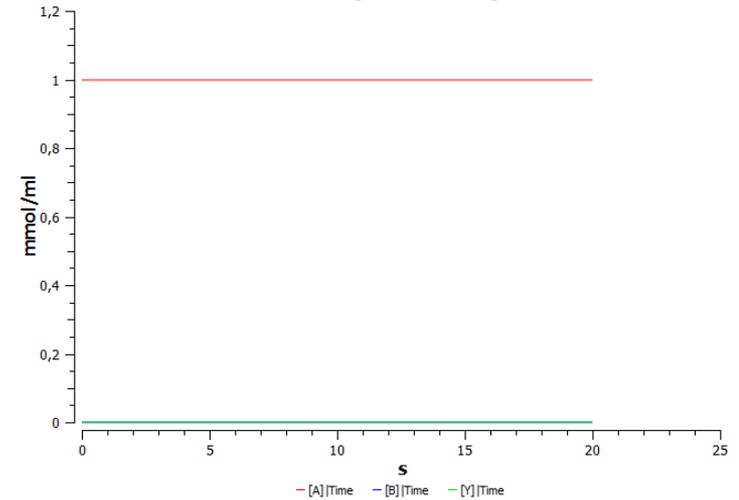


# 4. UND-Funktion

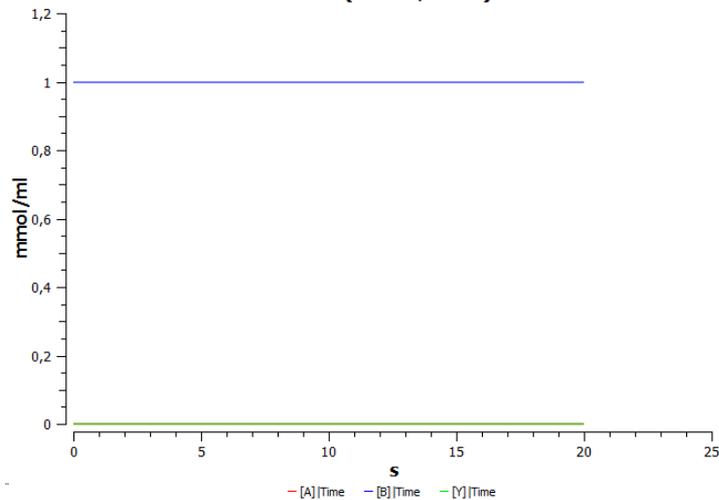
UND(TRUE,TRUE)



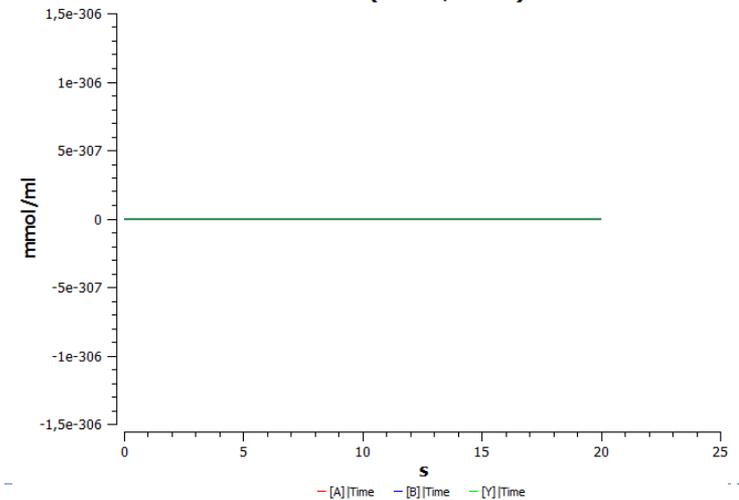
UND(TRUE,FALSE)



UND(FALSE,TRUE)

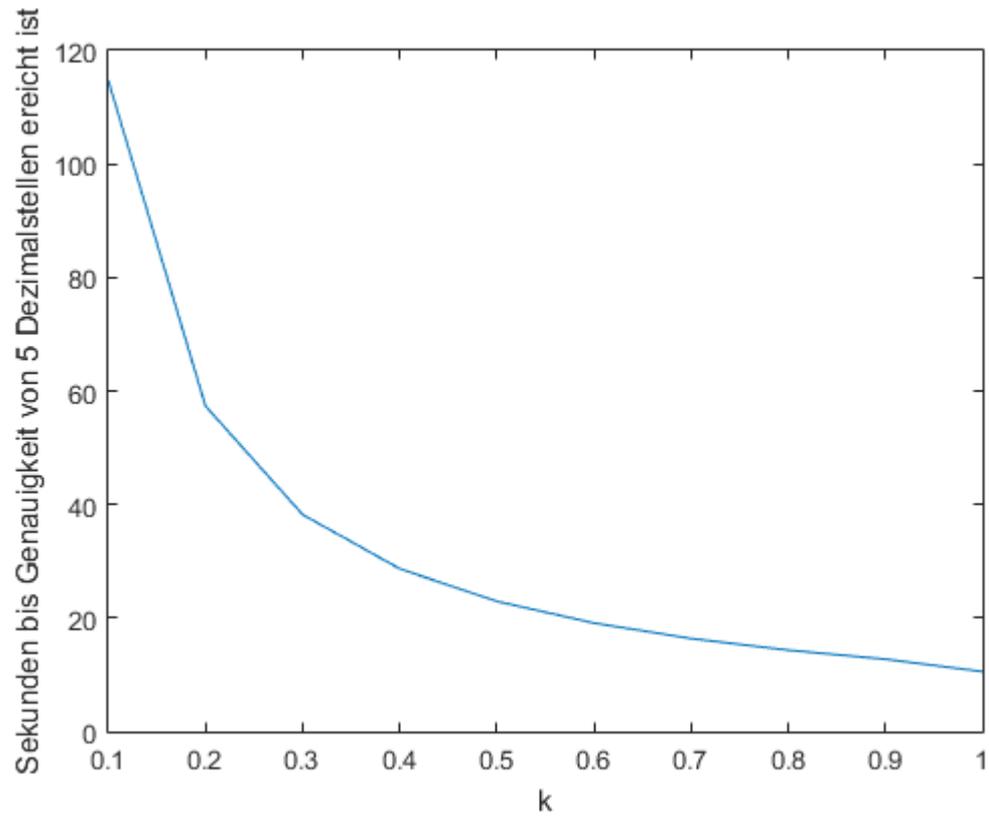


UND(FALSE,FALSE)



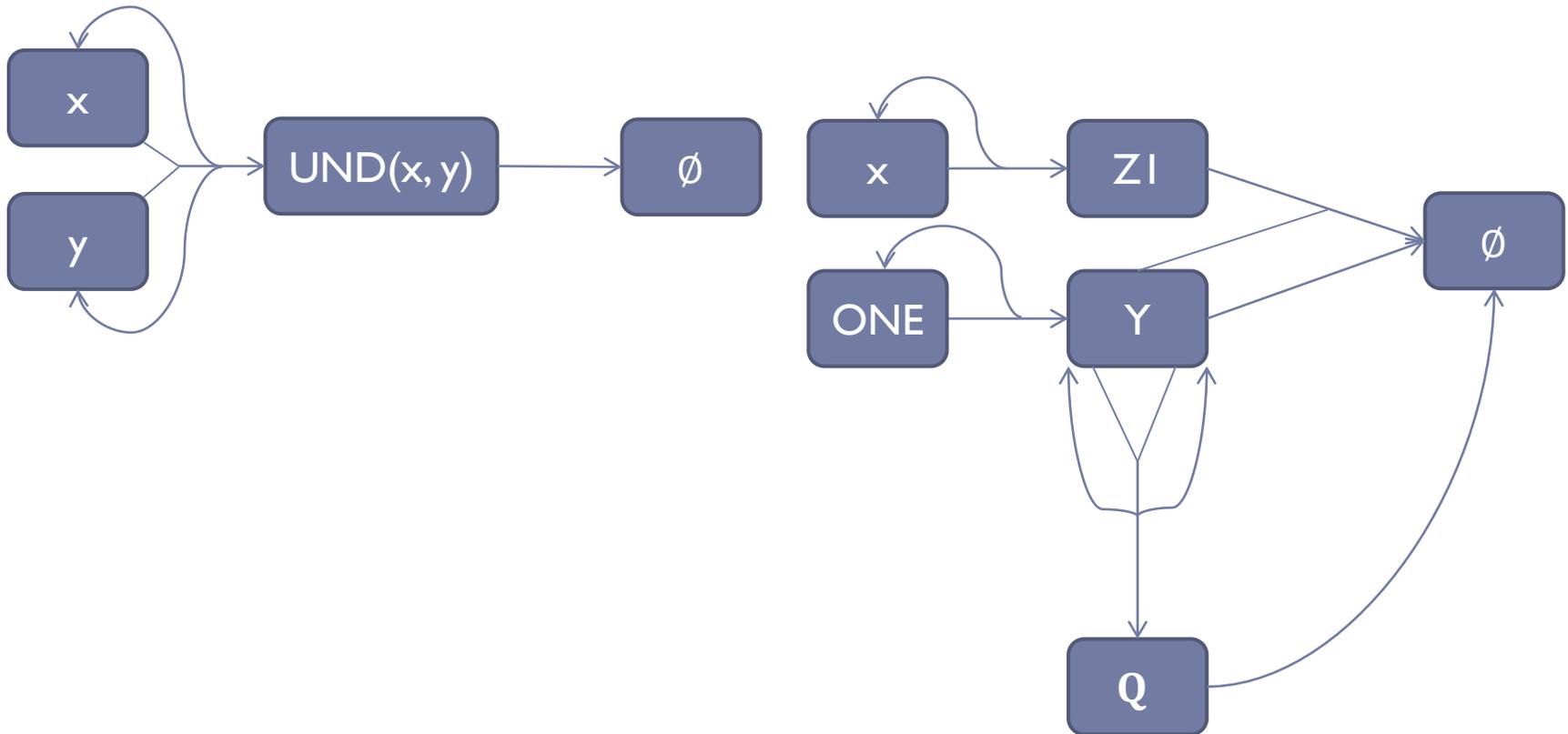
# 4. UND-Funktion

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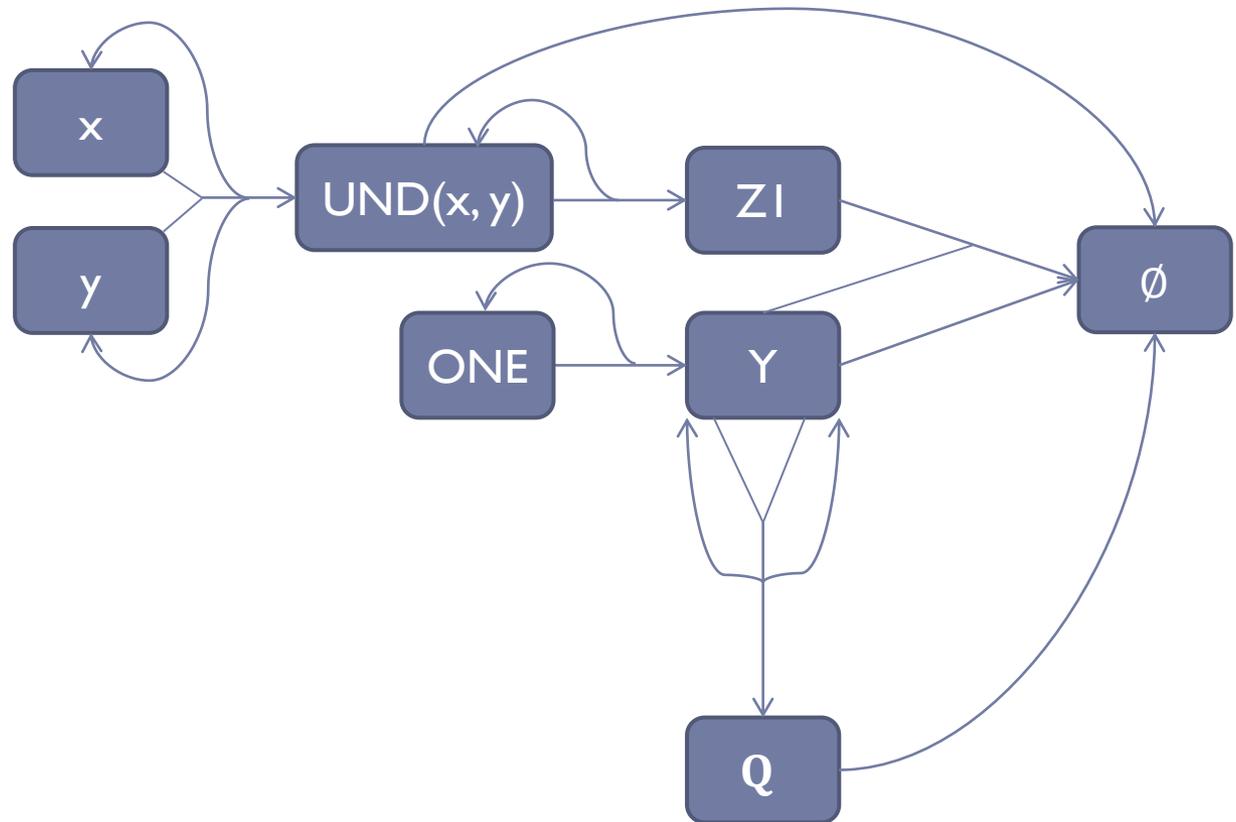
# 5. NAND

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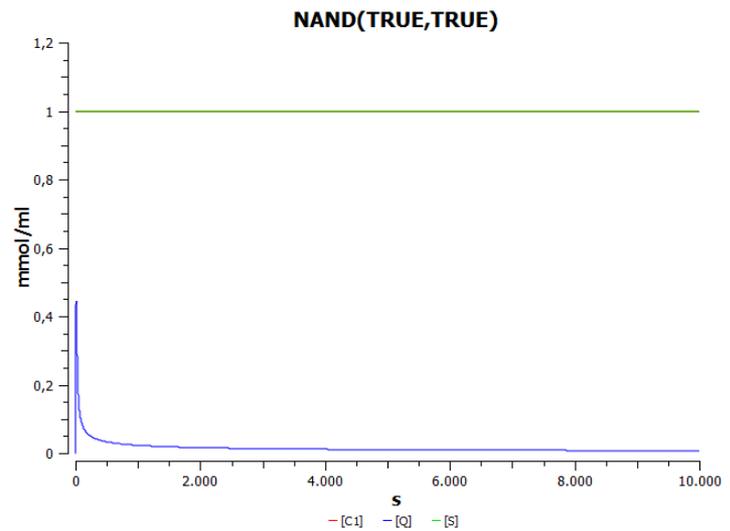
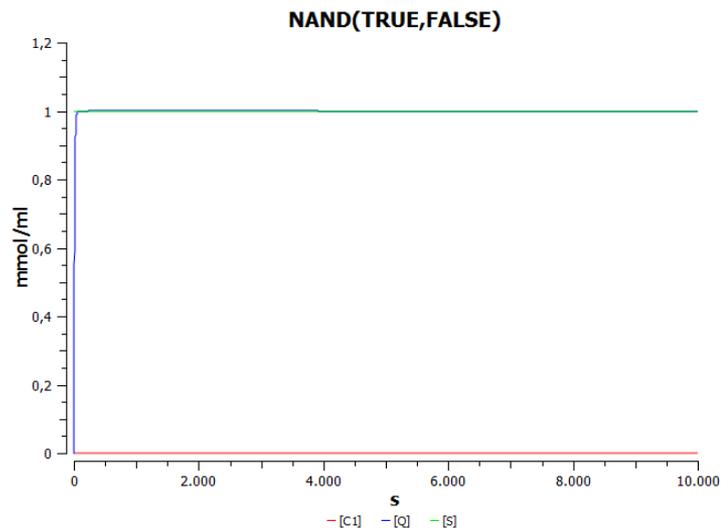
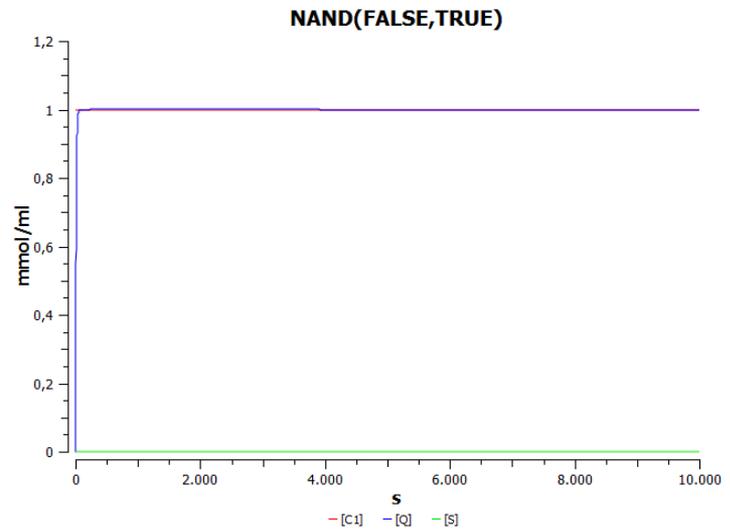
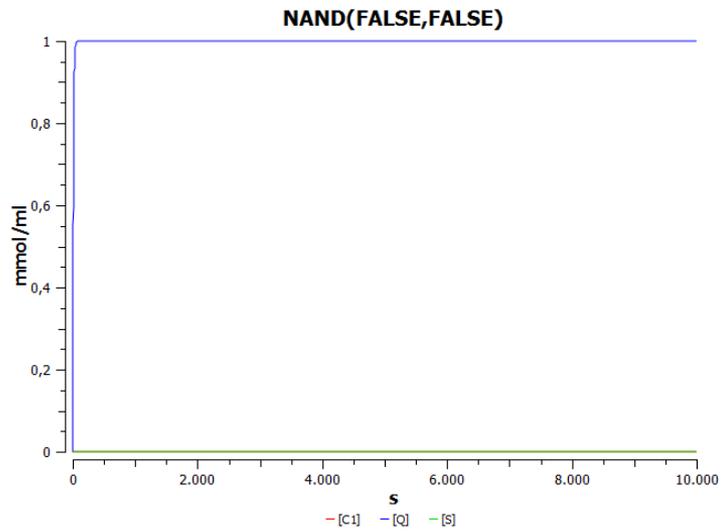


# 5. NAND

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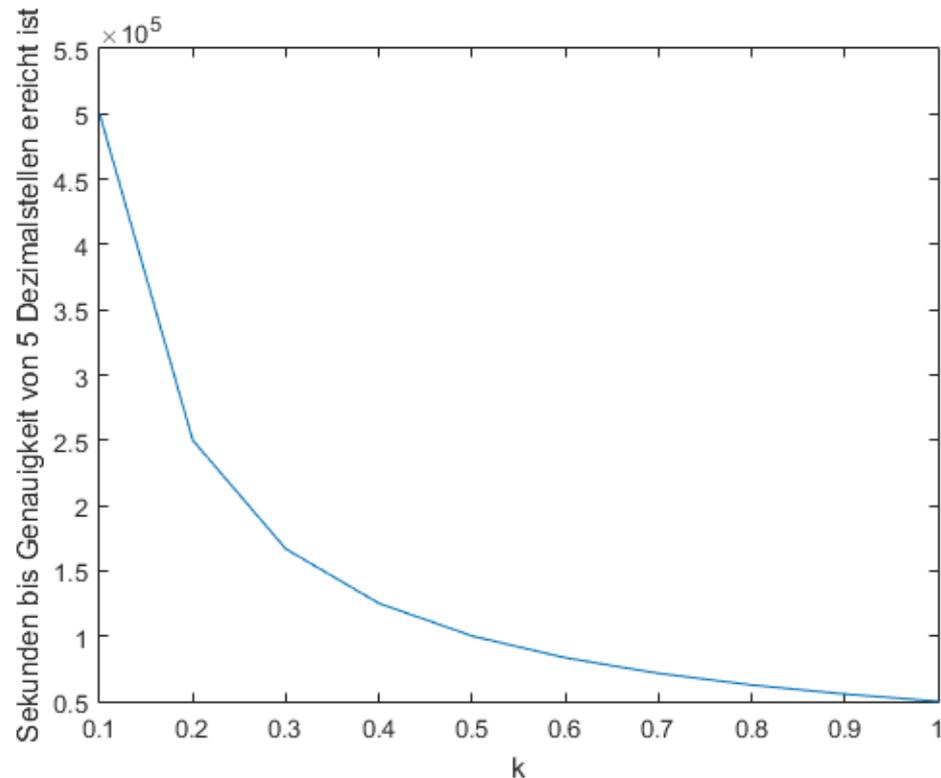
# 5. NAND



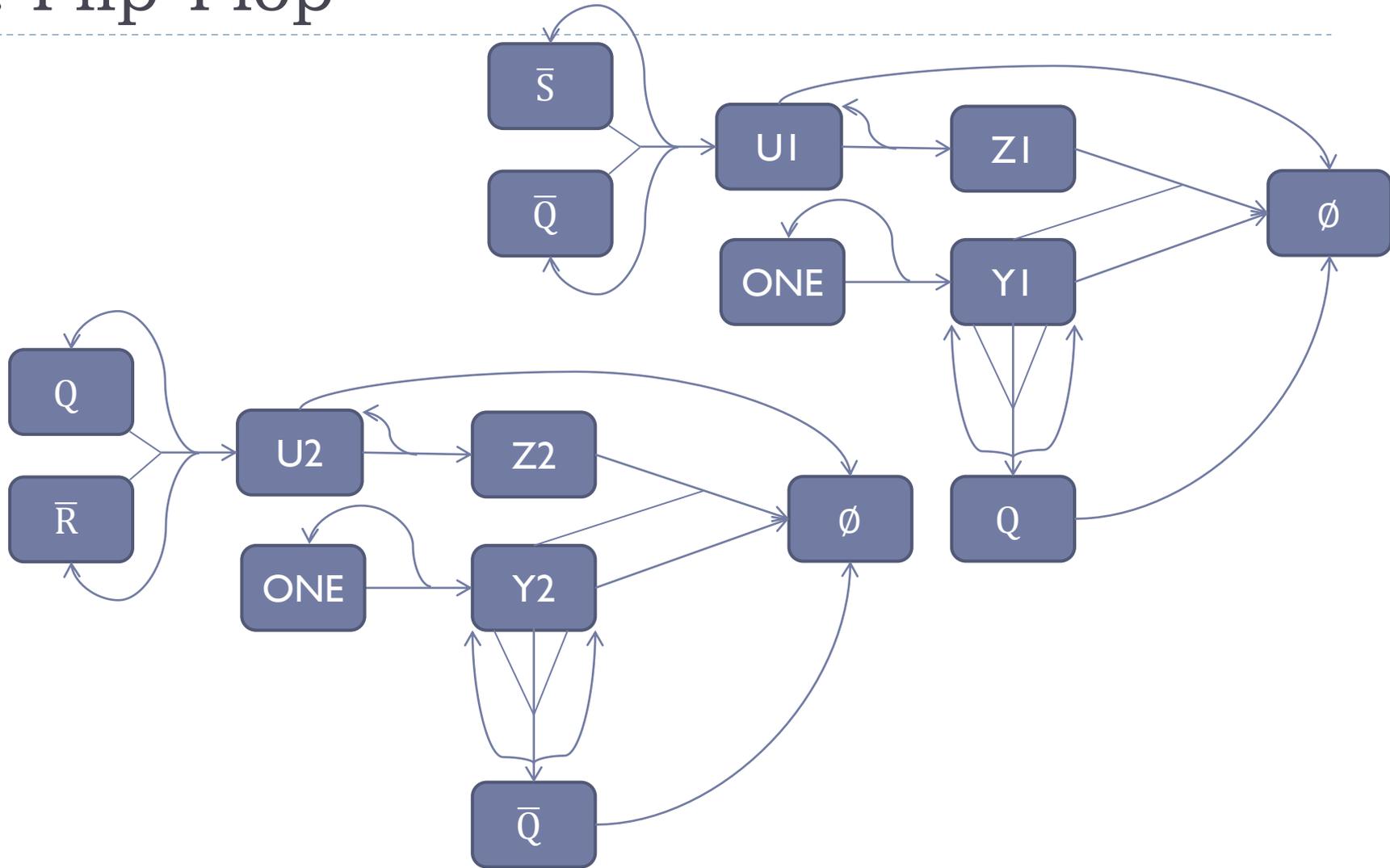
# 5. NAND

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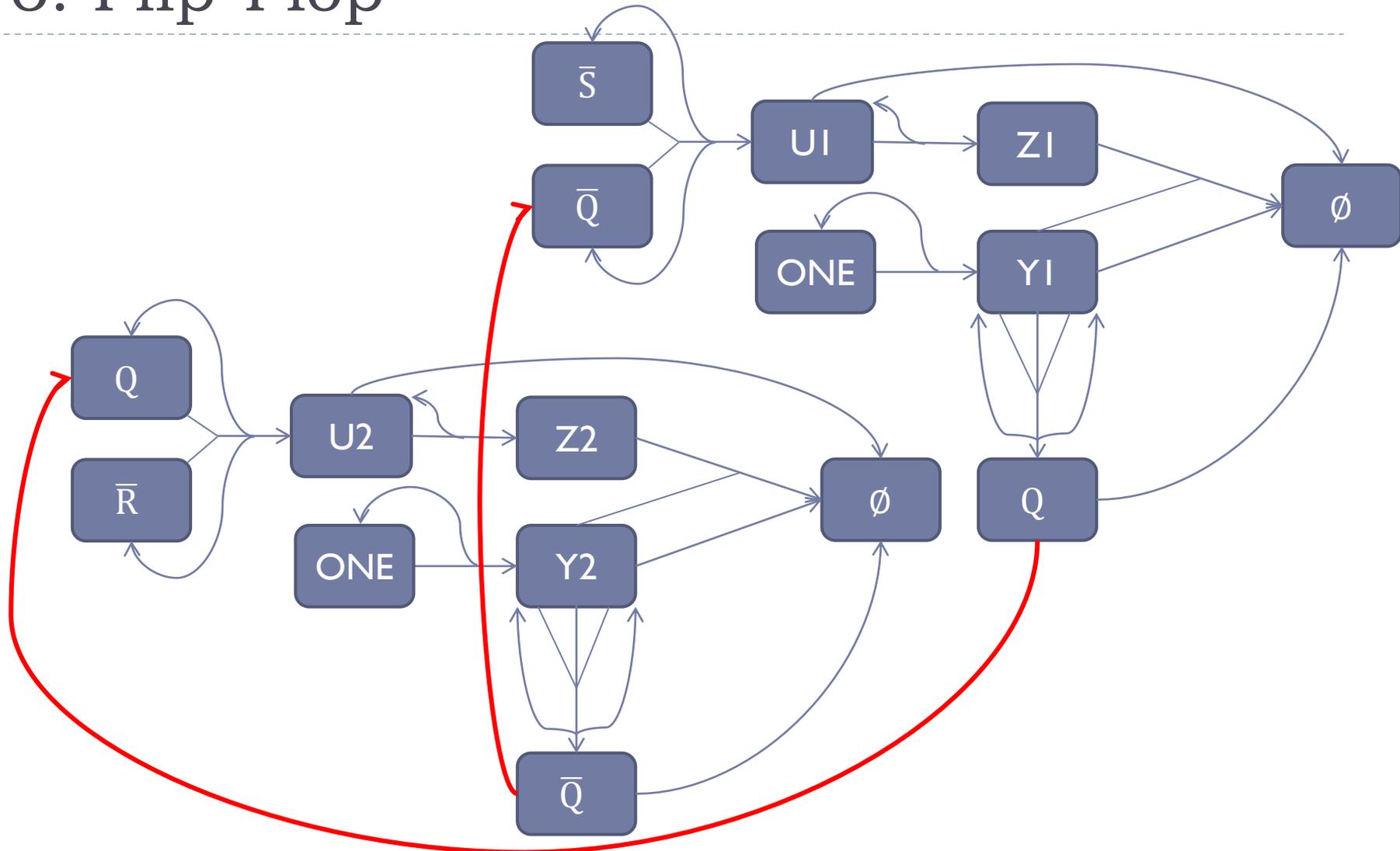
- ▶ Die einzige Ratenkonstante die zu Verbesserungen führt, ist das  $k$  von der Reaktion  $Z + Y \rightarrow \emptyset$ . Welche in der Negation verwendet wird.



# 6. Flip-Flop

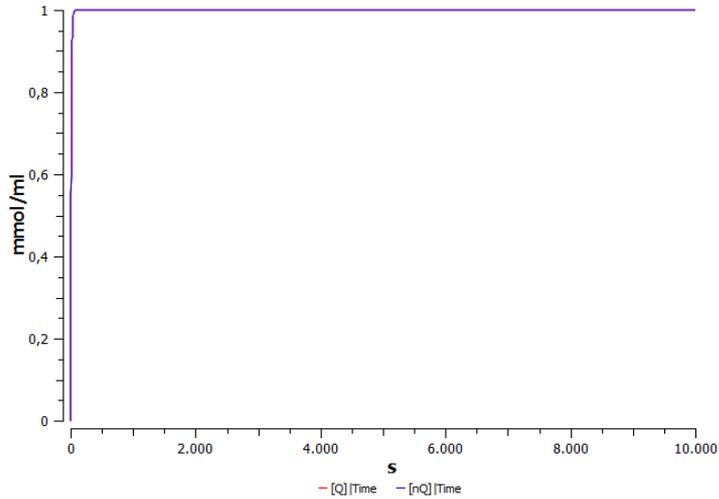


# 6. Flip-Flop

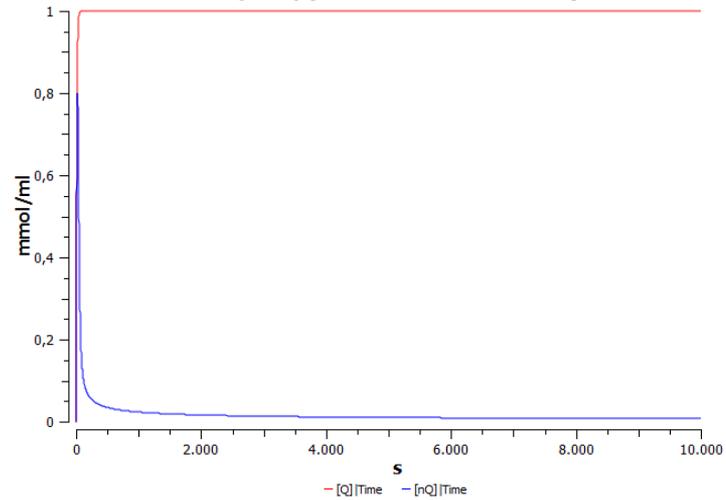


# 6. Flip-Flop

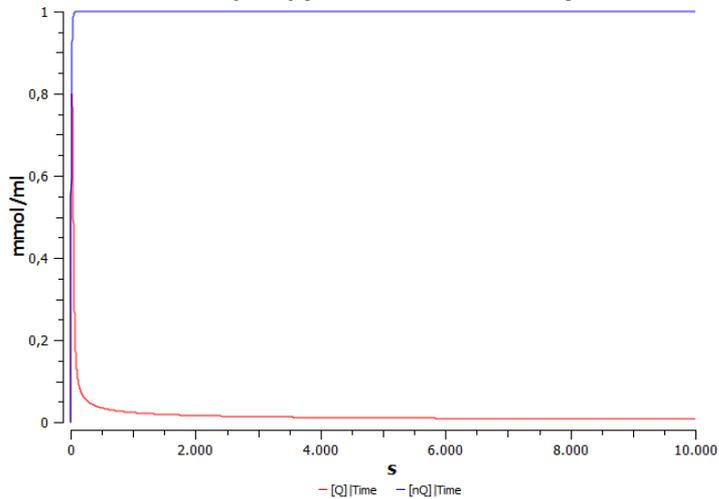
Flip-Flop(nS = FALSE, nR = FALSE)



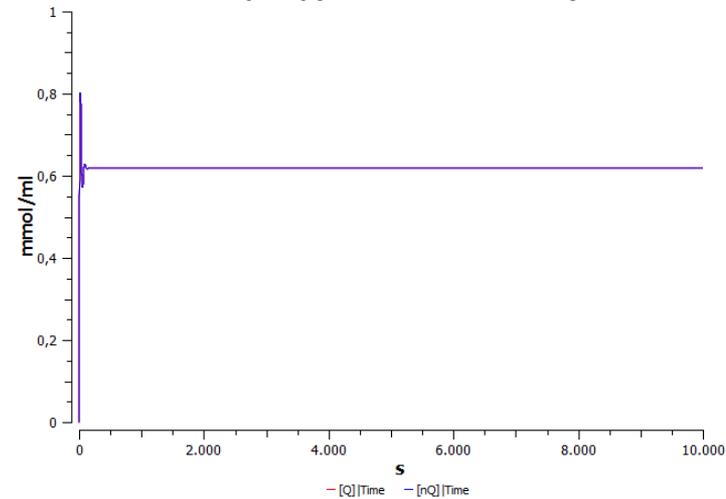
Flip-Flop(nS = FALSE, nR = TRUE)



Flip-Flop(nS = TRUE, nR = FALSE)

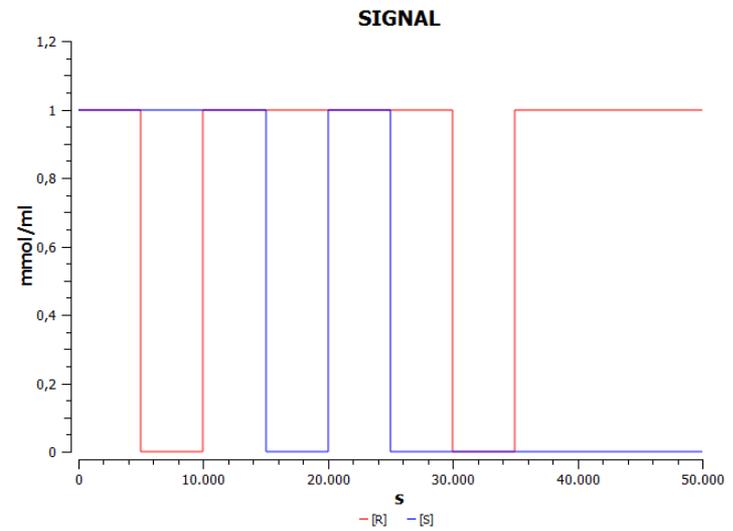
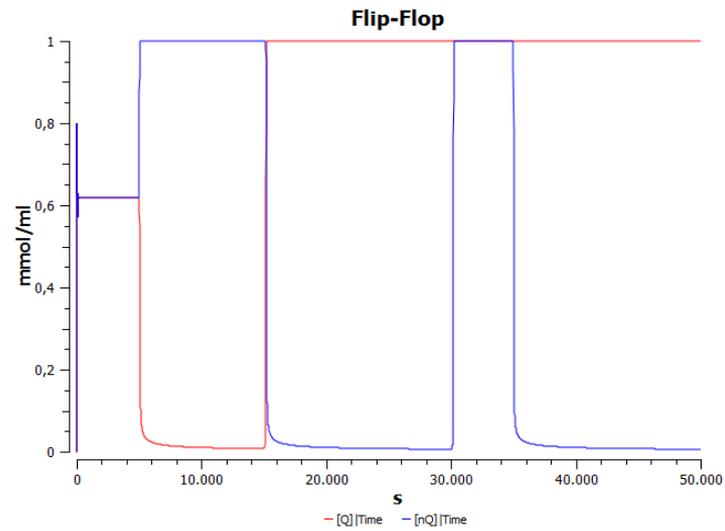


Flip-Flop(nS = TRUE, nR = TRUE)



# 6. Flip-Flop

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