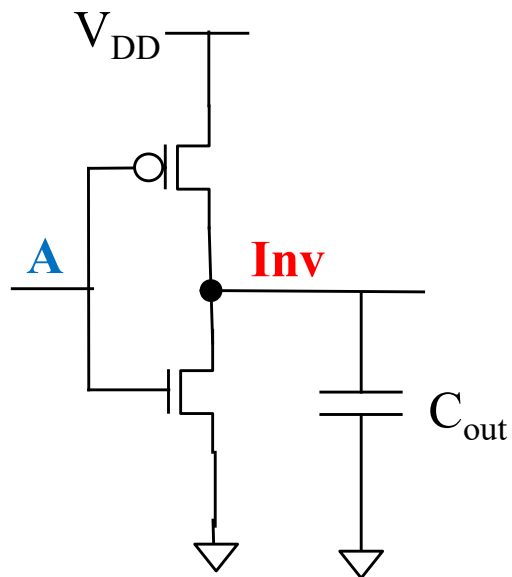
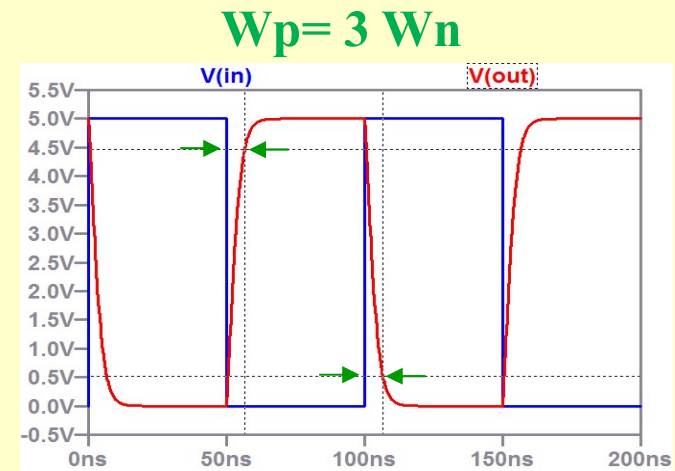
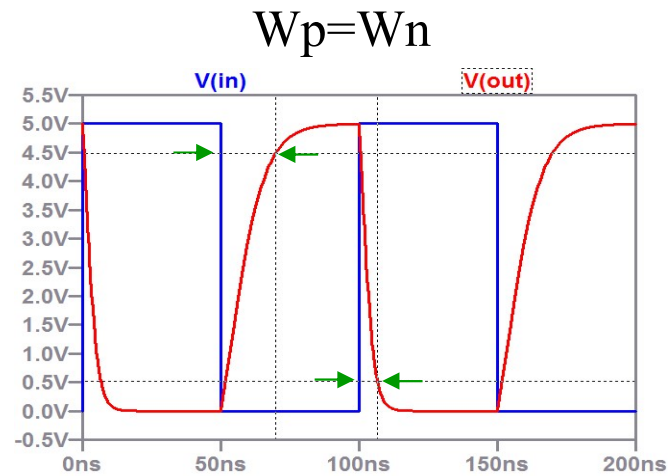


COMPOSANTS SEMI-CONDUCTEURS

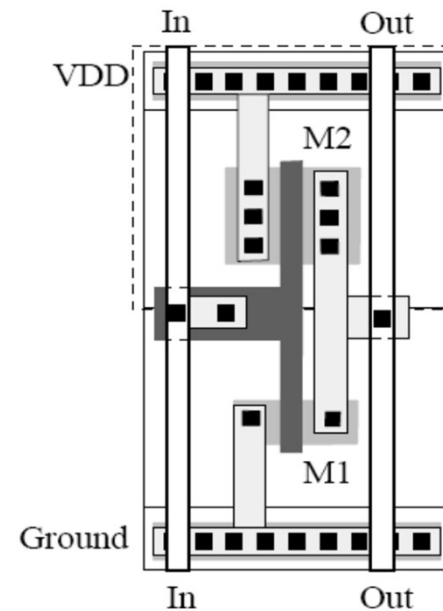
XII) Solutions S12

P.A. Besse

EPFL



Inverseur

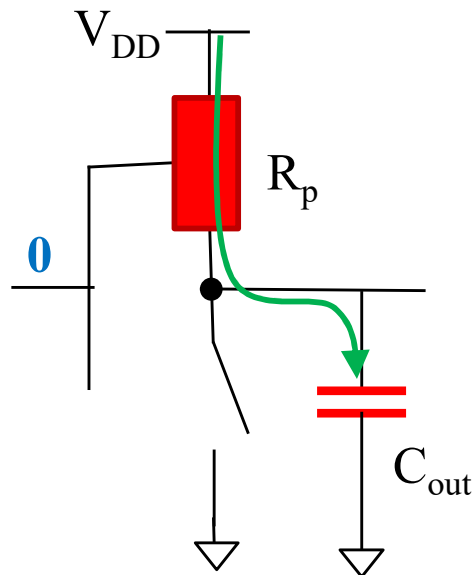


$W_p = 3 W_n$

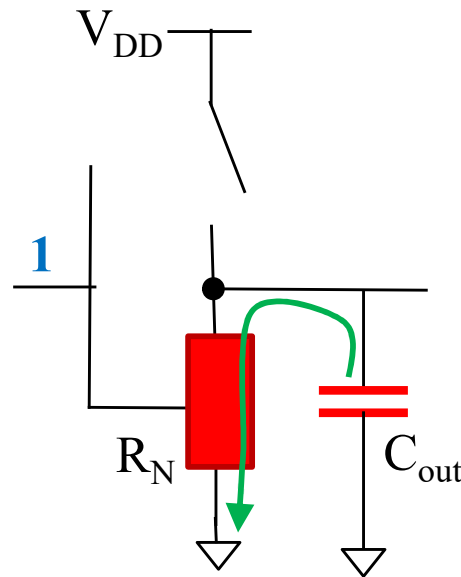


Condition:

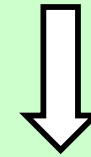
Charge



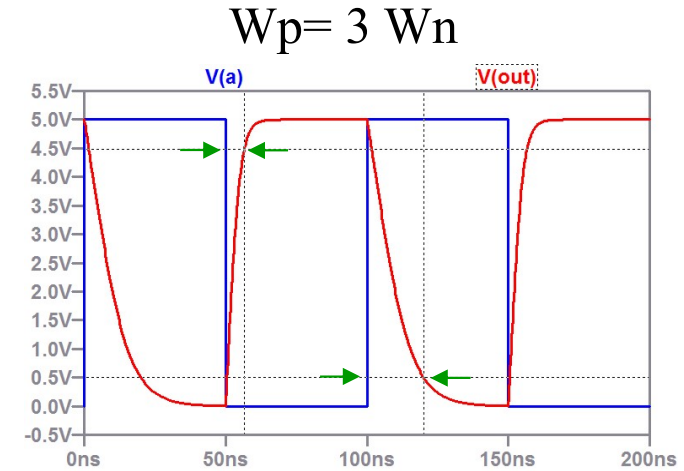
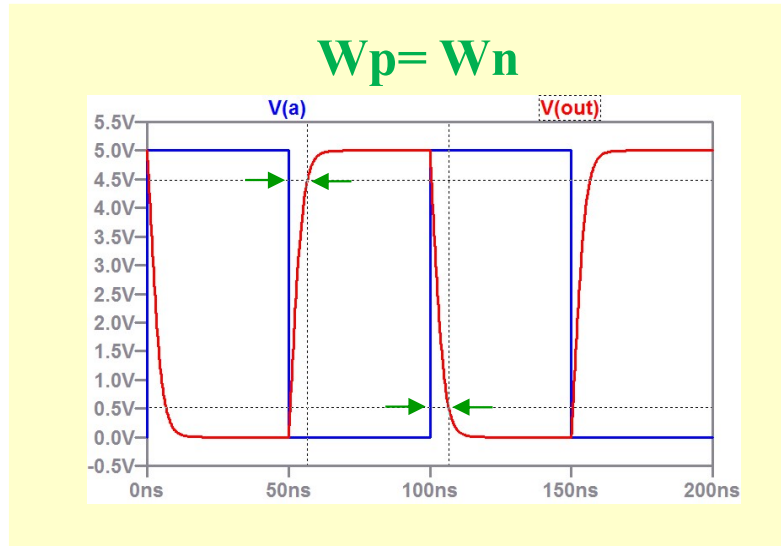
Discharge



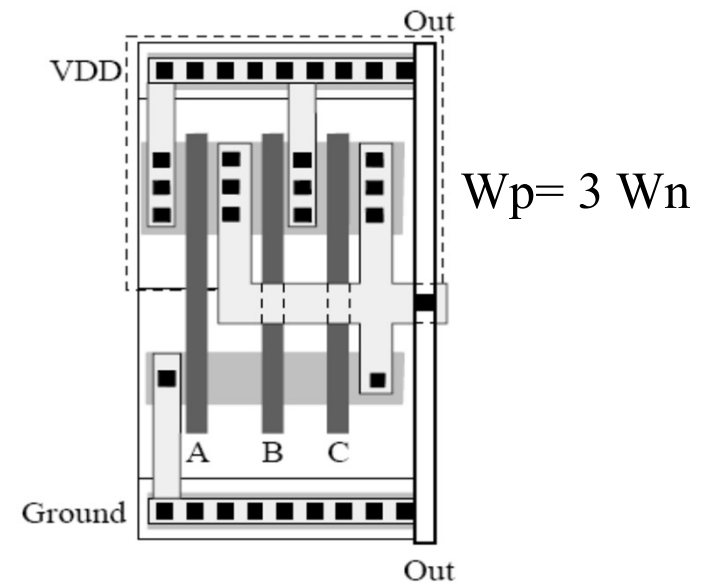
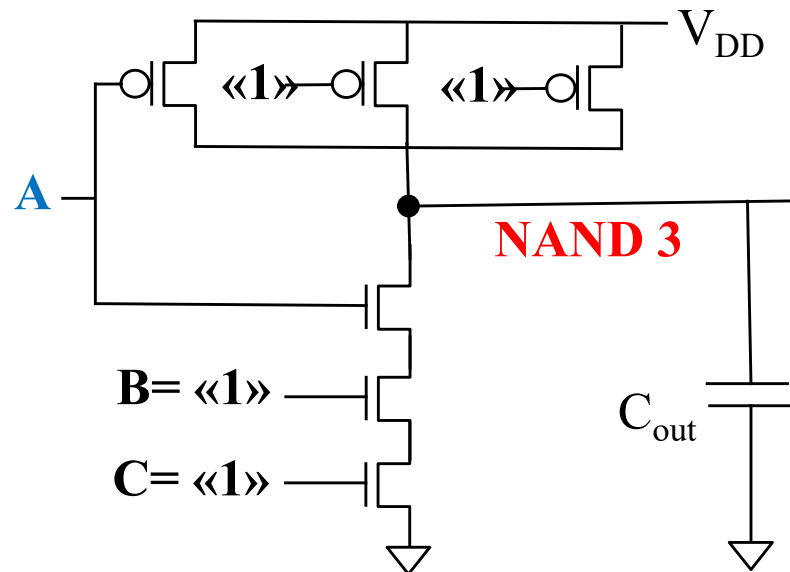
$$R_p C_{out} = R_N C_{out} \Rightarrow \frac{C_{out}}{W_P \mu_p} = \frac{C_{out}}{W_N \mu_N}$$



$$\frac{W_P}{W_N} = \frac{\mu_n}{\mu_P} = 3$$

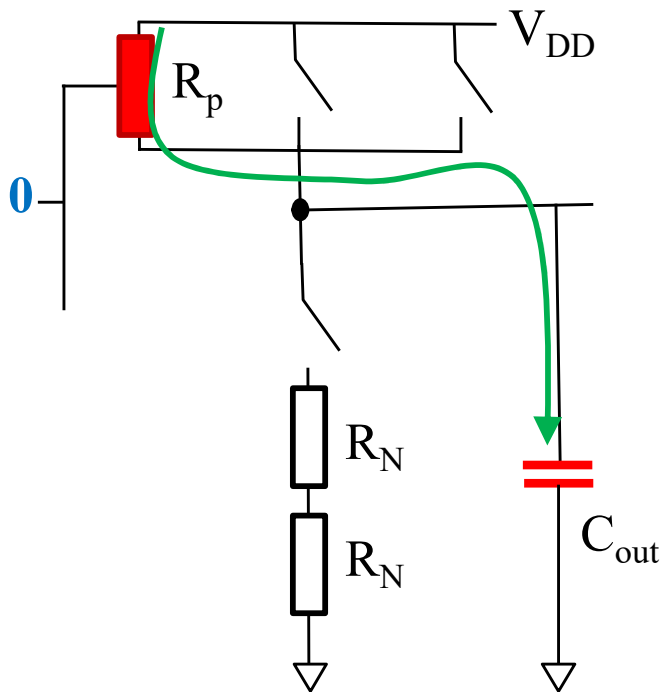


NAND 3

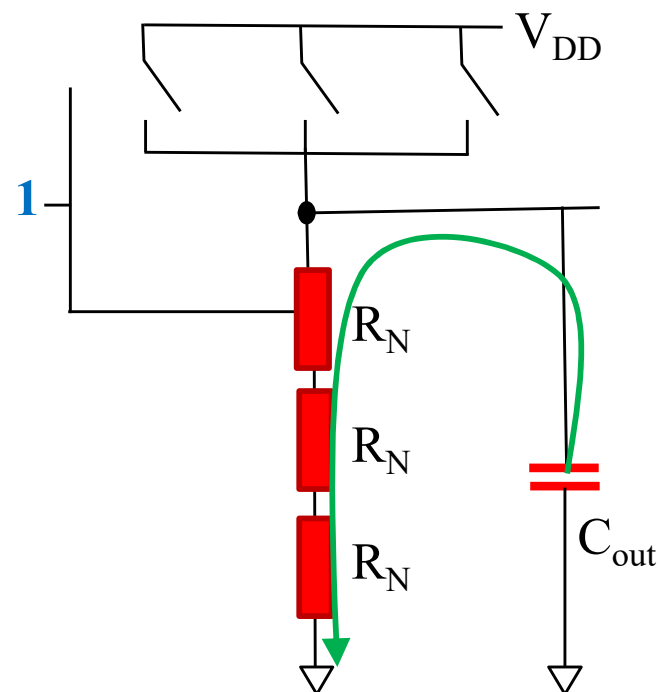




Charge

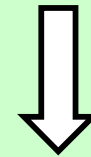


Discharge

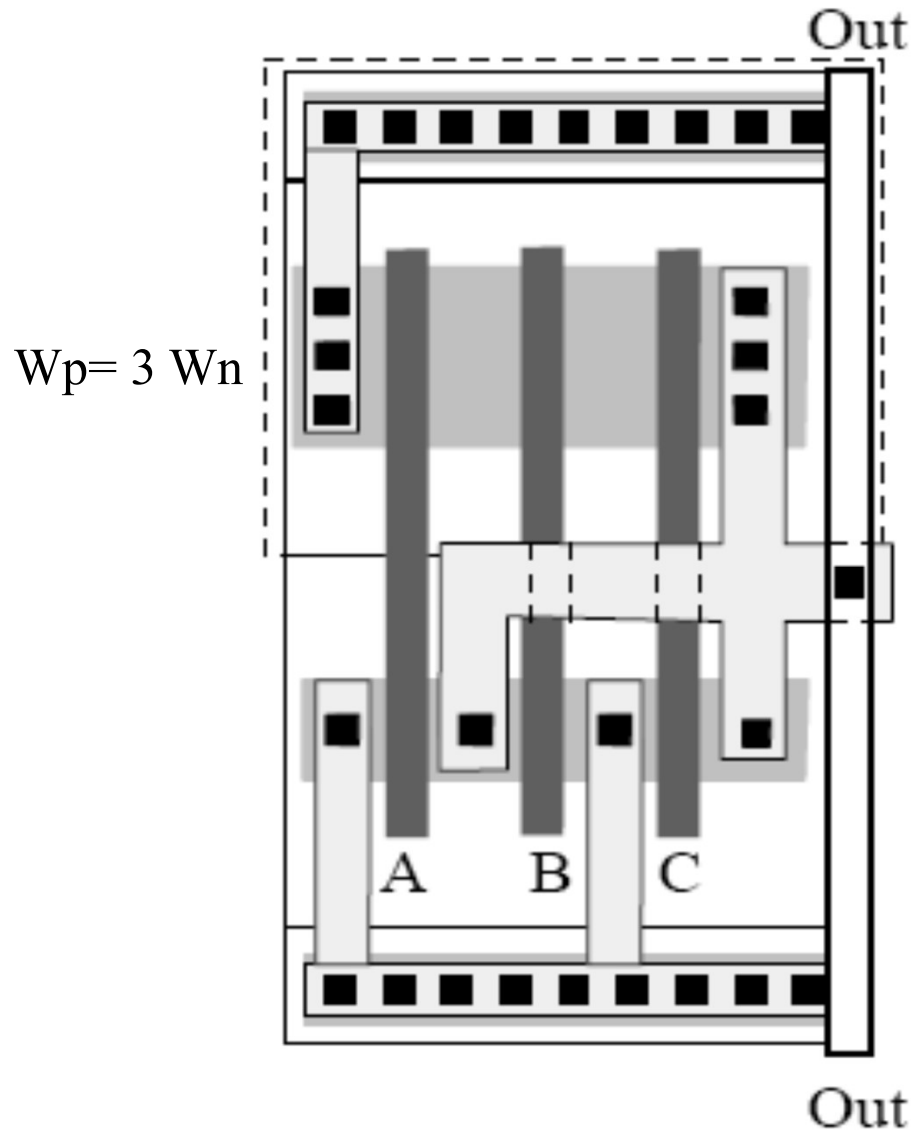


Condition:

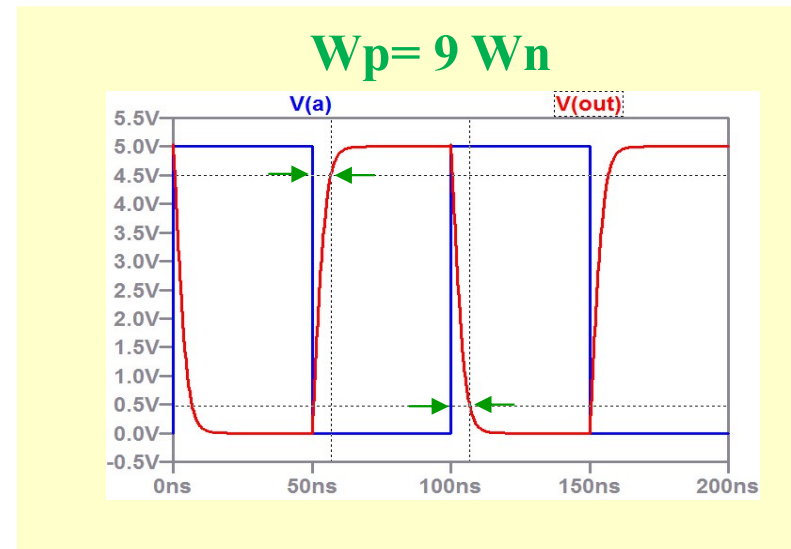
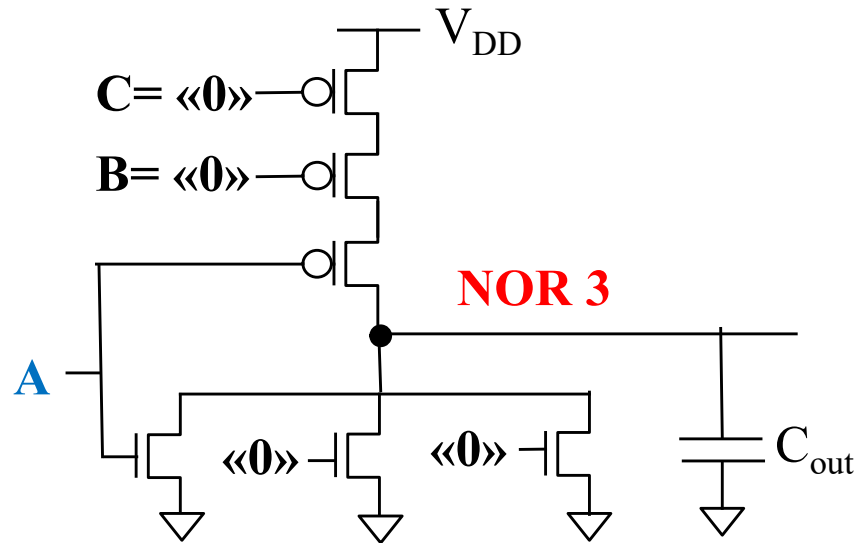
$$R_p C_{out} = 3R_N C_{out} \Rightarrow \frac{C_{out}}{W_P \mu_p} = \frac{3 \cdot C_{out}}{W_N \mu_N}$$



$$\frac{W_P}{W_N} = \frac{1}{3} \frac{\mu_n}{\mu_P} = 1$$



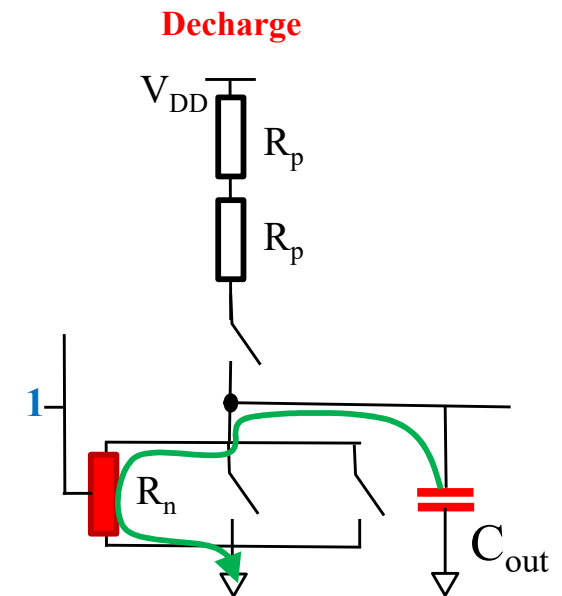
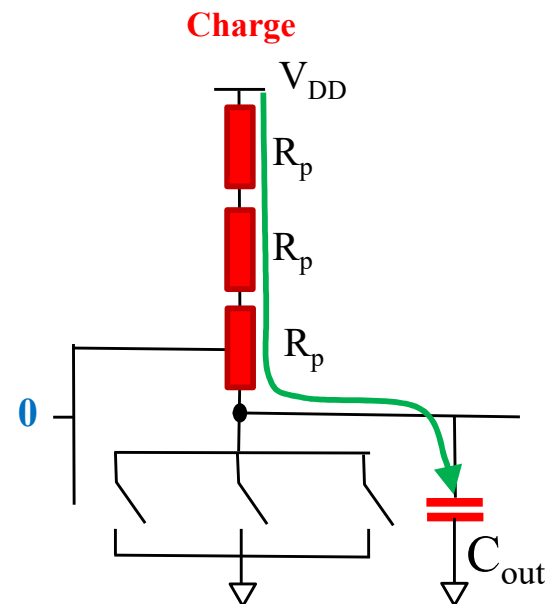
- Quelle est cette fonction ?
- Dessinez le circuit CMOS correspondant et analysez les temps de charge et de décharge pour le «worst case».
- En utilisant la même technologie ($\mu_p = \mu_n/3$), optimisez le rapport W_p/W_n .



$$3R_p C_{out} = R_n C_{out} \Rightarrow \frac{3 \cdot C_{out}}{W_p \mu_p} = \frac{C_{out}}{W_n \mu_n}$$



$$\frac{W_p}{W_n} = 3 \cdot \frac{\mu_n}{\mu_p} = 9$$



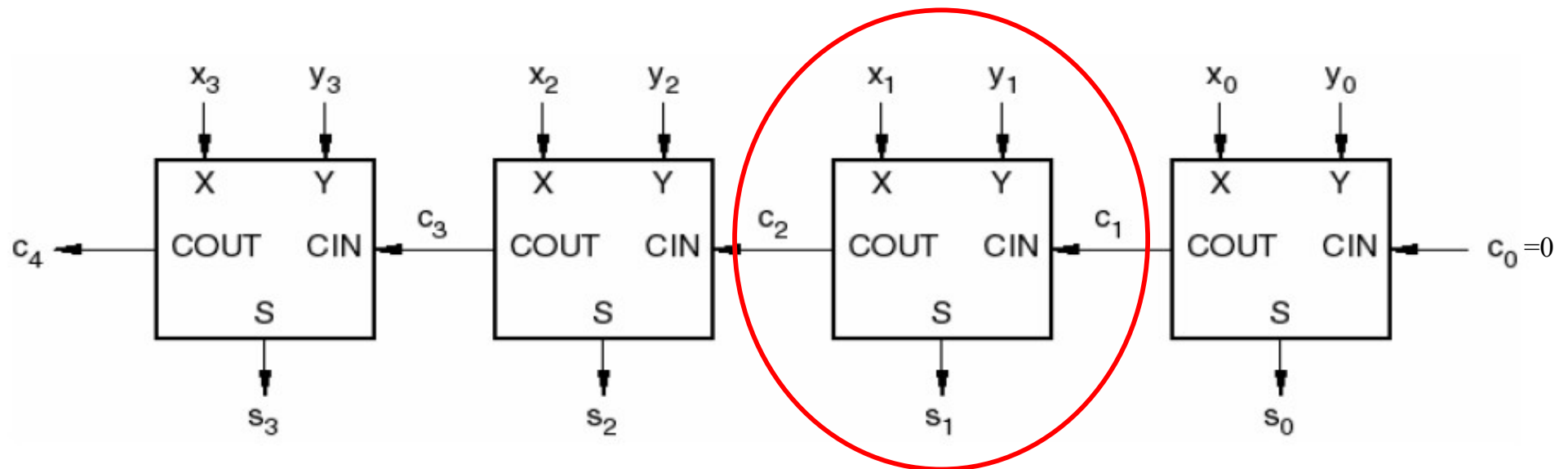


Principe

$$\begin{array}{r}
 c_4 \ c_3 \ c_2 \ c_1 \ 0 \\
 \quad x_3 \ x_2 \ x_1 \ x_0 \\
 + \quad y_3 \ y_2 \ y_1 \ y_0 \\
 \hline
 = \ c_4 \ s_3 \ s_2 \ s_1 \ s_0
 \end{array}$$

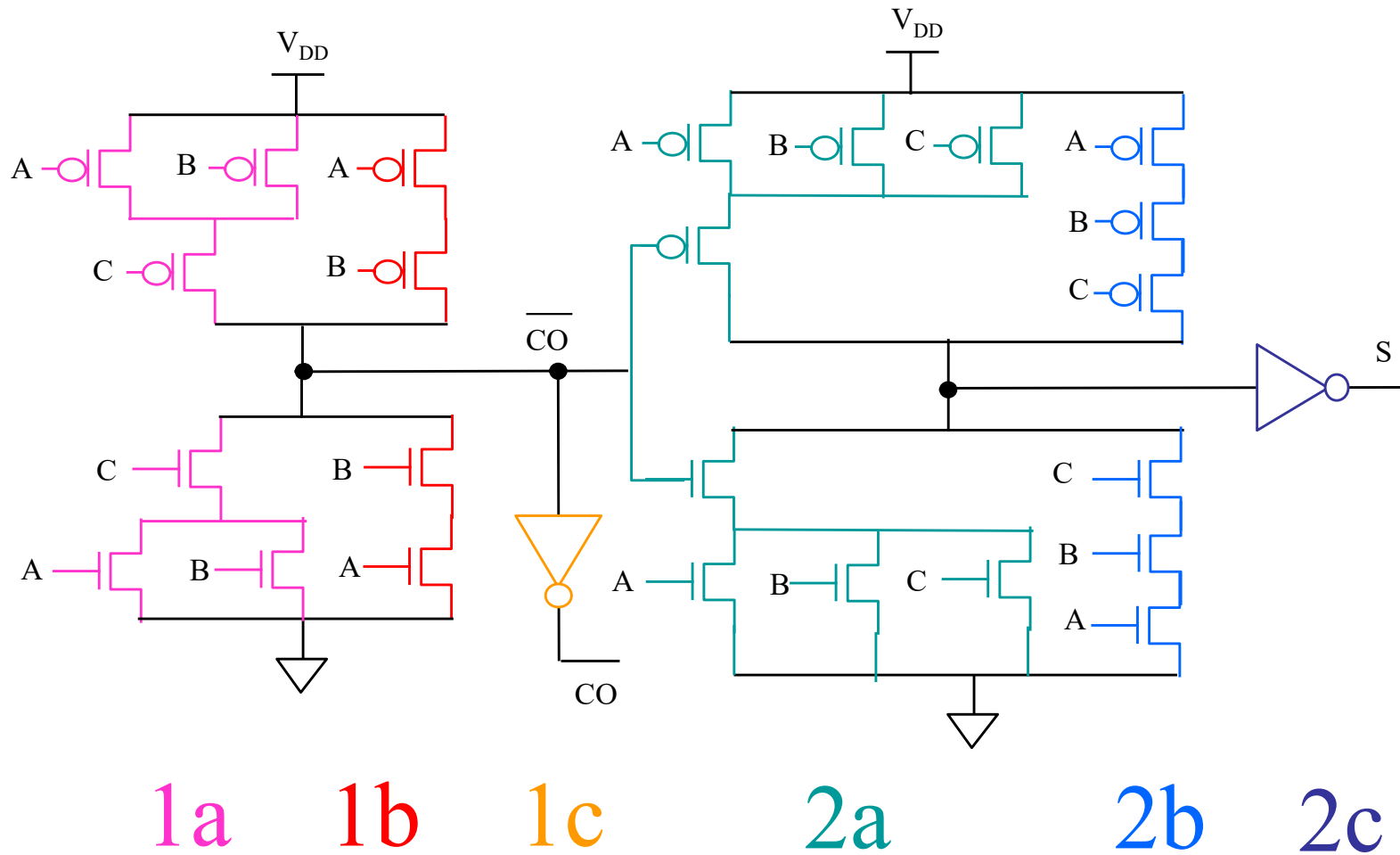
Exemple d'addition binaire:
1101 + 1001 = 10110

$$\begin{array}{r}
 \textcolor{blue}{1} \ \textcolor{blue}{0} \ \textcolor{blue}{0} \ \textcolor{blue}{1} \ 0 \quad C \\
 \quad 1 \ 1 \ 0 \ 1 \quad A \\
 + \quad 1 \ 0 \ 0 \ 1 \quad B \\
 \hline
 = \ \textcolor{red}{1} \ \textcolor{red}{0} \ \textcolor{red}{1} \ \textcolor{red}{1} \ 0 \quad S
 \end{array}$$





Calculez la table de vérité et montrez qu'elle correspond à une addition binaire



28 transistors

Zimmermann, Fichtner, IEEE journal of solid-state circuits, Vol. 32, No. 7, pp. 1-12.

Full Adder: layout

Weste/Harris, « CMOS VLSI design », Addison-Wesley

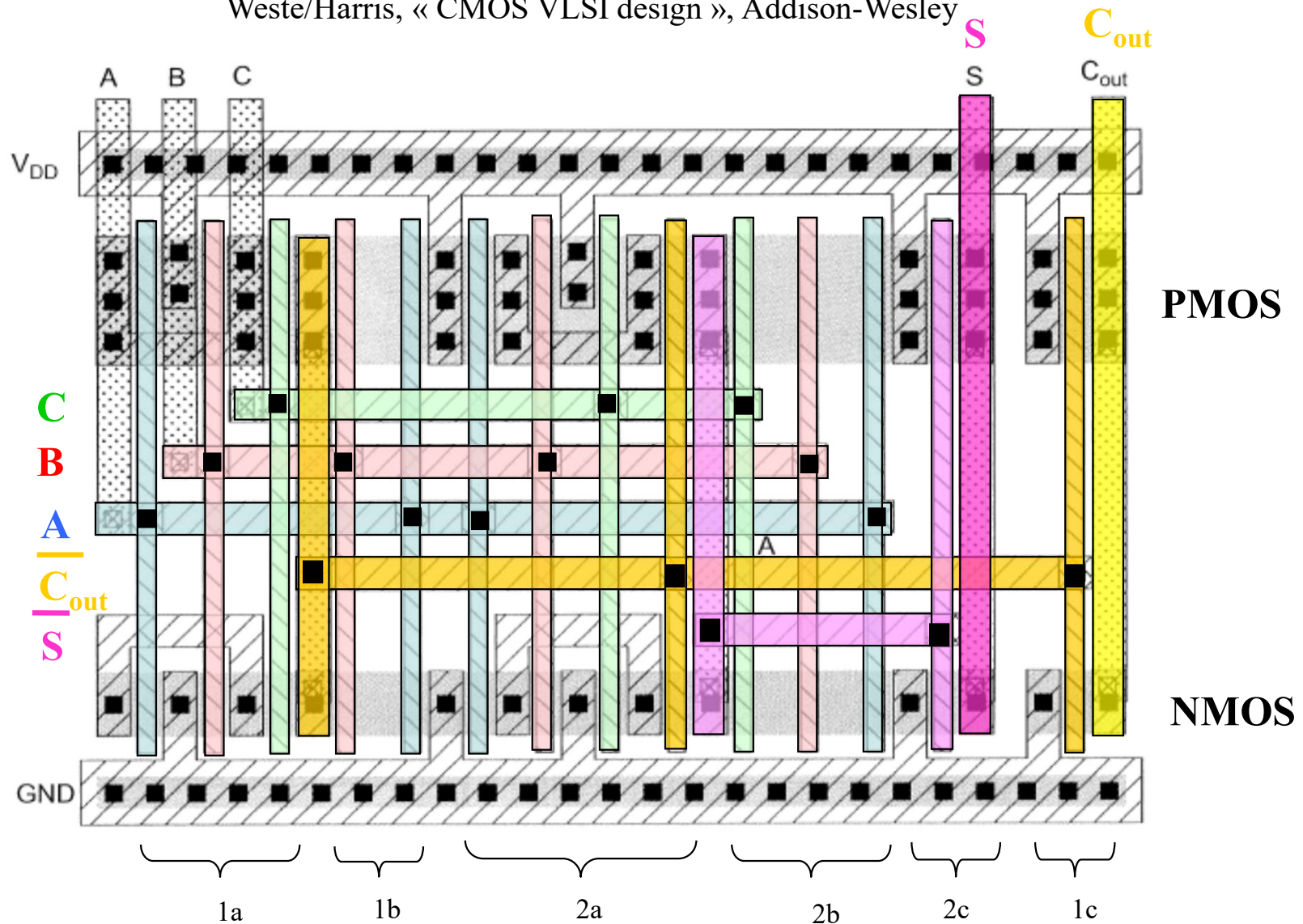


Table de vérité: « full adder » (1)

A	B	C	$\overline{CO}$	CO	$\overline{S}$	S
0	0	0				
0	0	1				
0	1	0				
0	1	1				
1	0	0				
1	0	1				
1	1	0				
1	1	1				

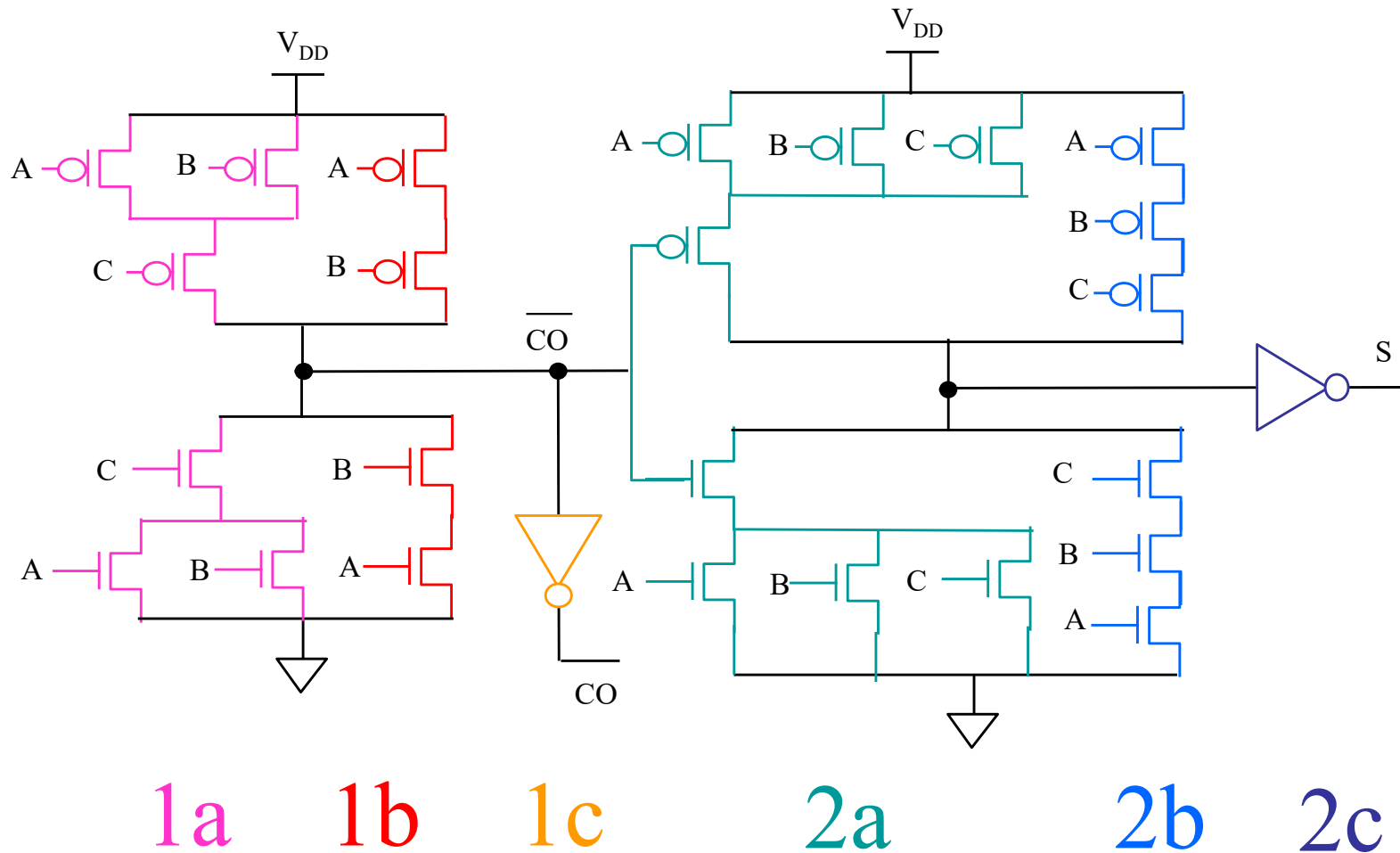
retenue

somme

somme



Calculez la table de vérité et montrez qu'elle correspond à une addition binaire



28 transistors

Zimmermann, Fichtner, IEEE journal of solid-state circuits, Vol. 32, No. 7, pp. 1-12.

somme

Table de vérité: « full adder » (1)

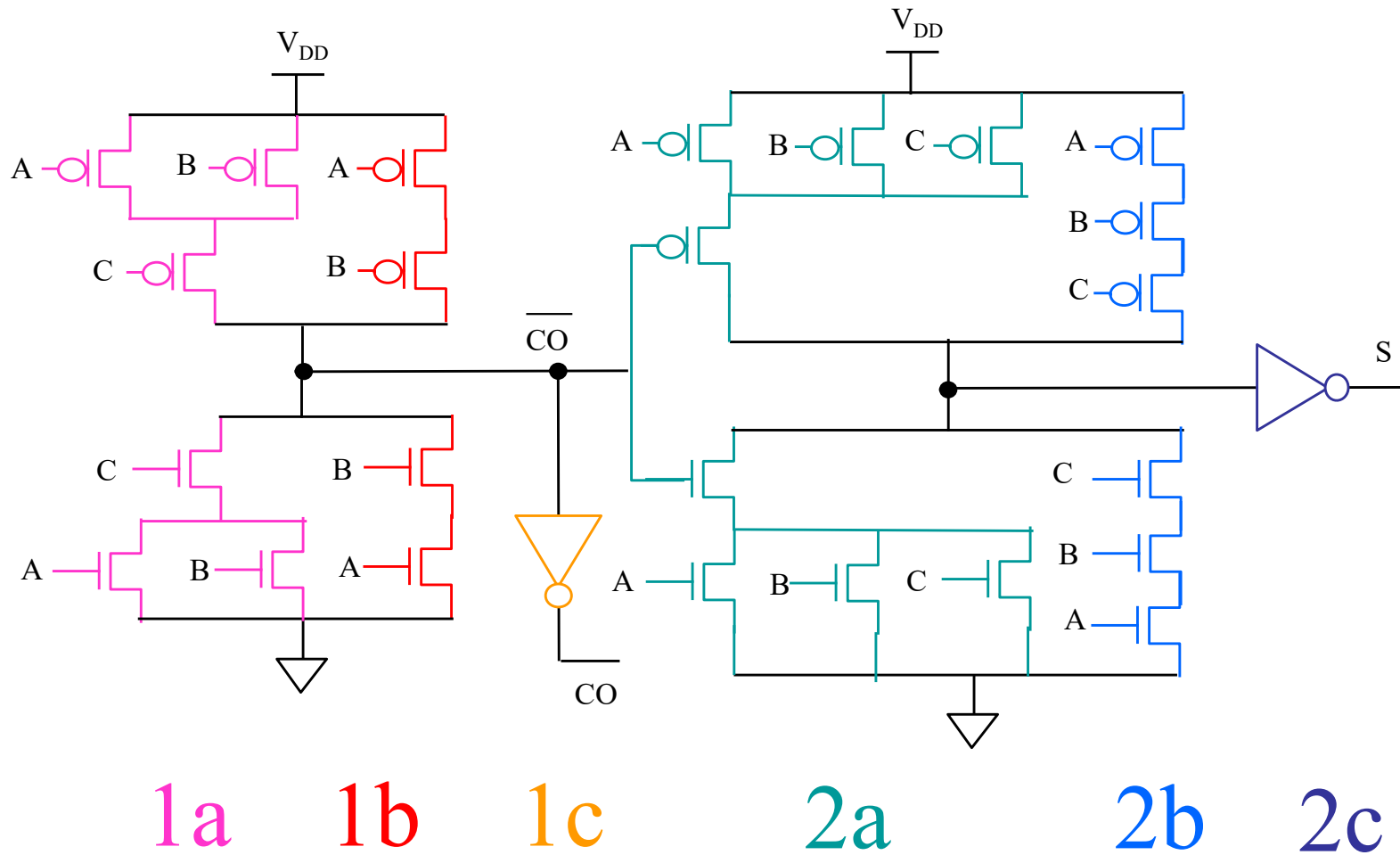
	A	B	C	$\overline{CO}$	CO	$\overline{S}$	S
A=B=C=0	0	0	0	1	0		
	0	0	1	1	0		
	0	1	0	1	0		
	0	1	1	0	1		
	1	0	0	1	0		
	1	0	1	0	1		
	1	1	0	0	1		
A=B=C=1	1	1	1	0	1		

retenue

somme



Calculez la table de vérité et montrez qu'elle correspond à une addition binaire



28 transistors

Zimmermann, Fichtner, IEEE journal of solid-state circuits, Vol. 32, No. 7, pp. 1-12.

Table de vérité: « full adder » (1)

	A	B	C	$\overline{CO}$	CO	$\overline{S}$	S
A=B=C=0	0	0	0	1	0	1	0
Au moins un «0» et un «1» →inverter	0	0	1	1	0	CO=0	1
	0	1	0	1	0	CO=0	1
	0	1	1	0	1	CO=1	0
	1	0	0	1	0	CO=0	1
	1	0	1	0	1	CO=1	0
A=B=C=1	1	1	0	0	1	CO=1	0
	1	1	1	0	1	0	1

retenue somme

Table de vérité: « full adder » (2)

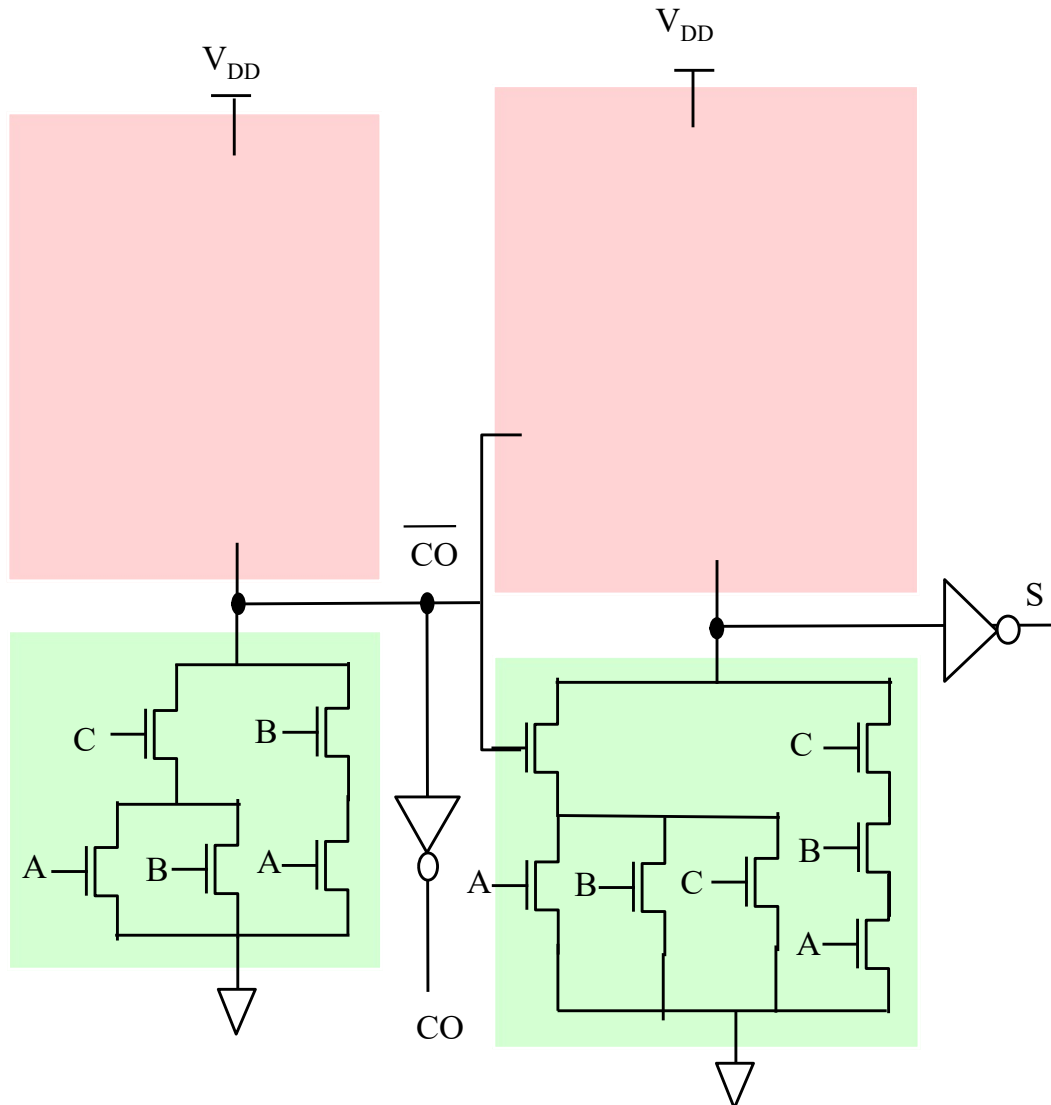
A	B	C	$\overline{CO}$	CO	$\overline{S}$	S
0	0	0	1	0	1	0
0	0	1	1	0	0	1
0	1	0	1	0	0	1
0	1	1	0	1	1	0
1	0	0	1	0	0	1
1	0	1	0	1	1	0
1	1	0	0	1	1	0
1	1	1	0	1	0	1

retenue

somme

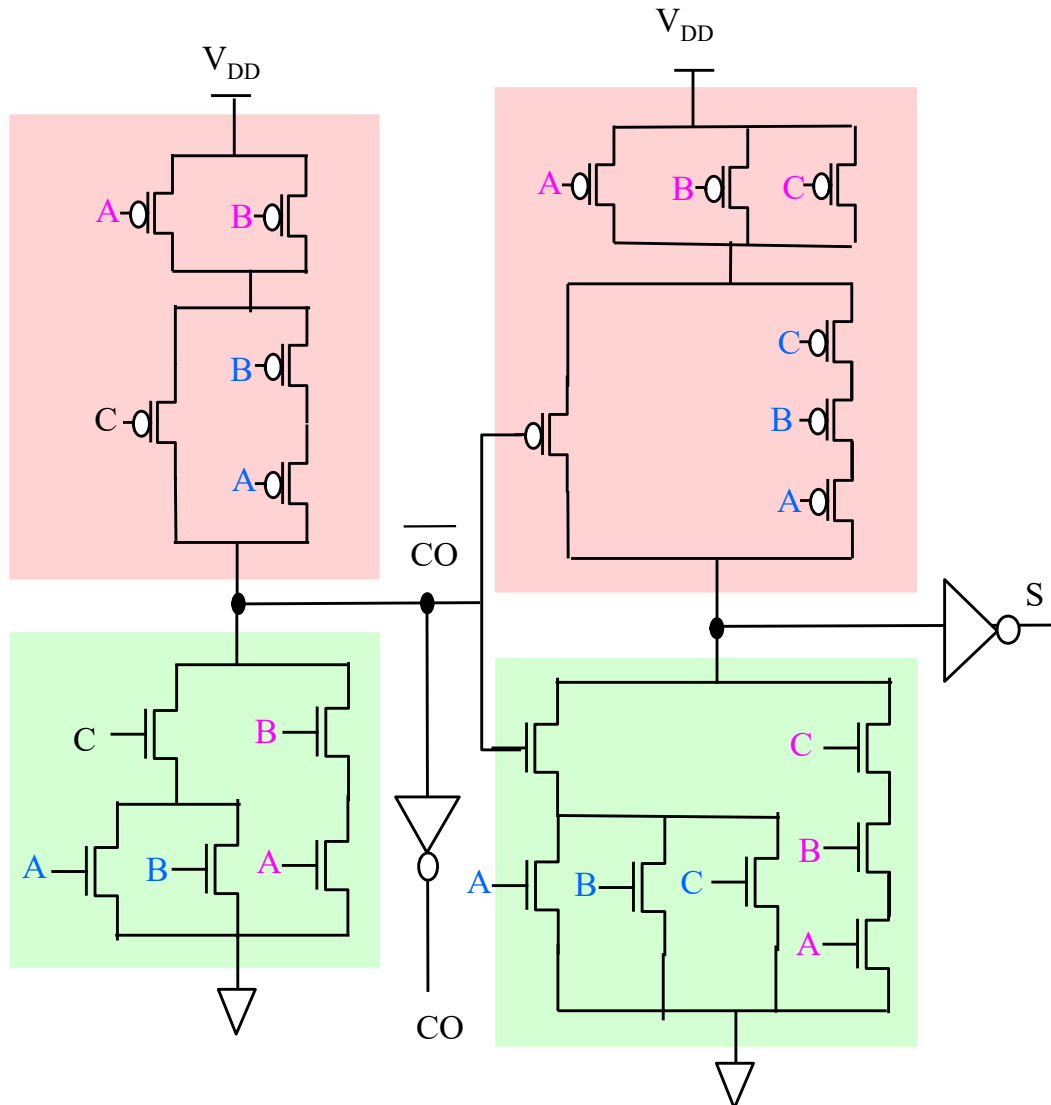
Exercice 12.6: Full adder: alternative

Déterminez les boîtes correspondantes avec parallèle $\leftrightarrow$ série



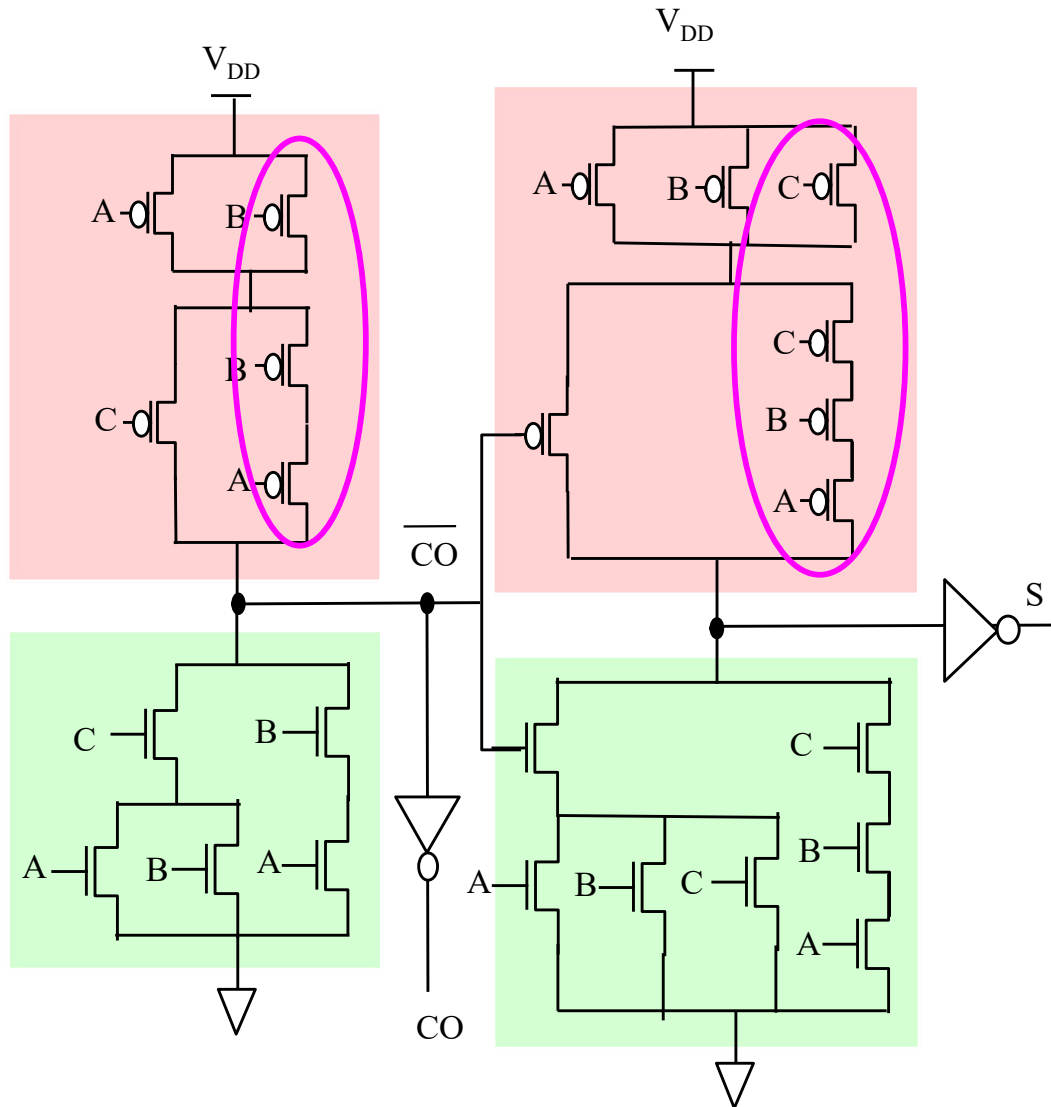
Exercice 12.6: Full adder: alternative

Déterminez les boîtes correspondantes avec parallèle $\leftrightarrow$ série



Exercice 12.6: Full adder: alternative

Longue chaîne de transistors en série → Lent !



Version standard

