

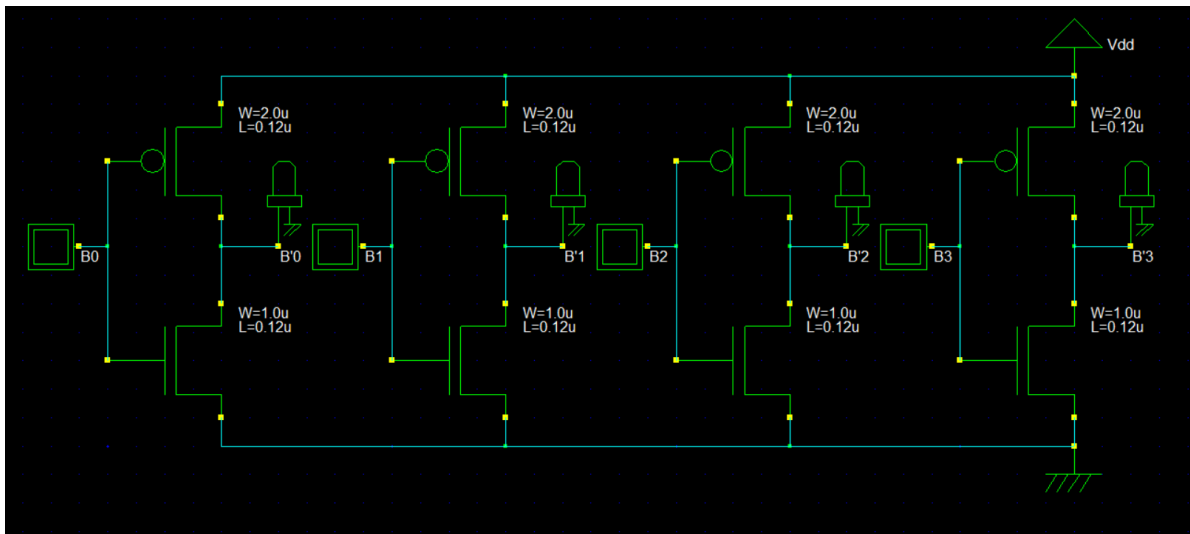
CMOS VLSI Design

Design and Simulation of a 4-bit ALU

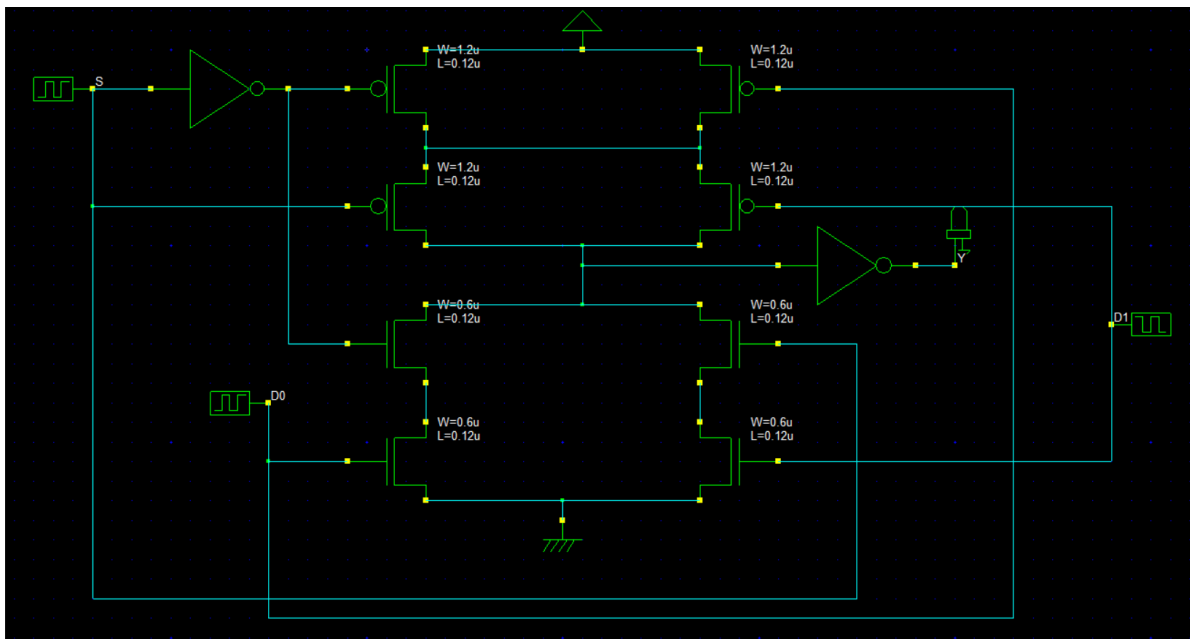
Individual components such as 4-bit inverter, 2-1 MUX, 4-bit Adder, 4-bit AND gate, 4-bit OR gate and 4-1 MUX were designed. Further, these components were connected to obtain the 4-bit ALU circuit.

Schematics:

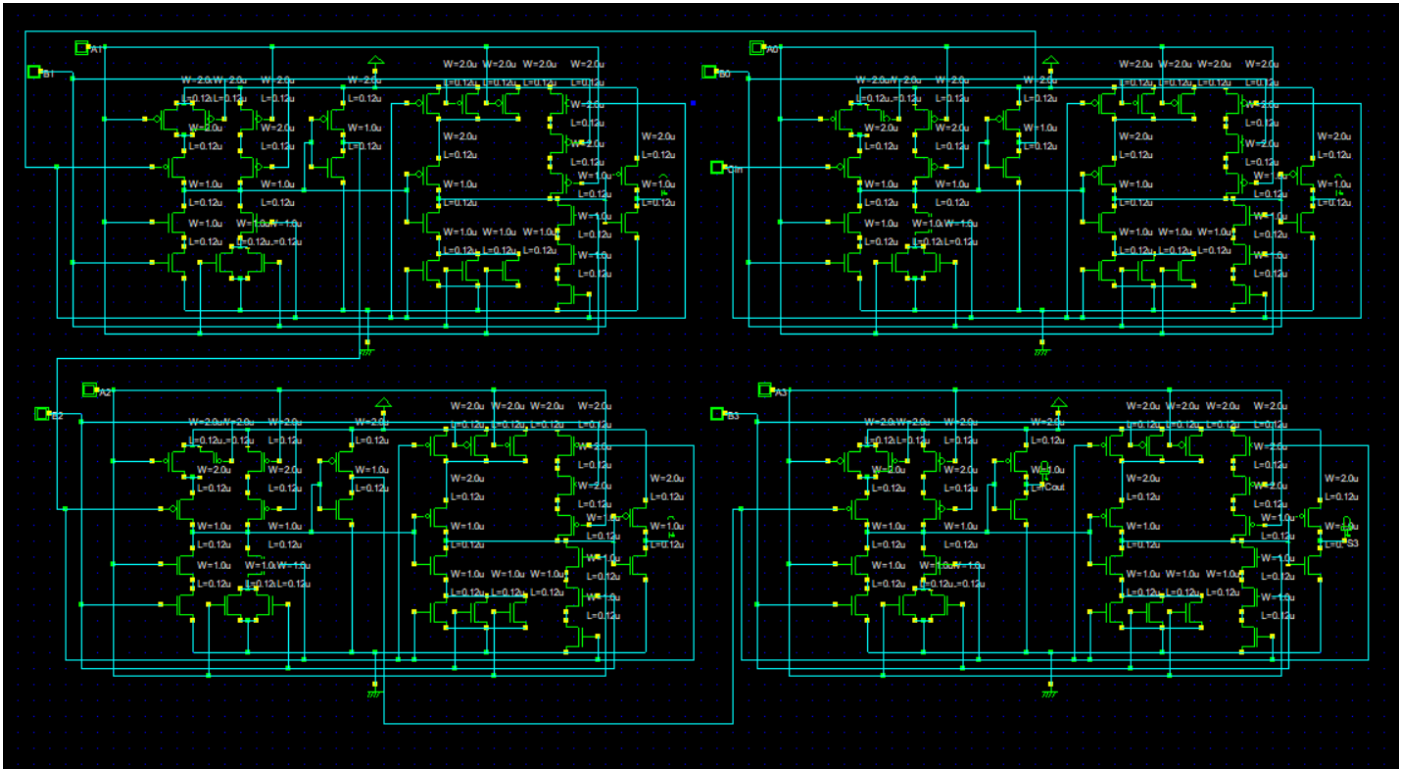
4-bit Inverter:



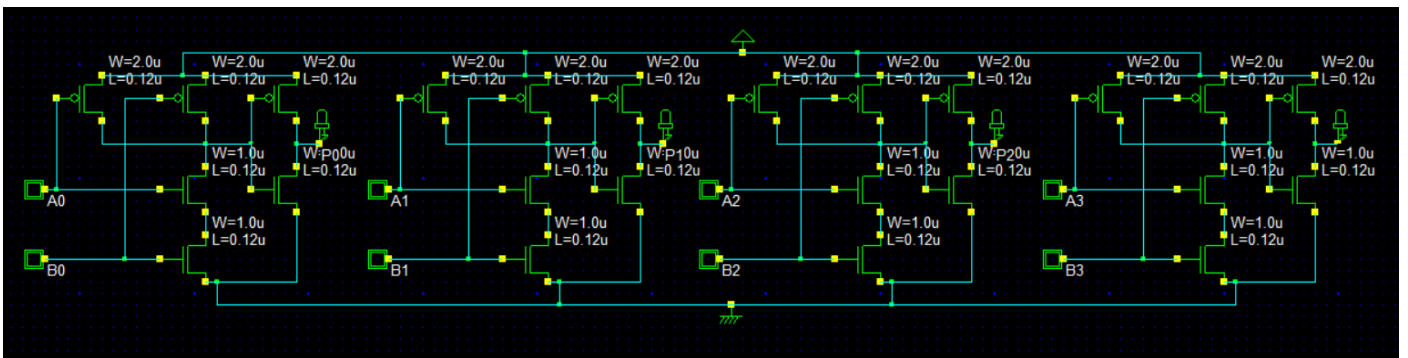
2-1 MUX:



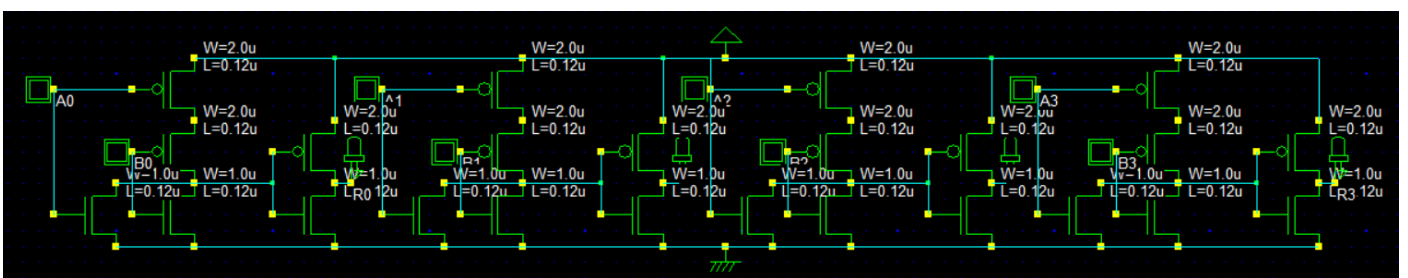
4-bit Adder (RCA style):



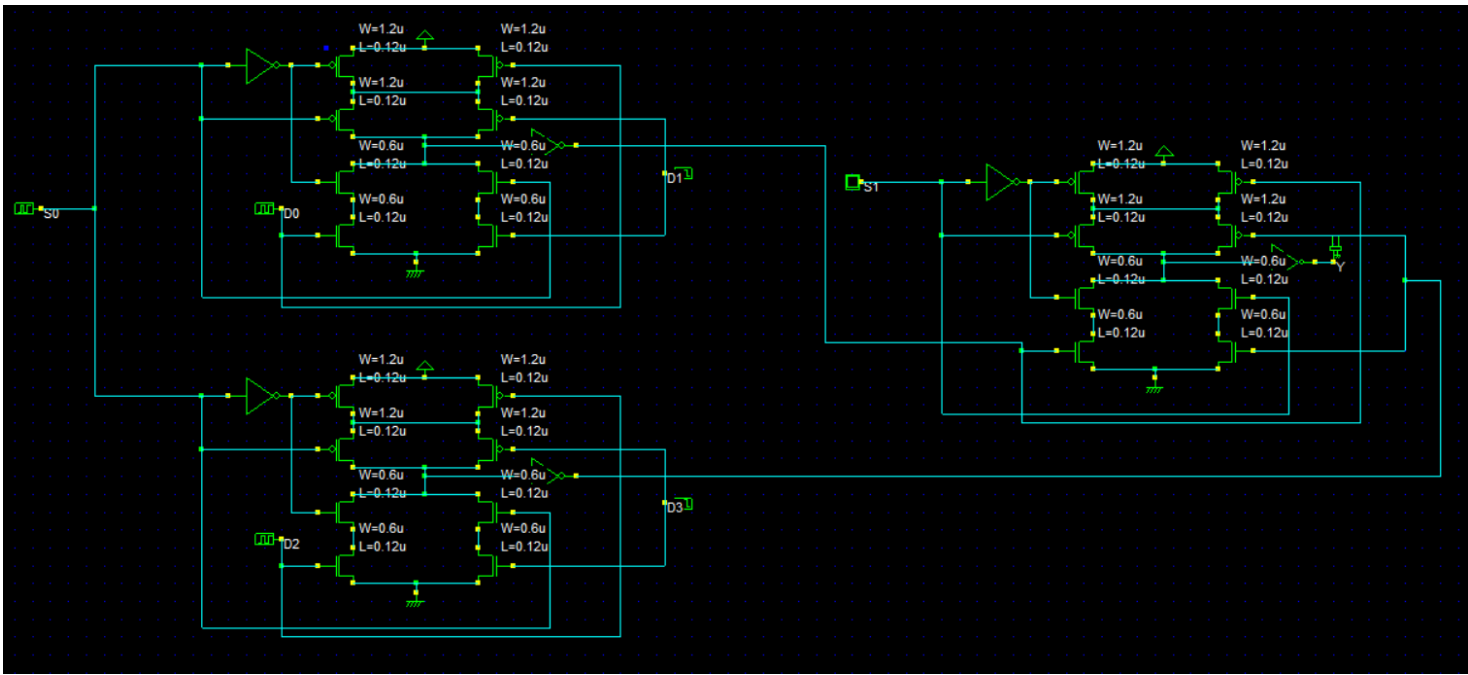
4-bit AND:



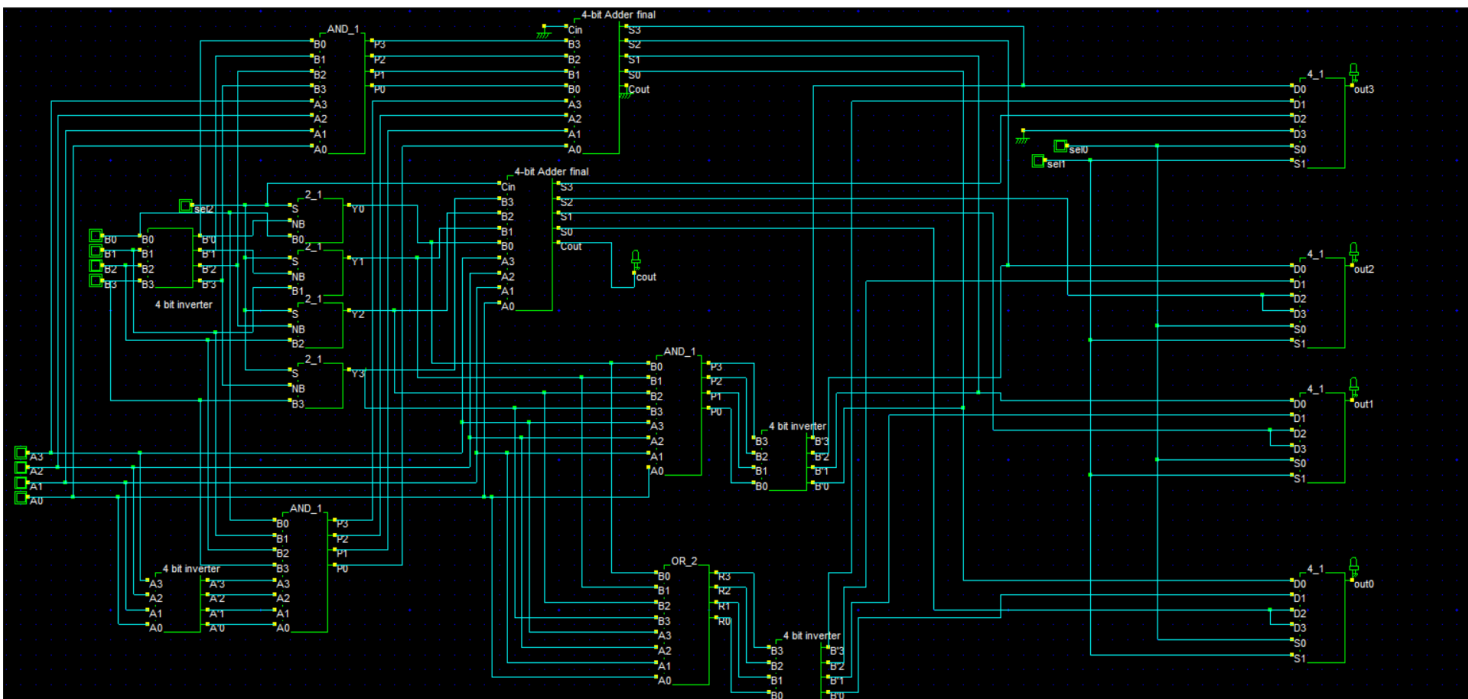
4-bit OR:



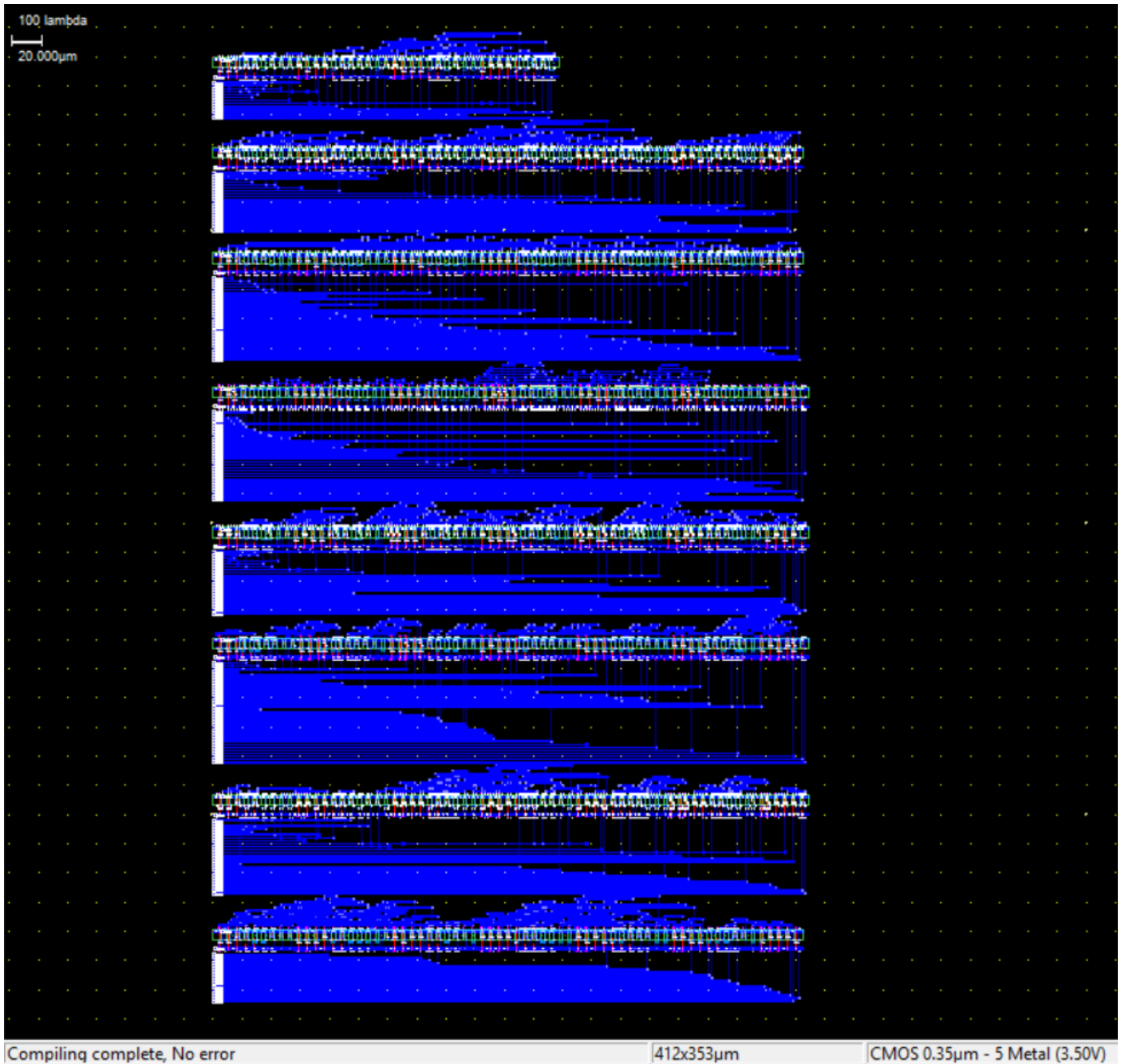
4-1 MUX:



4-bit ALU:



Layout:



Boolean Equations and Truth Table:

Addition(4-bit): $Y = A + B$

Subtraction (4-bit): $Y = A - B$

NAND (bitwise): $Y = (A \& B)'$

NOR (bitwise): $Y = (A | B)'$

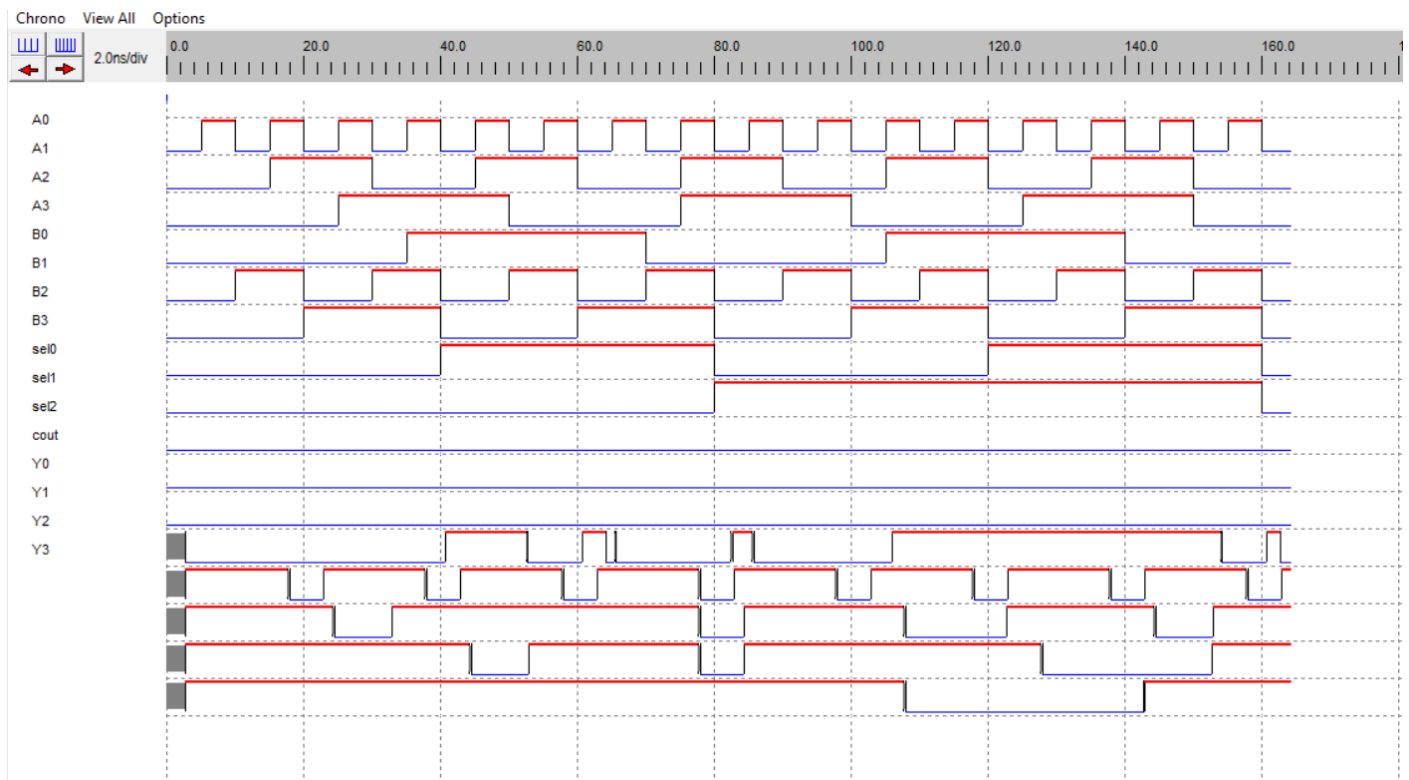
XOR(bitwise): $Y = A'B + AB'$

Comparison (SLT) (bitwise): $Y = \sim A \& B$

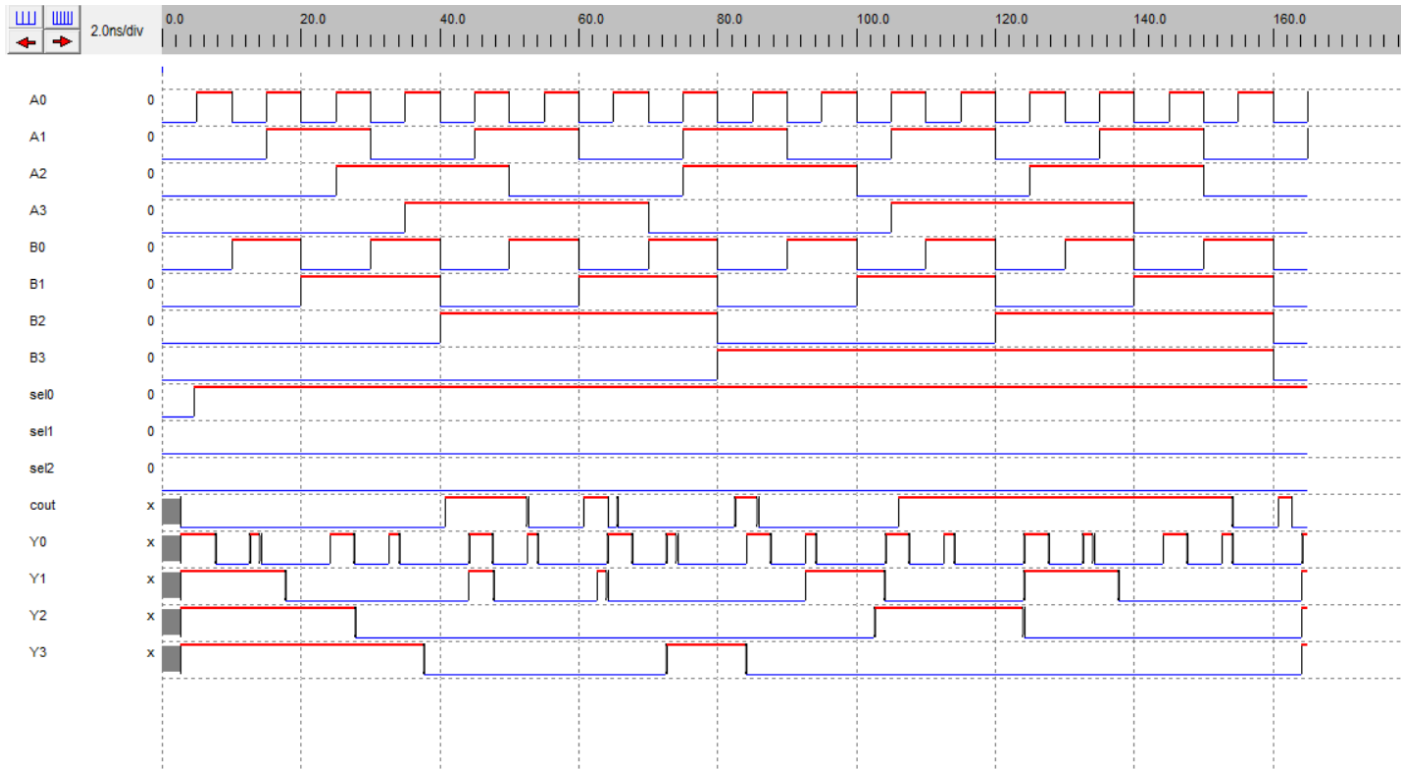
Control Signal	Operation	Output
000	NAND	$(A \& B)'$
001	NOR	$(A B)'$
010	ADDITION	$A + B$
011	XOR	$A' B + A B'$
110	SUBTRACTION	$A - B$
111	SLT (Comparison)	(0,1) Flags

Simulations:

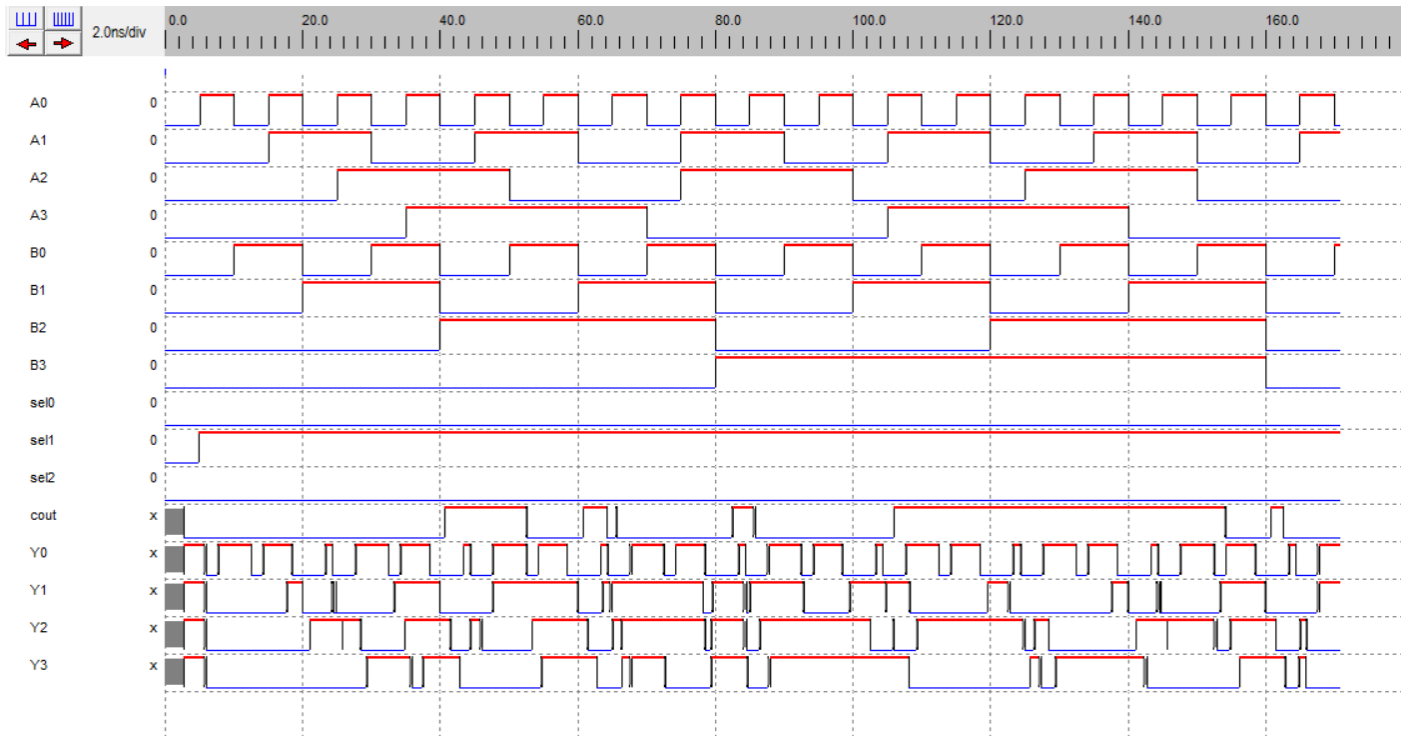
NAND:



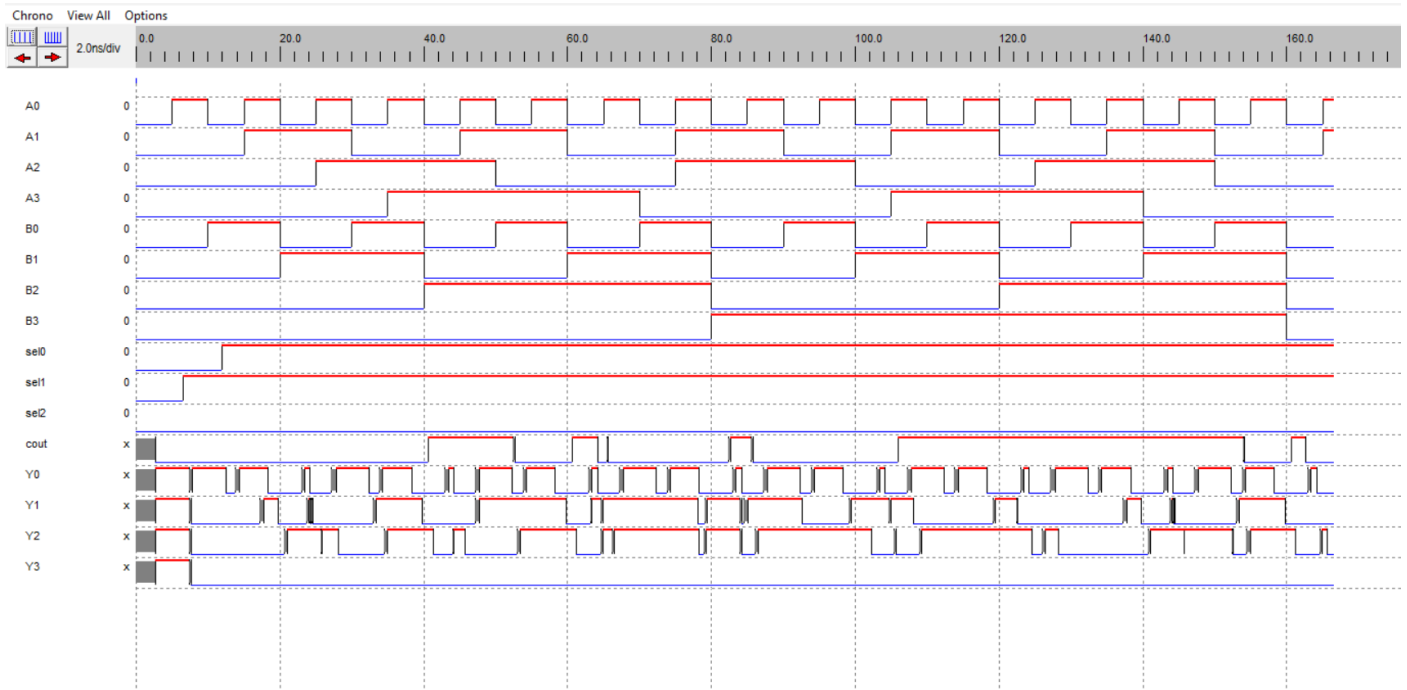
NOR:



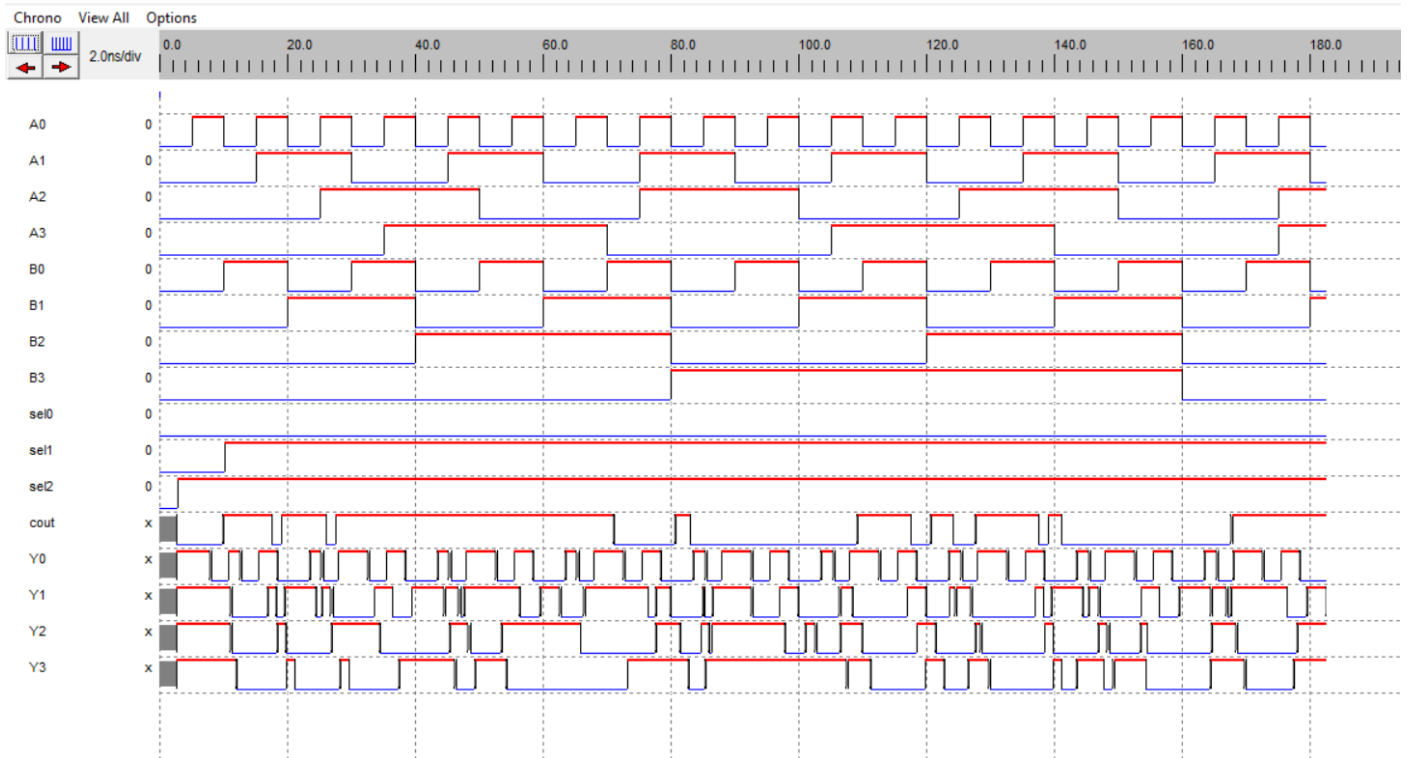
ADDITION:



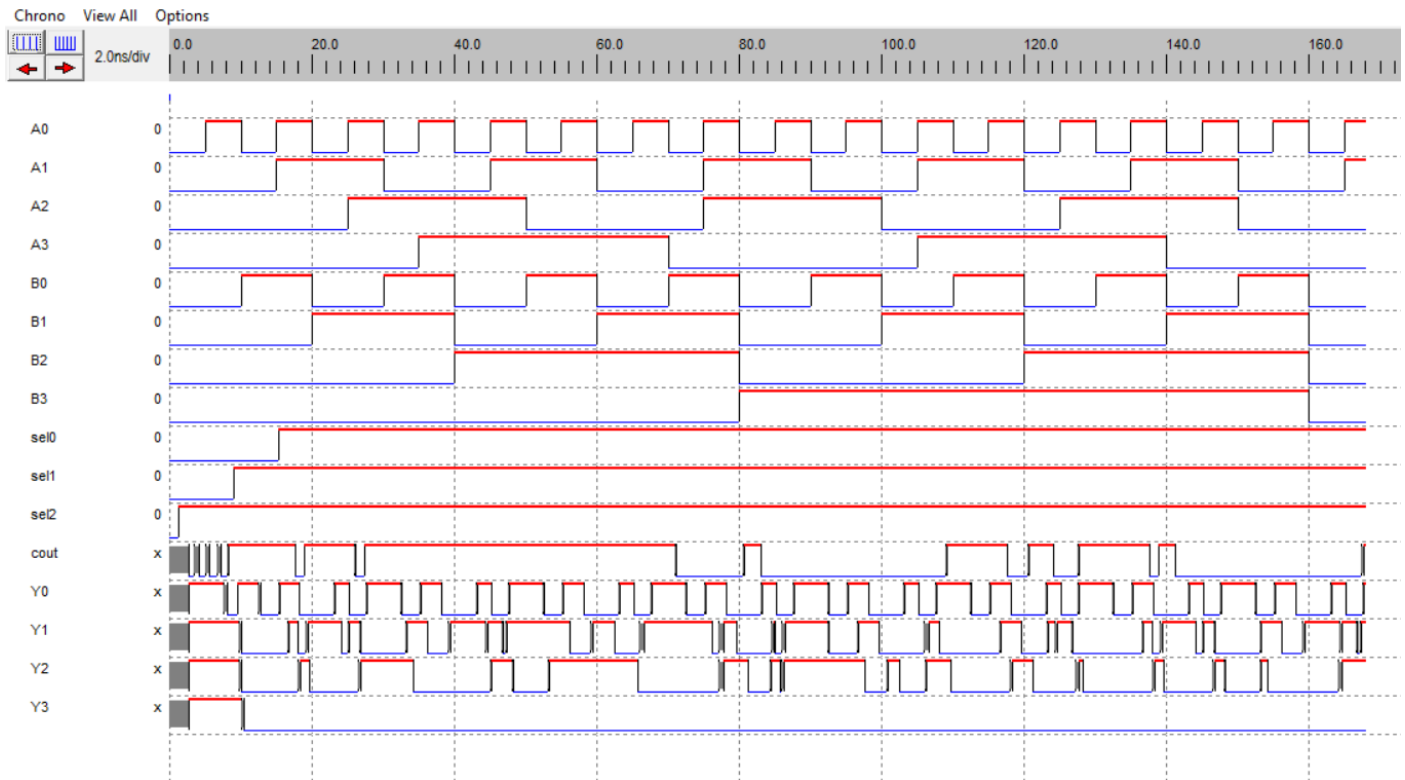
XOR:



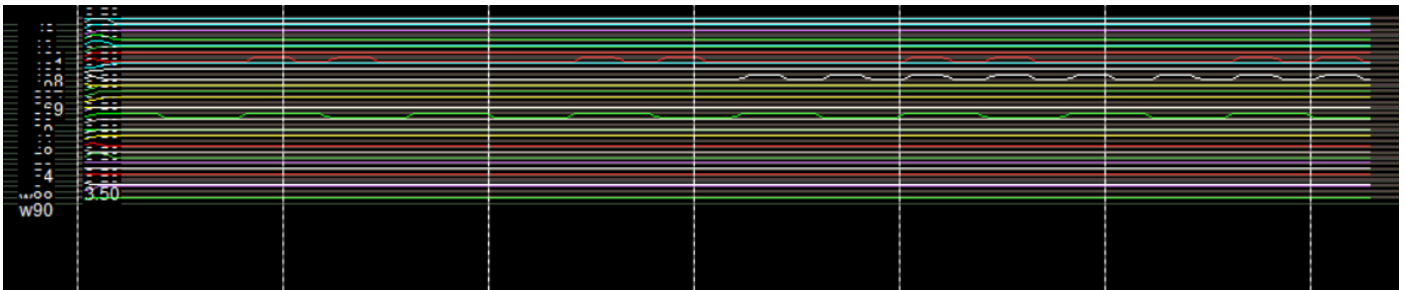
SUBTRACTION:



Comparison (SLT):



Layout simulation:



Reference:

1. EGEC180_Ch5.pptx (Project reference)
2. <https://www.geeksforgeeks.org/4-bit-binary-adder-subtractor>
3. Class notes and Presentation
4. <https://ieeexplore.ieee.org/document/8316623>