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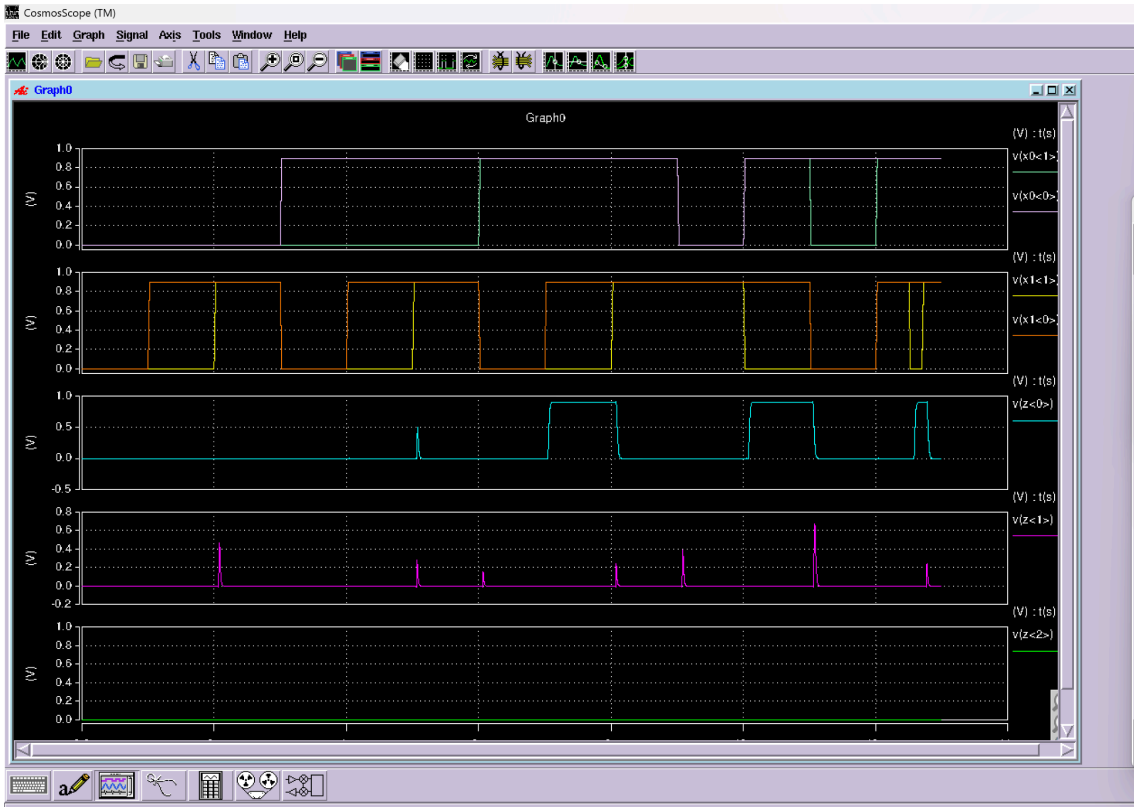
Milestone 2 Report

Testing: After testing the individual blocks, we decided to develop two separate test benches with fixed weights and different input combinations to test the main functionality as well as worst case scenarios.

Waveforms:

Test 1: Weights fixed at W00 = 2'b11, W10 = 2'b01, W20 = 2'b11



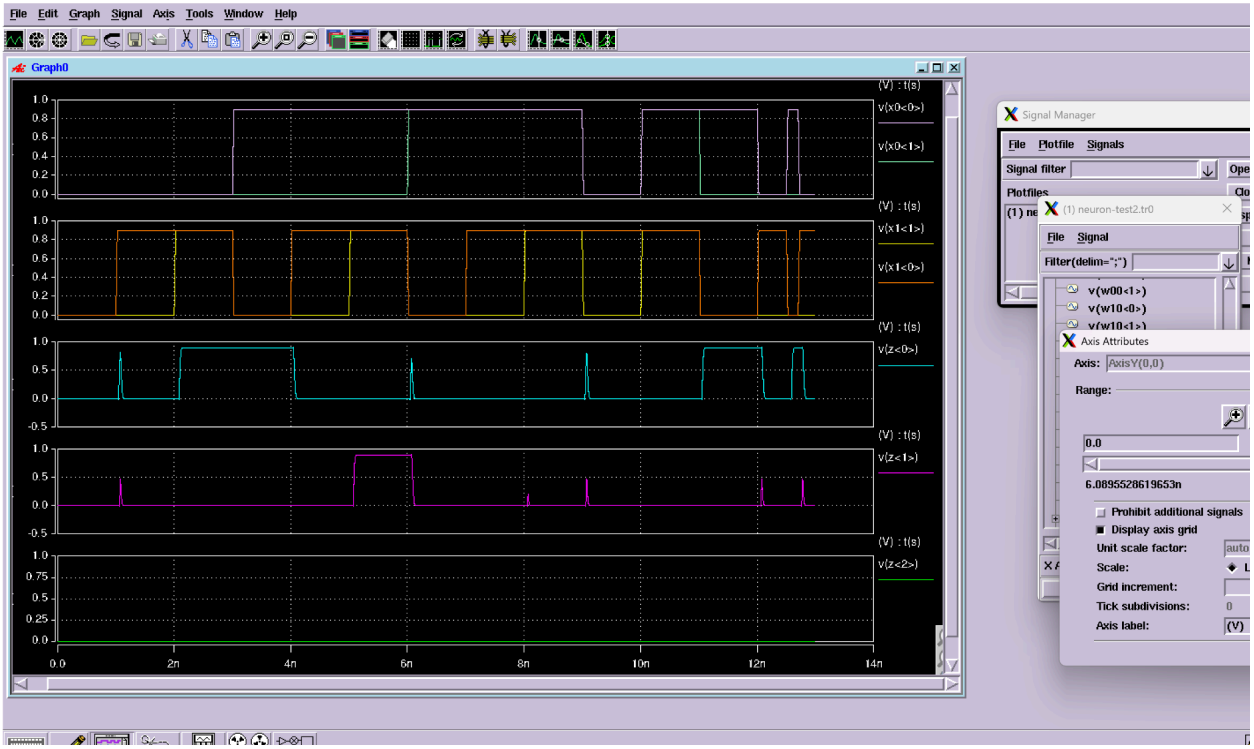
Test Case ID	Time Range	Input Combination ([x0,x1,w00,w10,w20])	$y_0 = x_1 - x_0 - 1$	Expected z0	Actual z0 (from sim)	Pass/Fail	Notes
T1-1	0–1 ns	([0, 0, -1, +1, -1])	(0 - 0 - 1 = -1)	0	0	Pass	Baseline case; output correctly low.

T1-2	1–2 ns	([0, +1, -1, +1, -1])	(+1 - 0 - 1 = 0)	0	0	Pass	ReLU boundary; y_0=0 so z0 remains 0.
T1-3	2–3 ns	([0, -1, -1, +1, -1])	(-1 - 0 - 1 = -2)	0	0	Pass	This is the case you asked about: $0\cdot(-1) + (-1)\cdot(+1) + (-1) = -2 \Rightarrow$ negative, so z0 must be 0. Your waveform (staying low) is correct.
T1-4	3–4 ns	([+1, 0, -1, +1, -1])	(0 - (+1) - 1 = -2)	0	0	Pass	Positive x0 alone isn't enough to overcome bias; z0 low.
T1-5	4–5 ns	([+1, +1, -1, +1, -1])	(+1 - (+1) - 1 = -1)	0	0	Pass	Sum is negative; ReLU clamps to zero.
T1-6	5–6 ns	([+1, -1, -1, +1, -1])	(-1 - (+1) - 1 = -3)	0	0	Pass	Most negative y_0; z0 correctly stays 0.
T1-7	6–7 ns	([-1, 0, -1, +1, -1])	(0 - (-1) - 1 = 0)	0	0	Pass	Another boundary y_0=0; z0 still 0.
T1-8	7–8 ns	([-1, +1, -1, +1, -1])	(+1 - (-1) - 1 = +1)	1	1 (z<0> ≈ 0.9 V)	Pass	The only combination that should give a HIGH z0. Waveform shows z<0> high for this full interval.

Test ID	Time Range	Inputs ([x0,x1])	y_0	Expected z0	Actual z0	Pass/Fail	Notes
T1-10	9–10 ns	[0, −1]	−2	0	0	Pass	Settles low; no false high before worst-case edge.
T1-11	10–11 ns	[−1, +1]	+1	1	1	Pass	Worst-case simultaneous change into the only positive y_0 state; z0 goes high and stays high despite ringing.
T1-12	11–12 ns	[+1, 0]	−2	0	0	Pass	Worst-case simultaneous change back to negative y_0; z0 returns low.

Test ID	Time Range	Inputs ([x0,x1])	y_0	Expected z0	Actual z0	Pass/Fail	Notes
T1-13	12.0–12.5 ns	[−1, −1]	−1	0	0	Pass	Baseline low before pulse.
T1-14	12.5–12.7 ns	[−1, +1]	+1	1	1	Pass	Short high pulse on z0 as expected; only in this sub-ns window.
T1-15	12.7–13.0 ns	[−1, −1]	−1	0	0	Pass	Output returns low; no extra spurious pulses.

Test 2: All inputs with fixed weights W00 = 1, W10 = -1, W20 = 0

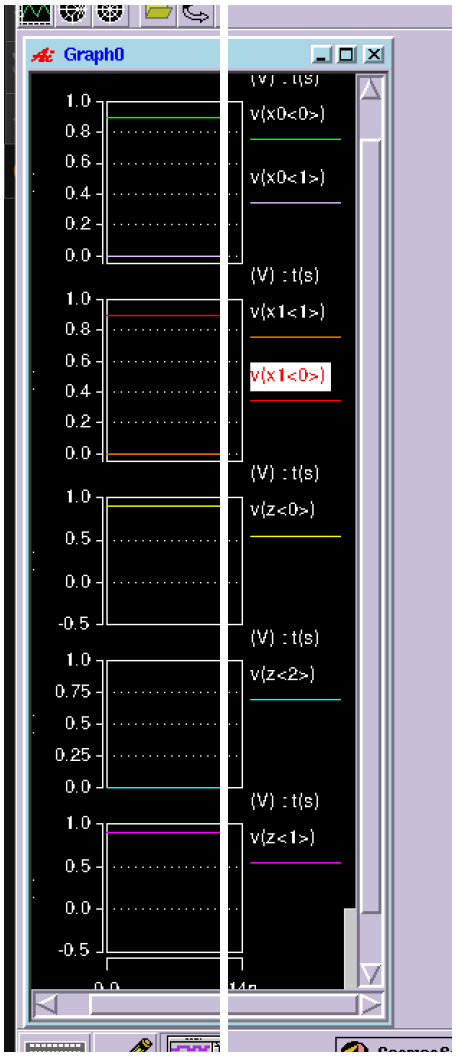


Test ID	Time Range	Inputs ([x0,x1,w00,w10,w20])	$y_0 = x_0 - x_1$	Expected z0	Actual z0	Pass/Fail	Notes
T2-1	0–1 ns	[0, 0, +1, −1, 0]	0	0	0	Pass	Baseline 0/0, z0 low.
T2-2	1–2 ns	[0, +1, +1, −1, 0]	−1	0	0	Pass	Negative y_0 → z0=0.
T2-3	2–3 ns	[0, −1, +1, −1, 0]	+1	1	1	Pass	First positive case; z0 high during 2–3 ns interval.
T2-4	3–4 ns	[+1, 0, +1, −1, 0]	+1	1	1	Pass	Second positive case; x0 > x1 gives z0 high.

T2-5	4–5 ns	[+1, +1, +1, −1, 0]	0	0	0	Pass	Boundary y_0=0; z0 returns low.
T2-6	5–6 ns	[+1, −1, +1, −1, 0]	+2	2	2	Pass	Largest positive y_0; 3-bit output is 010
T2-7	6–7 ns	[−1, 0, +1, −1, 0]	−1	0	0	Pass	Negative sum; z0 low.
T2-8	7–8 ns	[−1, +1, +1, −1, 0]	−2	0	0	Pass	More negative; still clamped.
T2-9	8–9 ns	[−1, −1, +1, −1, 0]	0	0	0	Pass	Equal inputs ⇒ y_0=0, z0 low.

Test ID	**Time Range**	**Inputs ([x0,x1])**	**$y_0 = x_0 - x_1$**	**Expected z0**	**Actual z0**	**Pass/Fail**	**Notes**
T2-10	9–10 ns	[0, +1]	−1	0	0	Pass	Pre-transition negative case.
T2-11	10–11 ns	[-1, −1]	0	0	Matches waveform	Pass	Simultaneous transition
T2-12	11–12 ns	[−1, 0]	−1	0	0	Pass	Worst-case fall back to negative; z0 low.

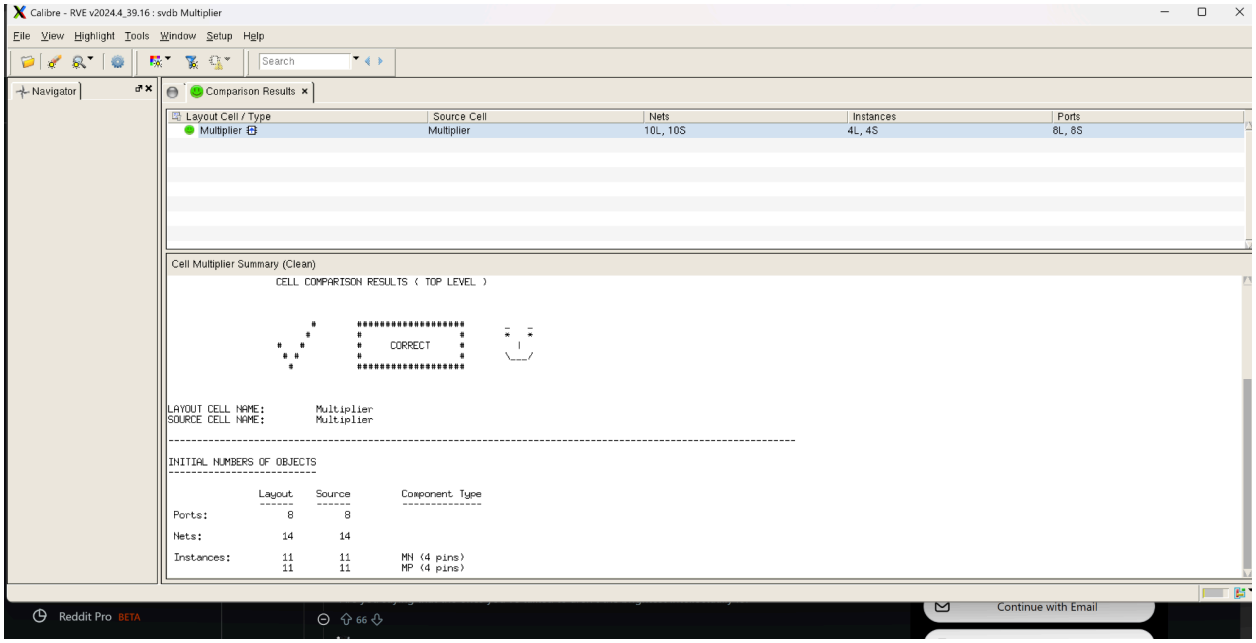
Also want to test if feeding 1 + 1 +1 into the multiplier, output Z0 goes to 011, so made a quick test bench just for this combination.

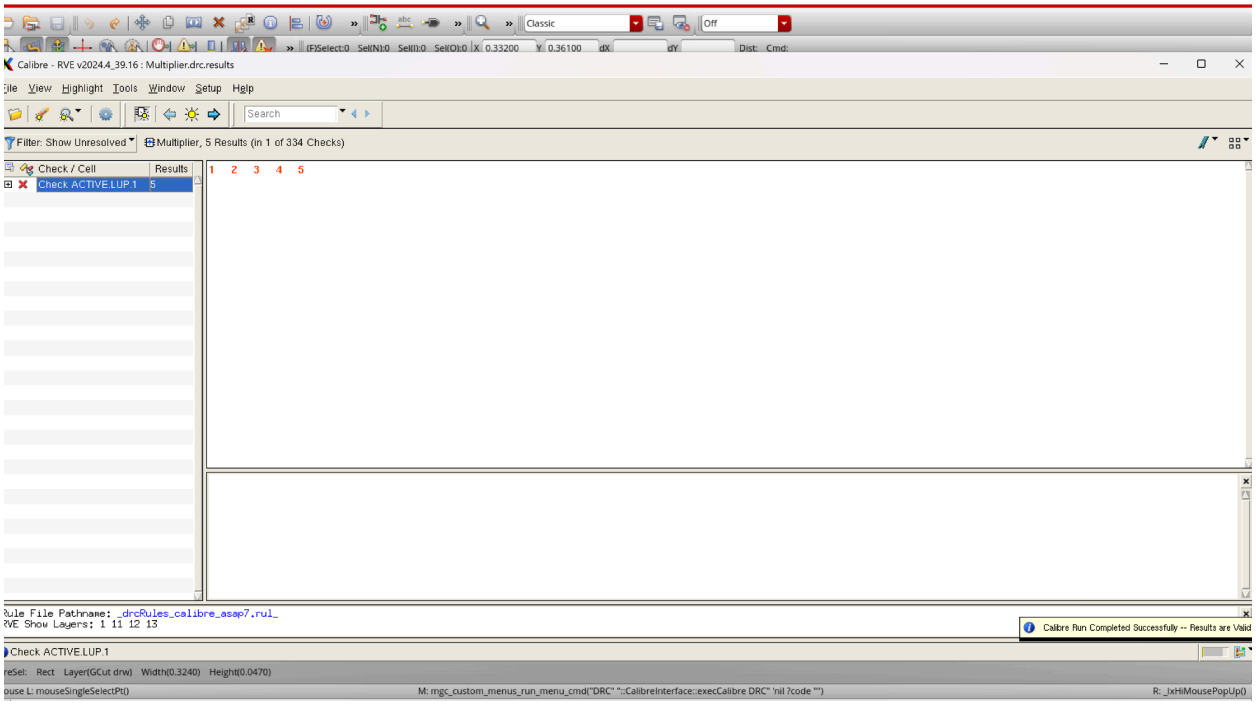


PASSED!

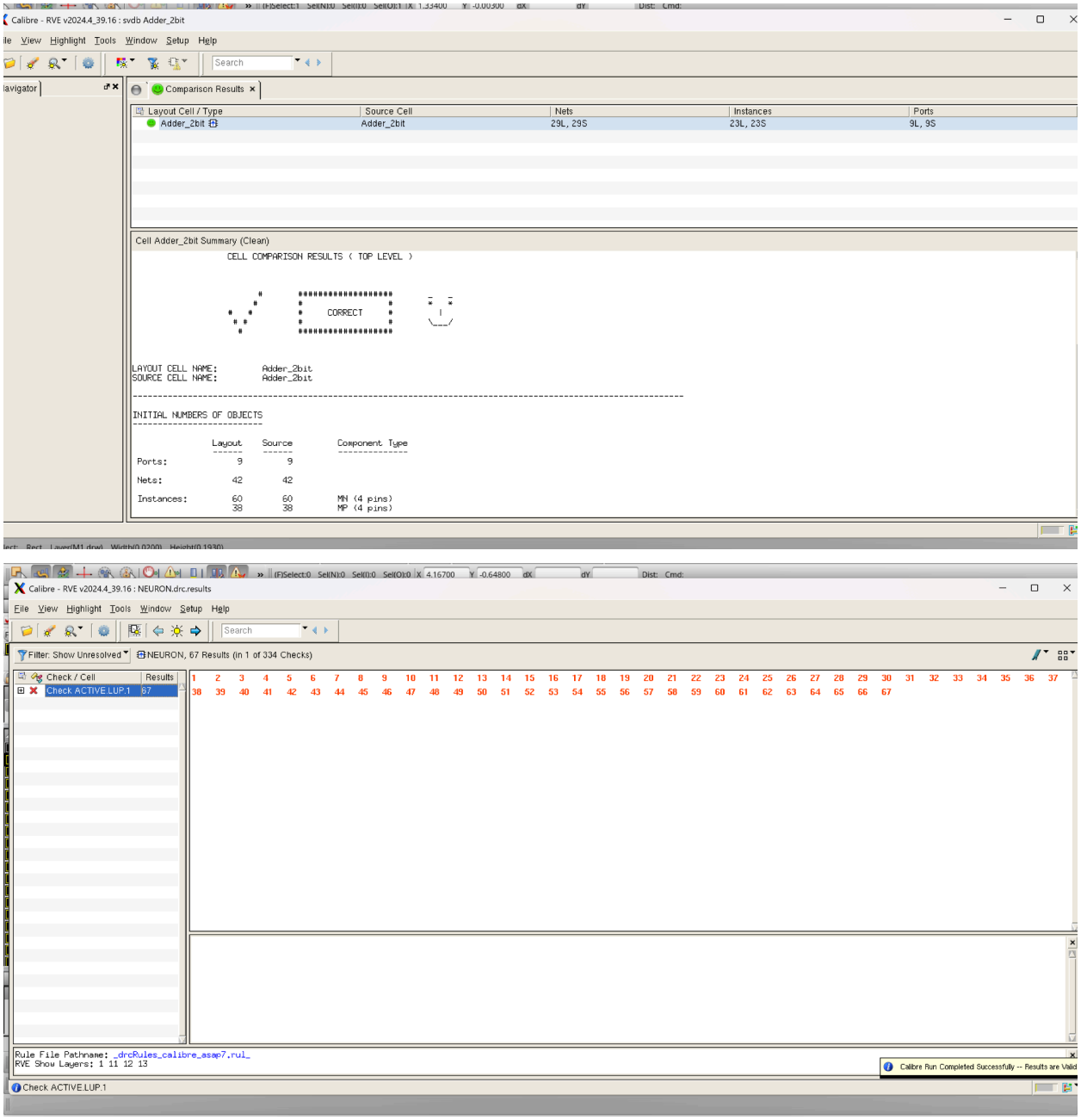
DRC and LVS:

Multiplier:



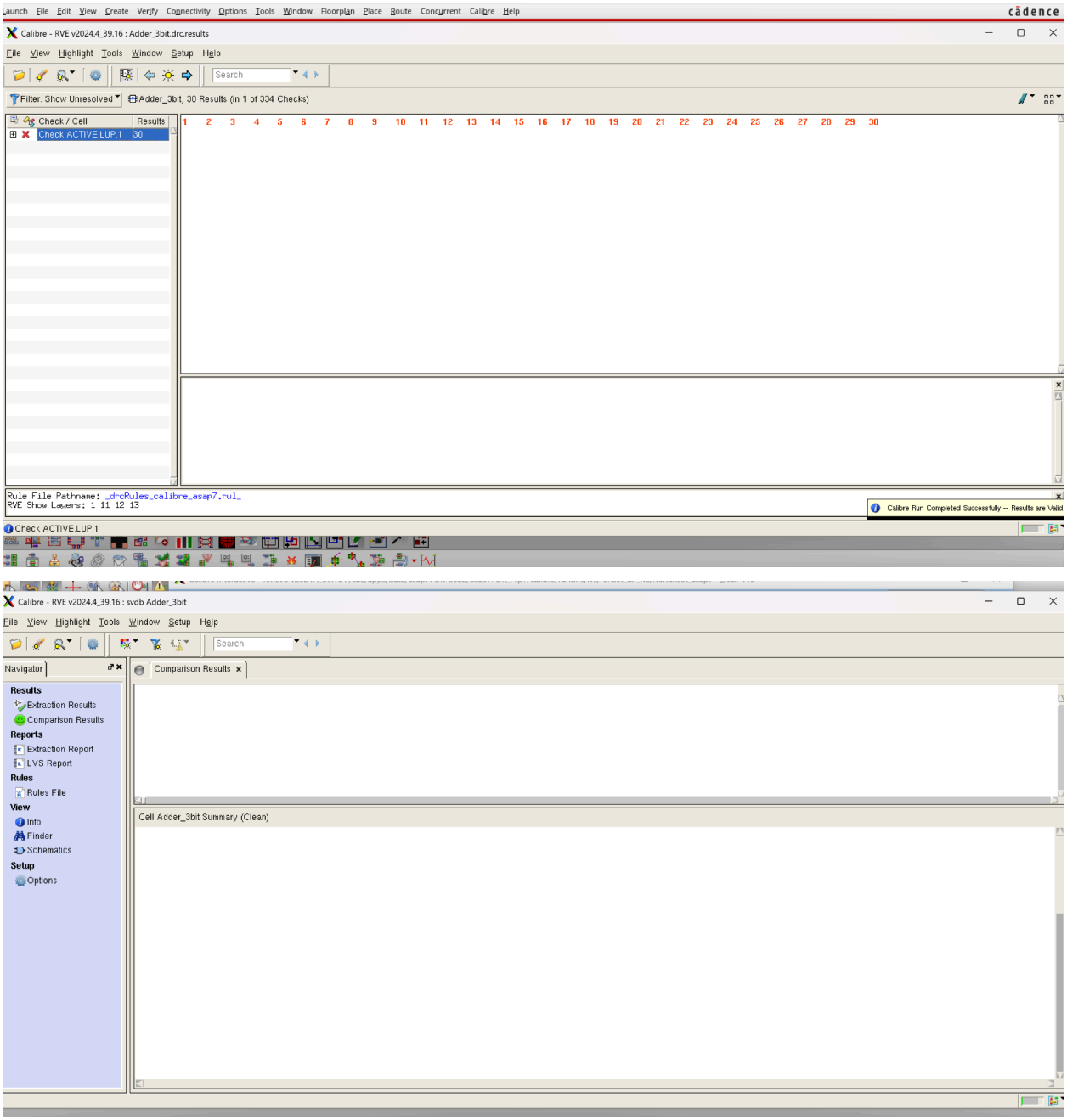


2 bit Adder:

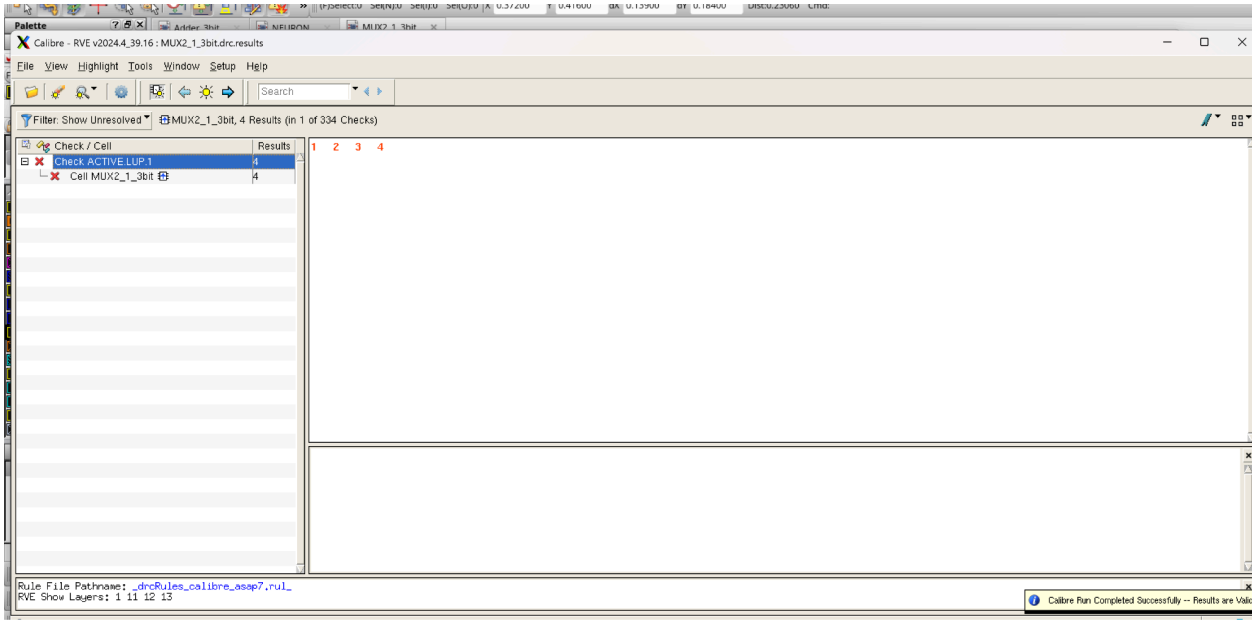

Calibre - RVE v2024.4_39.16 : svdb Adder_2bit
File View Highlight Tools Window Setup Help
Comparison Results
Layout Cell / Type
Source Cell
Nets
Instances
Ports
Adder_2bit
Adder_2bit
29L, 29S
23L, 23S
9L, 9S
Cell Adder_2bit Summary (Clean)
CELL COMPARISON RESULTS (TOP LEVEL)
CORRECT
LAYOUT CELL NAME: Adder_2bit
SOURCE CELL NAME: Adder_2bit
INITIAL NUMBERS OF OBJECTS
Layout
Source
Component Type
Ports: 9 9
Nets: 42 42
Instances: 60 60 MN (4 pins)
38 38 MP (4 pins)

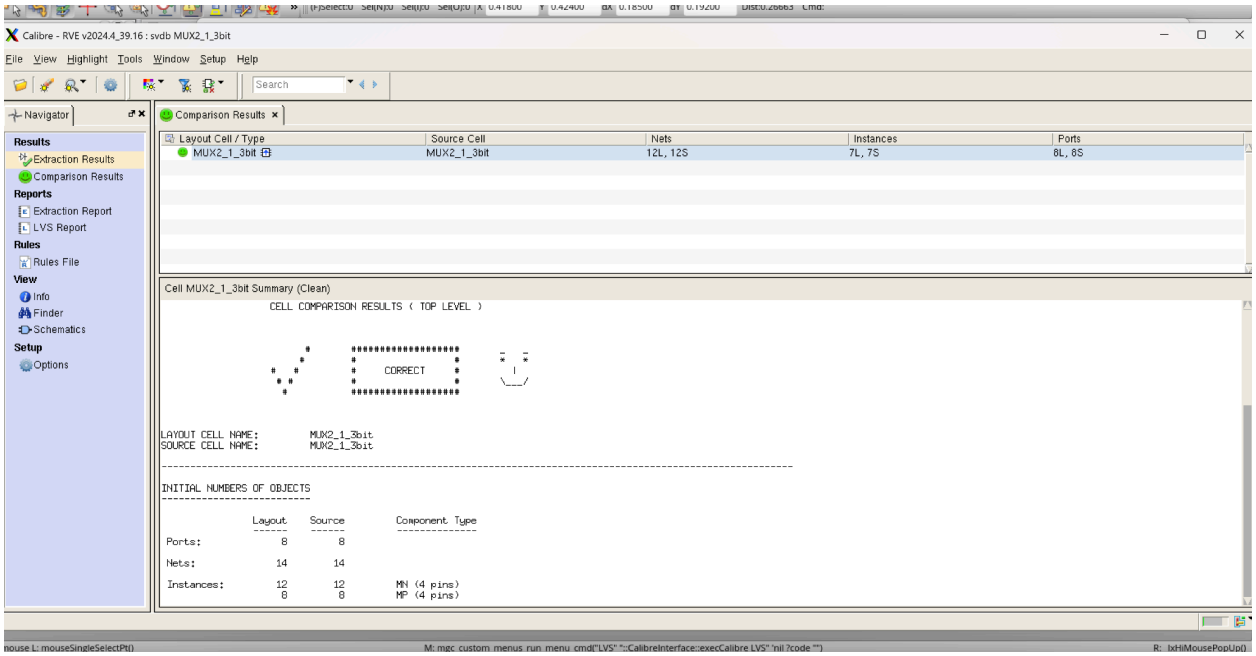
Calibre - RVE v2024.4_39.16 : NEURON.drc.results
File View Highlight Tools Window Setup Help
Filter: Show Unresolved
NEURON, 67 Results (in 1 of 334 Checks)
Check / Cell
Results
Check ACTIVE.LUP.1 67
Rule File Pathname: _drcRules_calibre_asap7.rul_
RVE Show Layers: 1 11 12 13
Calibre Run Completed Successfully -- Results are Valid
Check ACTIVE.LUP.1

3-bit adder:

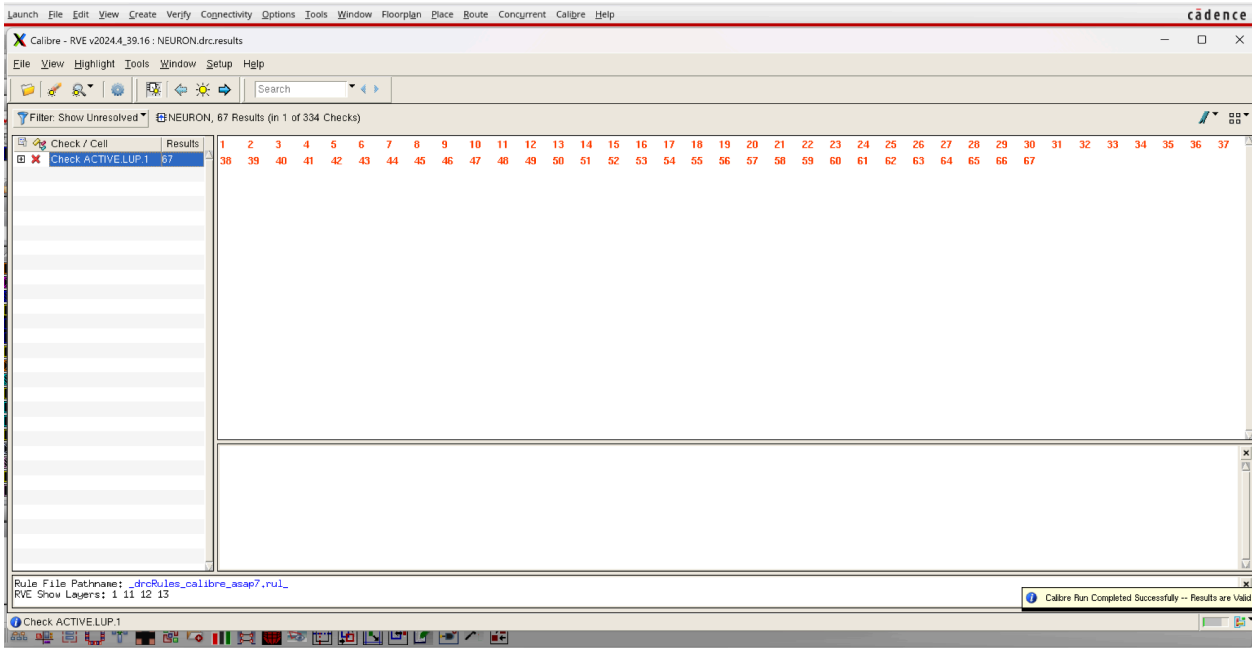

Launch File Edit View Create Verify Connectivity Options Tools Window Floorplan Place Route Concurrent Calibre Help
cadence
Calibre - RVE v2024.4_39.16 : Adder_3bit.drc.results
File View Highlight Tools Window Setup Help
Search
Filter: Show Unresolved
Adder_3bit, 30 Results (in 1 of 334 Checks)
Check / Cell
Results
Check ACTIVE.LUP.1
30
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Rule File Pathname: _drcRules_calibre_asap7.rul_
RVE Show Layers: 1 11 12 13
Calibre Run Completed Successfully -- Results are Valid
Check ACTIVE.LUP.1
Calibre - RVE v2024.4_39.16 : svdb Adder_3bit
File View Highlight Tools Window Setup Help
Search
Navigator
Comparison Results
Results
Extraction Results
Comparison Results
Reports
Extraction Report
LVS Report
Rules
Rules File
View
Info
Finder
Schematics
Setup
Options
Cell Adder_3bit Summary (Clean)

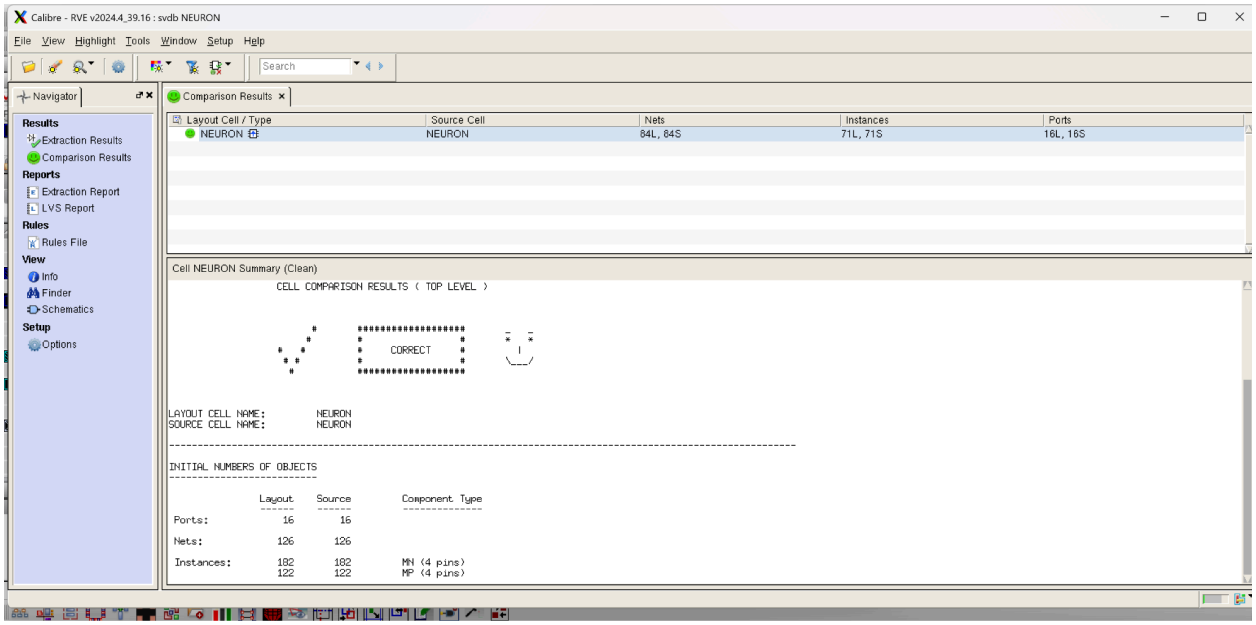
MUX:



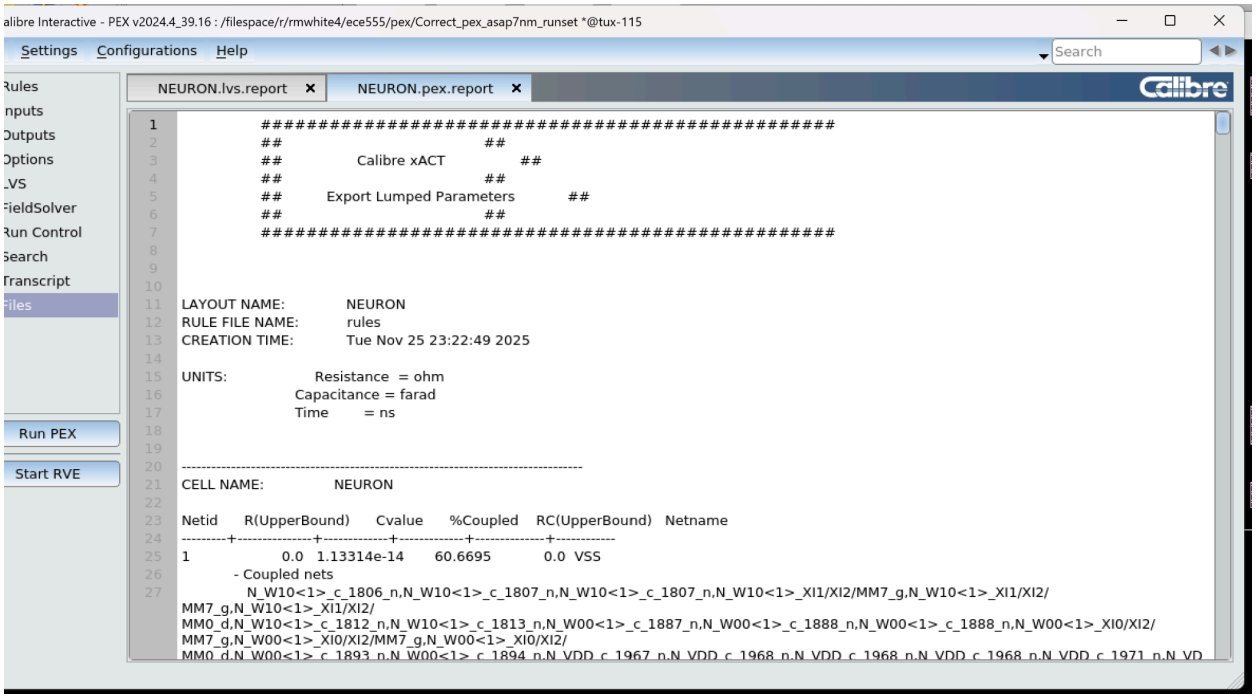


WHOLE NEURON:

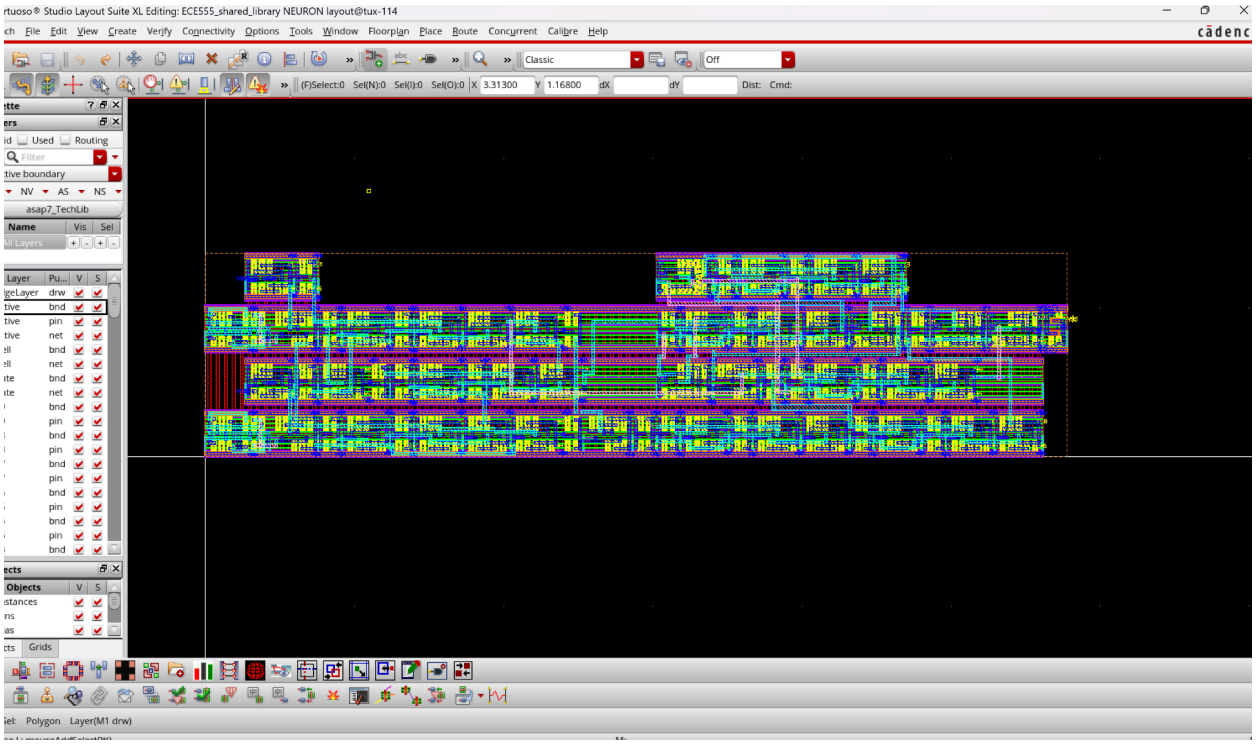




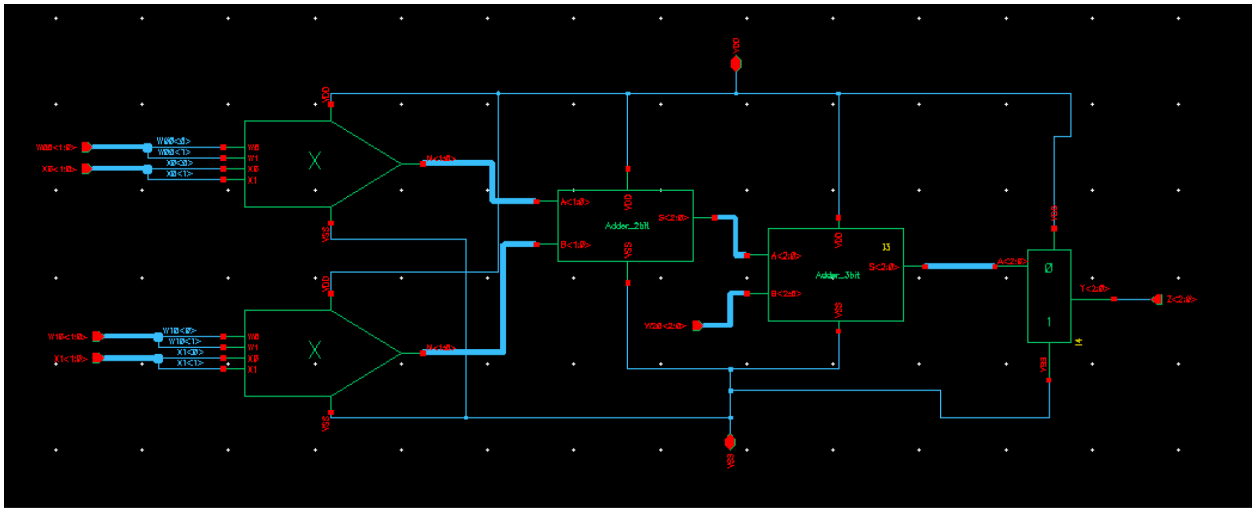
Neuron extraction:



Layout:



Schematic: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VSS
Adder_2bit
Adder_3bit
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