

Implementing 4-16 decoders using 3-8 decoders

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Abstract:

The decoder is a combinational circuit with n input lines and 2^n maximum output lines. Depending on the input combination, one of these outputs will be high when the decoder is enabled. Therefore, a particular code is detected by a decoder. In electronic circuits, it is used to convert instructions into CPU control signals. In logical circuits and data transfer, they are mainly used.

Circuit Details:

Let us use 3 to 8 decoders to implement 4 to 16 decoders. In 3 to 8 Decoder, there are three inputs, A_2 , A_1 , and A_0 , and eight outputs, Y_7 to Y_0 . As opposed to 4 to 16 Decoder, which has four inputs A_3 , A_2 , A_1 & A_0 and sixteen outputs Y_{15} to Y_0 . Two 3 to 8 decoders required to implement 4 to 16 decoders.

$$m_2 = 16 \quad m_1 = 8$$

Number of lower order decoders required
 $= m_2 / m_1 \quad 16/8 = 2$

$$Y_0 = A_0' . A_1' . A_2' . A_3'$$

$$Y_1 = A_0' . A_1' . A_2' . A_3$$

$$Y_2 = A_0' . A_1' . A_2 . A_3'$$

$$Y_3 = A_0' . A_1' . A_2 . A_3$$

$$Y_4 = A_0' . A_1 . A_2' . A_3'$$

$$Y_5 = A_0' . A_1 . A_2' . A_3$$

$$Y_6 = A_0' . A_1 . A_2 . A_3'$$

$$Y_7 = A_0' . A_1 . A_2 . A_3$$

$$Y_8 = A_0 . A_1' . A_2' . A_3'$$

$$Y_9 = A_0 . A_1' . A_2' . A_3$$

$$Y_{10} = A_0 . A_1' . A_2 . A_3'$$

$$Y_{11} = A_0 . A_1' . A_2 . A_3$$

$$Y_{12} = A_0 . A_1 . A_2' . A_3'$$

$$Y_{13} = A_0 . A_1 . A_2' . A_3$$

$$Y_{14} = A_0 . A_1 . A_2 . A_3'$$

$$Y_{15} = A_0 . A_1 . A_2 . A_3$$

Reference Circuit:

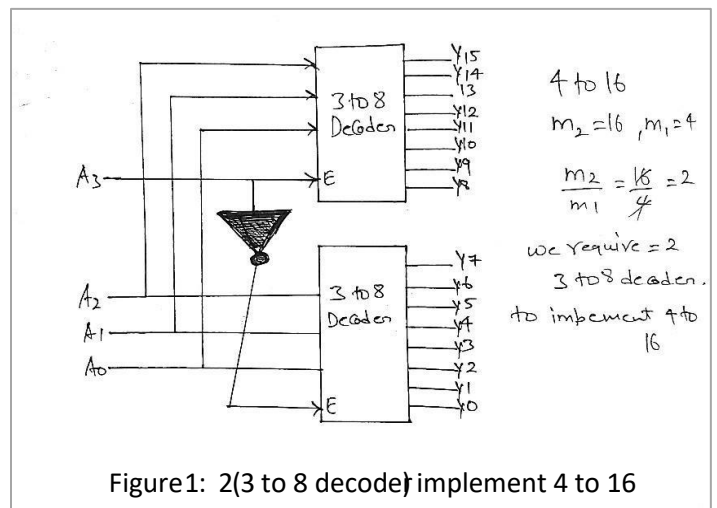
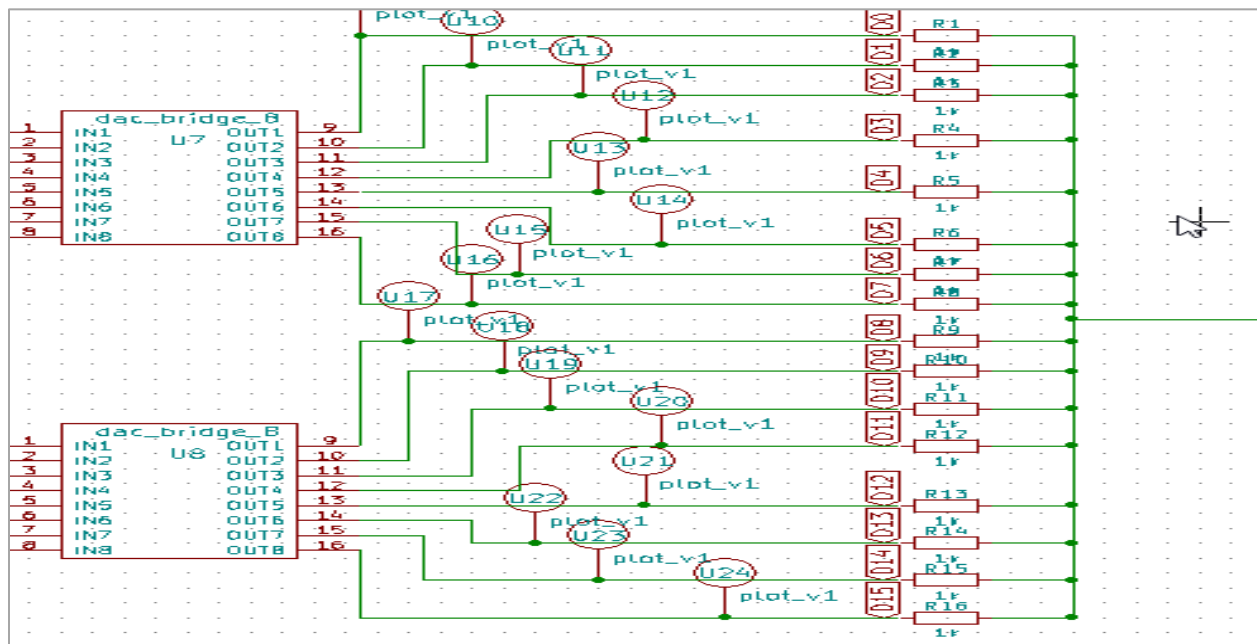


Figure1: 2(3 to 8 decoder) implement 4 to 16

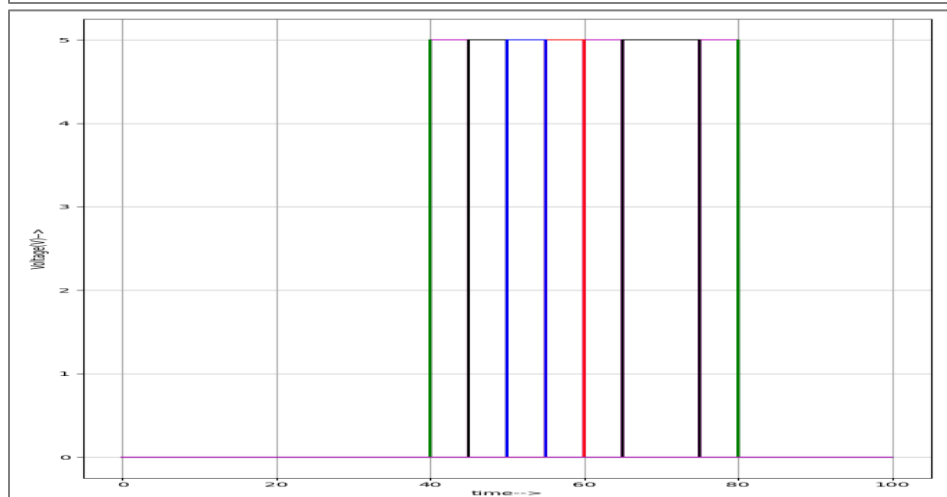
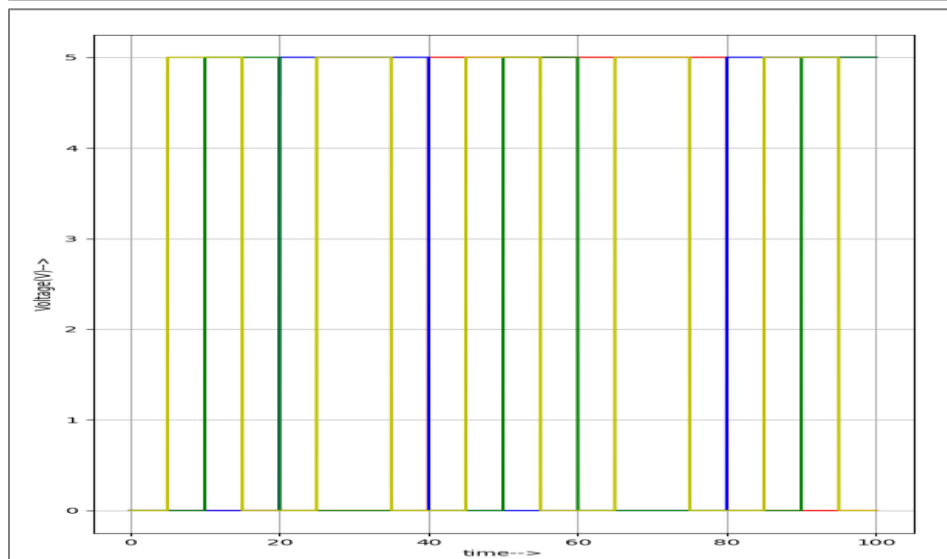
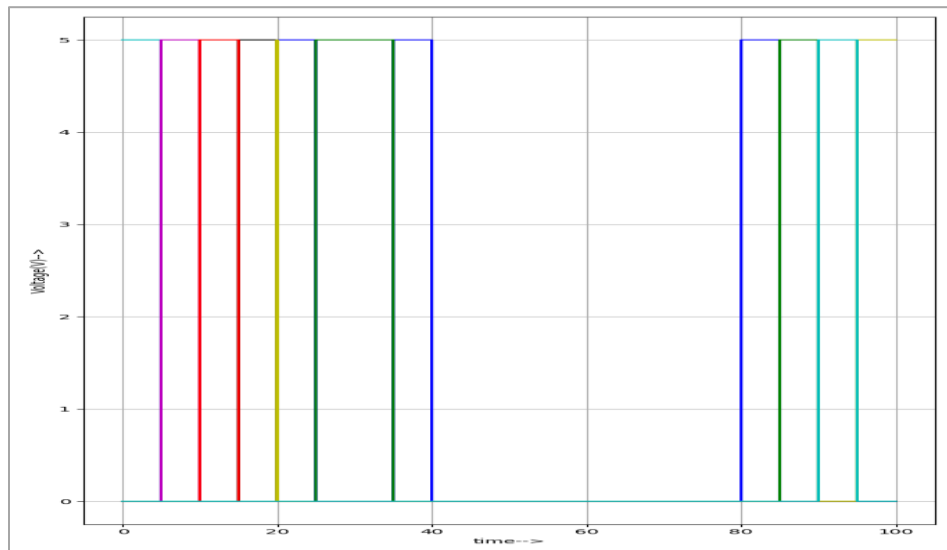
4X16 decoder

Inputs				Outputs															
A_3	A_2	A_1	A_0	Y_{15}	Y_{14}	Y_{13}	Y_{12}	Y_{11}	Y_{10}	Y_9	Y_8	Y_7	Y_6	Y_5	Y_4	Y_3	Y_2	Y_1	Y_0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
0	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
1	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
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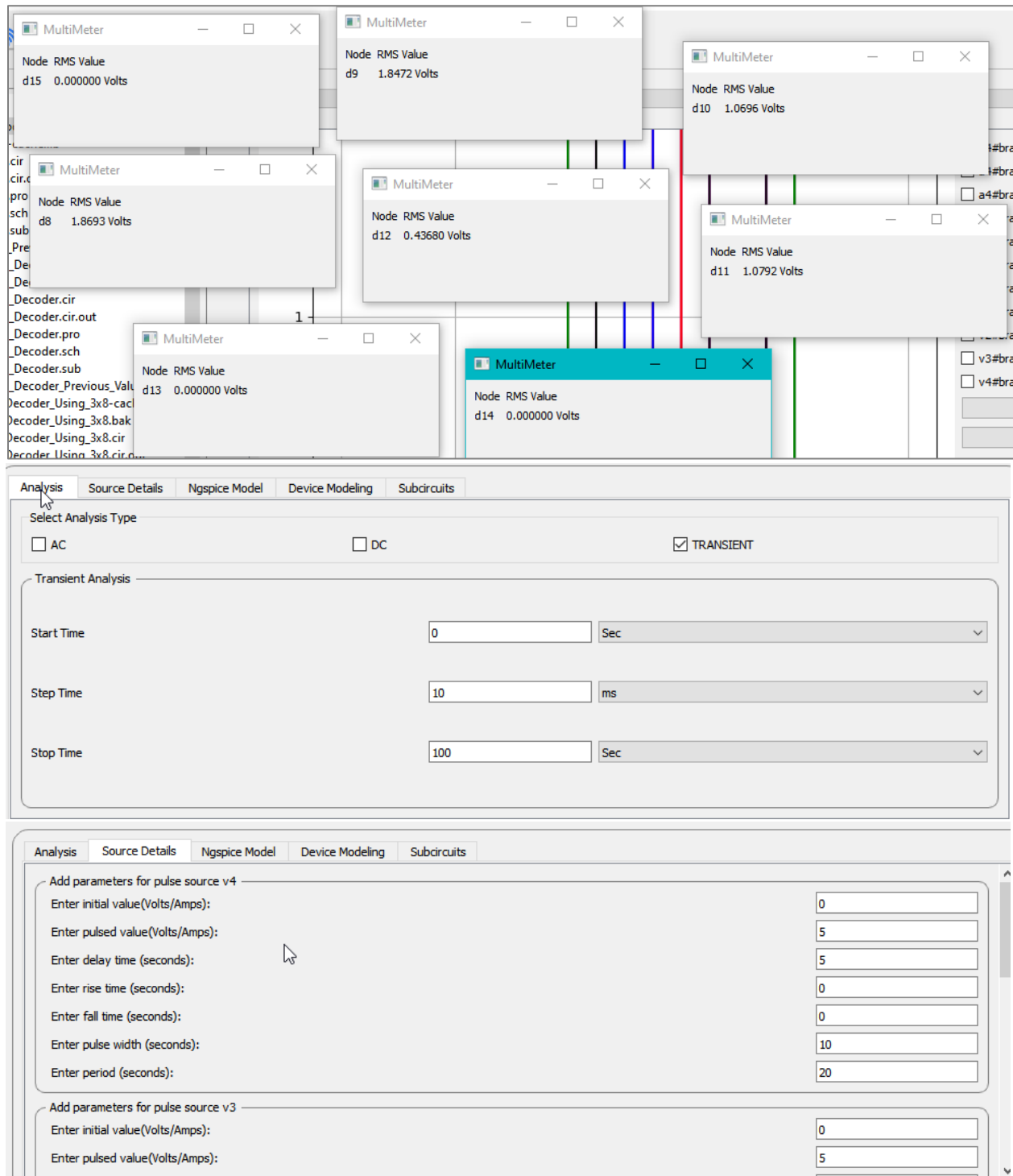
Figure 1.2: 4 to 16 decoder Truth Table



Plotting:



KicadToNgspice:



AnalysisSource DetailsNgspice ModelDevice ModelingSubcircuits

Enter delay time (seconds):10
Enter rise time (seconds):0
Enter fall time (seconds):0
Enter pulse width (seconds):10
Enter period (seconds):40

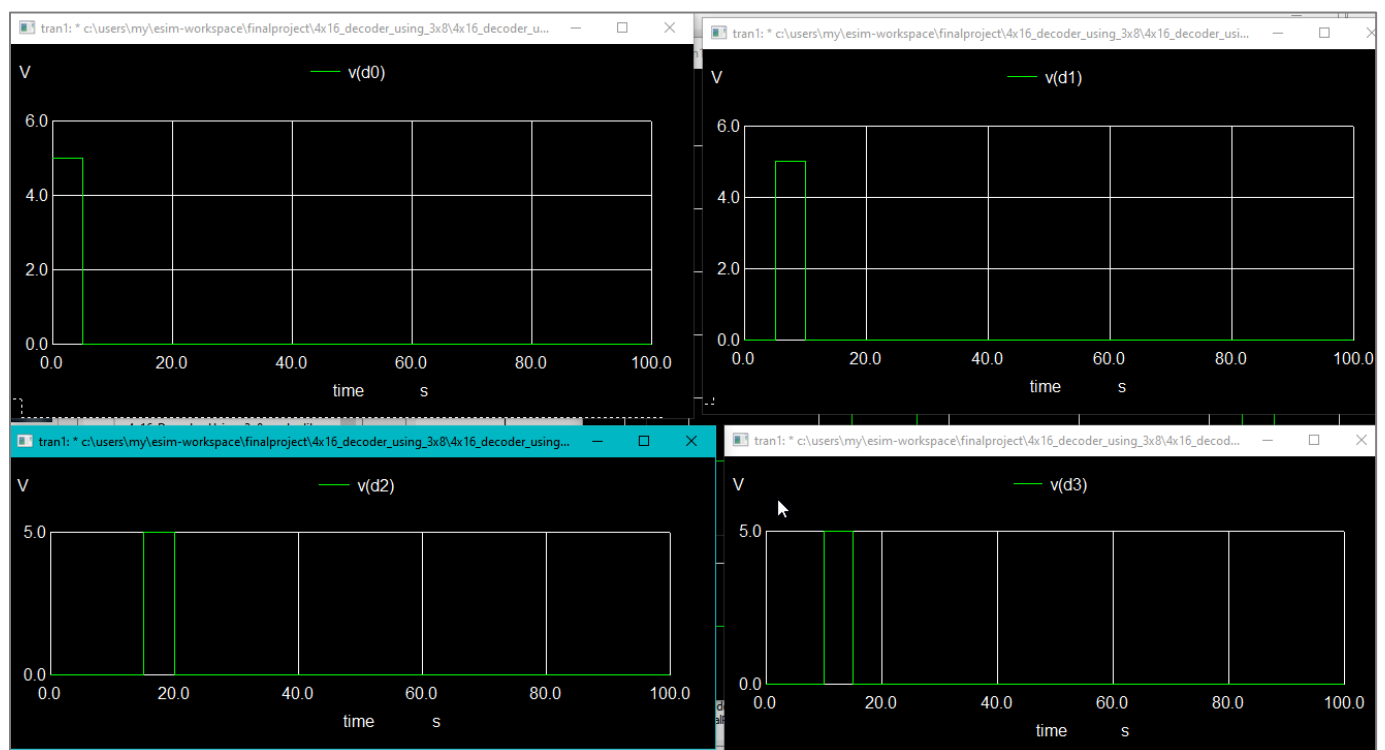
Add parameters for pulse source v2
Enter initial value(Volts/Amps):0
Enter pulsed value(Volts/Amps):5
Enter delay time (seconds):20
Enter rise time (seconds):0
Enter fall time (seconds):0

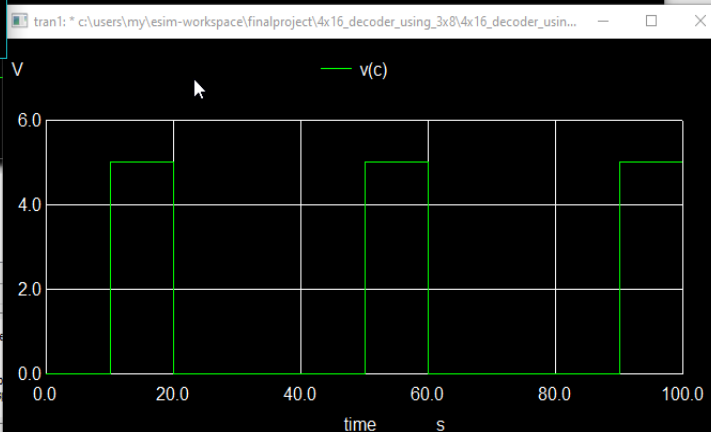
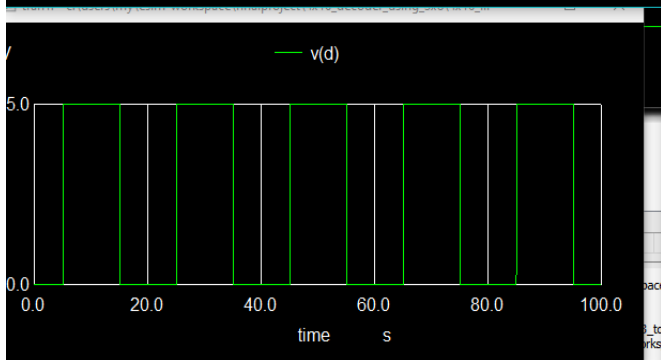
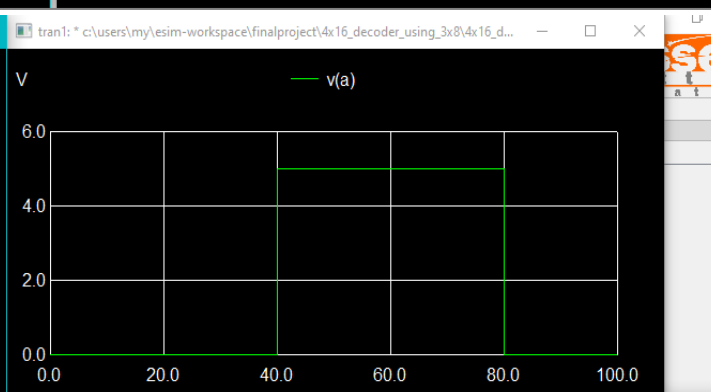
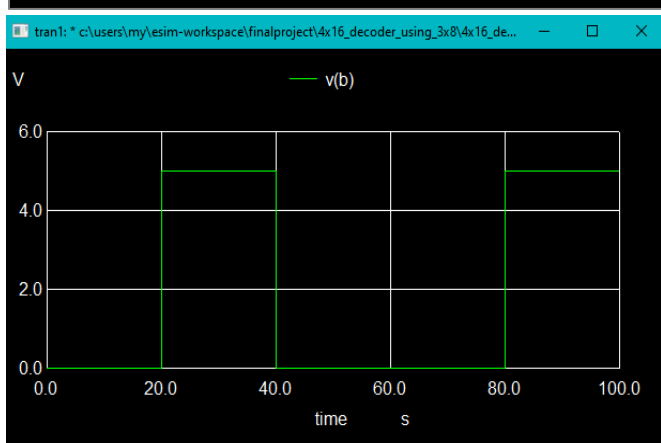
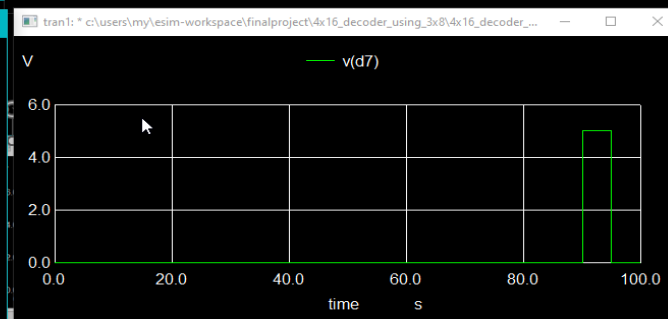
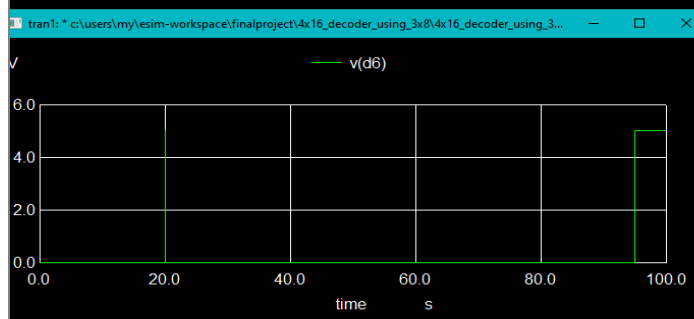
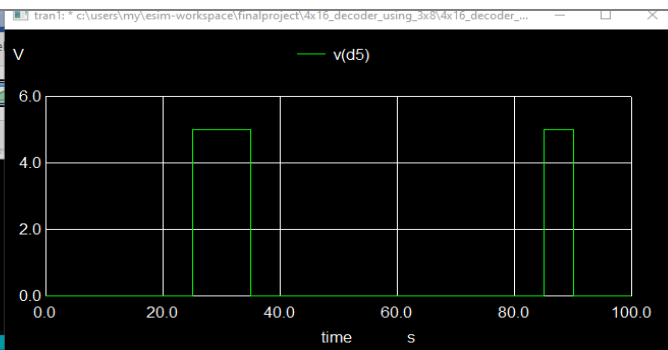
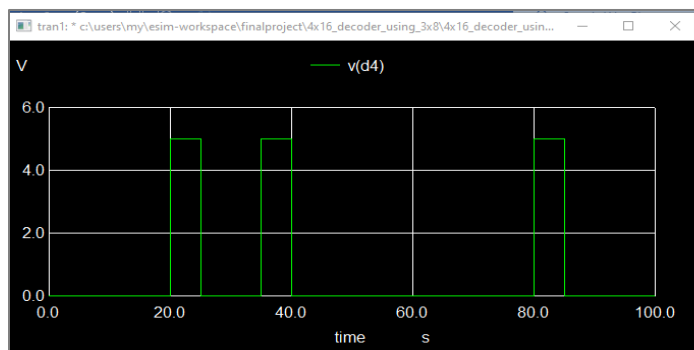
AnalysisSource DetailsNgspice ModelDevice ModelingSubcircuits

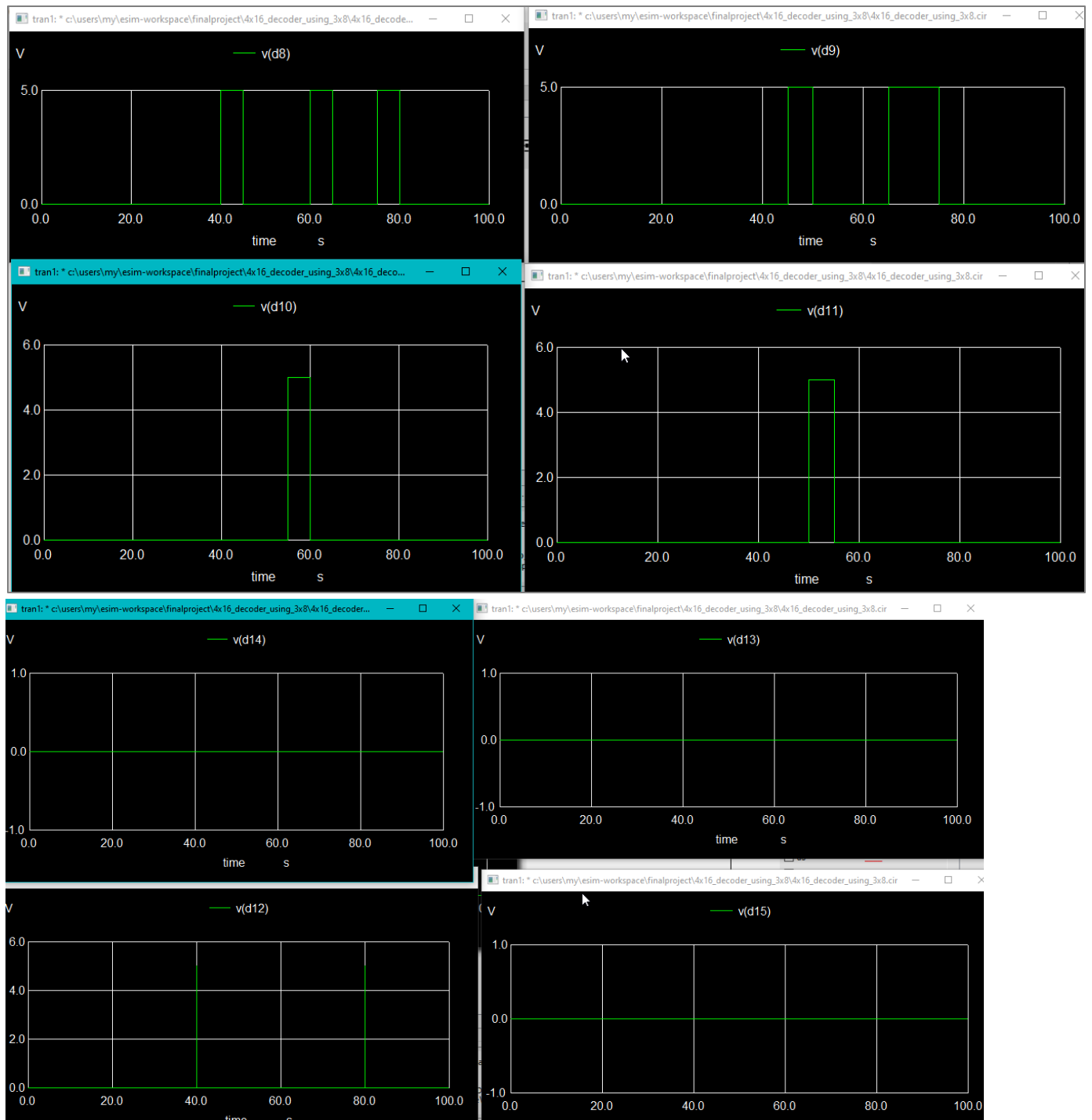
Enter tail time (seconds):0
Enter pulse width (seconds):20
Enter period (seconds):60

Add parameters for pulse source v1
Enter initial value(Volts/Amps):0
Enter pulsed value(Volts/Amps):5
Enter delay time (seconds):40
Enter rise time (seconds):0
Enter fall time (seconds):0
Enter pulse width (seconds):40
Enter period (seconds):100

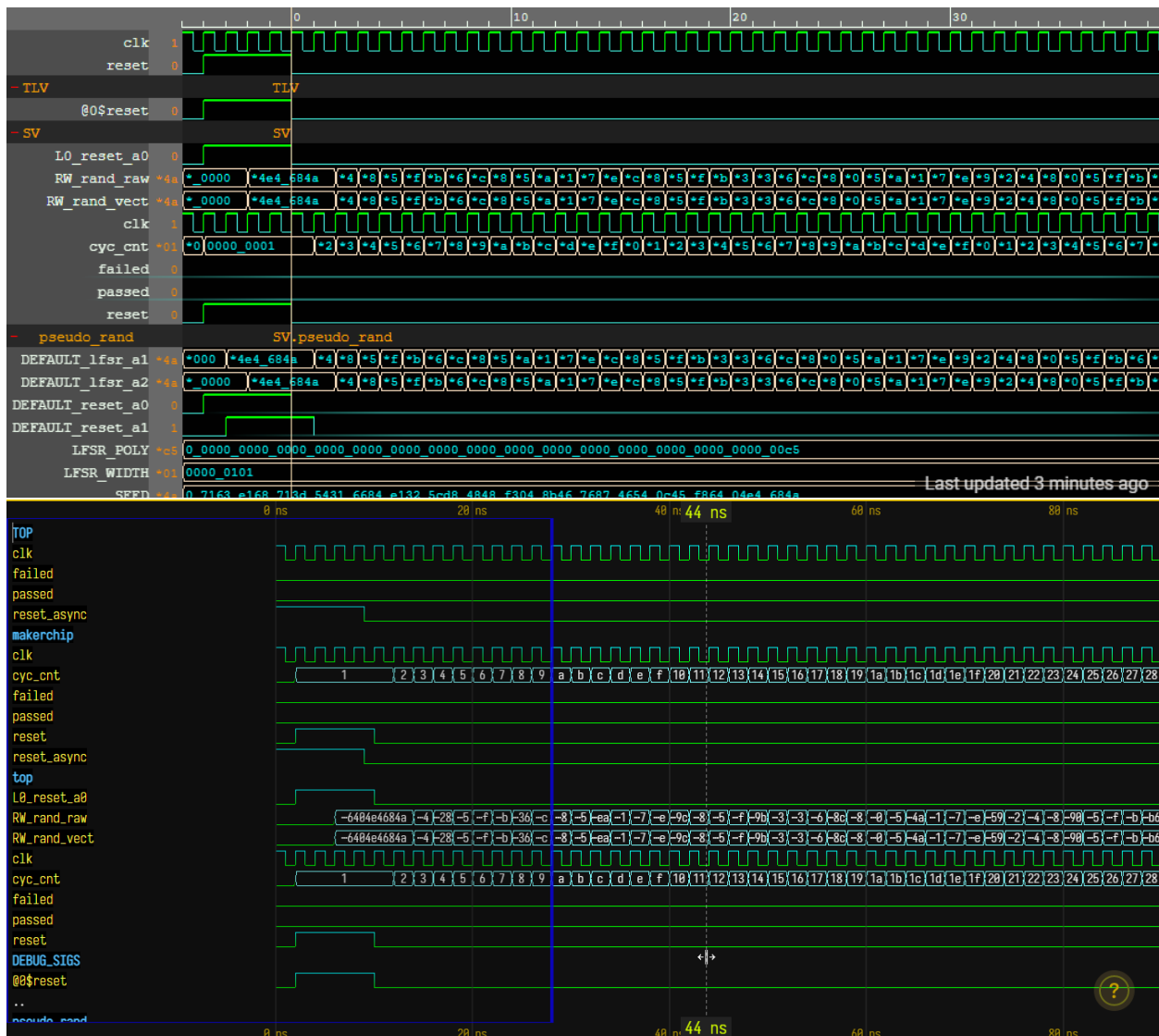
WaveForms:







Verilog:



References:

https://www.youtube.com/watch?v=iM4J_YA1i0Y

https://www.tutorialspoint.com/digital_circuits/digital_circuits_decoders.htm

<https://www.javatpoint.com/decoder-digital-electronics#:~:text=The%203%20to%208%20line,an%20enable%20input%20'E>

<http://vlsiqyan.com/verilog-code-of-decoder-3-to-8-decoder-verilog-code/>

<https://www.elprocus.com/designing-4-to-16-decoder-using-3-to-8-decoder/>

<https://www.youtube.com/watch?v=7rhQwNeEc4o>

<https://www.elprocus.com/designing-4-to-16-decoder-using-3-to-8-decoder/#:~:text=4%20to%2016%20decoder%20circuit%20is%20obtained%20from%20two%203,3%20to%208%20decoder%20circuit.>

<https://programmerbay.com/construct-3-to-8-decoder-with-truth-table-and-logic-gates/>