Circuit Simulation Project

https://esim.fossee.in/circuit-simulation-project

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Title of the circuit : Excess-3 to BCD code Conversion

Theory/Description :

The Excess-3 binary code is an example of a self-complementary BCD code. A self-complementary binary code is a code which is always complimented in itself. By replacing the bit 0 to 1 and 1 to 0 of a number, we find the 1's complement of the number. The sum of the 1'st complement and the binary number of a decimal is equal to the binary number of decimal 9.

The process of converting Excess-3 to BCD is opposite to the process of converting BCD to Excess-3. The BCD code can be calculated by subtracting 3, i.e., 0011 from each four-digit Excess-3 code. Below is the truth table for the conversion of Excess-3 code to BCD. In the below table, the variables w, x, y, and z represent the bits of the Excess-3 code. The variable 'z' represents the LSB, and the variable 'w' represents the MSB. In the same way, the variables A, B, C, and D represent the bits of the binary numbers. The variable 'D' represents the LSB, and the variable 'A' represents the MSB. The 'don't care conditions' is defined by the variable 'X'.

In this circuit an Excess-3 to BCD code to converter has been implemented and simulated using the AND, OR and NOT gates.

Truth Table:

Decimal Number	Excess-3 Code				BCD Code			
	A	B	C	D	W	X	Y	Z

0	0	0	0	0	X	X	X	X
1	0	0	0	1	X	X	X	X
2	0	0	1	0	X	X	X	X
3	0	0	1	1	0	0	0	0
4	0	1	0	0	0	0	0	1
5	0	1	0	1	0	0	1	0
6	0	1	1	0	0	0	1	1
7	0	1	1	1	0	1	0	0
8	1	0	0	0	0	1	0	1
9	1	0	0	1	0	1	1	0
10	1	0	1	0	0	1	1	1
11	1	0	1	1	1	0	0	0
12	1	1	0	0	1	0	0	1
13	1	1	0	1	X	X	X	X
14	1	1	1	0	X	X	X	X
15	1	1	1	1	X	X	X	X

From the above truth table we observe,

W=AD+ACD

B=X’Y’+X’Z’+XYZ

C=Y’Z+YZ’

D=Z’

Circuit Diagram(s) :

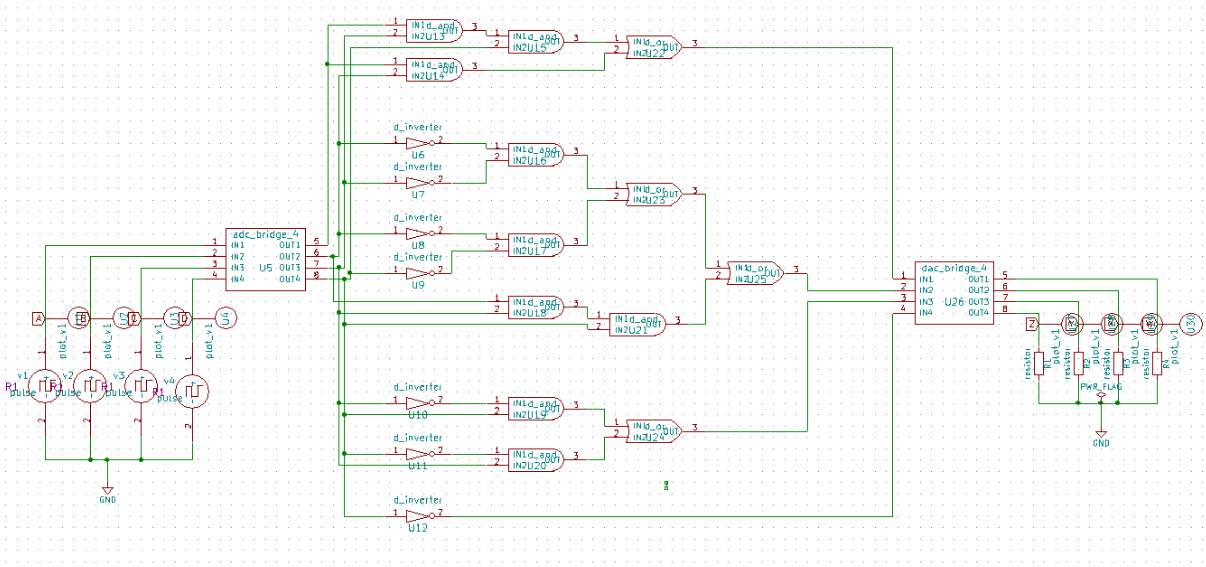


Fig. 1: Main Circuit

Fig. 1 represents the schematic for the main circuit. The pulse sources feed the inputs from 0000 to 1111. The ADC bridge is used to convert the analog voltage source inputs into digital bits to be used with the digital gates. The DAC bridge is used to convert the digital signals back to analog so that they can be plotted and viewed as output.

Results (Input, Output waveforms and/or Multimeter readings) :

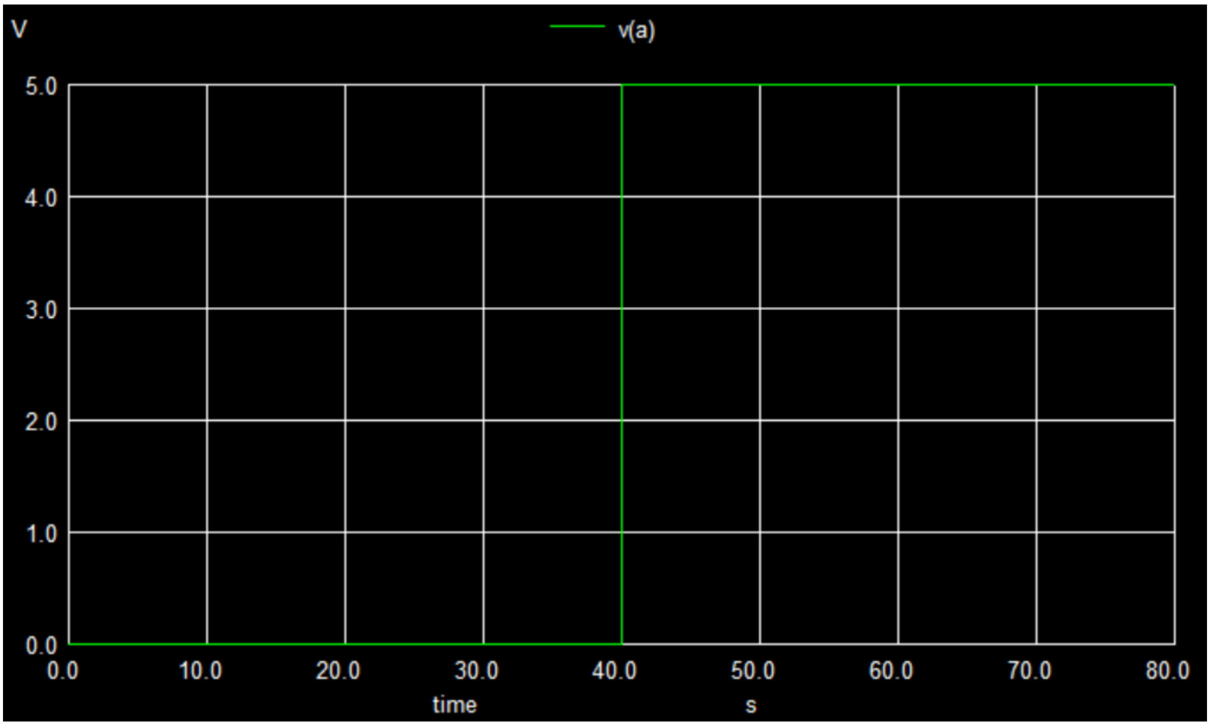


Fig. 2a: Analog signal for A (MSB)

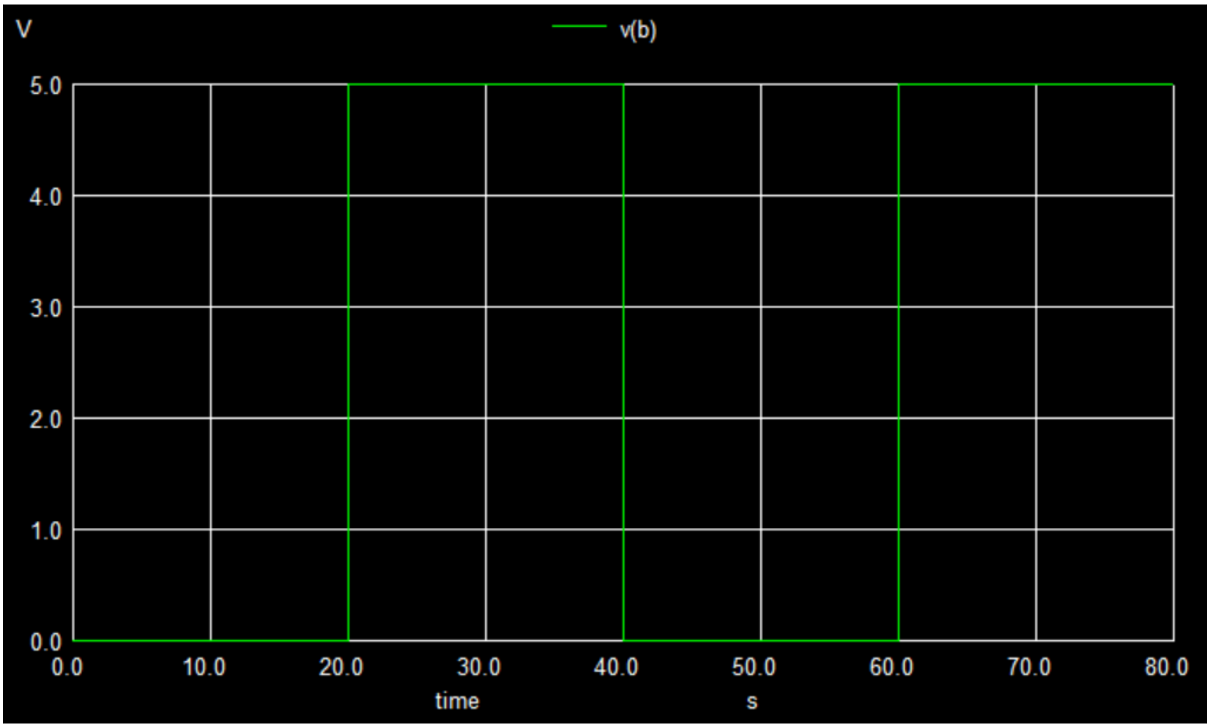


Fig. 2b: Analog signal for B

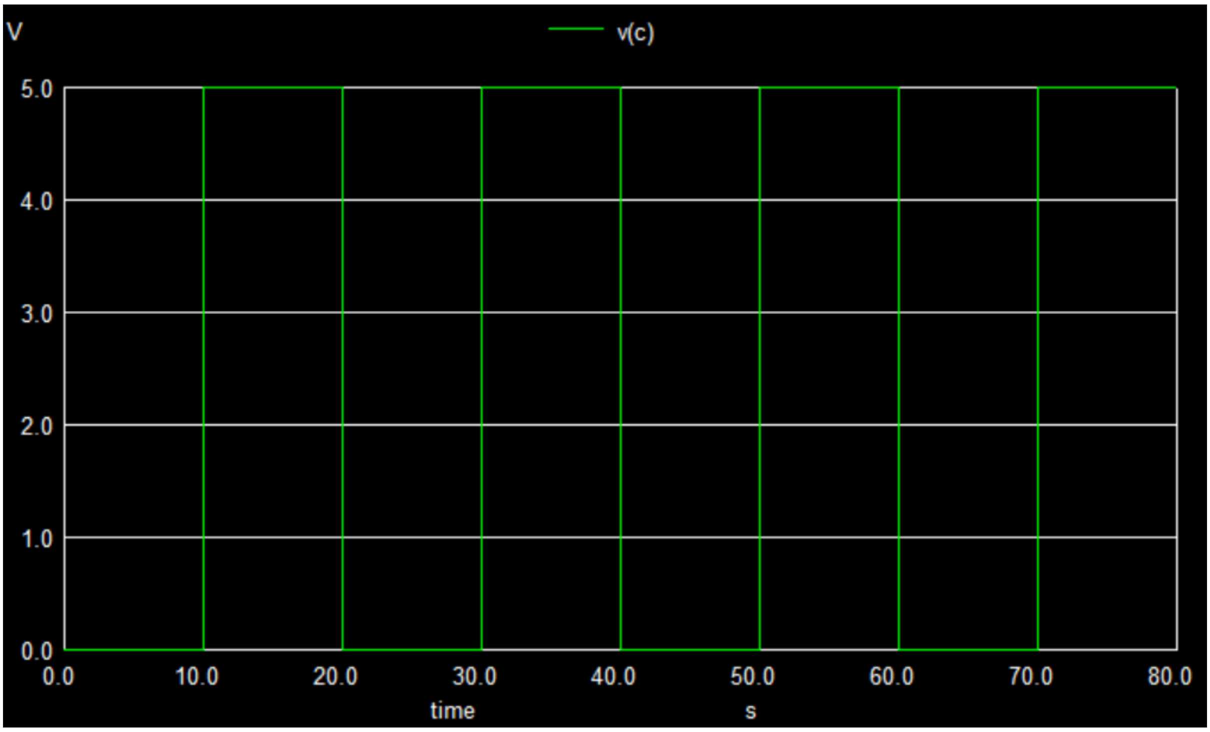


Fig. 2c: Analog signal for C

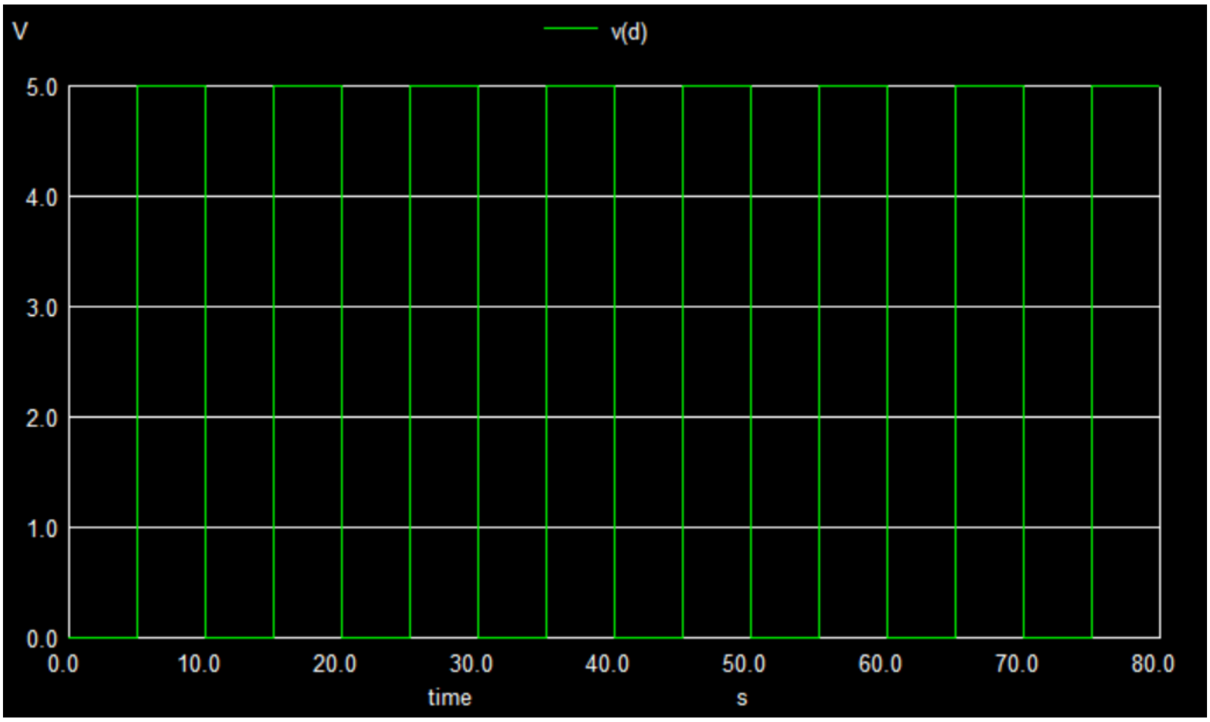


Fig. 2d: Analog signal for D (LSB)

Figures 2a trough 2d show the analog signals for each of the inputs bits (Excess-3 Code).

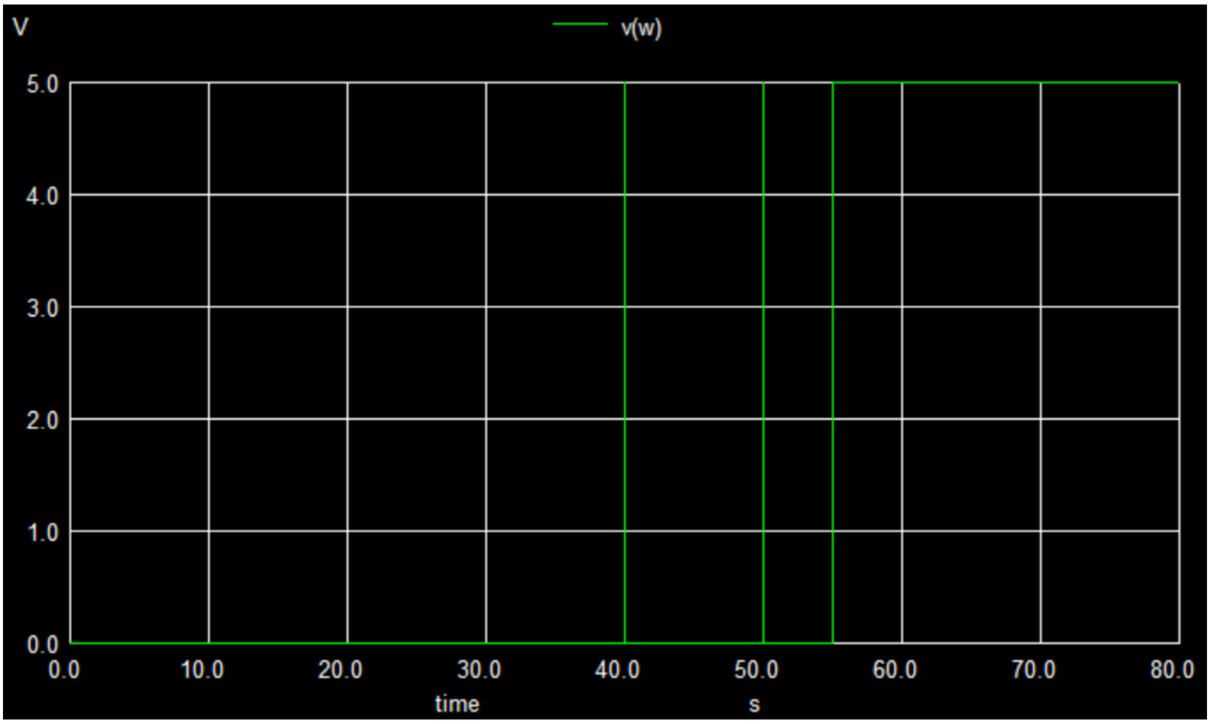


Fig. 3a: Analog signal for W (MSB)

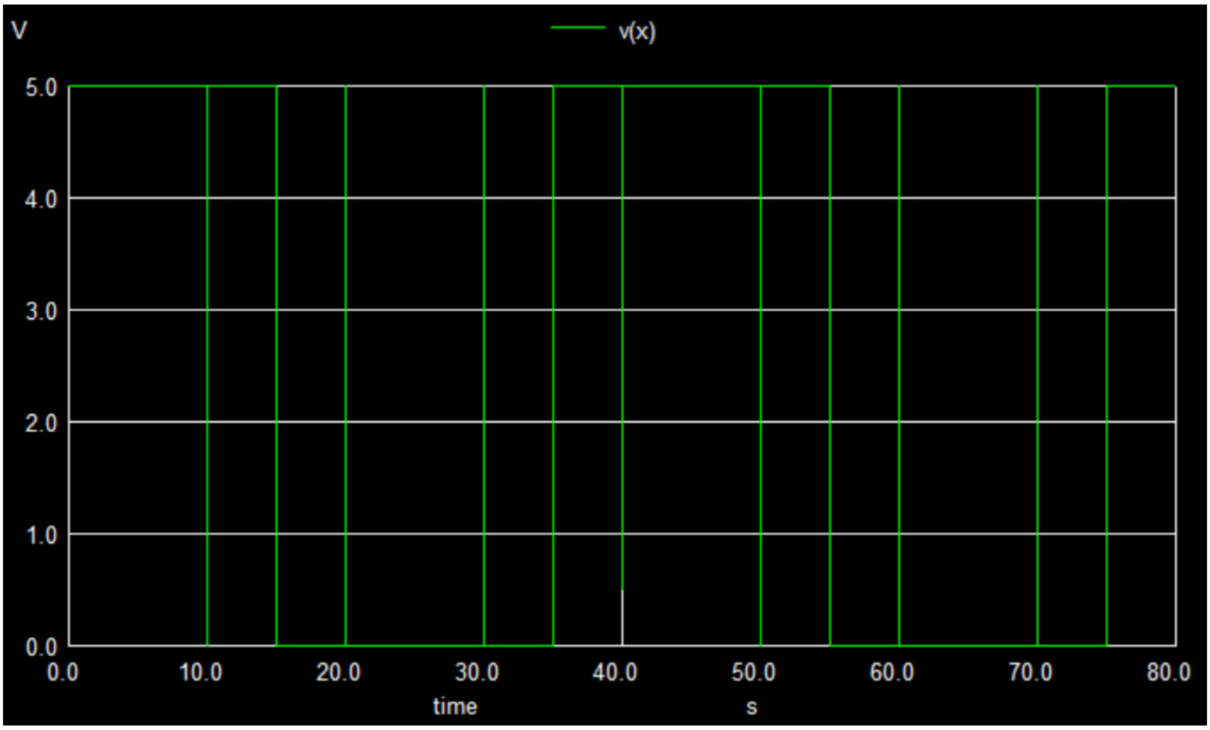


Fig. 3b: Analog signal for X

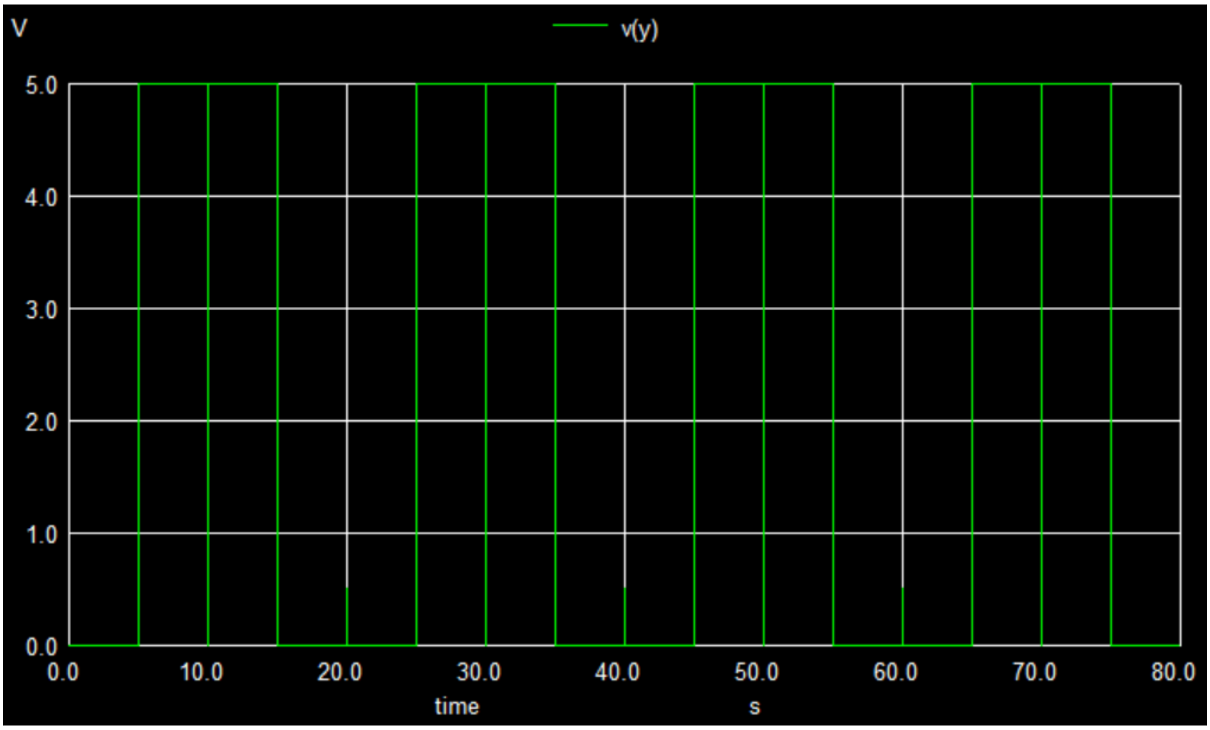


Fig. 3c: Analog signal for Y

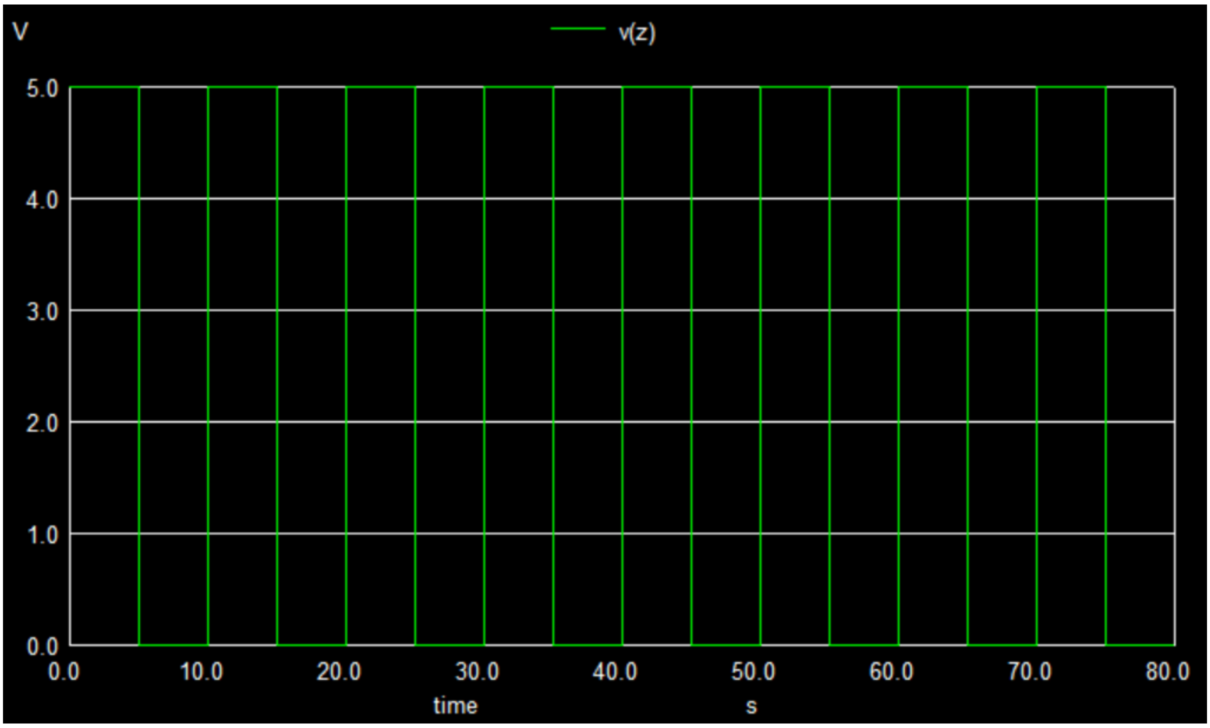


Fig.: 3d: Analog signal for Z (LSB)

Figures 3a through 3d display show the output analog signals for each of the output bits (Excess-3 code).

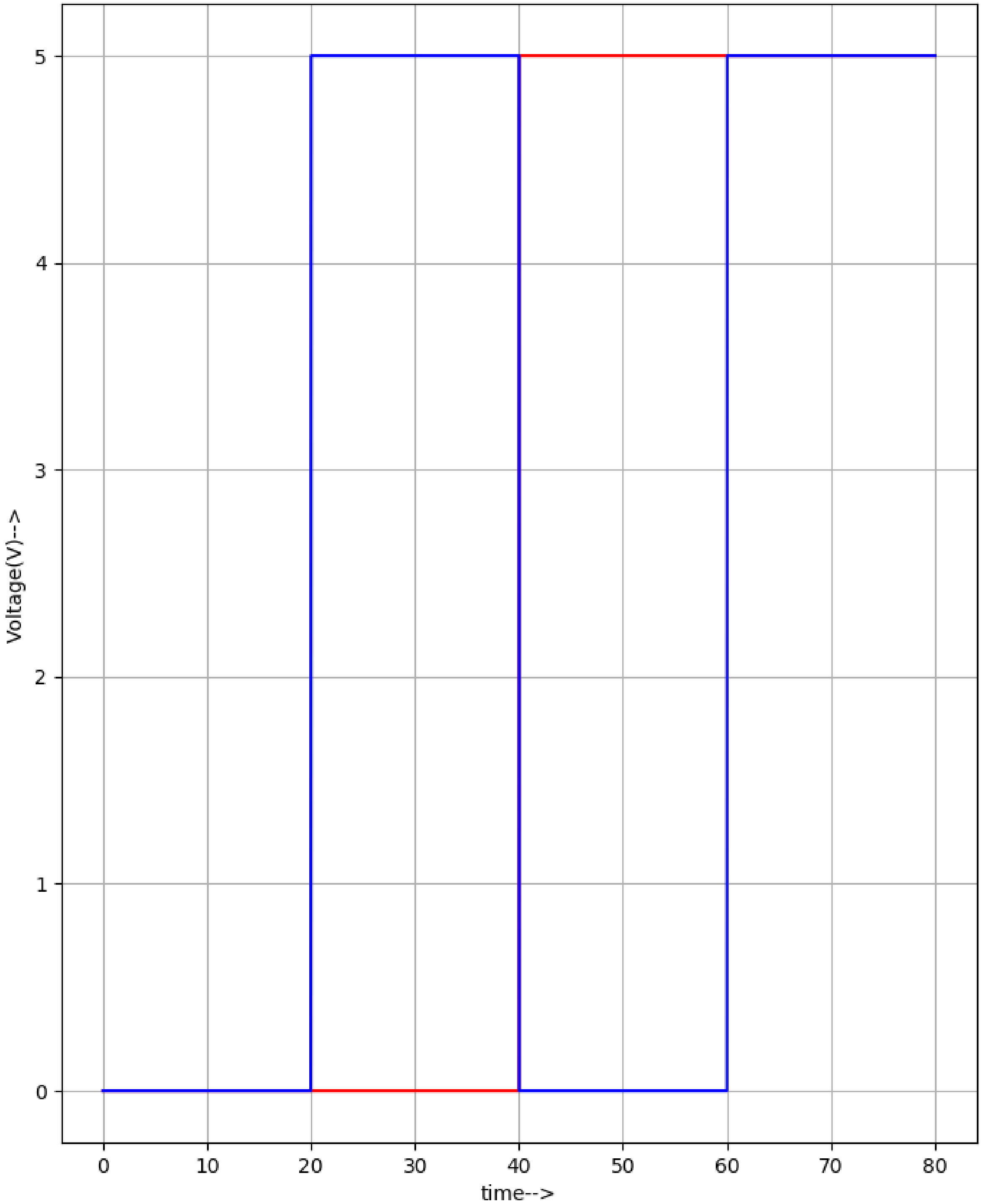


Fig. 4a: Python plots for A and B

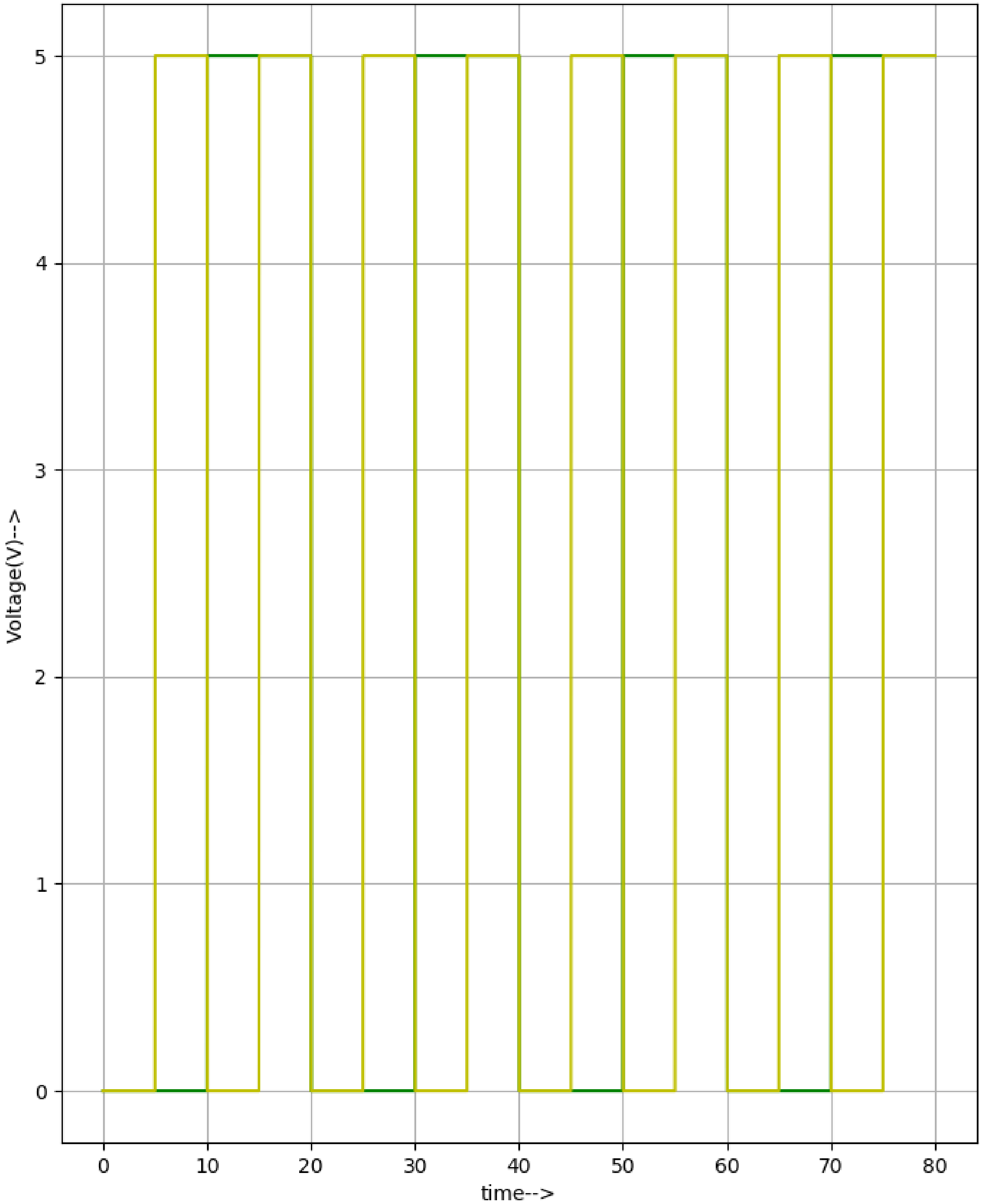


Fig. 4b: Python plots for C and D

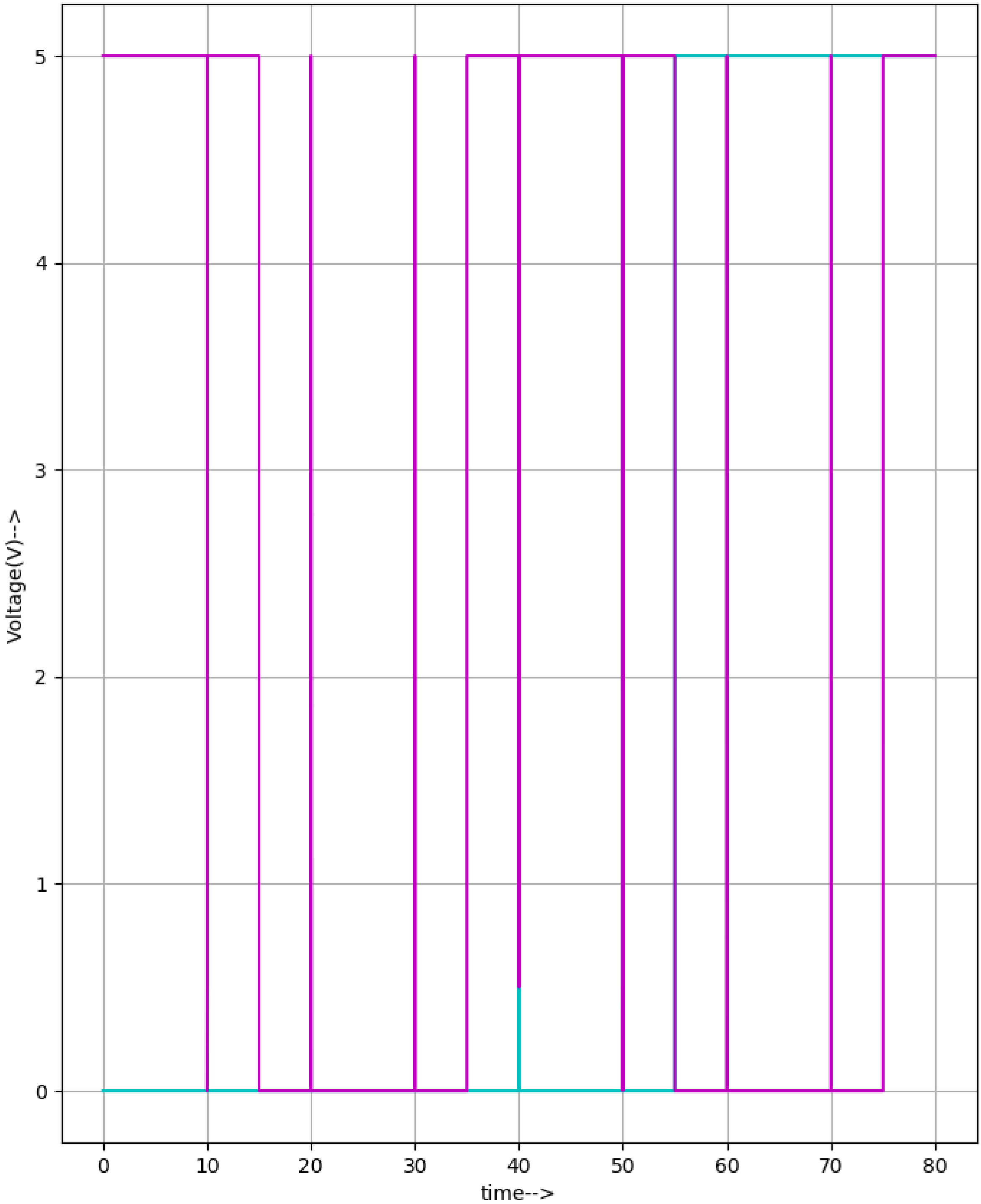


Fig. 4c: Python plots for W and X

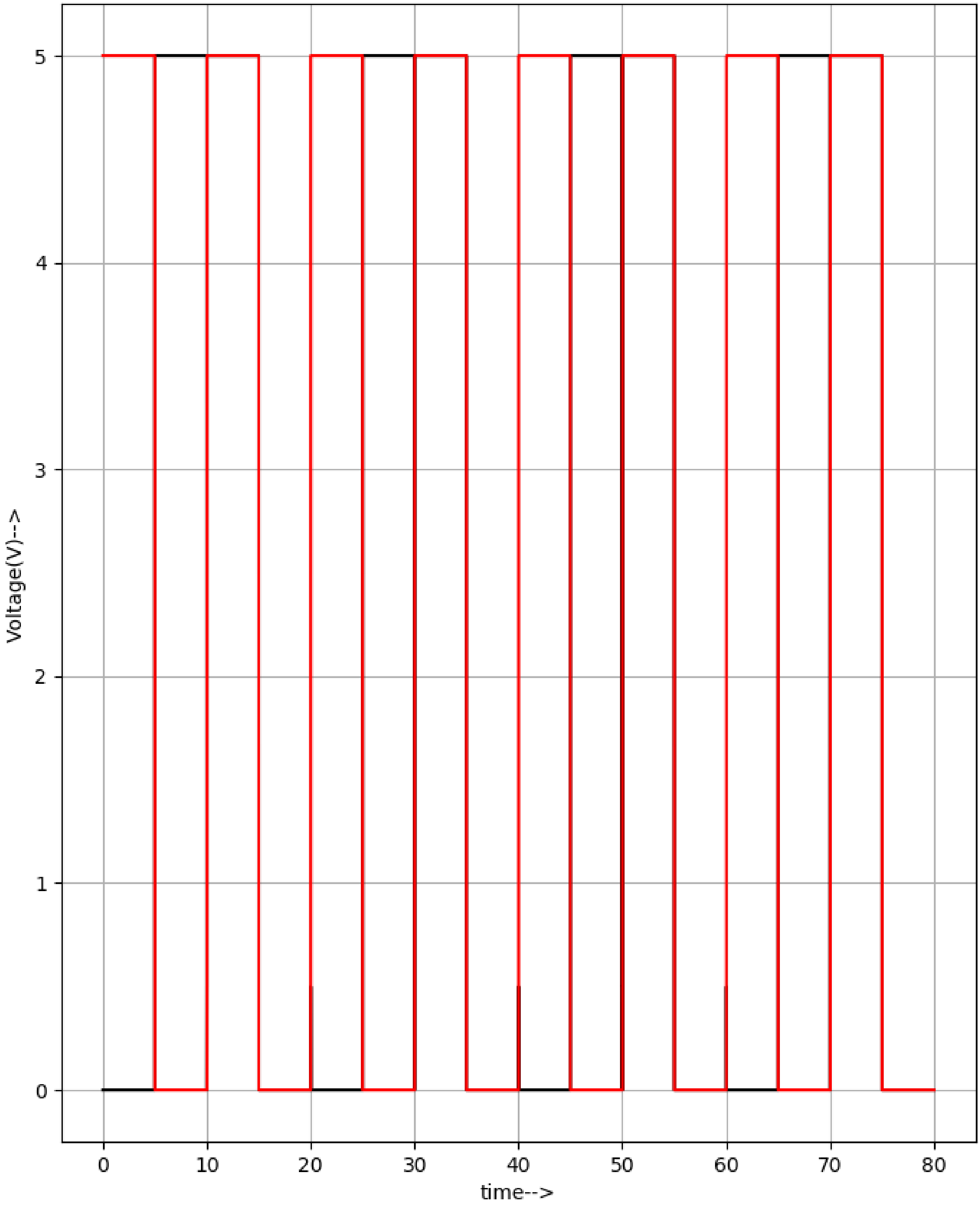
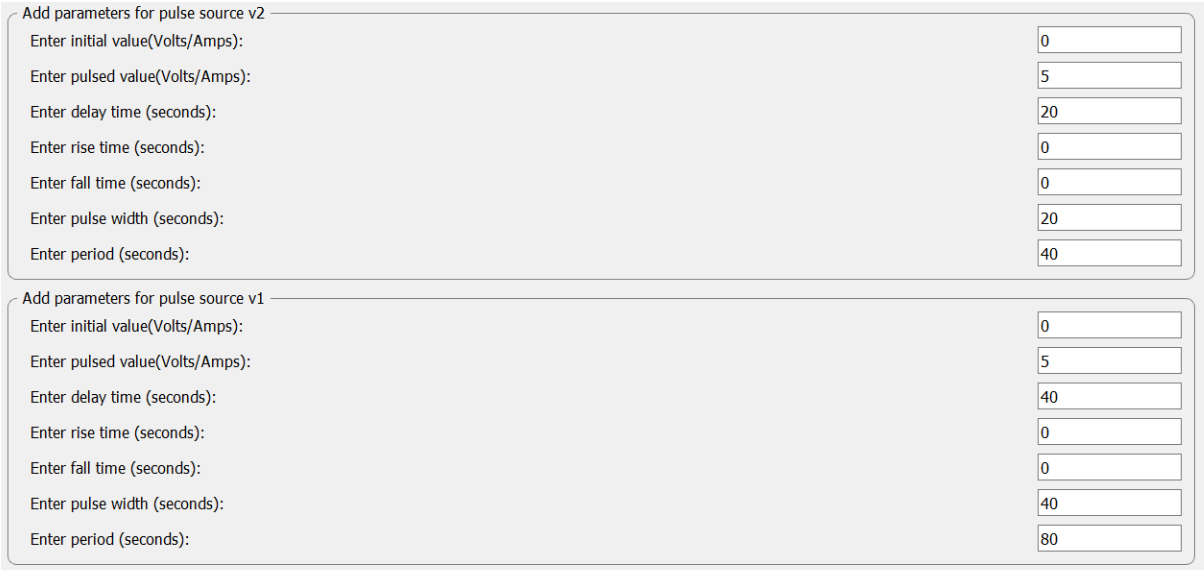


Fig. 4d: Python plots for Y and Z

Figures 4a through 4d show the python plots for the same signals for better visualisation.

Simulation parameter for reference:



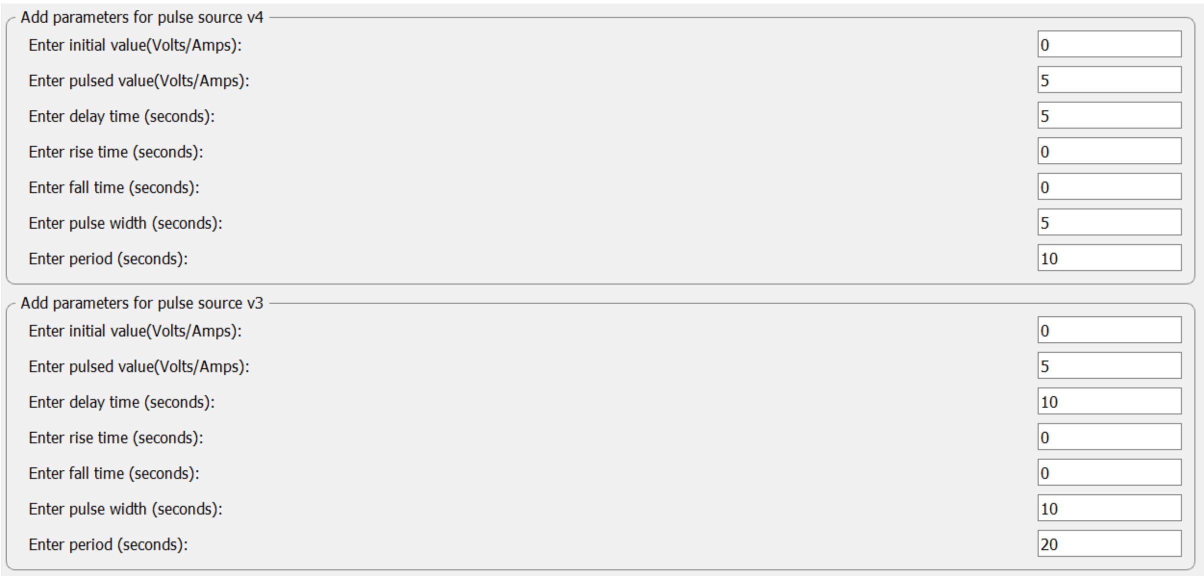
Add parameters for pulse source v2

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
Enter pulse width (seconds):	20
Enter period (seconds):	40

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):	80

Fig. 5a



Add parameters for pulse source v4

Enter initial value(Volts/Amps):	0
Enter pulsed value(Volts/Amps):	5
Enter delay time (seconds):	5
Enter rise time (seconds):	0
Enter fall time (seconds):	0
Enter pulse width (seconds):	5
Enter period (seconds):	10

Add parameters for pulse source v3

Enter initial value(Volts/Amps):	0
Enter pulsed value(Volts/Amps):	5
Enter delay time (seconds):	10
Enter rise time (seconds):	0
Enter fall time (seconds):	0
Enter pulse width (seconds):	10
Enter period (seconds):	20

Fig. 5b

Source/Reference(s) :

https://www.javatpoint.com/conversion-of-bcd-to-excess-3-code-in-digital-electronics

(Excess-3 to BCD conversion)