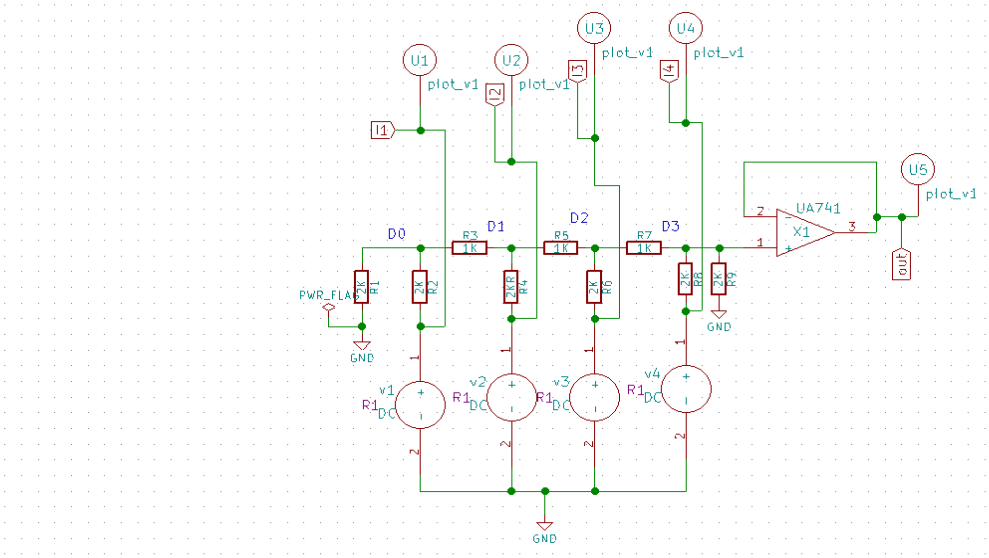
R-2R DAC using eSim

An alternative to the binary weighted input DAC is the R-2R Ladder, which uses fewer unique resistor values thus does not require precision resistors. A disadvantage of the former DAC design was its requirement of several different precise input resistor values: one unique value per binary input bit [3]. Its advantage comparing to the binary weighted is it only has two values of resistors, thus the actual values used is relatively less important if it is extremely large values. The staircase voltage result is more likely to be monotonic as the effect of the MSB resistor is not many times greater than that for LSB resistor .

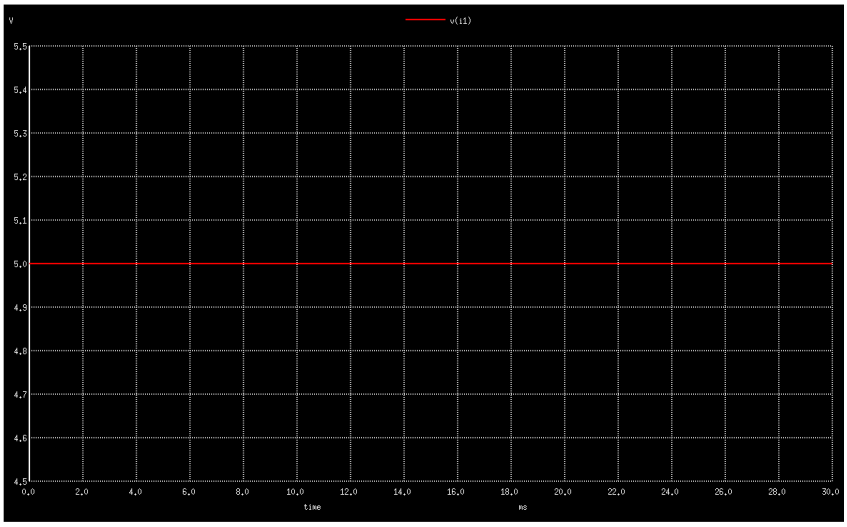
The R–2R ladder is inexpensive and relatively easy to manufacture, since only two resistor values are required (or even one, if R is made by placing a pair of 2R in parallel, or if 2R is made by placing a pair of R in series). It is fast and has fixed output impedance R. The R–2R ladder operates as a string of current dividers, whose output accuracy is solely dependent on how well each resistor is matched to the others. Small inaccuracies in the MSB resistors can entirely overwhelm the contribution of the LSB resistors. This may result in non-monotonic behavior at major crossings, such as from 01111_2 to 10000_2. Depending on the type of logic gates used and design of the logic circuits, there may be transitional voltage spikes at such major crossings even with perfect resistor values. These can be filtered with capacitance at the output node (the consequent reduction in bandwidth may be significant in some applications). Finally, the 2R resistance is in series with the digital-output impedance.



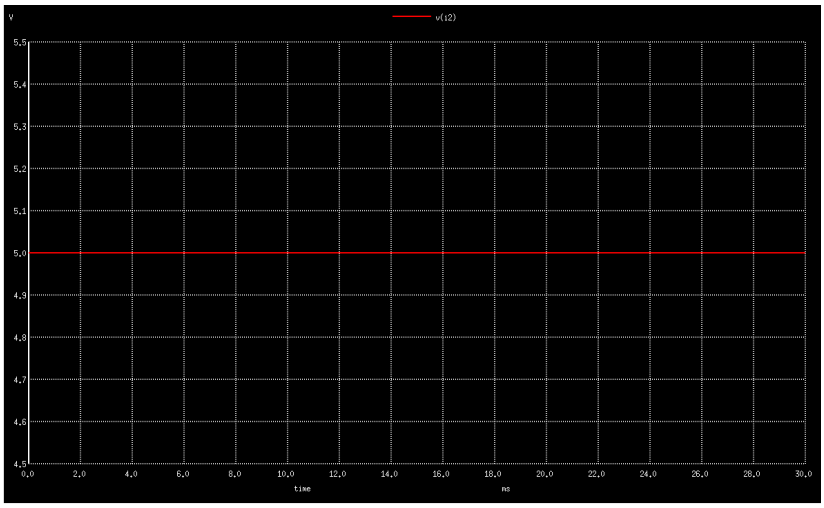
R-2R DAC eSim circuit

Ngspice plots

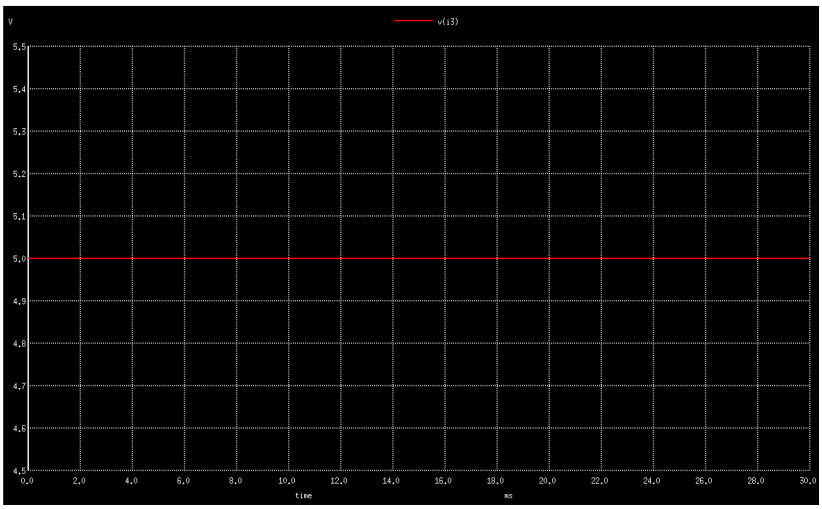
Input 1:



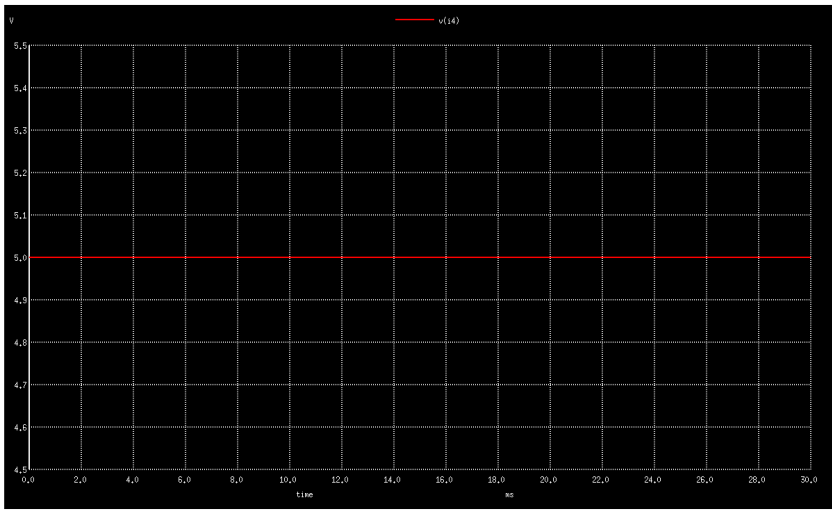
Input 2:



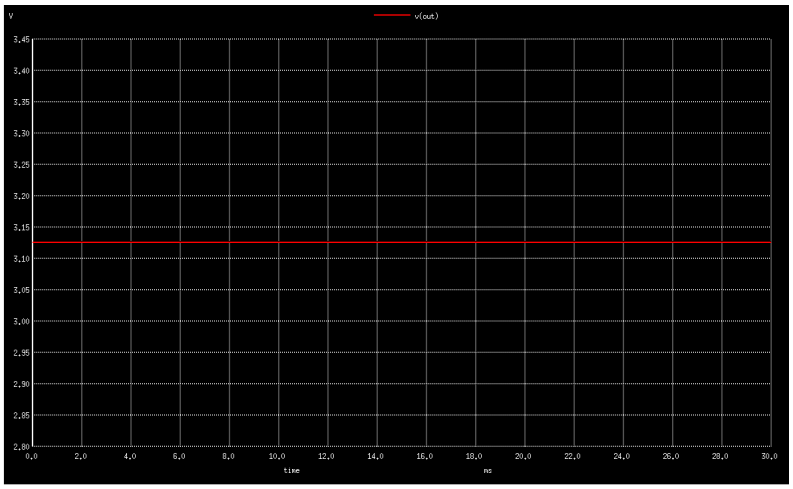
Input 3:



Input 4:

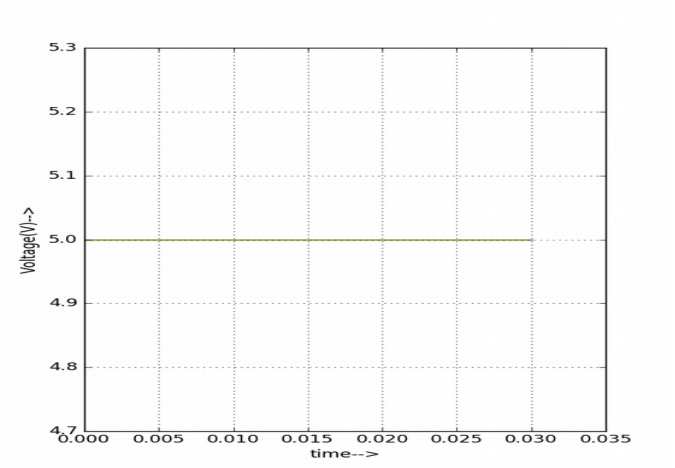


Output

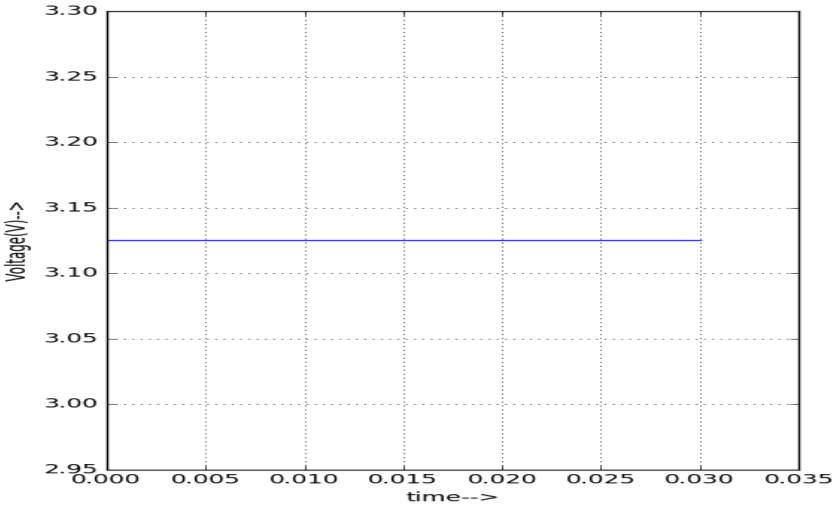


Python plot:

Input



Output plot



Reference:

1. http://www.electronics-tutorial.net/analog-integrated-circuits/data-converters/r-2r-ladder-dac/index.html

2.https://en.wikipedia.org/wiki/Resistor_ladder

3.http://iopscience.iop.org/article/10.1088/1755-1315/69/1/012194/pdf