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Analog Electronics Lab : Day - 7.
Assignment : 7
(Experiment No. : 07)

Date : 01.10.2021.

University of Engineering & Management, Kolkata.

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Title :- Study of DAC and ADC circuit.

Aim :- The aim of this experiment to study the concept of ADC and DAC with the Multisim online live simulator and provide the observation according to the simulation.

Apparatus Required :- (i) AC and DC power source
(ii) Op-Amp (3 channel)
(iii) SPDT switches.
(iv) LED s.
(v) Resistors.
(vi) ground.
(vii) Connecting wires.

Theory :-

(1) Study of DAC :- A Digital to Analog converter converts the digital signal into an analog output signal. The digital signal is separated by the binary code (1 and 0). The bits of a binary number can have only of the two values ie. either 0 and 1. Let the 3 digit binary number input as, $b_2 b_1 b_0$. Here b_2 is the MSB and b_0 is the LSB. The digital switches are shown above, will be connected to the ground, when the corresponding input bits are equal to 0. and are connected with the negative reference voltage, $-V_R$. when the corresponding input bits are 1.

Hence, the nodal equation will be,

$$\frac{0+V_R b_2}{2^0 R} + \frac{0+V_R b_1}{2^1 R} + \frac{0+V_R b_0}{2^2 R} + \frac{0+V_0}{R_f} = 0.$$

$$\Rightarrow \frac{V_0}{R_f} = \frac{V_R b_2}{2^0 R} + \frac{V_R b_1}{2^1 R} + \frac{V_R b_0}{2^2 R}.$$

$$\Rightarrow V_0 = \frac{V_R R_f}{R}\left\{\frac{b_2}{2^0} + \frac{b_1}{2^1} + \frac{b_0}{2^2}\right\}.$$

Substituting, $R = 2f_1$ and f in the above equation.

$$\Rightarrow V_0 = \frac{V_R R_f}{2R_f}\left\{\frac{b_2}{2^0} + \frac{b_1}{2^1} + \frac{b_0}{2^2}\right\}.$$

$$\Rightarrow V_0 = \frac{V_R}{2}\left\{\frac{b_0}{2^0} + \frac{b_1}{2^1} + \frac{b_0}{2^2}\right\}.$$

The above equation presents the output voltage equation of a 3 bit binary weighted resistor DAC as shown here.

$$\Rightarrow V_0 = \frac{V_R}{2}\left\{\frac{b_{N-1}}{2^0} + \frac{b_{N-2}}{b^1} + \cdots + \frac{b_0}{2^{N-1}}\right\}.$$

(2) Study of ADC :- An analog to digital converter takes an analog input voltage and after a certain amount of time produces a digital output code which presents the analog input. The A/D conversion process is generally more complex and time consuming than D/A process. Mainly there are two steps involved in A/D conversion,

(i) S/H : Sampling and Holding
(ii) Q/E : Quantizing and Encoding.

Flash ADC is one of the simplest ADCs. It is also known as the parallel ADC converter. It consists of a number of comparators. An encoder circuit is connected to the output of the comparators which provides the binary output. A flash ADC circuit may be comprised of various no of bits.

Procedure :- (i) Open any of your browsers and then open Multisim Online Live simulator, then click on the new circuit.

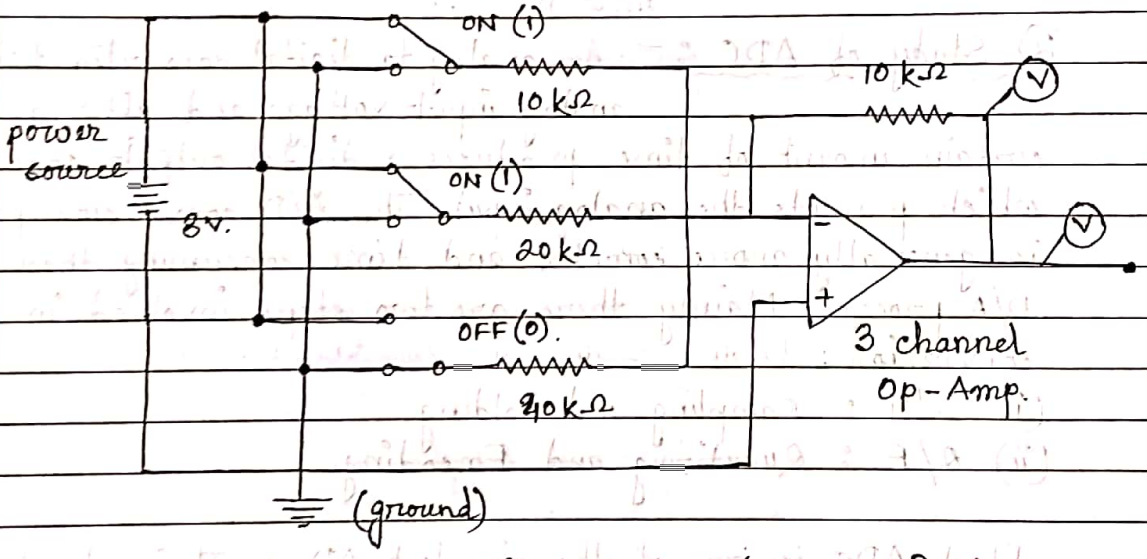
(ii) Place all the apparatus as per the circuit diagram and then connect them using the wires.

(iii) Check the connections properly and then simulate the circuit.

(iv) From the voltage probes/ voltmeters take out the measurements and note it down also you can check the grapher for correct output.

Circuit Diagram :-

(1) Study of DAC circuit :-



Calculating the Vout $= -\left\{\left(\frac{10}{10} \times 8\right) + \left(\frac{10}{20} \times 8\right)\right\}$ V.

$= -\{8 + 4\}$ V.

$= -12$ V.

And the simulation output is also (−12V) (Vout)

② Study of Flash ADC :-

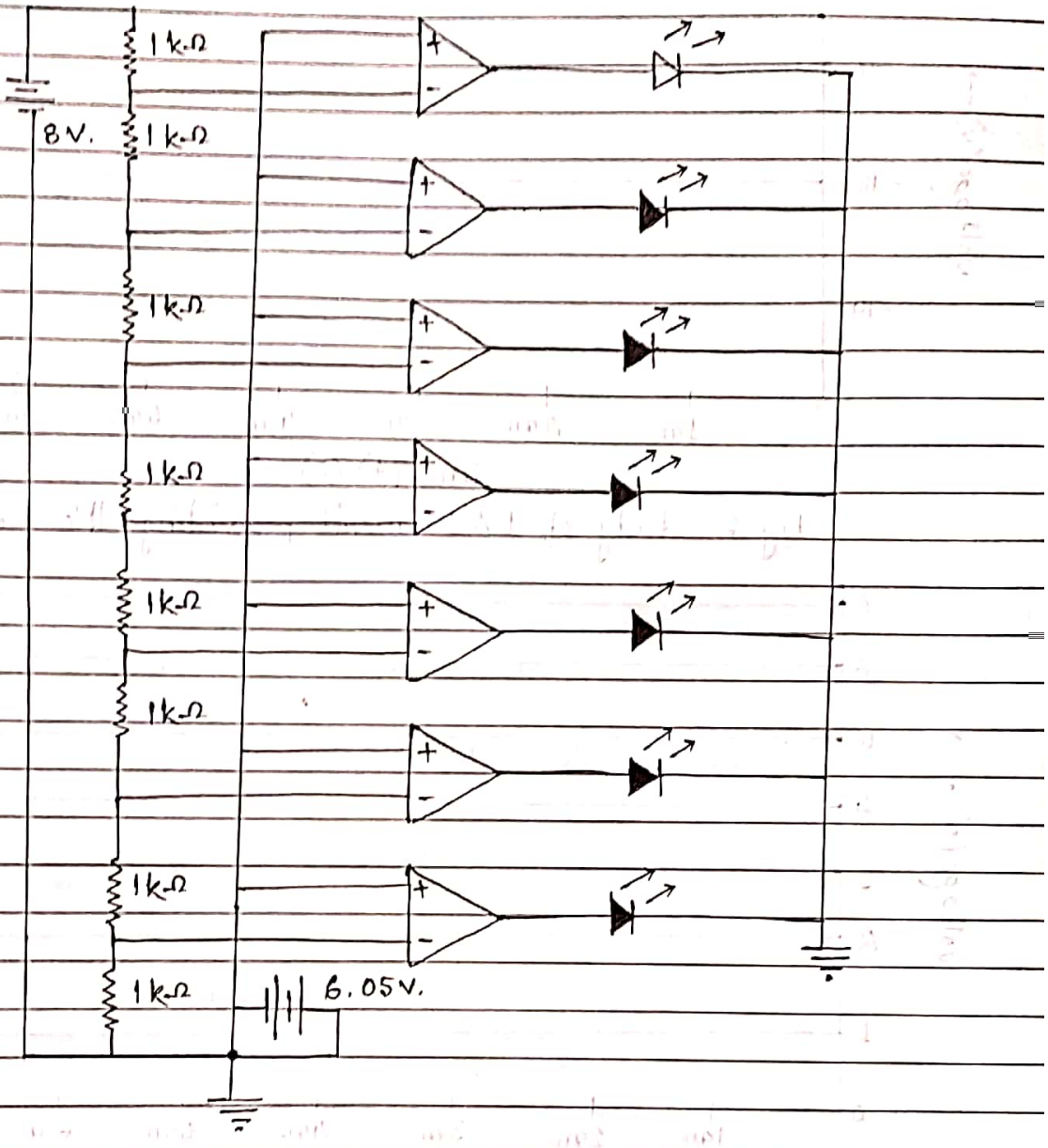


Fig : Circuit Diagram of Flash ADC.

P. T. O.

Graph :-

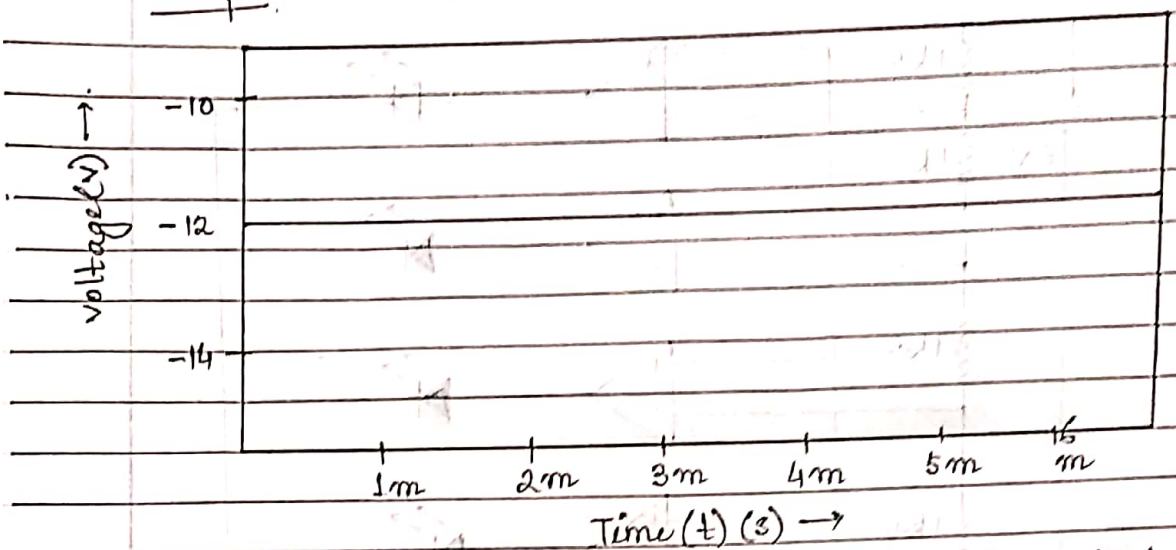


Fig : study of DAC circuit providing the output

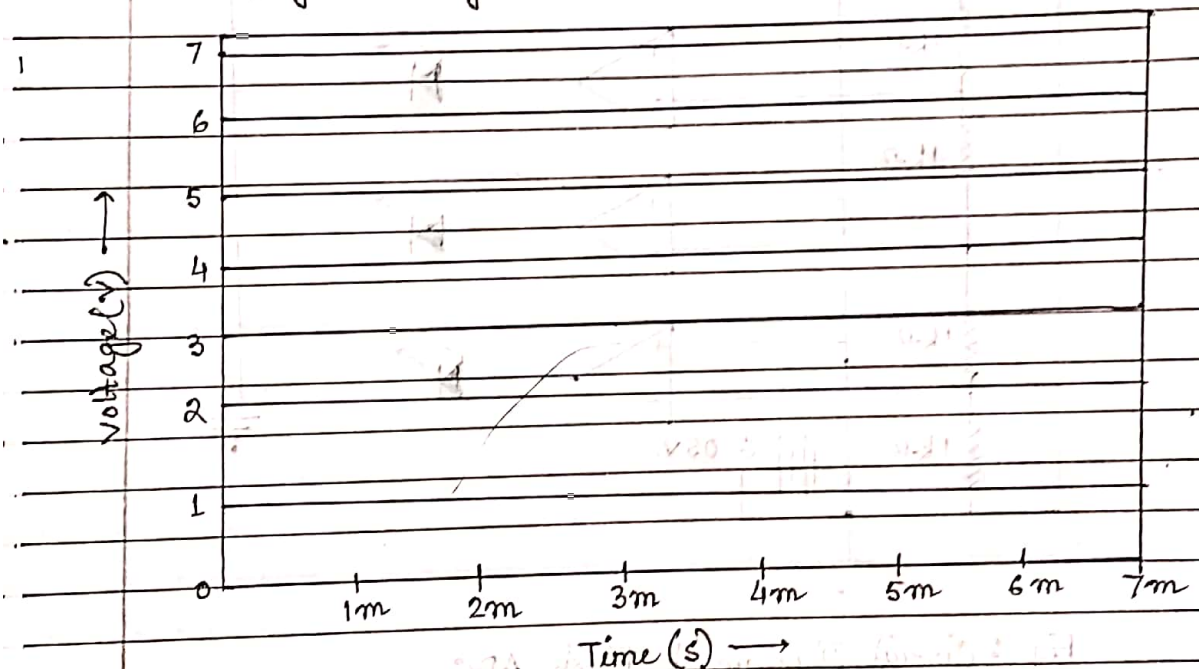


Fig : study of Flash ADC circuit

Conclusion :- All the circuits have been successfully deployed and the simulation is done properly. Hence the theory is justified by proper simulation.

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