Principles of Measurement & Instrumentation I Laboratory

PHYS417

Experiment 1-Methods of Signal Conversion: Analog to Digital Conversion & Digital to Analog Conversion

Pre-Report

Submitted By: Abdullah Burkan BEREKETOĞLU

Submitted to: Deniz Orhun BOZTEMUR & Enver BULUR

Student Id: 2355170

Experiment Date: 19.11.2021

Submission Date: 19.11.2021

Question 1: Explain the basic process of converting an analog signal to digital.

Answer: When the change in signal is continuous with time it is an analog signal, but if it has instant changes in a particular time area (discrete-time or amplitude) that is called a digital signal). To Be able to analyze and process data that comes from sensors it is essential to convert signals to digital from analog to use it on sensors with digital computing machines. Digital signals are a better way to gather data since its much faster and accurate.

It is a known fact that digital machines use the binary form, let's think of a 1V analog signal that is converted to digital by 3-bit Analog to Digital Converter (ADC), the rule is 2^n in here we have 3 bit so 2^3 = 8. So we have 8 parts. On those parts, 000 represents 0V 010, 0.25V and so. If more bits are used, better precision will be in the system.

As to conclude, one can say that changing the continuous to discrete in amplitude and time by binary number manipulation and quantizing signal is the process of converting analog signals to digital signals.

Question 2: Describe the purpose of the sample-and-hold function.

Purpose of the sample and hold. To take or capture the voltage of a continuously varying analog signal and hold its value for a specified period of time.

Question 3: Explain what an operational amplifier is

The operational amplifier(Op-amp) has 5 important pins which are inverting, non-inverting, +Vs, -Vs, and Vout even Vout has a complex system in itself. Op-amps can be used for mathematical operations, filtering, and signal conditioning. However, most commonly, it is used as a high-gain electronic voltage amplifier.

The logic behind the op-amp is based on 2 fundamental rules. First, there is no potential difference between V+(inverting) and V-(non-inverting), and second and last, there is no current on the cable which is going to the V+ or V-. It is so small, that's why the current is ignored. Knowing the given cases, we create and solve the circuits.

For the simplest example of the opamp, if Rf>R1 we gain, if Rf<R1 it is divided, and for Rf=R1 it is buffer.

Question 4: Show how the op-amp can be used as an inverting amplifier or comparator.

Inverting amplifier op-amps, have very high gain, and in reality, the inverting and non-inverting terminals are not equal. The only difference is when we grounded the non-inverting input, this part must be virtually at earth potential. By the op-amp, one can use two op-amps as a voltage comparator circuit on which there will be two-state output received and one can compare whether the output is in a specific range or not.

Question 5: Show how the op-amp can be used to sum up voltage signals.

With more input resistors added to the input, the output voltage will be proportional to the sum of the input voltages. From that one can get a summing up amplifier. E.g Vout=-(RF/Rin)*[V1+V2+V3+…].

Question 6: Explain the operation of a binary-weighted-input DAC.

This is one of the methods of conversion from digital to analog. It can be said that design is the opposite of a summing amplifier. In this scenario, Op-amp can be used as a current to voltage converter. In this system, binary weighted resistors produce an analog output. It has two disadvantages. Disadvantages can be named as, if X many inputs wanted only X many binary weighted resistor values required and needs to be that exact value. It needs high accuracy resistors.

Question 7: Explain the operation of an R/2R ladder DAC.

In this system, only two resistors are used which are R to 2R. Digital input will send less current to a point given. Therefore the effects on the V_out will be less.

The logic behind this, let’s assume that D3=1 and it gives 5V and D0=D1=D2=0V. R1 and R2 will be connected parallel to the ground. Their equivalent resistance will be R and R4+R= 2R. 2R and R3 will be connected parallel to the ground and again R+R6=2R and this one will be parallel with R5 to the ground. With the same approach, a much simpler circuit is made. There is no current on the equivalent resistor, hence ignore it.). At last, the output will be -5V.

Question 8: Explore the LM324 & LM741 datasheets, draw their schematic pin configuration

Question 9: Print out the LM324 & LM741 datasheets.

Question 10: Use an electronic simulation software (ask the assistant for a copy of Proteus 8.8 if you don’t have it) to construct and design 2-bit ADC as shown in Figure 2.2 by showing the values used for resistances and voltages at points A, B, C and D.