Green University of Bangladesh

Department of Computer Science and Engineering (CSE)
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ANALOG TO DIGITAL CONVERTER

Course Title: Electronic Devices and Circuits Pulse Techniques Lab
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Lab Project Status	
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Comments:	**Date:**

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Chapter 1

Introduction

1.1 Overview

The ADC (Analog to Digital Converter) project aims to design and implement a system that can convert analog signals into digital form. The project will involve the development of hardware components to accurately sample and digitize analog input signals, enabling their processing and analysis in digital systems.

1.2 Motivation

The motivation behind this project is our honorable faculty. He showed us a dream of making a project where we will send a voice, which is an analog signal. Then, the signal will be received by ADC and it will convert the analog signal into a digital signal. Again, the digital signal will be received by DAC (Digital to Analog) and it will convert that signal into an analog signal. After this process, we can hear, how our voice sounds like. This story is our motivation and we got interested in working on it.

1.3 Problem Definition

1.3.1 Problem Statement

The main problem addressed in this project is the accurate and efficient conversion of analog signals into digital form. This involves overcoming challenges such as signal noise, resolution limitations, sampling rates, linearity, and precision issues. All we have to do is to design an ADC system that can reliably convert analog signals into digital representation while maintaining the fidelity and accuracy of the original signal.

1.3.2 Complex Engineering Problem

Table 1.1: Summary of the attributes touched by the mentioned projects

Name of the P Attributess	**Explain how to address**
P1: Depth of knowledge required	The ADC project requires a certain level of knowledge in analog electronics, digital electronics, circuit design, and signal processing. Understanding the principles and functioning of ADCs, as well as the components involved, is essential.
P2: Range of conflicting requirements	The ADC project involves balancing various requirements such as resolution, sampling rate, linearity, noise reduction, and power supply stability. These requirements may sometimes conflict with each other, requiring careful consideration and trade-offs during the design process.
P3: Depth of analysis required	Designing an efficient ADC circuit involves analyzing various factors such as component specifications, circuit topologies, ICs, inputs, outputs and performance trade-offs. Detailed analysis is required to ensure optimal circuit performance.

1.4 Design Goals/Objectives

- Research and understand the principles of analog-to-digital conversion.
- Select and evaluate appropriate ADC architectures based on project requirements.
- Design and implement the hardware circuitry for analog signal conditioning, sampling, and quantization.
- Test and validate the ADC system's performance in terms of accuracy, resolution, noise, and dynamic range.

1.5 Application

The ADC technology developed through this project has a wide range of applications in various fields, including:

- Data acquisition systems: ADCs are used to convert analog signals from sensors or transducers into digital data for analysis and storage.
- Communication systems: ADCs enable the conversion of analog voice or video signals into digital form for transmission and processing.
- Instrumentation and measurement: ADCs play a vital role in capturing and digitizing signals in scientific instruments, oscilloscopes, and other measurement devices.
- Audio processing: ADCs are essential for converting analog audio signals into digital format for recording, playback, and digital audio processing.
- Control systems: ADCs facilitate the conversion of analog control signals into digital values for precise control and automation in industrial and robotic systems.

Chapter 2

Design/Development/Implementation of the Project

2.1 Introduction

The implementation phase of the ADC (Analog to Digital Converter) project focuses on translating the theoretical understanding of analog-to-digital conversion into a practical and functional system. This section provides an overview of the key components and steps involved in implementing the ADC system.

2.2 Project Details

The ADC project aims to design and implement an analog-to-digital conversion system capable of accurately and efficiently converting analog signals into their digital representation. The project will involve enabling the sampling, quantization, and processing of analog signals for use in digital systems. The implemented ADC system will be tested and optimized to meet specific application requirements.

2.2.1 Apparatus and Cost

NO.	APPARATUS	IC NAME	QUANTITY	PRICE (BDT)	TOTAL COST (BDT)
01.	Resister (10 k-ohm)	-	7	2.04	14.28
02.	OP-AMP	TL074	2 IC CONTAINS 8 OPAMPs	25.81	51.62
03.	8-3 PRIORITY ENCODER	74147 ENCODER	1	50.28	50.28
04.	POWER SUPPLY	-	Reference Voltage, Input Voltage, IC Power-up Voltage	-	-
05.	BREADBOARD	-	1	79.03	79.03
06.	WIRES	-	1 SET	199.61	199.61
07.	LEDs	-	3	1.90	5.70
TOTAL COST (BDT)					400.52

2.2.2 Block Diagram

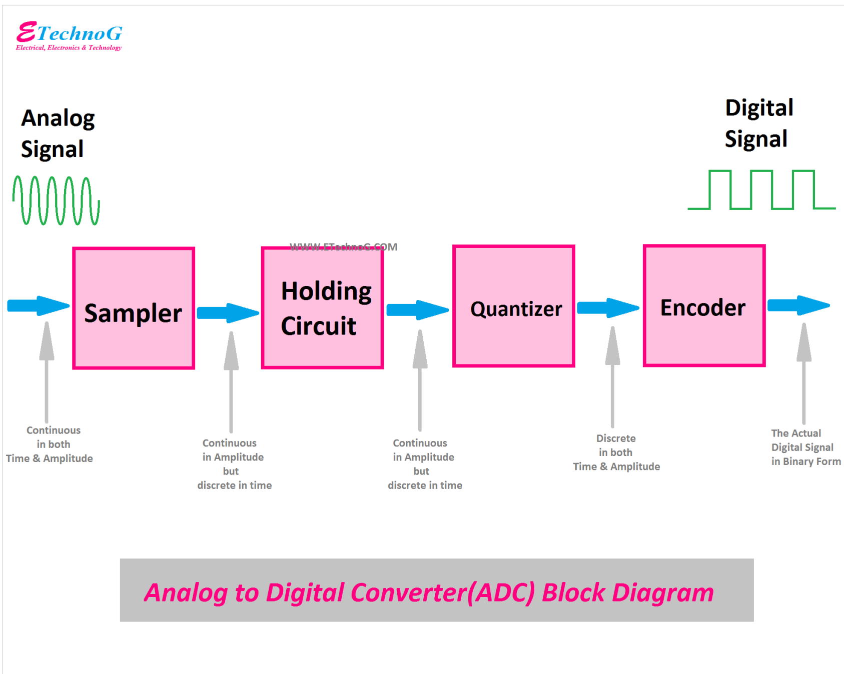

Figure 2.1: ADC Block Diagram

2.2.3 Circuit

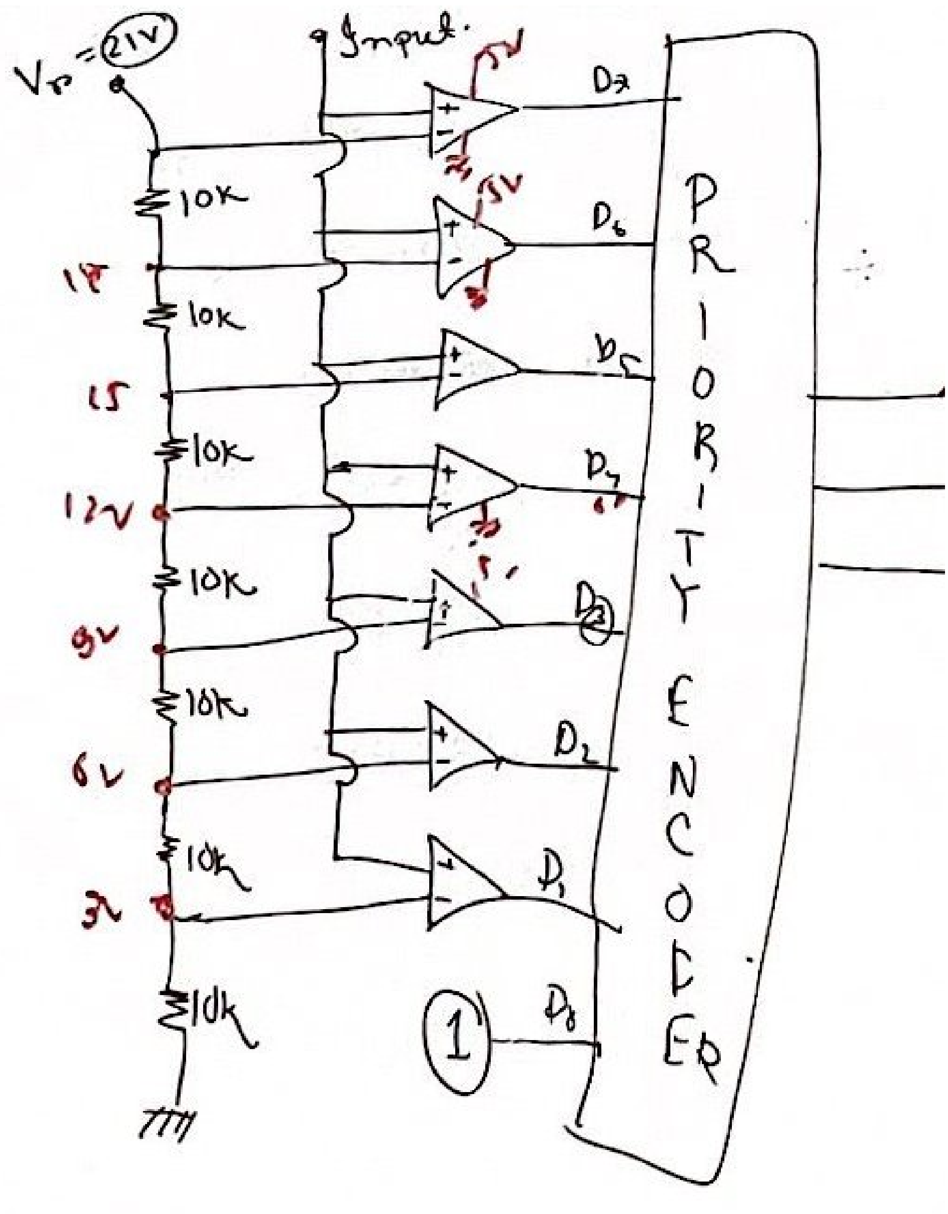

Figure 2.2: Basic ADC circuit

2.3 Implementation

2.3.1 TinkerCad/Simulation Implementation

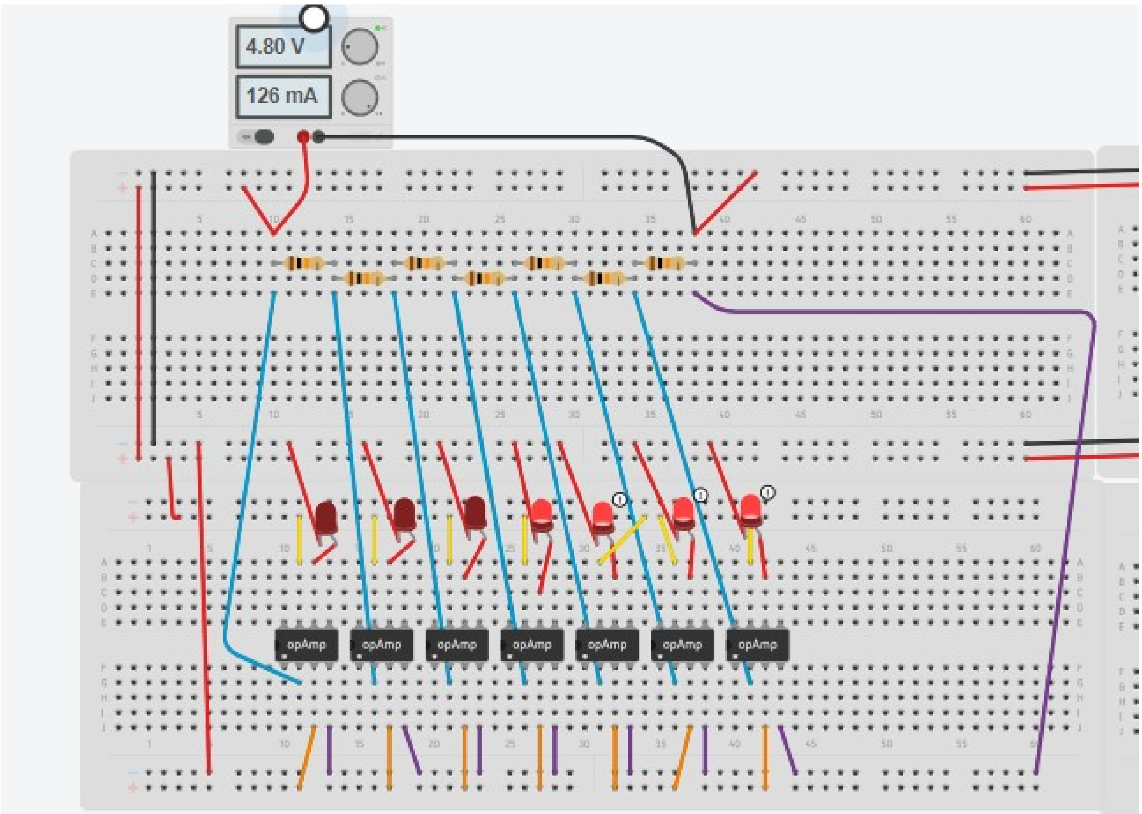

Figure 2.3: Implementation on TinkerCad

Since TinkerCad has no Priority Encoder IC, so we did it, without Priority Encoder. We've used LEDs directly from Op-amp outputs just to understand if it's working.

Click here to simulate

Link: `https://www.tinkercad.com/things/4b36ViUbRu7-eee-lab-project/editel?sharecode=zp50y6sjDiSg07Vu-ogSi8aYYcEJGrqAGqyP1kXNYgI`

2.3.2 The Final Device

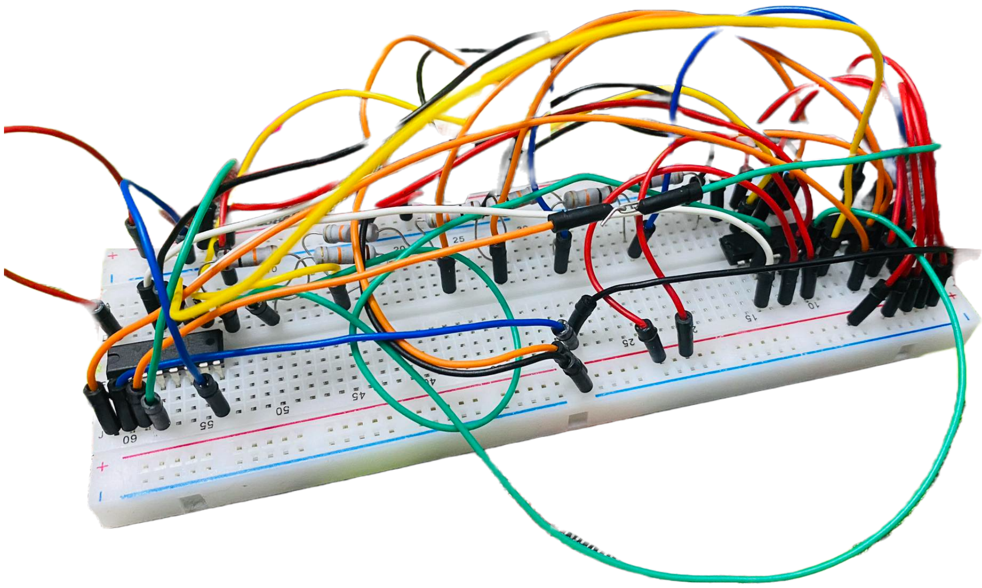

Figure 2.4: ADC Device

It's just here to see how it's look like after implementation. But there is nothing to understand from this image. Because there are so many cables and hard to understand through picture.

Guidelines:

1. We need to provide a 5V power supply to activate all the ICs in the circuit.
2. There is a separate voltage input slot, known as the "random voltage" slot, where we need to provide the input voltage.
3. Connect *LEDs* to the output of the priority encoder to visualize or use the digital output.

Chapter 3

Performance Evaluation

3.1 Simulation Environment/ Simulation Procedure

Yes, it is working on simulation. Here is an image of it-

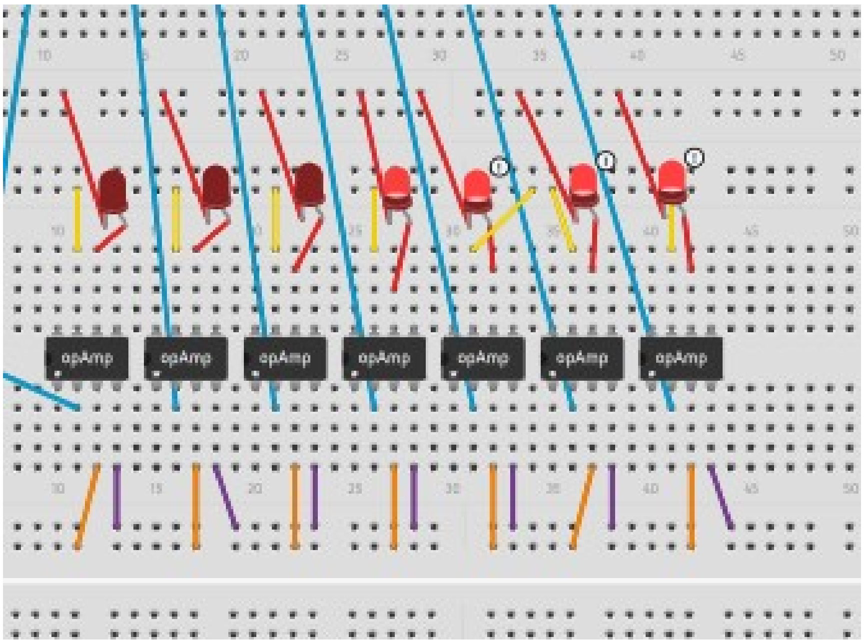

Figure 3.1: Output Testing

Here we've used 2.80V as input voltage, and we got 4 LEDs are turned ON. So, according to the voltage, these lights will TURN OFF/ON and give us different signals that which OP-AMP is producing output or not.

3.2 Results Analysis/Testing

When our respected faculty connected this project with different power supplies and LEDs, it was working. He tried with different voltages at different times and then this project gave us different digital output signals which is checked by LEDs. Since, this is a lab project and we have used only 7 layers for converting to digital signals. So, it wasn't working properly, but it worked.

Chapter 4

Conclusion

4.1 Discussion

Since it is not the finest one. So, the output of this project is not easily determined. Here, our faculty helped us to test. If we try to make this more finest version, then hopefully, it will give us a satisfactory result. In this project there are only 7 layers, if we increase layers by resister and opamp, then it will work more accurately.

4.2 Limitations

1. Resolution Limitations: The ADC's resolution is limited by the number of bits used for digital representation. Higher resolutions may require more complex circuitry and increase the project's cost and complexity.

2. Sampling Rate Limitations: The maximum sampling rate of the ADC is determined by the circuit's design and component capabilities. Very high sampling rates may necessitate specialized components and more advanced circuitry.

3. Input Voltage Range: The ADC may have a limited input voltage range beyond which accurate conversion cannot be guaranteed. This limitation restricts the effective conversion range for analog signals.

4. Cost Constraints: The project's budget may impose limitations on component selection and overall ADC performance. Cost-effective options may need to be considered, which could impact certain aspects of the design and performance.

5. Noise and Interference: The ADC circuit may be susceptible to noise and interference from external sources, such as electromagnetic or radio frequency interference. Proper shielding and filtering techniques may be required to minimize these effects.

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4.3 Scope of Future Work

- By adding more resistors and op-amps, we can increase the resolution and accuracy of the ADC circuit. This allows for finer measurement and representation of analog signals.
- The project can be extended to include an embedded voltage input system. This integration allows for convenient and direct input of analog voltages, eliminating the need for external sources.
- Embedding an output testing system within the project can provide real-time monitoring and verification of the converted digital output. This enables the evaluation of the ADC's performance and accuracy during operation.
- To expand the project's capabilities, a microphone, a DAC (Digital to Analog Converter), and a speaker can be incorporated. This addition would transform the ADC into a comprehensive sound-transferring system, capable of capturing analog audio, converting it to digital, and reproducing it as sound through the speaker.

References