University of Tehran
College of Engineering
School of Electrical & Computer Engineering

Experiment 2
Sessions 3, 4

Analog to Digital Converter

Digital Logic Laboratory
ECE 045, ECE 895
Laboratory Manual

Spring 1404

Contents

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Introduction

An Analog-to-Digital Converter (ADC) is an essential electronic component that converts continuous analog signals into discrete digital values. This conversion is crucial in modern electronics, as most real-world signals (such as sound, light, and temperature) are analog, while digital systems—like microcontrollers, computers, and digital signal processors—operate using binary data.

There are many types of ADCs available, including Flash ADC, Successive Approximation Register (SAR) ADC, Sigma-Delta ADC, Pipeline ADC, and Flash-and-Half ADC.

In this experiment, you will design a *Flash-and-Half ADC*, which is a hybrid approach that combines the speed of Flash ADCs with improved efficiency and reduced hardware complexity.

Analog to Digital Converter (ADC)

In this experiment, we build a Flash-and-Half ADC to convert a variable voltage (analog input) from a potentiometer into a digital output. A Flash-and-Half ADC is a hybrid architecture that combines the speed advantages of a Flash ADC with the efficiency and resolution benefits of a Successive Approximation Register (SAR) ADC. It is designed to strike a balance between high-speed performance and reduced power consumption and chip area.

The design includes a voltage divider with five resistors, four Comparators using the LM393 device, and a Priority Encoder using the 74HC148 device, as shown in Figure 1 .

The ADC compares the analog input with reference threshold voltages created by the voltage divider, identifies the closest value through the encoder, and converts it into digital form. It is important to note that the 74HC148 device is active low, so a 7404 (NOT gate) is required for its inputs. For evaluating the outputs, you can use an ohmmeter or an oscilloscope.

You will use a 4-to-2 priority encoder to generate a 2-bit binary output, allowing interaction with the digital world. This output will also be used in subsequent experiments.

- Implement the ADC using the wiring diagram shown in Figure 2, and observe the 2-bit output by adjusting the 10 kΩ potentiometer. Use two LEDs to visualize the output.
- Evaluate and analyze how changes in voltage affect the digital output.

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Figure 1: Flash and half ADC

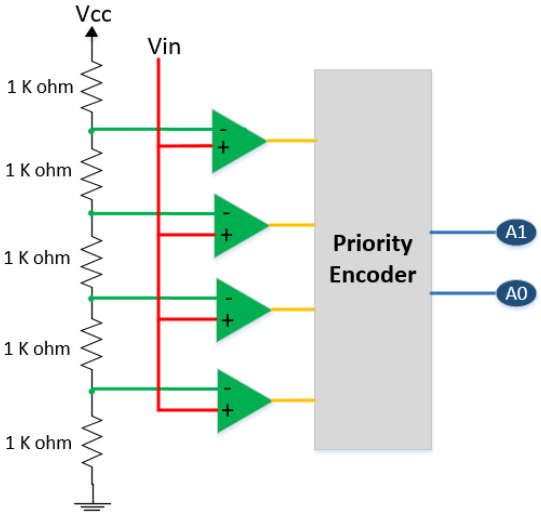

Figure 2: ADC Connection