MARMARA UNIVERSITY

CSE315 DIGITAL DESIGN

LABORATORY MANUAL

EXPERIMENT 7:

Analog-to-Digital Conversion

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There is no pre-lab work required for this experiment. However, be sure to read through the assignment completely prior to starting the practicum.

1. **Objectives:**

The purpose of this experiment is to become familiar with the conversion from analog to digital electronic signals and the properties and definitions associated with that conversions.

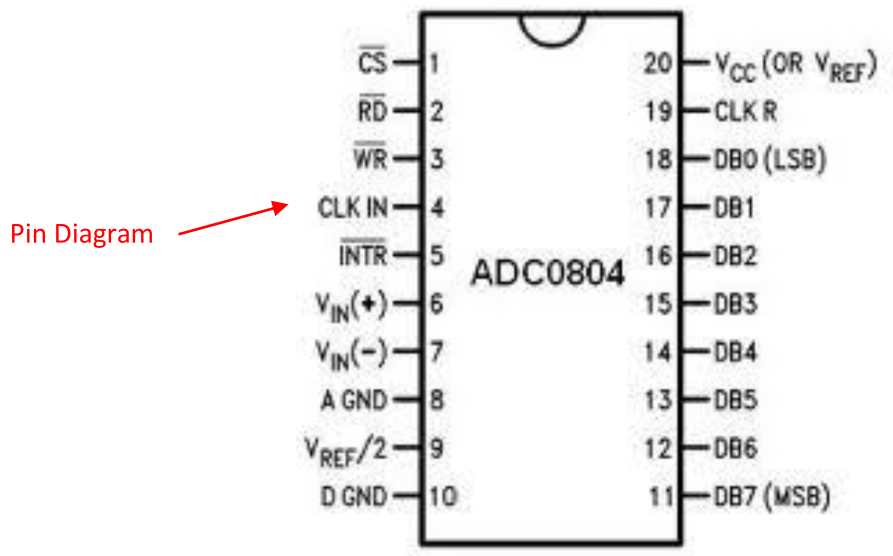
2. **Theoretical Introduction:**

There are many applications of the process related to the conversion of varying analog voltages to correlated binary values. This process is often referred to as digitization and is accomplished by sampling an analog voltage at repeated intervals and then storing, in binary form, a number that identifies the analog value of each sample. The resulting table of binary numbers can be stored, transmitted without electronic interference, and converted back to analog form if need be. Various sensors like temperature, pressure, force etc. convert the physical characteristics into electrical signals that are analog in nature.

There are many different methods to convert analog signals to digital values. Some electronic circuits that deserve attention include the dual-slope integrator used in digital meters, flash converters used for high-speed applications, and the successive approximation type converter used for many digital instrumentation applications.

ADC PIN DIAGRAM AND DESCRIPTION:

The ADC0804 is a versatile chip that can be configured in many different ways, depending on how its pins are connected to each other and to external components.



Pin Description

Pin No	Function	Name
1	Activates ADC; Active low	Chip select
2	Input pin; High to low pulse brings the data from internal registers to the output pins after conversion	Read
3	Input pin; Low to high pulse is given to start the conversion	Write
4	Clock Input pin; to give external clock.	Clock IN
5	Output pin; Goes low when conversion is complete	Interrupt
6	Analog non-inverting input	Vin(+)
7	Analog inverting Input; normally ground	Vin(-)
8	Ground(0V)	Analog Ground
9	Input pin; sets the reference voltage for analog input	Vref/2
10	Ground(0V)	Digital Ground
11	8 bit digital output pins	D7
12		D6
13		D5
14		D4
15		D3
16		D2
17		D1
18		D0
19	Used with Clock IN pin when internal clock source is used	Clock R
20	Supply voltage; 5V	Vcc

In this lab you'll use the ADC0804 in a self-clocking mode by using an external RC timing network. The device is optimized for a clock around 600 kHz and requires approximately 64 clock cycles per conversion. The clock frequency may be figured by the following equation:

$$f_{CLK} = 1 / (1.1 * R * C) \qquad \text{(Eq.1)}$$

Conversions are initiated by pulsing the chip's ~WR line (pin 3) low. The conversion cyclebegins when this line goes high again. ~WR must then remain high during the conversion or theprocess will be abandoned. When the conversion is complete, the ~INTR line (pin 5) produces alow pulse to indicate an end-of-conversion (EOC). In this circuit we've tied ~INTR and ~WRtogether, so that as soon as one conversion is completed, another one is immediately begun.

Differential analog voltage inputs allow offsetting the analog zero input voltage value. This means that the Vin(-) input (pin 7) can be used to automatically subtract a fixed voltage value from the input reading. In addition, the VREF/2 input (pin 9) can be adjusted to allow converting a smaller analog voltage span to the full 8 bits of resolution. In this experiment, the VREF/2 input will be set at 2.5 volts. Therefore our reference voltage VREF is equal to 5 V.

An external clock can be given at the Clock IN (pin 4). ADC 0804 also has an inbuilt clock which can be used in absence of external clock. A suitable RC circuit whose clock frequency formula is given Eq.1 is connected between the Clock IN (pin 4) and Clock R (pin 19) to use the internal clock.

<u>CALCULATING STEP SIZE OF A/D SIGNALS:</u>

ADC0804 is a very commonly used 8-bit analog to digital convertor. It is a single channel IC, i.e., it can take only one analog signal as input. The digital outputs vary from 0 to a maximum of 255. The step size can be adjusted by setting the reference voltage at pin9. When this pin is not connected, the default reference voltage is the operating voltage, i.e., Vcc. The step size at 5V is 19.53mV (5V/255), i.e., for every 19.53mV rise in the analog input, the output varies by 1 unit. To set a particular voltage level as the reference value, this pin is connected to half the voltage. For example, to set a reference of 4V (Vref), pin9 is connected to 2V (Vref/2), thereby reducing the step size to 15.62mV (4V/255).

3. Equipment List:

ADC0804 IC

Three units of 1 kΩ resistors.

10 kΩ resistors.

10 kΩ potentiometer

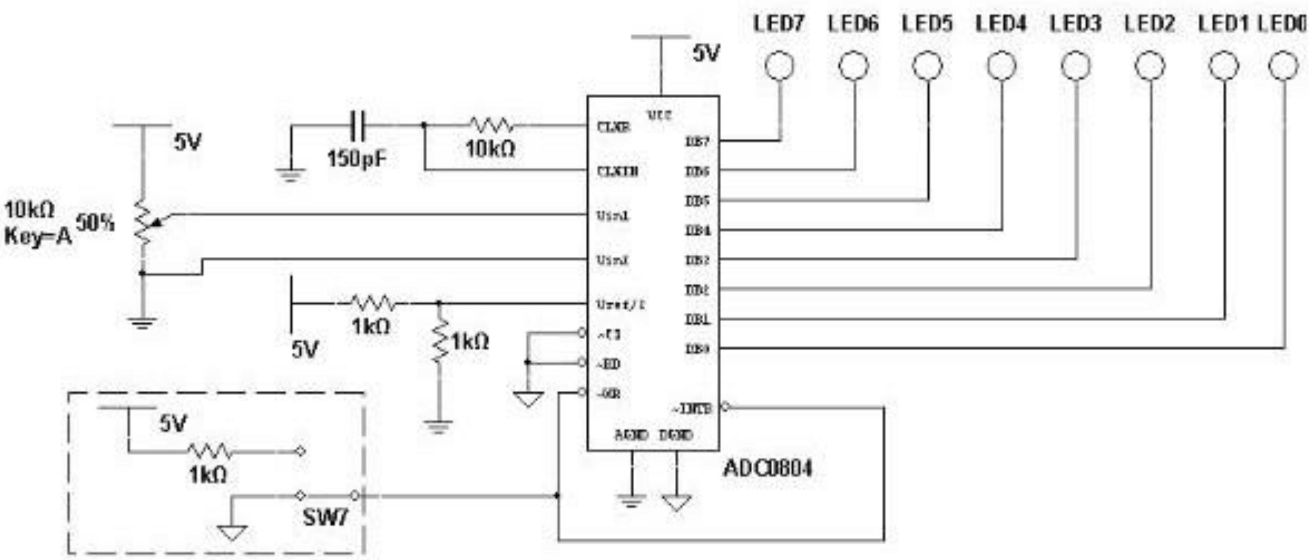
150 pF condansator

Eigth units of red LEDs

C.A.D.E.T set equipments (for Vcc and Ground connetions)

4. Experimental Procedure:

1. Write pin numbers on the ADC0804 in the circuit shown below.



2. Make SW7 is surrounded by a dashed box to remind you that the associated power connections and resistor are internal to the trainer. To tell the chip to start performing conversions, momentarily set SW7 LOW, then set it back HIGH and leave it HIGH.
3. Apply power, and adjust the potentiometer until the voltage at Pin 6 is equal to 0V. Then, by SLOWLY increasing the voltage at Pin 6, indicate on Table is given below the lowest voltage at which the digital output first switches to the indicated binary value. To test the circuit's operation, complete the following table. First, use your step size from page 1 to predict the 8-bit digital code that should be produced for each of the analog input voltages listed. Then carefully set your circuit's analog input voltage to each of these values, and record the digital output code that your circuit produces.

Analog Input Voltage	Digital Output Code		
	Predicted	Measured	Calculating Vo_{AC}
0.1 V			
0.2 V			
0.5 V			
0.7 V			
1 V			

1.5 V			
2 V			
2.5 V			
3 V			
3.5 V			
4 V			
4.5 V			
5 V			