Sanuj Shakya
IoE, Pulchowk campus

Experiment No: 4

This experiment is divided into two sections and both sections are due to be completed in a single lab session. For the first session roll numbers 1-12 or 25-36 will work on section A, and roll numbers 13-24 or 37-48 will carry out section B. After completion, students will swap the lab works.

Initial report must include programs (mnemonics and opcodes) for all sample programs and given problems. Also include necessary look-up tables that would be used in programs, if applicable.

Section A

ADC (ANALOG TO DIGITAL CONVERTER) INTERFACING

Introduction

Microprocessors can process digital data only; whereas most physical signals are analog in nature. Hence, in microprocessor based systems, analog input signals have to be converted into equivalent digital values using ADC chips.

In our lab, there is a 16 channel, 8 bit A/D converter (ADC0816) Interface Module, interfaced with 8085 microprocessor in MPS 85-3 trainer kit through on board 8255A PPI (Base address 40H). To select a particular input channel among the 16 analog input channels, there are 4 address lines (**ADD A**, **B**, **C** and **D**) in ADC0816. These address lines are connected to 4 pins of Port A of 8255A viz. PA_3, PA_2, PA_1 and PA_0. Some examples of channel selection are shown below.

Address Lines				Channel Selected
PA3 D	PA2 C	PA1 B	PA0 A	
0	0	0	0	0
0	0	1	0	2
0	1	0	0	4
1	1	0	0	12
1	1	1	1	15

The 8 bit equivalent digital data (**D_7 – D_0**) from ADC can be read through Port B of 8255A. The **START** and **ALE** signals of ADC are tied together and are connected to **PA_5**.The **EOC** signal can be read through **PC_0**. The **OE** signal ADC is connected to **PA_6** of 8255A.

Installation

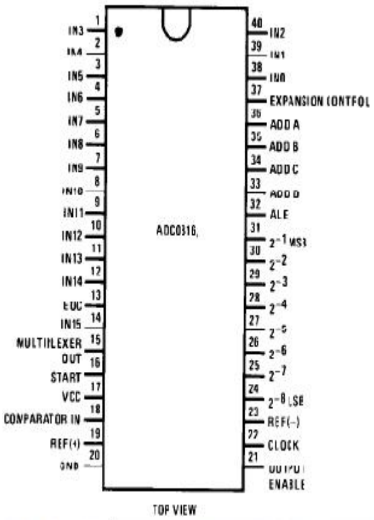
The interface module has a 26-pin connector at one edge of the card which is connected to connector **J2** of the microprocessor trainer kit using a flat ribbon cable.

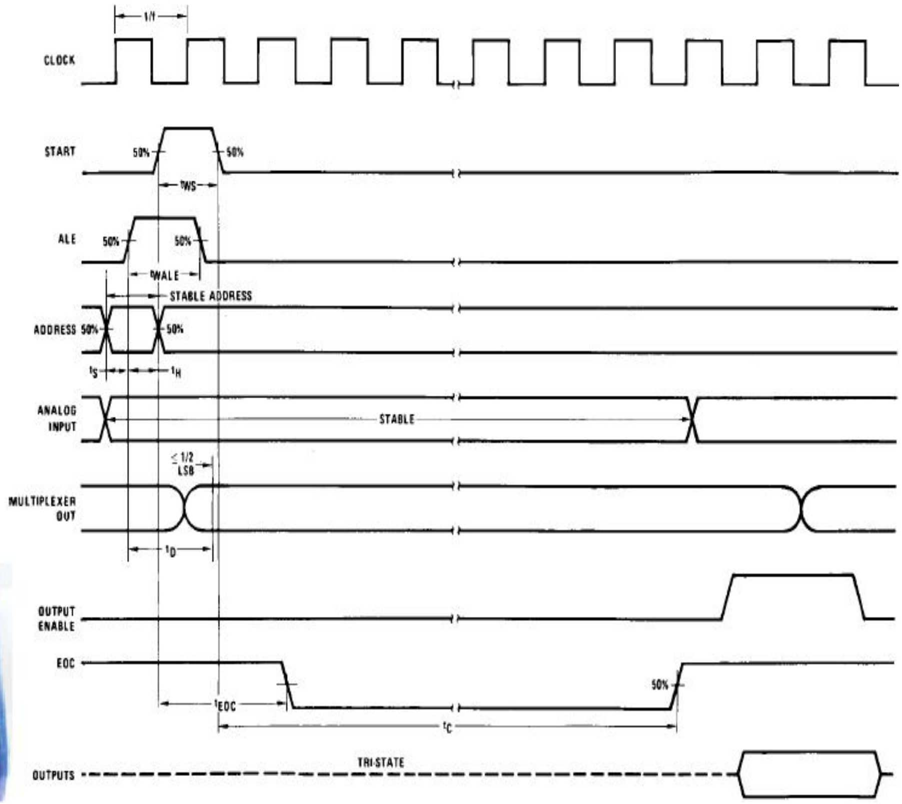
- If you use external + 12 V power supply, then arrange the jumpers as follows

  JP1 → B and JP3 → B

- If +5V from the trainer is being used (via connector J1) for V_{cc} and reference voltage, then arrange the jumpers as follows

  JP1 → A and JP3 → A





Problems

1. In the initial report, draw a simple diagram of interface between ADC0816 in ADC module and on board 8255A PPI, on the basis of the connections described above. Also, generate the appropriate control word for the on board 8255A PPI.
2. Run the following program by varying the input analog voltage and observe the equivalent digital data at 9000H. In the program below, use the control word derived above. Also, change the input channel no, if required.

```
        MVI A,  …….     ; 8255A control word
        OUT     43H
        MVI D,  00H     ; channel no
        MOV     A, D
        OUT     40H     ; load channel no
        ORI     20H
        OUT     40H     ; assert SC/ALE signal
        NOP
        NOP
        MOV     A, D
        OUT     40H     ; Disable SC/ALE
EOC_0:  IN      42H     ; check if EOC is 0
        ANI     01H
        JNZ     EOC_0
EOC_1:  IN      42H     ; check if EOC is 1
        ANI     01H
        JZ      EOC_1
        MOV     A, D
        ORI     40H
        OUT     40H     ; Assert OE
        NOP
        IN      41H     ; Read Data
        STA     9000
        MOV     A, D
        OUT     40      ; Disable OE
        RST 5
```

3. Modify the above program to read the analog signals from two different input channels and store the corresponding digital equivalents to 9000H and 9001H respectively.
4. Again modify the program to continuously convert and store 5 digital data of analog input signal in a single channel with certain delay (e.g., 1 sec) in between the conversions.

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Section B

DAC (DIGITAL TO ANALOG CONVERTER) INTERFACING

Introduction

The DAC interface module in our lab consists of two 8 bit digital to analog converters (DAC0800) which can be used to generate different analog waveforms. The digital inputs to these DACs are provided through Port A and Port B of on board 8255A PPI. The analog outputs from the DACs are given to operational amplifiers which act as current to voltage converters. The op-amp outputs are marked as $\mathbf{X_{out}}$ (corresponding to Port A input) and $\mathbf{Y_{out}}$ (corresponding to Port B input), which can be observed using an oscilloscope. The analog outputs vary between 0 to 5V corresponding to digital values between 00 to FF. Different waveforms can be observed at the op-amp outputs according to the input digital patterns.

Installation

- The interface module has a 26-pin connector at one edge of the card which has to be connected to connector **J2** of the microprocessor trainer kit using a flat ribbon cable.
- Connect external power supply to the DAC module.
- Connect analog outputs $\mathbf{X_{out}}$ and $\mathbf{Y_{out}}$ to the oscilloscope using *crocodile to BNC* probes.

Problems

1. Run the following program and observe the output at oscilloscope.

```
        MVI     A, .....    ; 8255A control word
        OUT     43H
        XRA     A
L1:     OUT     40H         ; for Xout
        OUT     41H         ; for Yout
        INR     A
        CPI     FF
        JNZ     L1
L2:     OUT     40H         ; for Xout
        OUT     41H         ; for Yout
        DCR     A
        JNZ     L2
        JMP     L1
```

Draw the waveform of the observed output. Also, calculate peak to peak voltage and frequency of generated waveform.

2. Modify the above program to change the amplitude and/or frequency of the output waveform.
3. Write assembly language programs to generate the following waveforms continuously.
   a. Square wave
   b. Sine wave

<u>Hint for 3.b</u>

Since the output of the DAC in our lab can range from 0V to 5V only, both positive and negative half cycles of the sinusoidal signal must be in the positive voltage range i.e. each sample must be offset by a certain value so as to eliminate negative values. Here, let us use the entire available range (00 to FF) such that 00 H or 0V represents negative peak and FF H or 5V represents positive peak of sine wave. In this case, amplitude of the sine wave is 7F H (digital) and the required offset value is 80 H. The samples of sine wave can be generated by the expression:

$$\text{Dec} = 128 + 127 \sin x \text{ (in decimal values)}$$

The smoothness of the sine wave depends upon the number of sample inputs per cycle.

Let us take samples at every 15 degrees. Then the input at certain interval can be calculated by:

$$Dec = 128 + 127 \sin (i*15°), \text{ for } i=0 \text{ to } n-1$$

where, $n = 360°/15° = 24$ =no of samples per cycle

Only the magnitude of sine wave within the angles ranging from 0 to $\pi/2$ is sufficient to calculate the value in all the range of sine wave. Hence look-up table of range 0 to $\pi/2$ is sufficient. Or else, the digital data for all samples in a cycle needs to be placed in the look-up table.

Some calculations for obtaining digital input data is shown below: (for n=24)

i	**Angle= i*15°**	**Dec**	**Hex**
0	0	128	**80**
2	30	192	**C0**
4	60	237	**EE**
6	90	255	**FF**
10	150	192	**C0**
20	300	18	**12**

Hex Value should be stored in the memory and passed into output port on regular interval as DAC input to get sine wave. Repeat the table continuously to get continuous analog outputs.