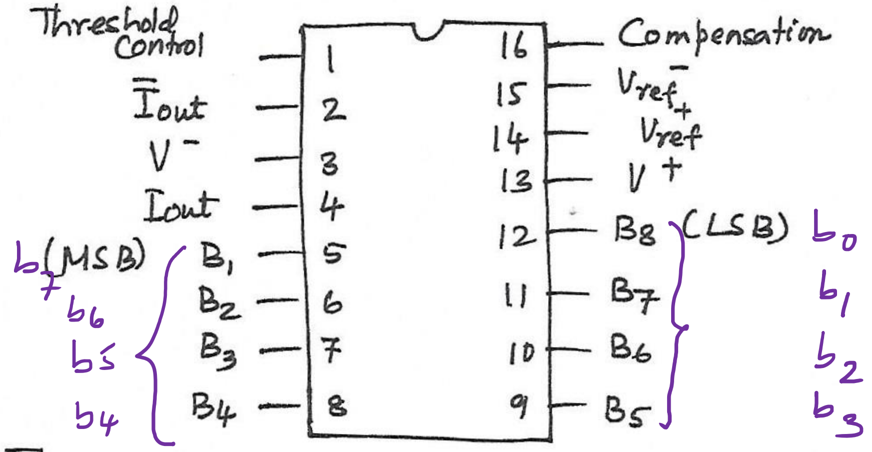
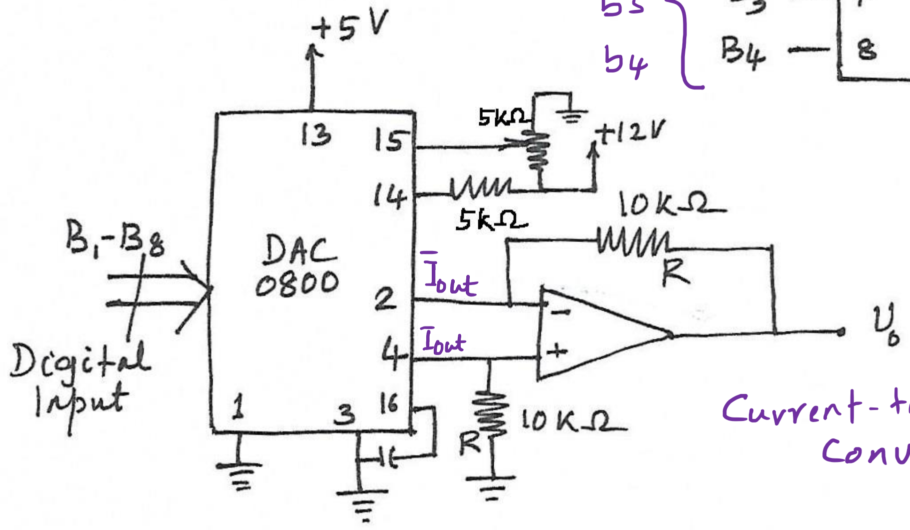
Digital-to-Analog Converter (DAC)

8-bit DAC (DAC 0800)





Current-to-Voltage Converter

<0-5V> Unipolar output

$\bar{I}_{out} = -I_{out}$

$$V_o = I_{out} \cdot R - \bar{I}_{out} R$$
$$= R(I_{out} - \bar{I}_{out}) = 2 R I_{out}$$

EXPERIMENT 5 : INTERFACE EXPERIMENTS USING DUAL DAC CARD OF THE 8085 MICROPROCESSOR KIT

Introduction

The aim of this experiment is to do some basic operations using the Dual DAC Interface Card of the MPS 85-3 8085 Microprocessor Kit.

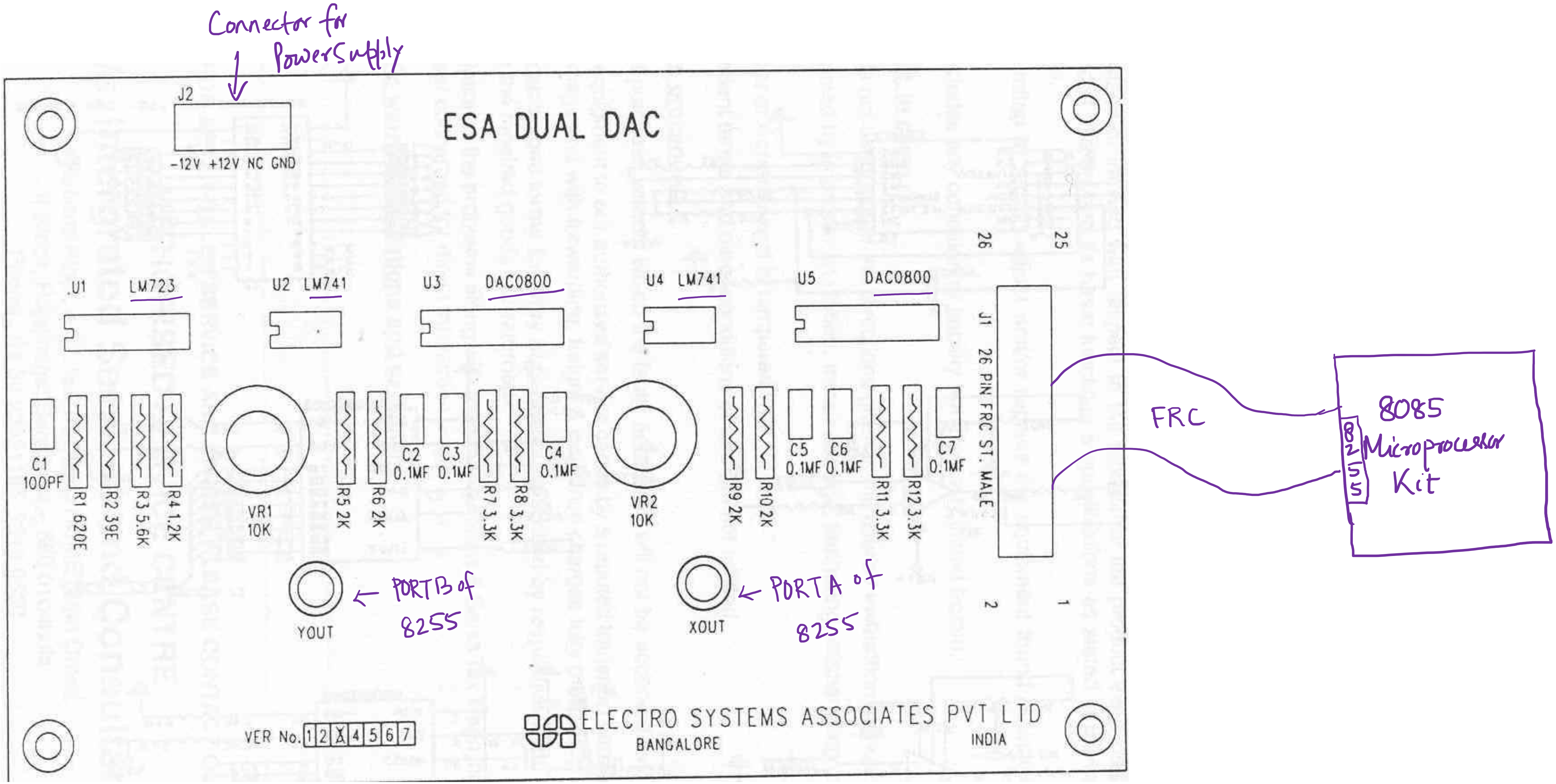
PART A DUAL DAC INTERFACE CARD

The MPS 85-3 8085 Microprocessor kit has a Dual DAC interface for generating software controlled voltages through the on board 8255 PPI. 8255 ports are accessible through a 26-pin FRC connector. We shall use the Dual DAC Interface Card to generate different waveforms under program control. Major features of this Dual DAC Interface Card are given below.

(i) The board has two eight bit digital to analog converters based on the DAC 0800 chip. The digital inputs to these DACs are provided through Ports A and B of the 8255. The analog outputs from the DACs are given to operational amplifiers which act as current to voltage converters.

(ii) The reference voltage required for the DACs is obtained from an onboard μA723 voltage regulator chip. The regulator output is designed to give about +8V output. The outputs from the DACs vary between 0 to 5V corresponding to the input data range from 00H and FFH.

8-bit



Connector for PowerSupply
J2
-12V +12V NC GND
ESA DUAL DAC
U1 LM723
U2 LM741
U3 DAC0800
U4 LM741
U5 DAC0800
26 25
J1 26 PIN FRC ST. MALE
2 1
C1 100PF
R1 620E
R2 39E
R3 5.6K
R4 1.2K
VR1 10K
R5 2K
R6 2K
C2 0.1MF
C3 0.1MF
R7 3.3K
R8 3.3K
C4 0.1MF
VR2 10K
R9 2K
R10 2K
C5 0.1MF
C6 0.1MF
R11 3.3K
R12 3.3K
C7 0.1MF
YOUT
PORT B of 8255
XOUT
PORT A of 8255
FRC
8085 Microprocessor Kit
8255
VER No. 1 2 3 4 5 6 7
ELECTRO SYSTEMS ASSOCIATES PVT LTD
BANGALORE
INDIA

(i) The Dual DAC interface card is physically connected to Port A and Port B of 8255. Ports A and B are to be programmed as Mode 0, output ports.

(ii) The outputs of the DACs are available at the two opamp outputs, marked as Xout and Yout. A byte output at Port A generates Xout, while Port B byte generates Yout.

(iii) 8255 Port adresses are: Port A : 40H ; Port B : 41H ; Port C : 42H ; Control Reg : 43H

(iv) The interface card requires +12V and -12V supplies which are connected to the card using a 4-pin connector provided.

Using the above features of the Dual DAC card one can generate a variety of waveforms.

Configure PORTA & PORTB as output Ports in Mode-0.

Objectives - To generate various waveforms by writing assembly language programs.

PART B: WAVEFORM GENERATION UNDER SOFTWARE CONTROL

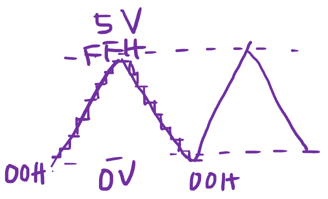
$00H \equiv 0V$

$FFH \equiv 5V$

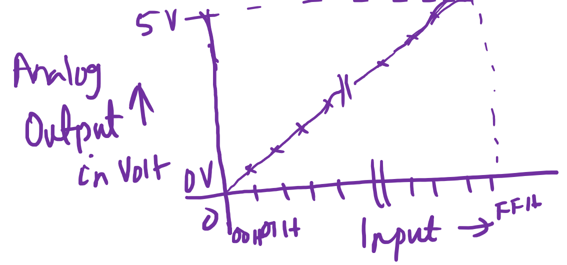
Note: In all your programs at the very beginning itself initialize Port A and Port B as Mode 0 Output ports. Port C may be made input port (as Port C is not connected to the card). Commands MVI A,h'89 ; OUT h'43 will make Ports A, B as outputs and Port C as input.

1. Program 1: SAMPLE PROGRAM

A sample program is given below which generates identical waveforms on Xout and Yout test points of the Card. Make suitable changes to this program for the other programs of the experiment. Observe Xout or Yout waveform on the CRO. Sketch the waveform and note the salient voltage levels of the same. What is the frequency of the waveform?

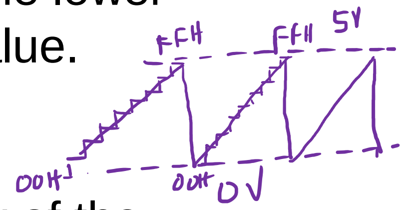


ADDRESS	OPCODE			LABEL	MNEMONIC	COMMENTS
8C00	3E	80			MVI A,H'89	;Initialize 8255 for ;mode 0
8C02	D3	43			OUT H'43	;Port A & Port B output ports
8C04	AF				XRA A	;Starts with a value 00H
8C05	D3	40		LOOP1 :	OUT PORTA	;Out to DAC 1
8C07	D3	41			OUT PORTB	;Out to DAC 2
8C09	3C				INR A	;Increment the DAC input
8C0A	FE	FF			CPI H'FF	;Has the Peak value been reached
8C0C	C2	05	8C		JNZ LOOP1	;No, loop back
8C0F	D3	40		LOOP2 :	OUT PORTA	;Out to DAC 1
8C11	D3	41			OUT PORTB	;Out to DAC 2
8C13	3D				DCR A	;Decrement the DAC input
8C14	C2	0F	8C		JNZ LOOP2	;Minimum value not reached , loop back
8C17	C3	05	8C		JMP LOOP1	;Repeat for ever



2. PROGRAM 2: LINEARITY TEST FOR THE DUAL DAC

Write a few lines of code to output about 8 values (equally spaced) between 00H and FFH to the DACs. Choose a few extra bytes at the lower and upper ends. Use a DMM to measure the analog outputs corresponding to these bytes. See whether the DAC outputs are linear, especially at the lower and higher ends. Also measure the resolution of the DAC and compare it with the expected value.

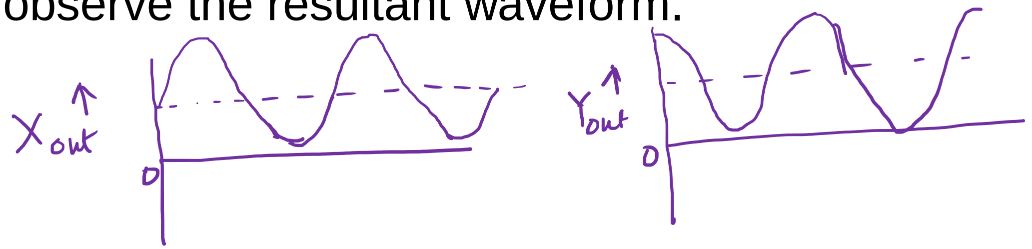


3. Program 3: GENERATION OF A SAWTOOTH WAVEFORM

Write a program to generate a sawtooth waveform, going from 0 to 5V. Measure the frequency of the sawtooth waveform. Calculate the frequency value theoretically and compare with the frequency value obtained experimentally. Write another program to generate a sawtooth wave of approximately half the frequency of that generated earlier.

4. Program 4: GENERATION OF SINE AND COSINE WAVEFORMS

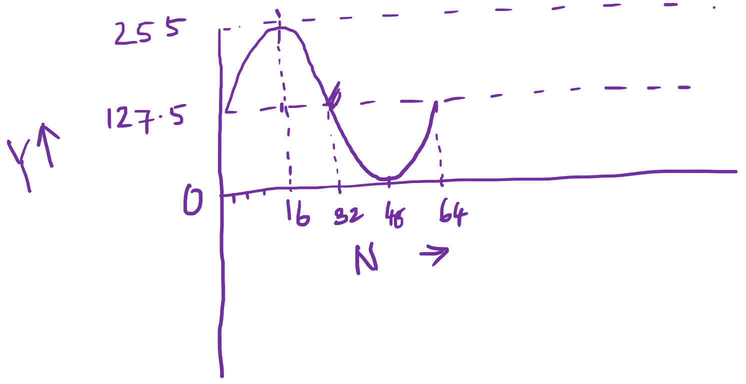
(a) Write a program which will generate one cycle of a sine wave on Xout and a cosine wave on Yout. Run your program and observe the outputs. Sketch them noting the salient voltage levels.
(b) Using X-Y display mode of the CRO observe the resultant waveform.



Sine wave from 0 deg to 180 deg

N	Rad	Deg	Sin	Dec	Round	Hex
0	0	0	0	127.5	128	80
1	π/32	5.625	0.098017	139.9972	140	8C
2	2π/32	11.25	0.19509	152.374	152	98
3	3π/32	16.875	0.290284	164.5113	165	A5
4	4π/32	22.5	0.382683	176.2921	176	B0
5	5π/32	28.125	0.471396	187.603	188	BC
6	6π/32	33.75	0.55557	198.3352	198	C6
7	7π/32	39.375	0.634393	208.3851	208	D0
8	8π/32	45	0.707106	217.6561	218	DA
9	9π/32	50.625	0.77301	226.0588	226	E2
10	10π/32	56.25	0.831469	233.5123	234	EA
11	11π/32	61.875	0.881921	239.9449	240	F0
12	12π/32	67.5	0.923879	245.2946	245	F5
13	13π/32	73.125	0.95694	249.5099	250	FA
14	14π/32	78.75	0.980785	252.5501	253	FD
15	15π/32	84.375	0.995185	254.386	254	FE
16	16π/32	90	1	255	255	FF
17	17π/32	95.625	0.995185	254.3861	254	FE
18	18π/32	101.25	0.980786	252.5502	253	FD
19	19π/32	106.875	0.956941	249.51	250	FA
20	20π/32	112.5	0.92388	245.2947	245	F5
21	21π/32	118.125	0.881922	239.9451	240	F0
22	22π/32	123.75	0.831471	233.5125	234	EA
23	23π/32	129.375	0.773012	226.059	226	E2
24	24π/32	135	0.707108	217.6563	218	DA
25	25π/32	140.625	0.634395	208.3853	208	D0
25	26π/32	146.25	0.634395	208.3853	208	D0
27	27π/32	151.875	0.471399	187.6033	188	BC
28	28π/32	157.5	0.382686	176.2924	176	B0
29	29π/32	163.125	0.290287	164.5116	165	A5
30	30π/32	168.75	0.195093	152.3743	152	98
31	31π/32	174.375	0.09802	139.9975	140	8C
32	32π/32	180	2.65E-06	127.5003	128	80

8100H to
81FFH



$$Y = 127.5\left(1 + \sin \frac{360^\circ}{64} N\right) \leftarrow \text{decimal value } (0 \text{ to } 255)$$

$N = 64$, $N = 0, 1, 2, \ldots, 64$

Express Y in hexadecimal

```
.ORG H'8000
        LXI H,H'8100H
        MVI M,H'80        ; Storing Sine values from 0 deg to 90 deg (17 values)
        INX H
        MVI M,H'8C
        INX H
        MVI M,H'98
        INX H
        MVI M,H'A5
        INX H
        MVI M,H'B0
        INX H
        MVI M,H'BC
        INX H
        MVI M,H'C6
        INX H
        MVI M,H'D0
        INX H
        MVI M,H'DA
        INX H
        MVI M,H'E2
        INX H
        MVI M,H'EA
        INX H
        MVI M,H'F0
        INX H
        MVI M,H'F5
        INX H
        MVI M,H'FA
        INX H
        MVI M,H'FD
        INX H
        MVI M,H'FE
        INX H
        MVI M,H'FF
```

8100H to 81FF H