

Lab 2

Assembly

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First Program

A)

Write a program that searches for a certain byte in a string, if found, put the address of the byte in register A else, put 0xFFFFFFF

Code:

```
c: > FPC > prog > ≡ srcfile.txt
1   .234567890123456789
2   PROB1    START    1000
3   |         LDX      #0
4   |         LDA      #0
5   |         LDS      #0
6   KHAL     TD      INDEV
7   |         JEQ      KHAL
8   |         RD      INDEV
9   |         RMO      A,S
10  |        LDA      #0
11  LOOP     LDCH    STR,X
12  |        COMPR   A,S
13  |        JEQ      DO
14  |        JLT      DOF
15  |        JGT      DOF
16  DO       JSUB    DOE
17  DOF      RMO     X,A
18  |        ADD     #1
19  |        RMO     A,X
20  |        LDA     #5
21  |        COMPR   X,A
22  |        JLT      LOOP
23  |        RMO     T,A
24  |        JEQ      EXIT
25  DOE      LDA     #STR
26  |        ADDR    X,A
27  |        J       EXIT
28  STR      BYTE    C'ABCDEF'
29  INDEV    BYTE    X'F3'
30  EXIT     END     PROB1
```

Assumptions:

- 1- The string is known.
- 2- The size of the string is known.
- 3- The character is read from device F3.

Sample Runs:

1-Search for character ‘C’ in ‘ABCDE’

The screenshot shows the SIC SIMulator interface. At the top, it displays various registers and flags: A=001046, X=000002, L=001028, B=FFFFFF, S=000043, T=FFFFFF, P=000080, and CC=EQ. Below this is a memory dump table with columns for address (0 to 10F0) and memory contents (A, B, C, D, E, F). The character 'C' is found at address 001046 (hex 43), which is highlighted with a red box. The status bar at the bottom of the window says "Press Esc to Quit, Up or Dn arrows Scrolling".

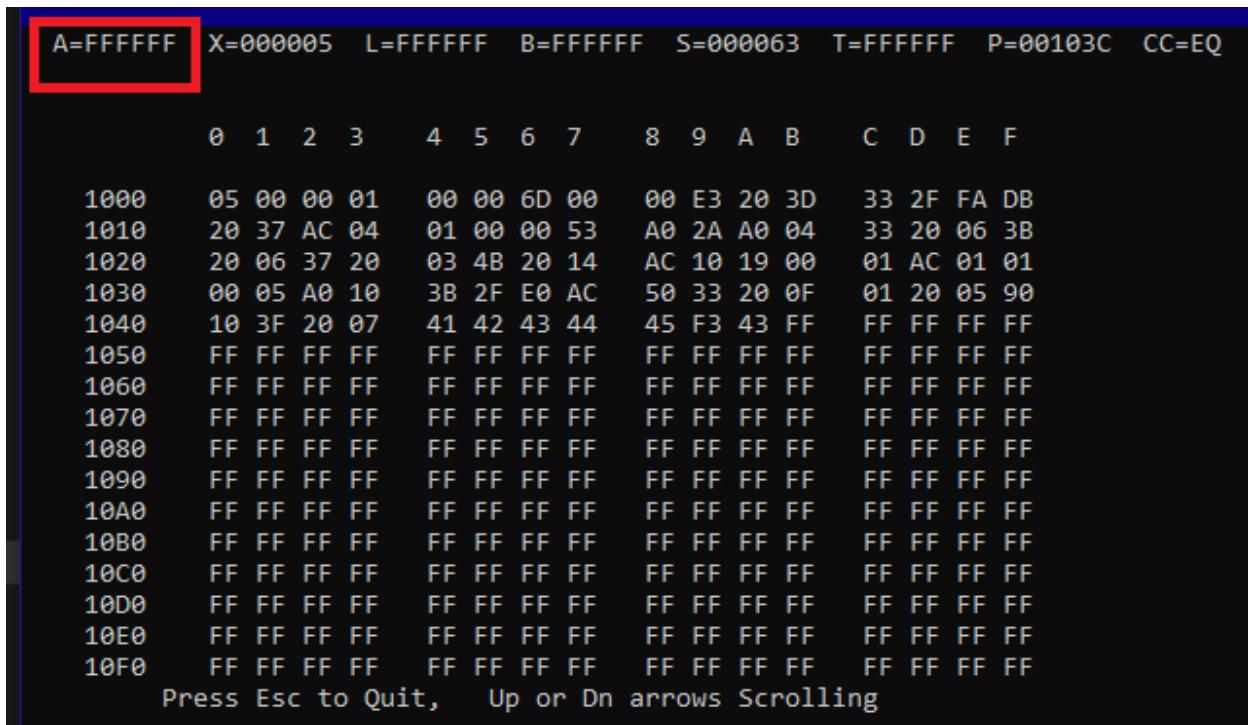
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
1000	05	00	00	01	00	00	6D	00	00	E3	20	3D	33	2F	FA	DB
1010	20	37	AC	04	01	00	00	53	A0	2A	A0	04	33	20	06	3B
1020	20	06	37	20	03	4B	20	14	AC	10	19	00	01	AC	01	01
1030	00	05	A0	10	3B	2F	E0	AC	50	33	20	0F	01	20	05	90
1040	10	3F	20	07	41	42	43	44	45	F3	43	FF	FF	FF	FF	FF
1050	FF															
1060	FF															
1070	FF															
1080	FF															
1090	FF															
10A0	FF															
10B0	FF															
10C0	FF															
10D0	FF															
10E0	FF															
10F0	FF															

Press Esc to Quit, Up or Dn arrows Scrolling

The desired character ‘C’ address is “001046” in the Accumulator which is written as “43” in hexadecimal.

2-Search for 'c' in 'ABCDE' which does not exist

Desired output in the Accumulator: FFFFFFF



A=FFFFFFF X=000005 L=FFFFFF B=FFFFFF S=000063 T=FFFFFF P=00103C CC=EQ

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
1000	05	00	00	01	00	00	6D	00	00	E3	20	3D	33	2F	FA	DB
1010	20	37	AC	04	01	00	00	53	A0	2A	A0	04	33	20	06	3B
1020	20	06	37	20	03	4B	20	14	AC	10	19	00	01	AC	01	01
1030	00	05	A0	10	3B	2F	E0	AC	50	33	20	0F	01	20	05	90
1040	10	3F	20	07	41	42	43	44	45	F3	43	FF	FF	FF	FF	FF
1050	FF															
1060	FF															
1070	FF															
1080	FF															
1090	FF															
10A0	FF															
10B0	FF															
10C0	FF															
10D0	FF															
10E0	FF															
10F0	FF															

Press Esc to Quit, Up or Dn arrows Scrolling

Program 2

B) Read a string from an input device and print it reversed to an output device.

Code:

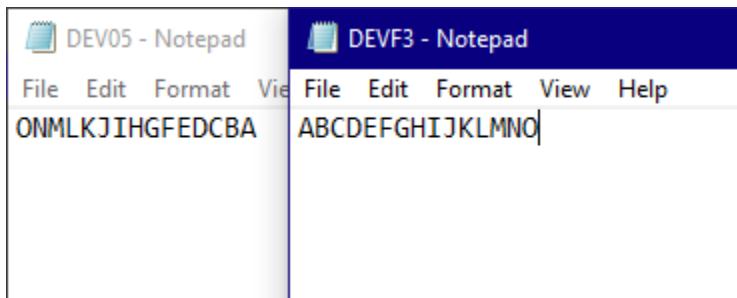
```
c: > FPC > prog >  srcfile.txt
 2  PROB1    START   1000
 3          LDX     #0
 4          LDA     #0
 5  LOOP1    LDS     #4
 6  AGAIN1   TD      INDEV
 7          JEQ     AGAIN1
 8          RD      INDEV
 9          COMPR   A,S
10         JGT     ZWD
11         JEQ     MID
12  ZWD     STCH   ARR,X
13          RMO     X,A
14          ADD     #1
15          RMO     A,X
16          JGT     LOOP1
17  MID     RMO     X,A
18          SUB    #1
19          RMO     A,X
20          J      KHAL
21  KHAL   TD      OUTDEV
22          JEQ     KHAL
23          LDCH   ARR,X
24          WD     OUTDEV
25          RMO     X,A
26          SUB    #1
27          RMO     A,X
28          COMP   #0
29          JGT     KHAL
30          JEQ     KHAL
31  INDEV  BYTE   X'F3'
32  OUTDEV BYTE   X'05'
33  ARR    RESB   10
34          END    PROB1
```

Assumptions:

- 1- The input is printed reversed to the output, but it is not reversed in the memory.

Sample Runs:

- 1- Reverse “ABCDEFGHIJ KLMNO”



The image shows a terminal window for the SIC Simulator running on C:\sic\Simulator\SICSIM.exe. The window displays assembly code and memory dump information. At the top, it shows register values: A=FFFFFFFFFF, X=FFFFFFFFFF, L=FFFFFFFFFF, B=FFFFFFFFFF, S=0000004, T=FFFFFFFFFF, P=00104D, and CC=LT. Below this is a memory dump table with columns for address (0-15), memory content (hex pairs), and registers (A, B, C, D, E, F). The memory dump shows the string "ABCDEFGHIJKLMMNO" reversed in memory. At the bottom of the window, there is a prompt: "Press Esc to Quit, Up or Dn arrows Scrolling".

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
1000	05	00	00	01	00	00	6D	00	04	E3	20	41	33	2F	FA	DB
1010	20	3B	A0	04	37	20	03	33	20	0D	57	A0	32	AC	10	19
1020	00	01	AC	01	37	2F	DF	AC	10	1D	00	01	AC	01	3F	20
1030	00	E3	20	1A	33	2F	FA	53	A0	15	DF	20	11	AC	10	1D
1040	00	01	AC	01	29	00	00	37	2F	E7	33	2F	E4	F3	05	41
1050	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	FF	FF
1060	FF															
1070	FF															
1080	FF															
1090	FF															
10A0	FF															
10B0	FF															
10C0	FF															
10D0	FF															
10E0	FF															
10F0	FF															

Press Esc to Quit, Up or Dn arrows Scrolling.

When printing the M character which is the 12th character and has index C in hexadecimal.

```
C:\sic\Simulator\SICSIM.exe

      S t a t e   A f t e r   F e t c h   C y c l e

      C o n t e n t s   o f   R e g i s t e r s

      A       X       L       B       S       T       P C       C C
00004D   00000C   FFFFFF   FFFFFF   000004   FFFFFF   00103D   LT

      I n s t r u c t i o n
location      instruction      format      mnemonic
00103A        DF2011          3           wd

      O p e r a n d
indxd      Calculation of Target Address      TA      mode
no         adrs + (PC)                  01678     direct

Press any key to execute , Esc to continue
```

Program 3

C. Read a string from an input device and print the string to an output device after converting it to UPPER case.

(You must use at least two subroutines in this problem .One for converting a letter to an upper case. Another one for writing one character to an output device)

Code:

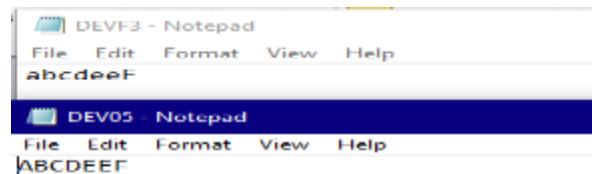
```
c:\> FPC > prog > ≡ srcfile.txt
 1   .234567890123456789
 2   PROB1     START    1000
 3   |         | LDA      #0
 4   LOOP1     LDS      #4
 5   AGAIN1    TD       INDEV
 6   |         | JEQ      AGAIN1
 7   |         | RD      INDEV
 8   |         | COMPR    A,S
 9   |         | JEQ      EXIT
10  |         | JLT      EXIT
11  |         | JSUB     CONV
12  |         | JSUB     WRITE
13  |         | J       AGAIN1
14  CONV     COMP      #90
15  |         | JGT      DO
16  |         | RSUB
17  DO      SUB       #32
18  |         | RSUB
19  WRITE    TD       OUTDEV
20  |         | JEQ      WRITE
21  |         | WD      OUTDEV
22  |         | RSUB
23  INDEV    BYTE      X'F3'
24  OUTDEV   BYTE      X'05'
25  EXIT     END      PROB1
```

Assumptions:

No specific assumption

Sample Runs:

1- Print “abcdeeF” in upper case .



```
A=000004  X=FFFFFF  L=00101D  B=FFFFFF  S=000004  T=FFFFFF  P=001014  CC=EQ

      0   1   2   3   4   5   6   7   8   9   A   B   C   D   E   F

1000  01 00 00 6D  00 04 E3 20  32 33 2F FA  DB 20 2C A0
1010  04 33 20 29  3B 20 26 4B  20 06 4B 20  12 3F 2F E6
1020  29 00 5A 37  20 03 4F 00  00 1D 00 20  4F 00 00 E3
1030  20 0A 33 2F  FA DF 20 04  4F 00 00 F3  05 FF FF FF
1040  FF FF FF FF  FF FF FF FF  FF FF FF FF  FF FF FF FF
1050  FF FF FF FF  FF FF FF FF  FF FF FF FF  FF FF FF FF
1060  FF FF FF FF  FF FF FF FF  FF FF FF FF  FF FF FF FF
1070  FF FF FF FF  FF FF FF FF  FF FF FF FF  FF FF FF FF
1080  FF FF FF FF  FF FF FF FF  FF FF FF FF  FF FF FF FF
1090  FF FF FF FF  FF FF FF FF  FF FF FF FF  FF FF FF FF
10A0  FF FF FF FF  FF FF FF FF  FF FF FF FF  FF FF FF FF
10B0  FF FF FF FF  FF FF FF FF  FF FF FF FF  FF FF FF FF
10C0  FF FF FF FF  FF FF FF FF  FF FF FF FF  FF FF FF FF
10D0  FF FF FF FF  FF FF FF FF  FF FF FF FF  FF FF FF FF
10E0  FF FF FF FF  FF FF FF FF  FF FF FF FF  FF FF FF FF
10F0  FF FF FF FF  FF FF FF FF  FF FF FF FF  FF FF FF FF

Press Esc to Quit, Up or Dn arrows Scrolling.
```

When reading “a” character and then printing it after converting it to upper case. (from 61 to 41 in hexadecimal)

```
      S t a t e   A f t e r   F e t c h   C y c l e
                                         C o n t e n t s   o f   R e g i s t e r s
      A          X          L          B          S          T          P C          C C
000061    FFFFFF    FFFFFF    FFFFFF    000004    FFFFFF    001011    LT

      I n s t r u c t i o n
location      instruction      format      mnemonic
00100F        A004          2            compr

      O p e r a n d s   a r e :
      R 1          R 2
      0            4
      A            S

Press any key to execute , Esc to continue
```

```
      S t a t e   A f t e r   F e t c h   C y c l e
                                         C o n t e n t s   o f   R e g i s t e r s
      A          X          L          B          S          T          P C          C C
000041    FFFFFF    00101D    FFFFFF    000004    FFFFFF    001038    LT

      I n s t r u c t i o n
location      instruction      format      mnemonic
001035        DF2004        3            wd

      O p e r a n d
      i n d x d     C a l c u l a t i o n   o f   T a r g e t   A d d r e s s
      n o           a d r s + (P C)           TA          01660       mode
                                         direct

Press any key to execute , Esc to continue
```

Program 4

D. Implement the bubble sort to sort characters in a string.

Code:

c: > FPC > prog >	srcfile.txt					
1	.234567890123456789	33			JLT	LOOP2
2	PROB1	START	1000	34	JEQ	LOOP2
3		LDS	#0	35	DO	LDS #1
4		LDX	#0	36		JSUB SWAP
5	LOOP1	LDS	#1	37		J LOOP2
6		LDA	I	38		STX J
7		ADD	#1	39		LDA J
8		STA	I	40		SUB #1
9		COMP	LAST	41		COMP I
10		LDA	#6	42		JGT LOOP2
11		STA	J	43		JLT LOOP1
12		JLT	LOOP2	44		JEQ LOOP1
13		JGT	TEST	45	SWAP	LDCH ARR,X
14		JEQ	TEST	46		STCH TEMP
15	LOOP2	LDA	J	47		RMO X,A
16		SUB	#1	48		STA FI
17		COMP	I	49		SUB #1
18		STA	J	50		STA SI
19		JLT	LOOP1	51		LDX SI
20		JEQ	LOOP1	52		LDCH ARR,X
21		LDX	J	53		LDX FI
22		LDCH	ARR,X	54		STCH ARR,X
23		RMO	A,T	55		LDX SI
24		RMO	X,A	56		LDCH TEMP
25		SUB	#1	57		STCH ARR,X
26		RMO	A,X	58		RSUB
27		LDCH	ARR,X	59	TEST	LDX #0
28		COMPR	A,T	60	KHAL	TD OUTDEV
29		RMO	X,A	61		JEQ KHAL
30		ADD	#1	62		LDCH ARR,X
31		RMO	A,X	63		WD OUTDEV
32		JGT	DO	64		RMO X,A

```

64
65      ADD    #1
66      COMP   #5
67      RMO    A,X
68      JGT    EXIT
69      JEQ    KHAL
70      JLT    KHAL
71 TEMP   RESB   1
72 ARR    BYTE    C'azbgjw'
73 LINDX  WORD    5
74 FI     RESW   1
75 SI     RESW   1
76 I      WORD    -1
77 J      WORD    6
78 LAST   WORD    5
79 OUTDEV BYTE    X'05'
80 EXIT   END     PROB1

```

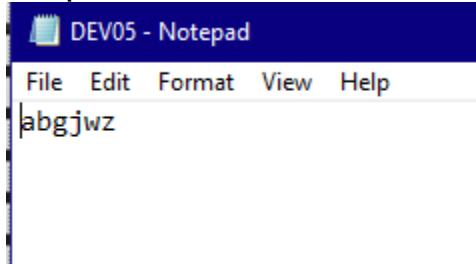
Assumptions:

- 1- The string and its size is known in advance and is written in the code.

Sample Runs:

- 1- Sort “azbgjw”

Output:



Memory Contents:

C:\sic\Simulator\SICSIM.exe																
A=000006 X=000006 L=001060 B=FFFFFF S=000001 T=00007A P=0010BD CC=GT																
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
1000	6D	00	00	05	00	00	6D	00	01	03	20	C7	19	00	01	0F
1010	20	C1	2B	20	C4	01	00	06	0F	20	BB	3B	20	06	37	20
1020	80	33	20	7D	03	20	AF	1D	00	01	2B	20	A6	0F	20	A6
1030	3B	2F	D3	33	2F	D0	07	20	9D	53	A0	88	AC	05	AC	10
1040	1D	00	01	AC	01	53	A0	7C	A0	05	AC	10	19	00	01	AC
1050	01	37	20	06	3B	2F	CD	33	2F	CA	6D	00	01	4B	20	18
1060	3F	2F	C1	13	20	70	03	20	6D	1D	00	01	2B	20	64	37
1070	2F	B2	3B	2F	91	33	2F	8E	53	A0	49	57	20	45	AC	10
1080	0F	20	4A	1D	00	01	0F	20	47	07	20	44	53	A0	35	07
1090	20	3B	57	A0	2F	07	20	38	53	20	28	57	A0	26	4F	00
10A0	00	05	00	00	E3	20	35	33	2F	FA	53	A0	17	DF	20	2C
10B0	AC	10	19	00	01	29	00	05	AC	01	37	20	20	33	2F	E4
10C0	3B	2F	E1	77	61	62	67	6A	77	7A	00	00	05	00	00	05
10D0	00	00	04	00	00	05	00	00	06	00	00	05	05	FF	FF	FF
10E0	FF															
10F0	FF															

Press Esc to Quit, Up or Dn arrows Scrolling

The screenshot shows two windows of the CPU Simulator. The left window displays the state after 1 fetch cycle, showing registers R0 through R7 with various values like FFFFFFFF and 00000001. The right window shows the assembly code being executed, with instruction 24 highlighted in red, which corresponds to the RMO operation in the register dump.

Register	R0	R1	R2	R3	R4	R5	R6	R7
R0	00000001	00000000	00000000	00000000	00000000	00000000	00000000	00000000
R1	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
R2	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
R3	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
R4	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
R5	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
R6	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
R7	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000

Instruction details:

location	instruction	format	mnemonic
00100E	AC10	2	RMO

Operands are:

R 1	R 2
1	0
X	A

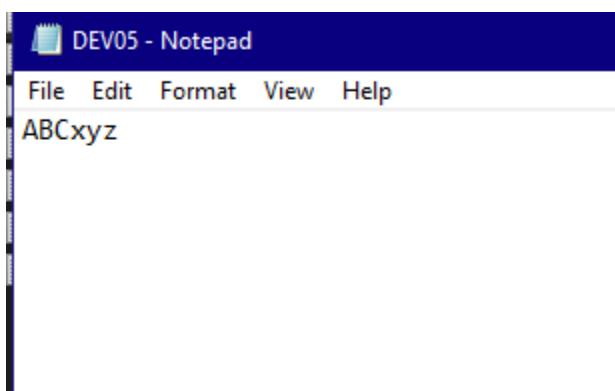
Press any key to execute. Esc to continue.

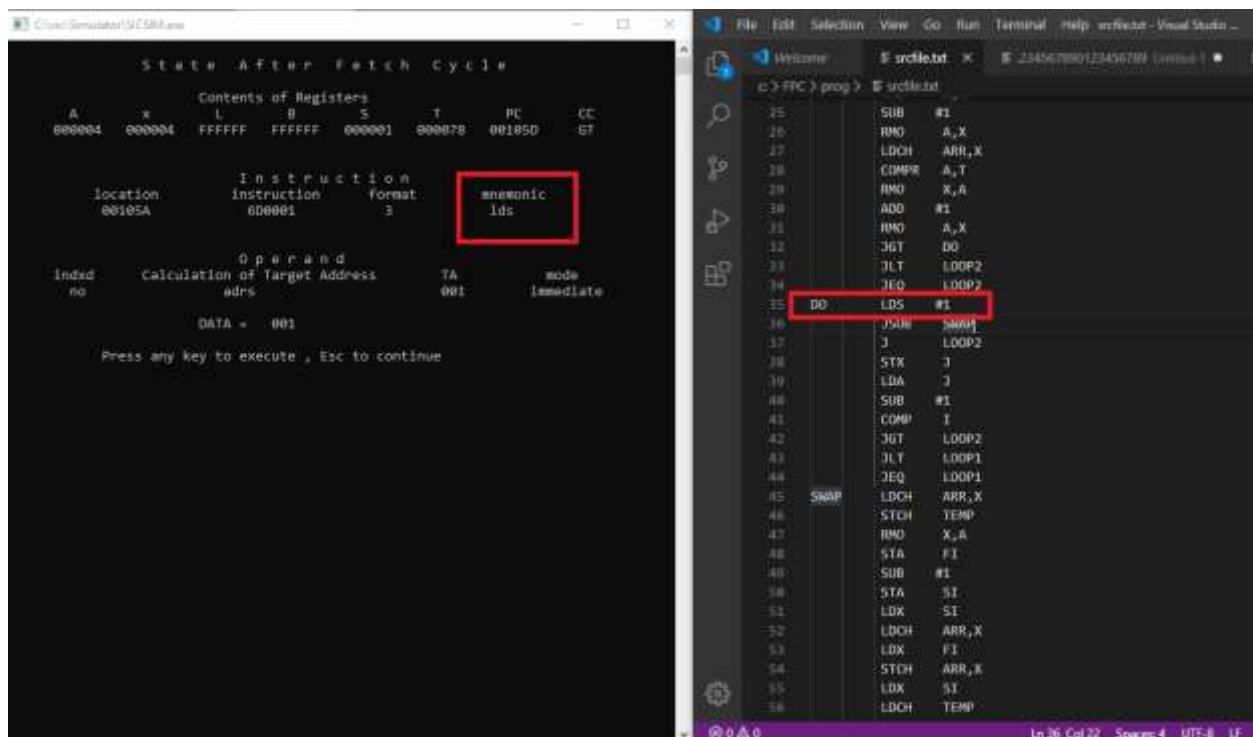
Assembly code (highlighted line 24):

```

C:\PFC> ping > F.asm.txt
1. .314567899123456789
2. PROB1 START 1000
3.
4. LDS #0
5. LOX #0
6. LOOP1 LDS #1
7. LDA I
8. ADD #1
9. STA I
10. COMP LAST
11. LOA #6
12. STA Z
13. JLT LOOP2
14. JGT TEST
15. LOOP2 LDA Z
16. SUB #1
17. COMP I
18. STA Z
19. JLT LOOP1
20. JEQ LOOP1
21. LOX Z
22. LOCH ARK,X
23. RMO A,T
24. RMO X,A
25. SOR #1
26. RMO A,X
27. LOCH ARK,X
28. COMP: B,T
29. RMO X,B
30. ADD #1
31. RMO A,X
32. JGT 00
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2- Sort “ABCzxy”





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C:\sic\Simulator\SICSIM.exe

A=000006  X=000006  L=001060  B=FFFFFF  S=000001  T=00007A  P=0010BD  CC=GT

      0   1   2   3   4   5   6   7   8   9   A   B   C   D   E   F
1000  6D 00 00 05  00 00 6D 00  01 03 20 C7  19 00 01 0F
1010  20 C1 2B 20  C4 01 00 06  0F 20 BB 3B  20 06 37 20
1020  80 33 20 7D  03 20 AF 1D  00 01 2B 20  A6 0F 20 A6
1030  3B 2F D3 33  2F D0 07 20  9D 53 A0 88  AC 05 AC 10
1040  1D 00 01 AC  01 53 A0 7C  A0 05 AC 10  19 00 01 AC
1050  01 37 20 06  3B 2F CD 33  2F CA 6D 00  01 4B 20 18
1060  3F 2F C1 13  20 70 03 20  6D 1D 00 01  2B 20 64 37
1070  2F B2 3B 2F  91 33 2F 8E  53 A0 49 57  20 45 AC 10
1080  0F 20 4A 1D  00 01 0F 20  47 07 20 44  53 A0 35 07
1090  20 3B 57 A0  2F 07 20 38  53 20 28 57  A0 26 4F 00
10A0  00 05 00 00  E3 20 35 33  2F FA 53 A0  17 DF 20 2C
10B0  AC 10 19 00  01 29 00 05  AC 01 37 20  20 33 2F E4
10C0  3B 2F E1 79  41 42 43 78  79 7A 00 00  05 00 00 05
10D0  00 00 04 00  00 05 00 00  06 00 00 05  05 FF FF FF
10E0  FF FF FF FF  FF FF FF FF  FF FF FF FF  FF FF FF FF
10F0  FF FF FF FF  FF FF FF FF  FF FF FF FF  FF FF FF FF

Press Esc to Quit, Up or Dn arrows Scrolling

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