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EEE - 3210– Microprocessor, Interfacing & System Design Sessional

Sessional Report

Student Lab Report

Submitted by

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Experiment No. 01

1.1 Experiment Name

Introduction to Assembly Language Programming and Kit Mode of MDA 8086 Trainer Board

1.2 Objectives

- To understand the structure of Assembly Language programming
- To learn about the microprocessor emulator "Emu 8086" and its operation
- To get acquainted with the "MDA 8086" Trainer Board and its operation
- To learn how to implement program in “MDA 8086” Trainer Board and interconnect it with “Emu 8086”

1.3 Theory

The Assembly language is a low-level computer programming language that consists primarily of symbolic versions of a computer's machine language. Different manufacturers' computers use different machine languages and require different assemblers and assembly languages.

A microprocessor is a type of computer processor that contains the capabilities of a central processing unit on an integrated circuit (IC) or a few integrated circuits that comprises the arithmetic, logic, and control circuitry required to perform the central processing unit functions of a digital computer.

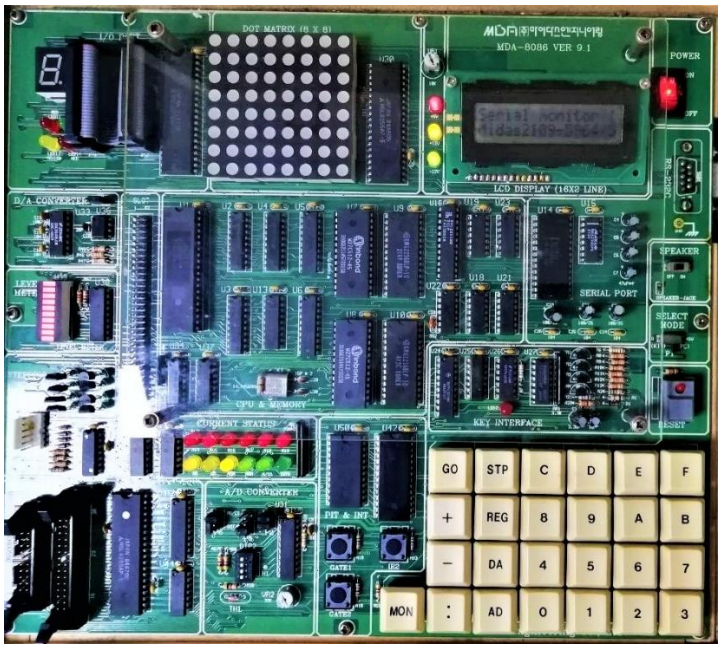


Fig 1.1: MDA 8086 Trainer Microprocessor Kit

The 8086 microprocessor has eight general-purpose registers. They are as follows: AX, BX, CX, DX, SP, BP, SI, and DI. The accumulator is AX. To perform 8-bit instructions, it is separated into two 8-bit registers, AH (upper byte) and AL (lower byte). The MOV operation moves the data item specified by its second operand (register, memory) to the location

specified by its first operand. MOV AX, 10D, for example. The source operand is 10D, while the destination operand is AX. The final result is really accumulated at the destination. In 1978, Intel debuted the 8086 microprocessors. This 16-bit microprocessor marked a significant advancement over the previous generation.

The MDA 8086 microprocessor has the following features:

- A 16-bit microprocessor
- A 20-bit address bus allows it to directly access 220 bits, or 1 MB, of memory.
- The 8086 has fourteen sixteen-bit registers.
- Clock frequency (5 to 10 MHz)

The MDA 8086 consists of a central processing unit (CPU), ROM, SRAM, display, keyboard, speaker, DOT matrix LED, A/D & D/A converter, stepping motor.

It also has function key which operate as follows

[AD]	Set memory address	[GO]	Go to user's final program instruction
[DA]	Update segment & offset, and input data to memory	[REG]	Register display
[STP]	Executing user's program in single steps	[MON]	Immediately break user's program and non-makeable interrupt
[:]	Offset data		

The working operation are as follows

- After imitating the code, it was saved in the software emu8086
- It executed the software step by step by clicking the single step
- The value 10D was first recorded in register AX
- By clicking the single step, the value 17H was recorded in register BX
- Finally, after clicking a single button, the addition of AX and BX, or 10D and 17H, was saved in register AX and displayed on the screen as 21H
- The same phenomenon happens in the MDA 8086 microprocessor kit, and it can be verified step by step.

1.4 Apparatus

- Emu 8086 - Microprocessor Emulator
- MDA 8086 - Trainer Board

1.5 Emulator Code

MOV AX, 10D; MOVE 10D TO AX

MOV BX, 17H; MOVE 1122H TO BX

ADD AX, BX; ADD AX AND BX, AND THE ADDITION WILL BE STORED IN AX

1.6 Output

Emu 8086

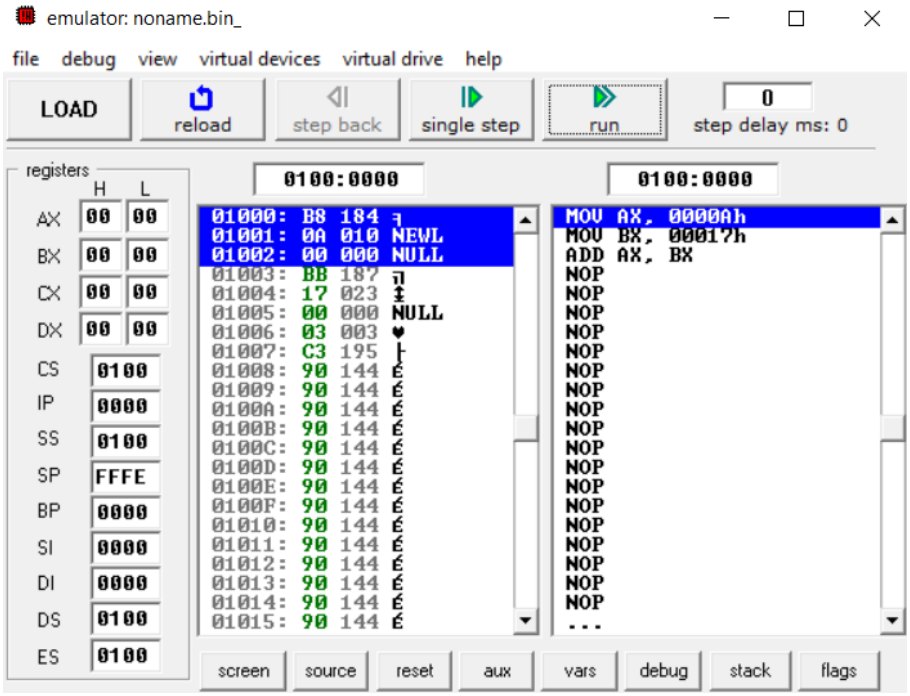


Fig 1.1: Emulator output for Assembly Language Program (After Step 0)

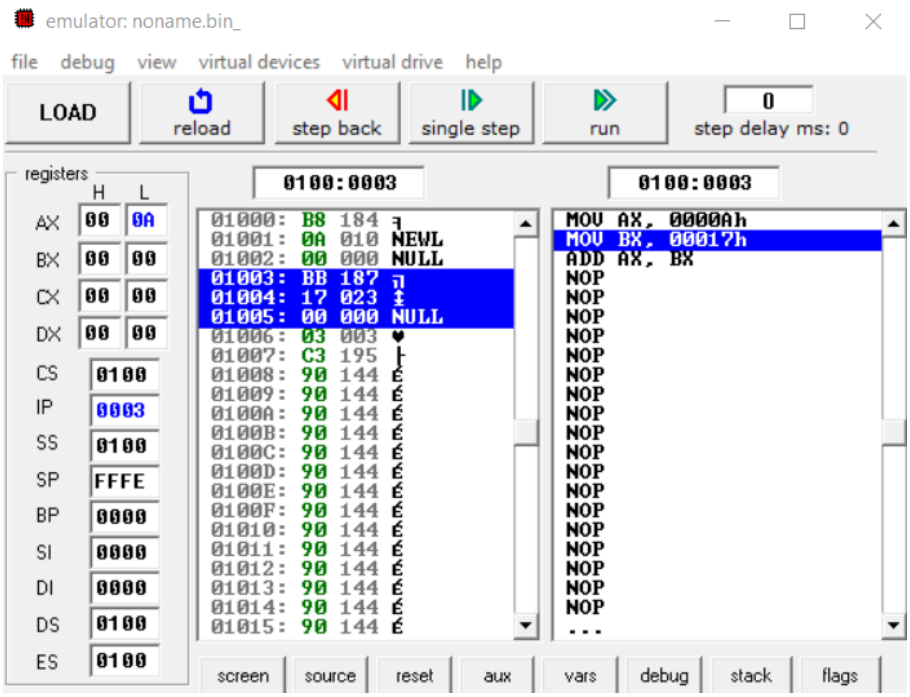


Fig 1.2: Emulator output for Assembly Language Program (After Step 1)

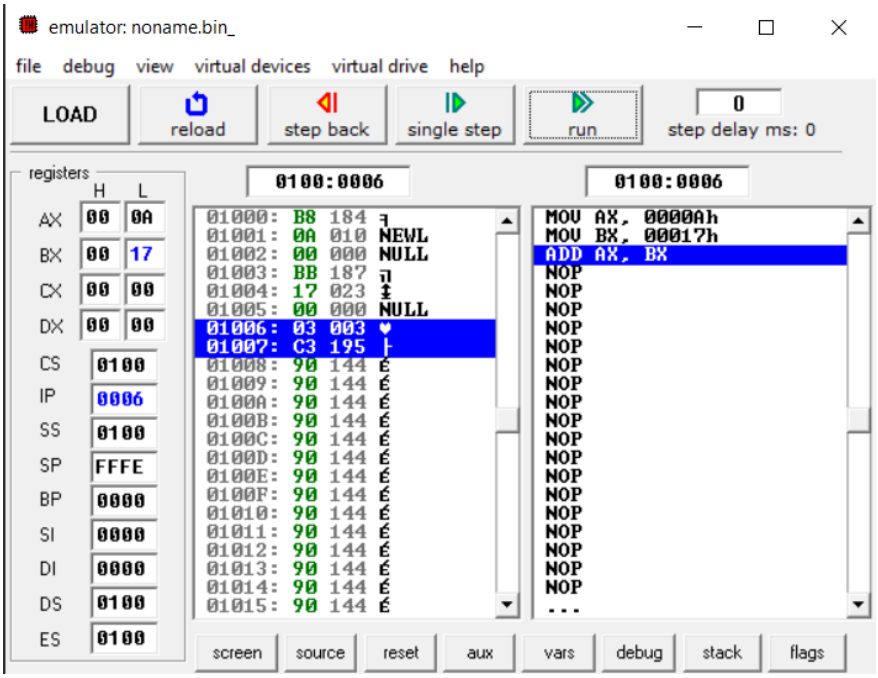


Fig 1.3: Emulator output for Assembly Language Program (After Step 2)

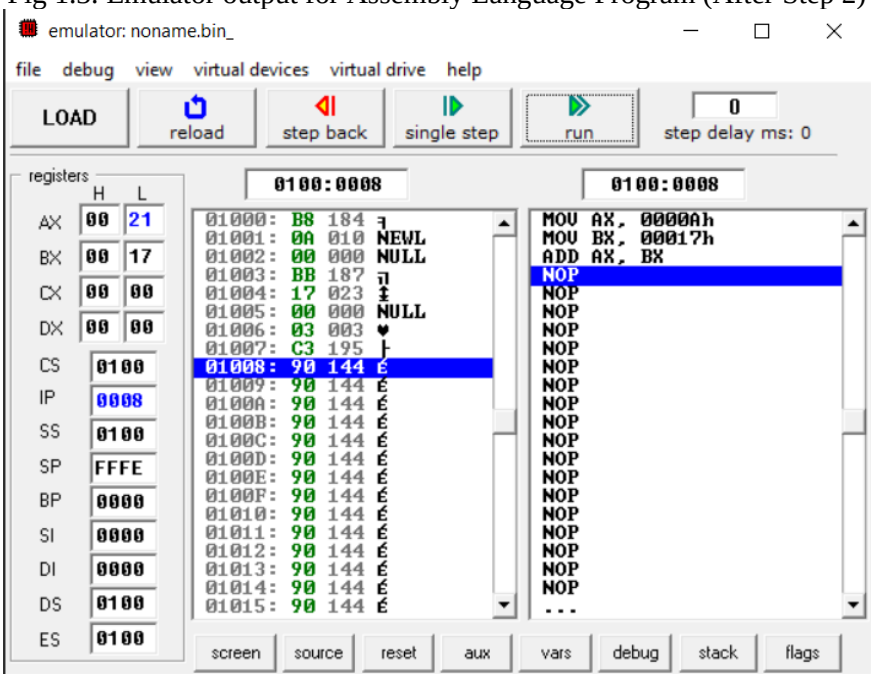


Fig 1.4: Emulator output for Assembly Language Program (After Step-3)

MDA 8086

Fig 1.4: Trainer kit output for Assembly Language Program

1.7 Discussion & Conclusion

In this experiment, the MDA-8086 kit used includes a central processor unit and other components. During this experiment, we became acquainted with the MDA-8086 microprocessor kit and the EMU program.

The instructions are initially stored in memory in a sequential order. The microprocessor reads the instructions from memory, decodes them, and executes them until the STOP command is reached. It then transmits the binary result to the output port. The register stores temporary data between these steps, while the Assembly Language performs computing functions, in this case, we utilized the ADD instruction. In the end, output from emulator and trainer kit was compared and was similar.

Experiment No. 02

2.1 Experiment Name

Arithmetic operations (addition, subtraction, division, and multiplication) using memory location

2.2 Objectives

- To understand the structure of Assembly Language programming
- To learn about the microprocessor emulator "Emu 8086" and its operation
- To know how to addition, subtraction, multiplication, division bit-size number using memory location at “Emu8086” using Assembly language
- To learn how to implement program in “MDA 8086” Trainer Board and interconnect it with “Emu 8086”

2.3 Theory

Arithmetic operations are a branch of mathematics that deals with the study of numbers and the numerical operations that are used in all other branches of mathematics. Assembly-language programming is used to implement it. A low-level programming language for microprocessors and other programmable devices is assembly language. A microprocessor executes a set of instructions written in machine language, directing the processor what to do. A 16-bit microprocessor trainer board, the MDA-8086 Kit. It is made up of various units. Arithmetic instructions are classified into four types: addition, subtraction, multiplication, and division.

- The ADD instruction modifies the contents of another register (destination) or memory address by adding immediate data or the contents of a memory location specified in the instruction. The outcome is saved in the destination operand.
- The SUB instruction modifies the contents of another register (destination) or memory address by subtracting immediate data or the contents of a memory location specified in the instruction.
- The MUL operation is used to multiply two unsigned numbers, while the IMUL procedure is used to multiply two signed numbers. Based on the number of bits, multiplication is split into three types.
- The DIV operation is used for division of two unsigned numbers or operands.

2.4 Apparatus

- Emu 8086 - Microprocessor Emulator

2.5 Emulator Code & Output

- **Addition**

```
DTA DW 5,2,1,9,8
MOV SI, OFFSET DTA
MOV AX, [SI]
MOV BX, [SI+6H]
ADD AX, BX
DAA
```

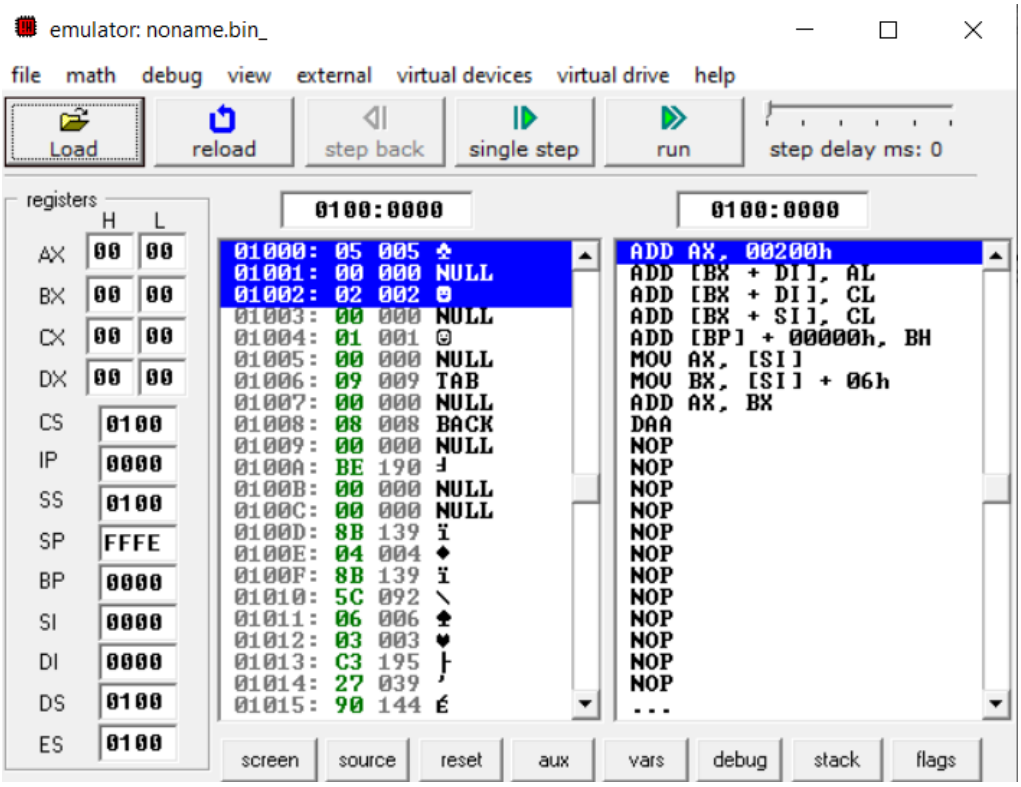


Fig 2.1: Emulator output for Assembly Language Program (After Step 0)

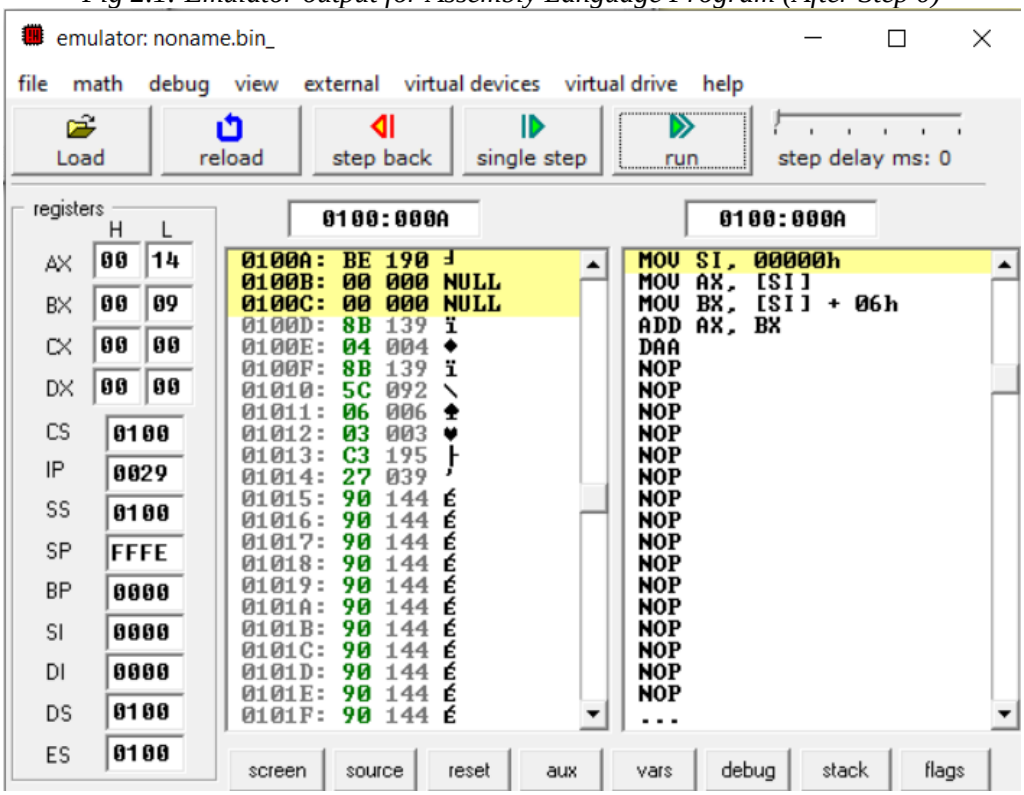


Fig 2.2: Emulator output for Assembly Language Program (After Step 1)

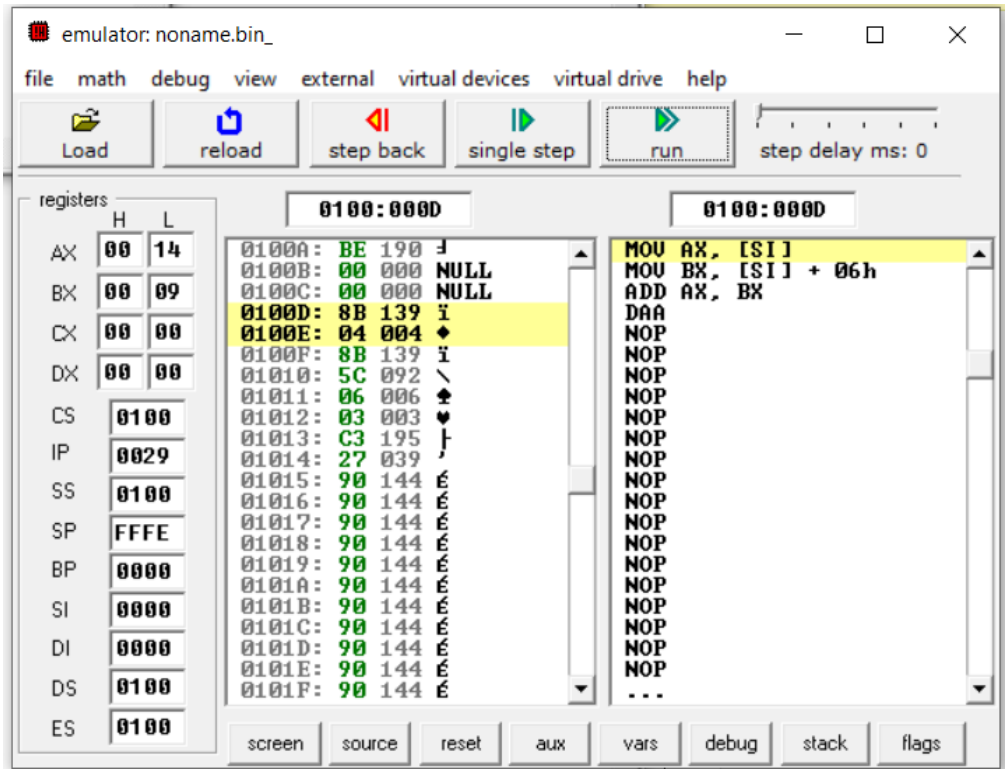


Fig 2.3: Emulator output for Assembly Language Program (After Step 2)

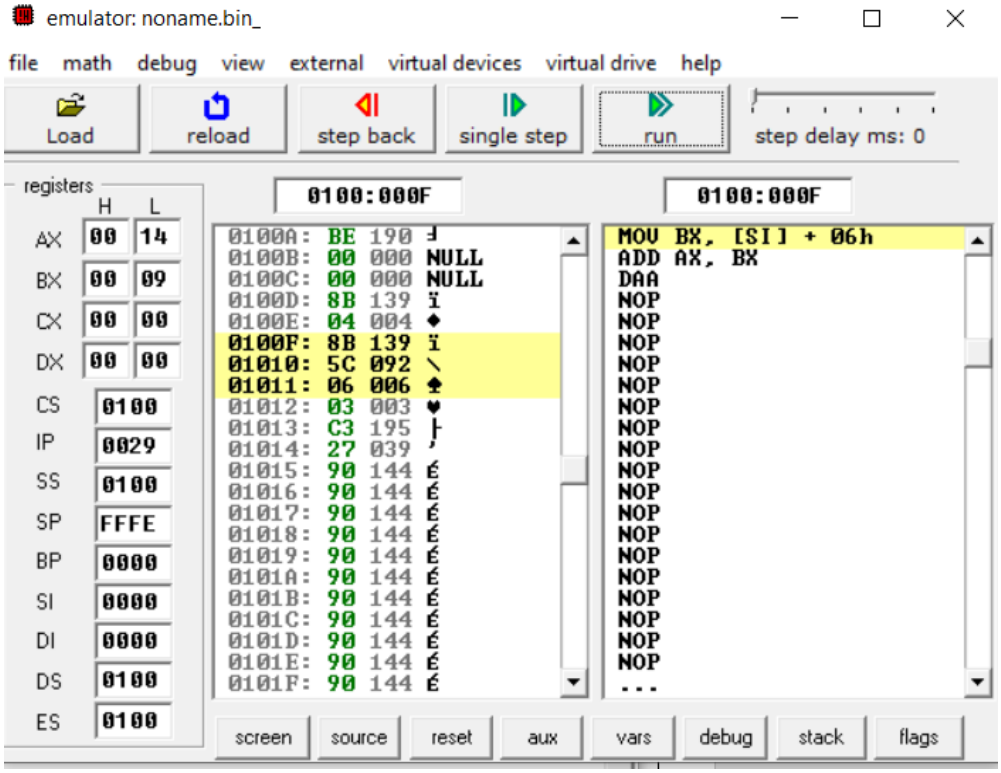


Fig 2.4: Emulator output for Assembly Language Program (After Step-3)

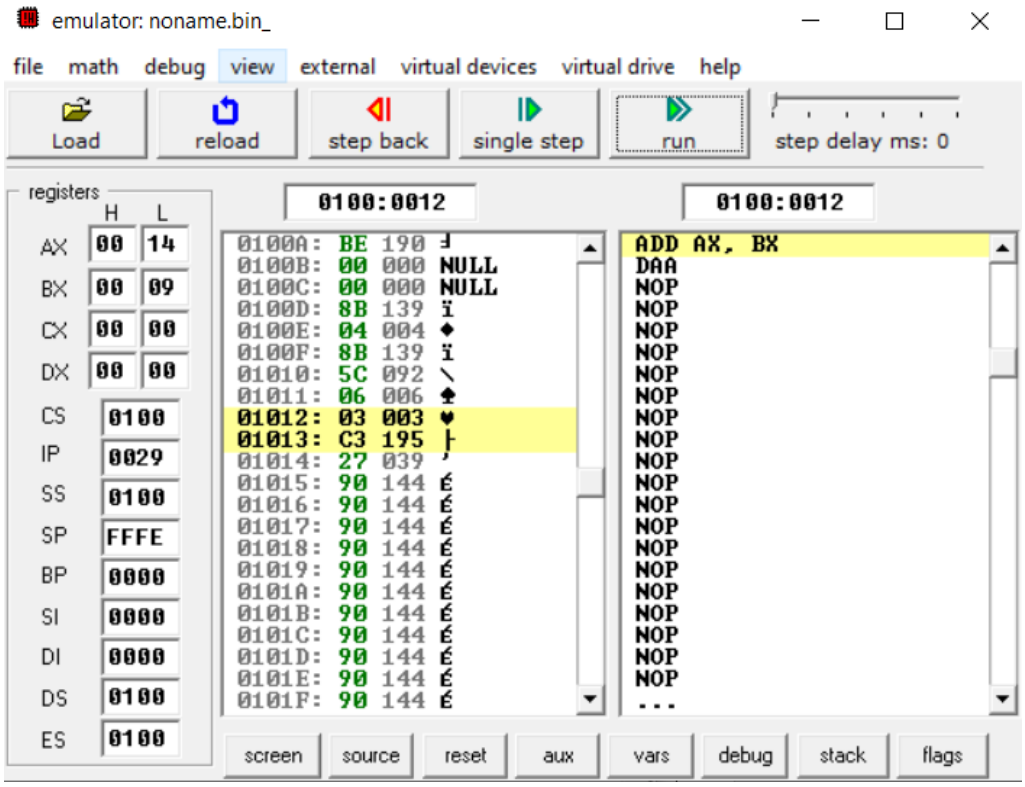


Fig 2.5: Emulator output for Assembly Language Program (After Step-4)

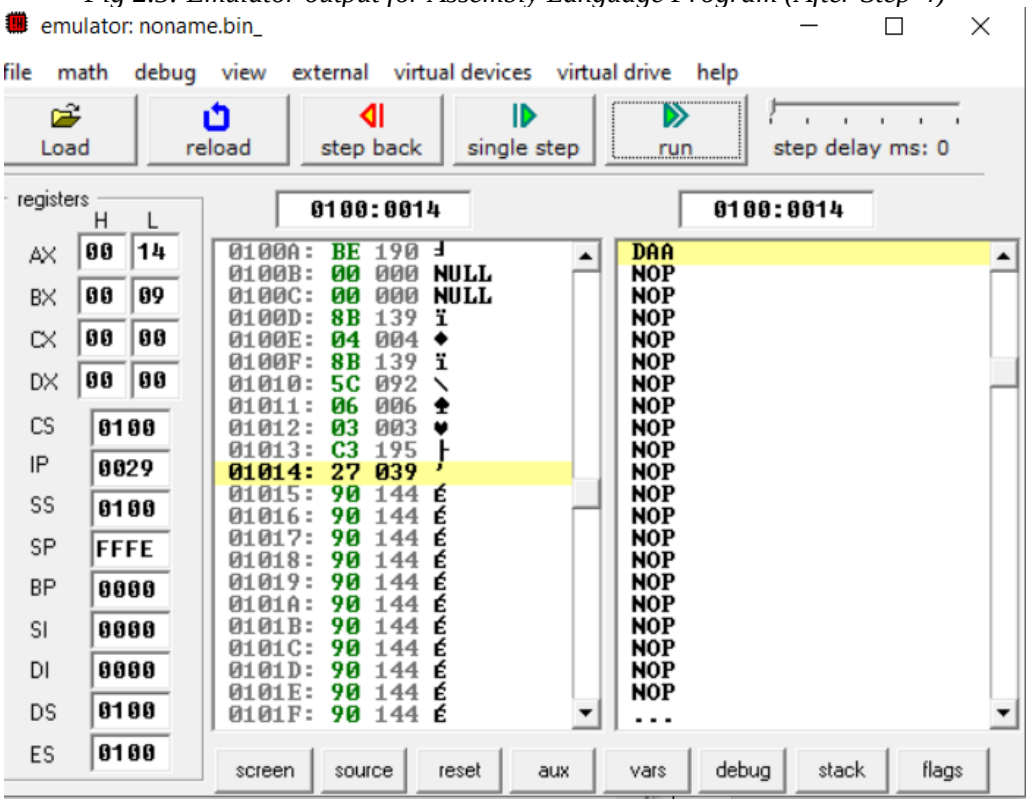


Fig 2.6: Emulator output for Assembly Language Program (After Step-5)

- **Subtraction**

DTA DW 5,2,1,9,8
MOV SI, OFFSET DTA
MOV AX, [SI+6H]

MOV BX, [SI+2H]
ADD AX, BX
DAA

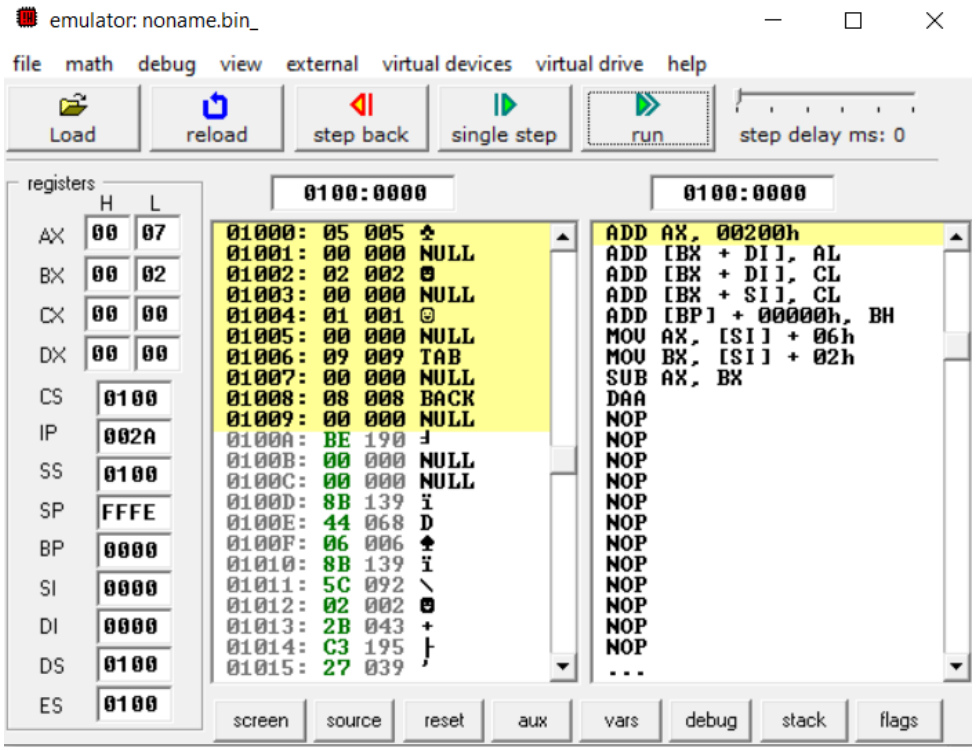


Fig 2.7: Emulator output for Assembly Language Program (After Step 0)

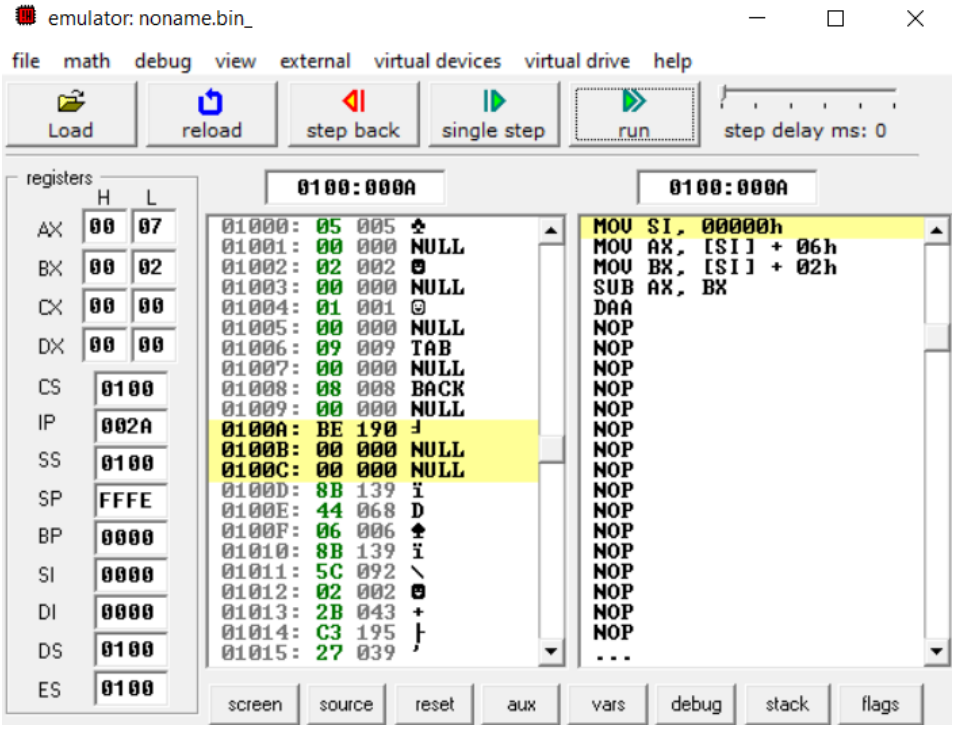


Fig 2.8: Emulator output for Assembly Language Program (After Step 1)

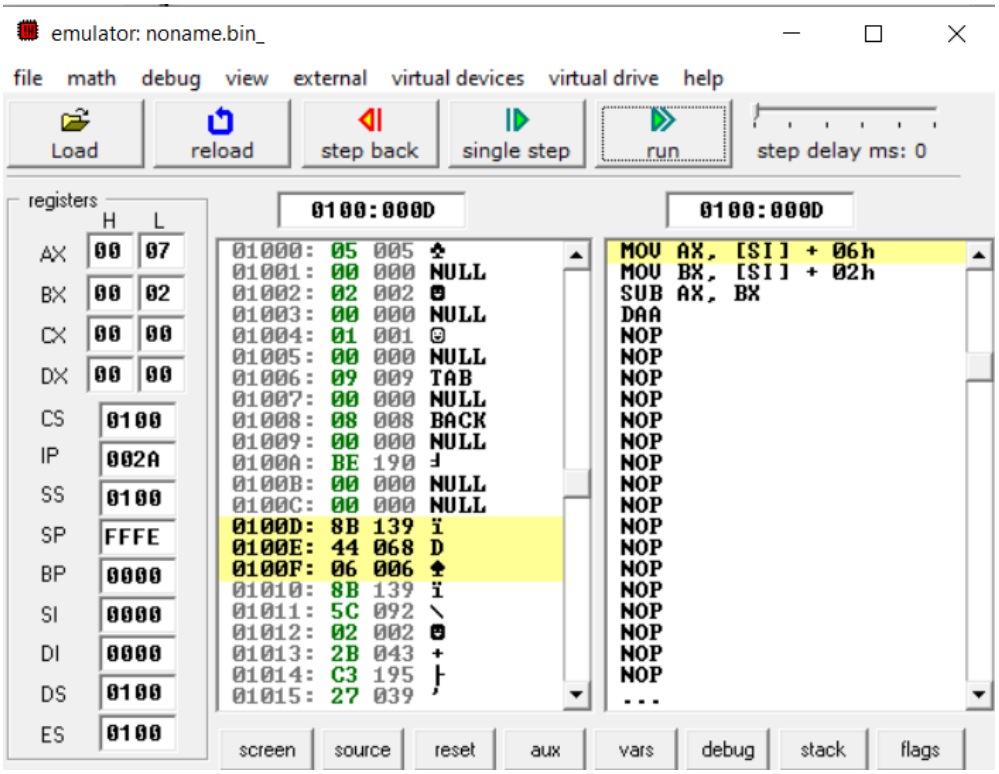


Fig 2.9: Emulator output for Assembly Language Program (After Step 2)

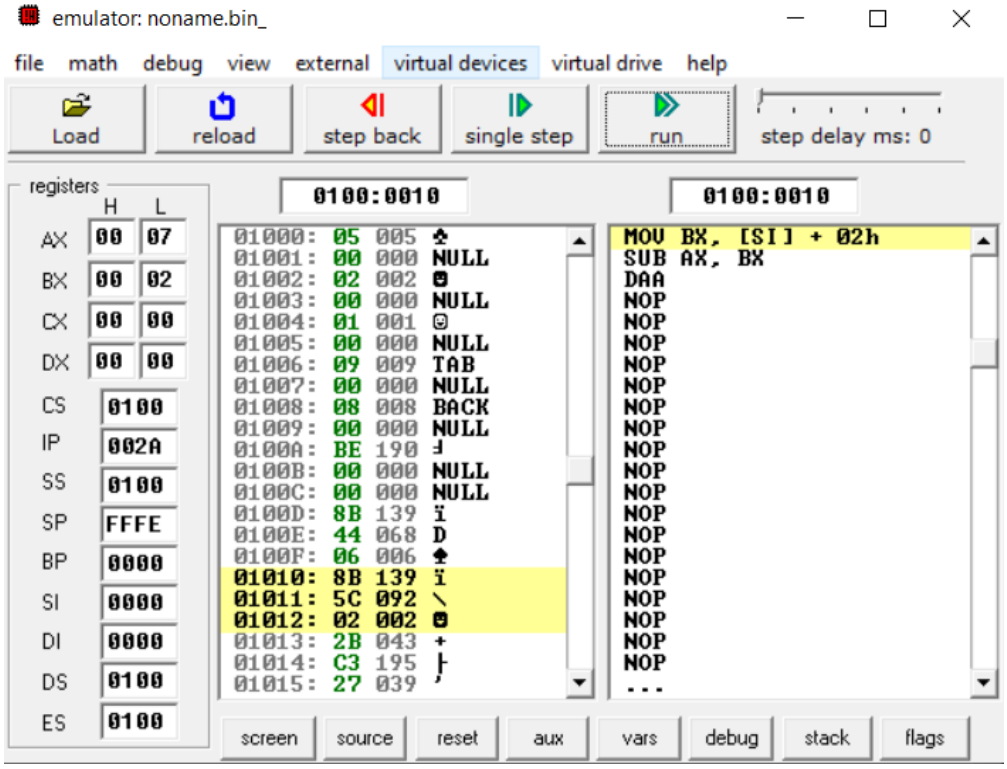


Fig 2.10: Emulator output for Assembly Language Program (After Step 3)

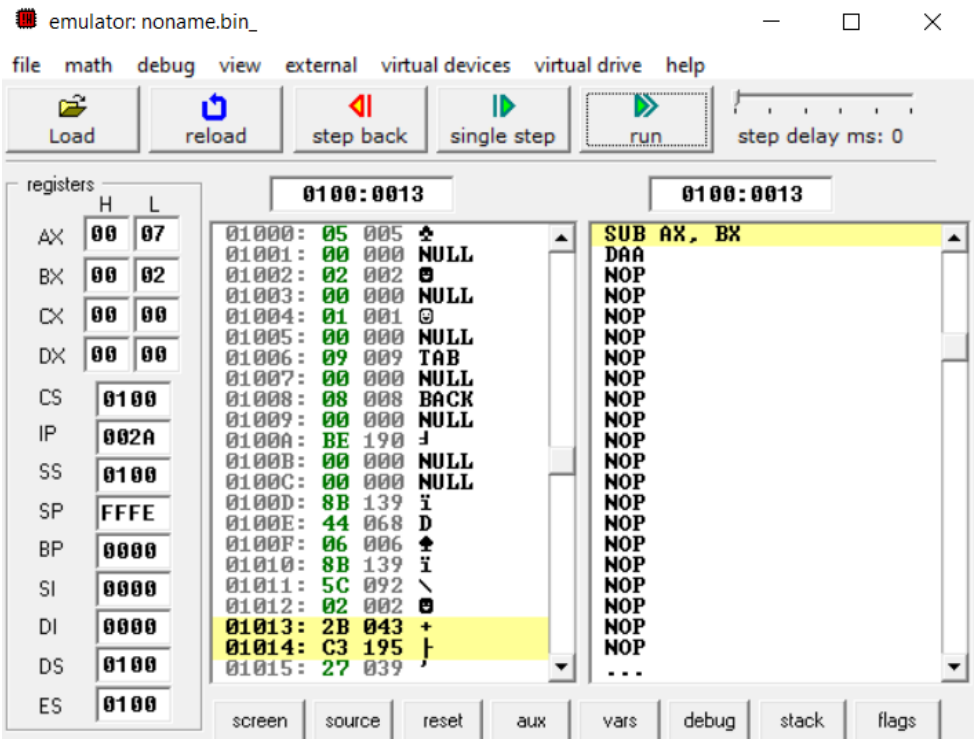


Fig 2.11: Emulator output for Assembly Language Program (After Step 4)

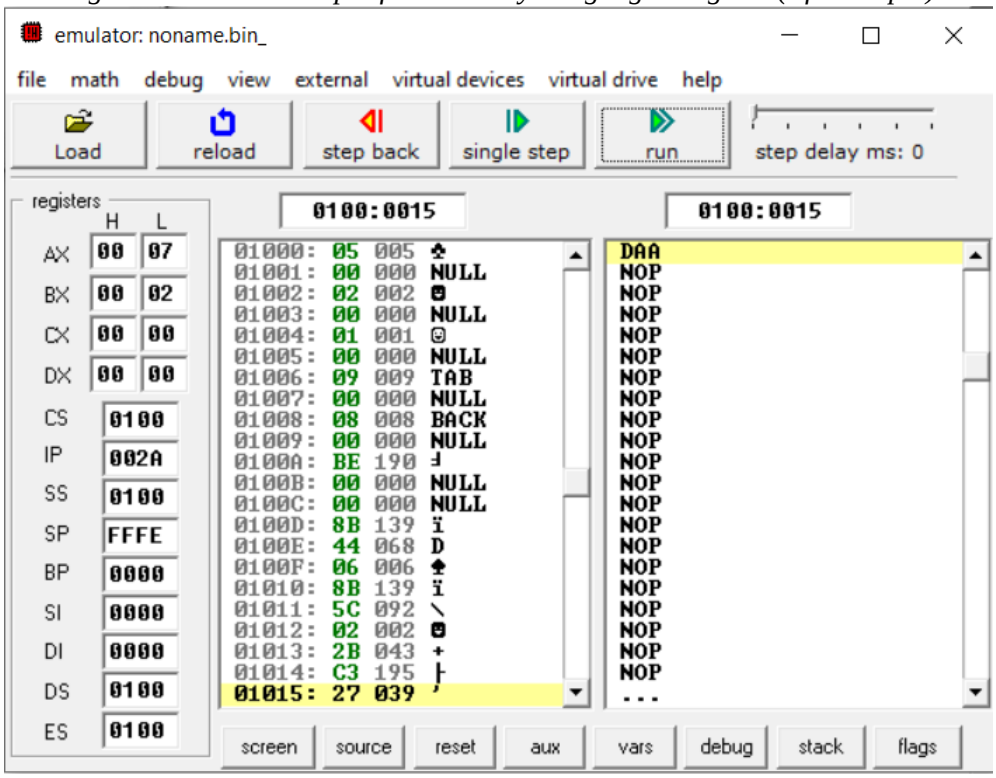


Fig 2.12: Emulator output for Assembly Language Program (After Step 5)

- **Multiplication**

```
MOV AL, 4
MOV SI, 0120H
MOV [SI], 3
MUL [SI]
```

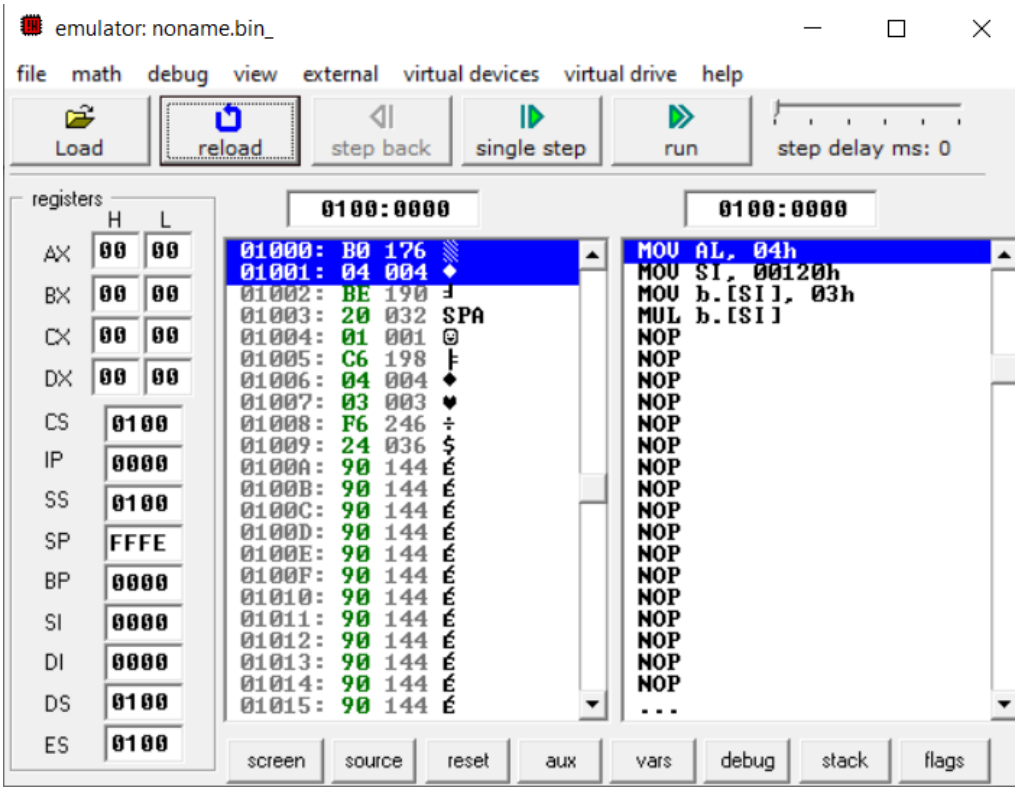


Fig 2.13: Emulator output for Assembly Language Program (After Step 0)

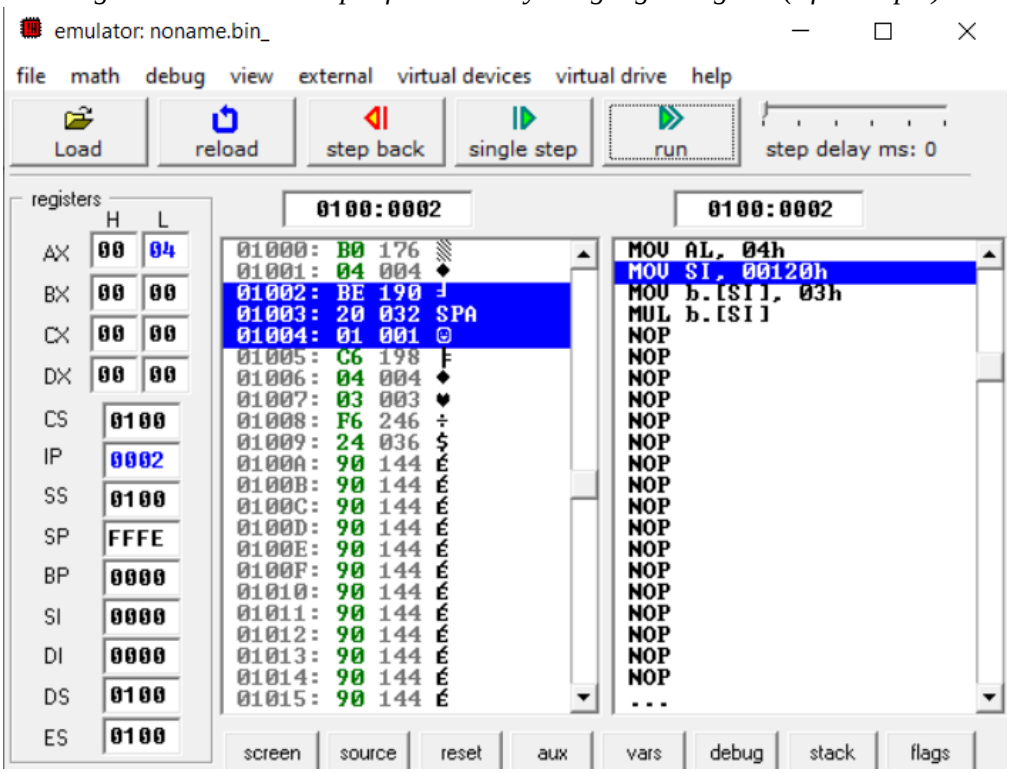


Fig 2.14: Emulator output for Assembly Language Program (After Step 1)

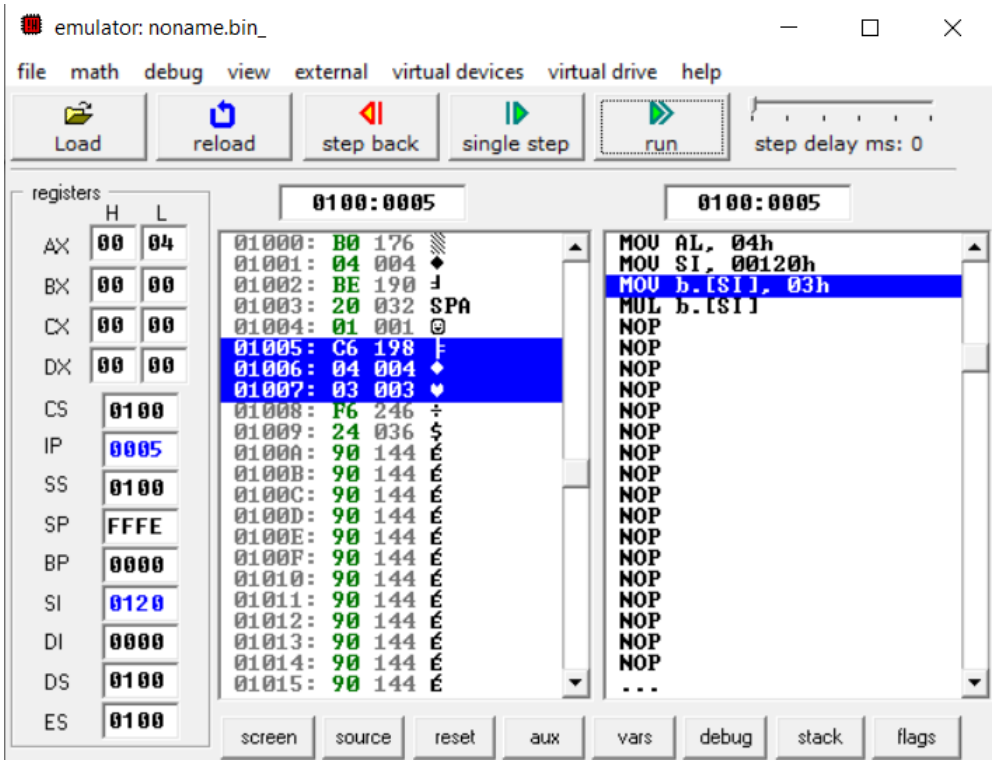


Fig 2.15: Emulator output for Assembly Language Program (After Step 2)

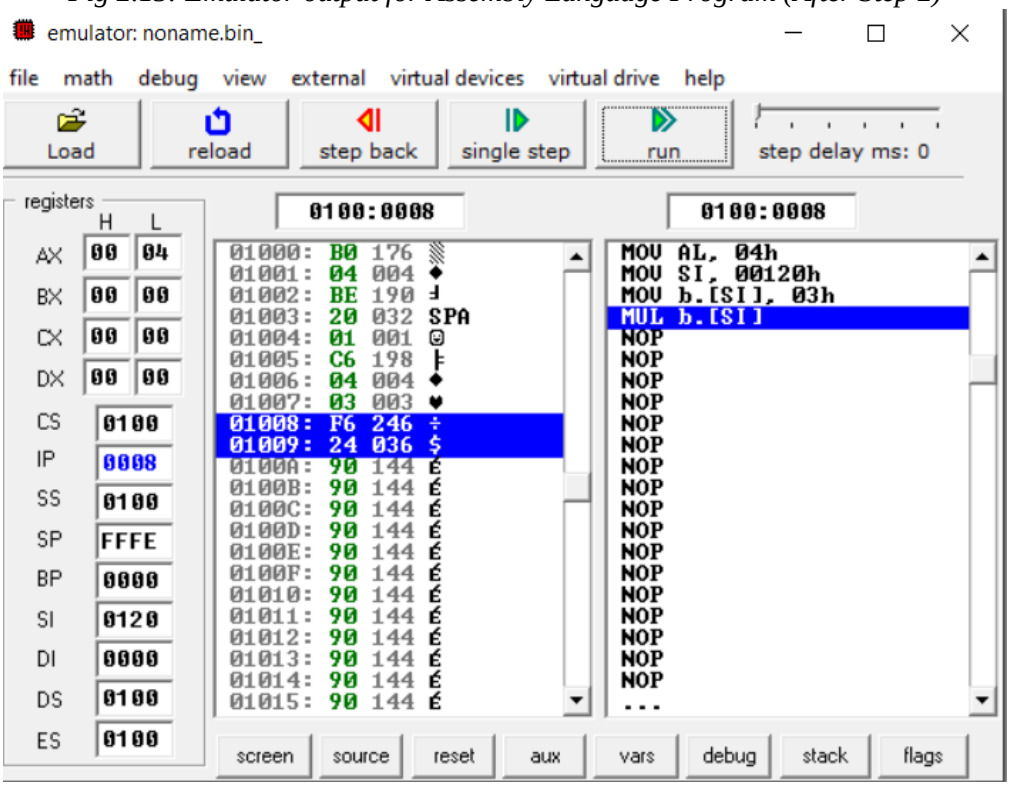


Fig 2.16: Emulator output for Assembly Language Program (After Step 3)

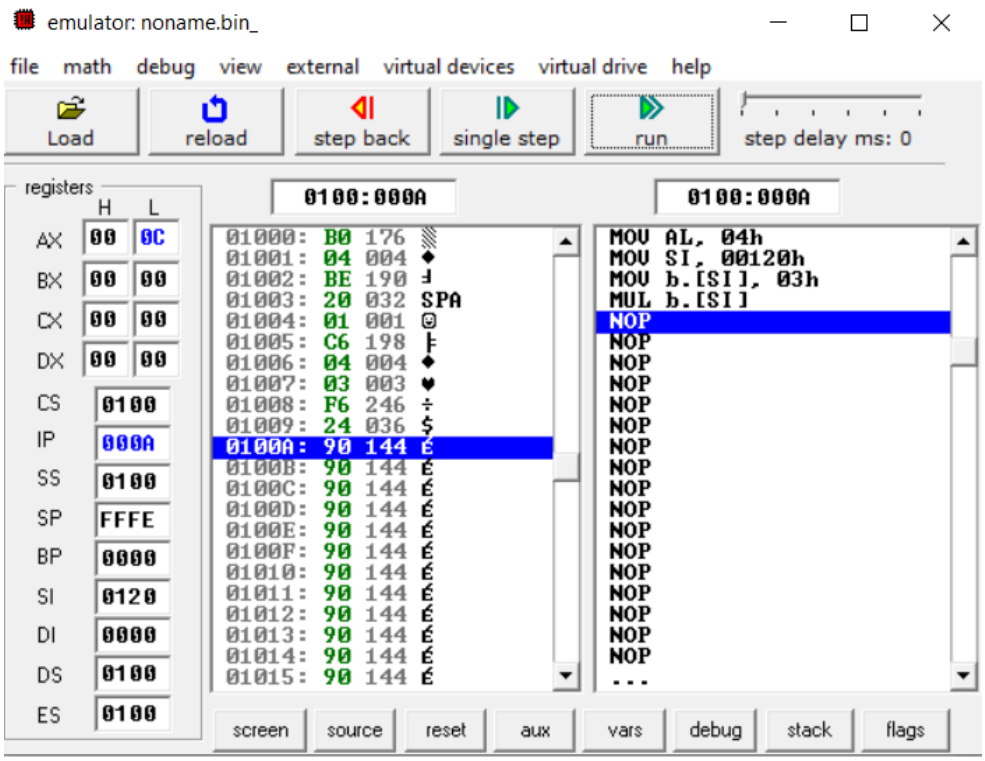


Fig 2.17: Emulator output for Assembly Language Program (After Step 4)

- **Division**

MOV AL, 4
MOV SI, 0120H
MOV [SI], 3
DIV [SI]

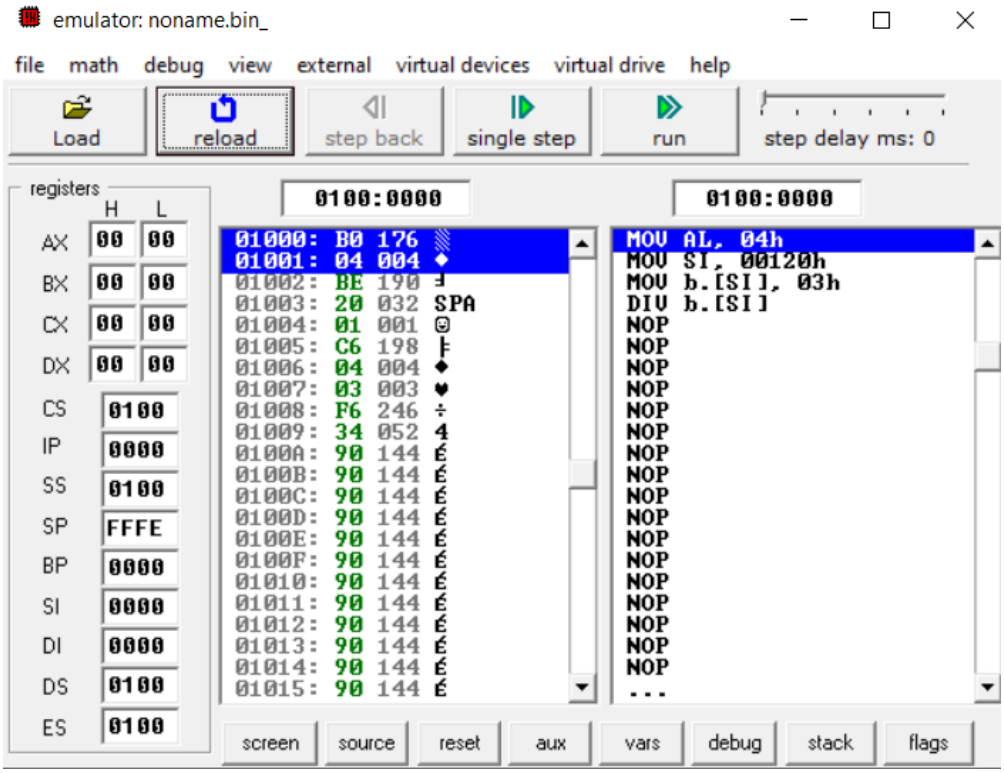


Fig 2.18: Emulator output for Assembly Language Program (After Step 0)

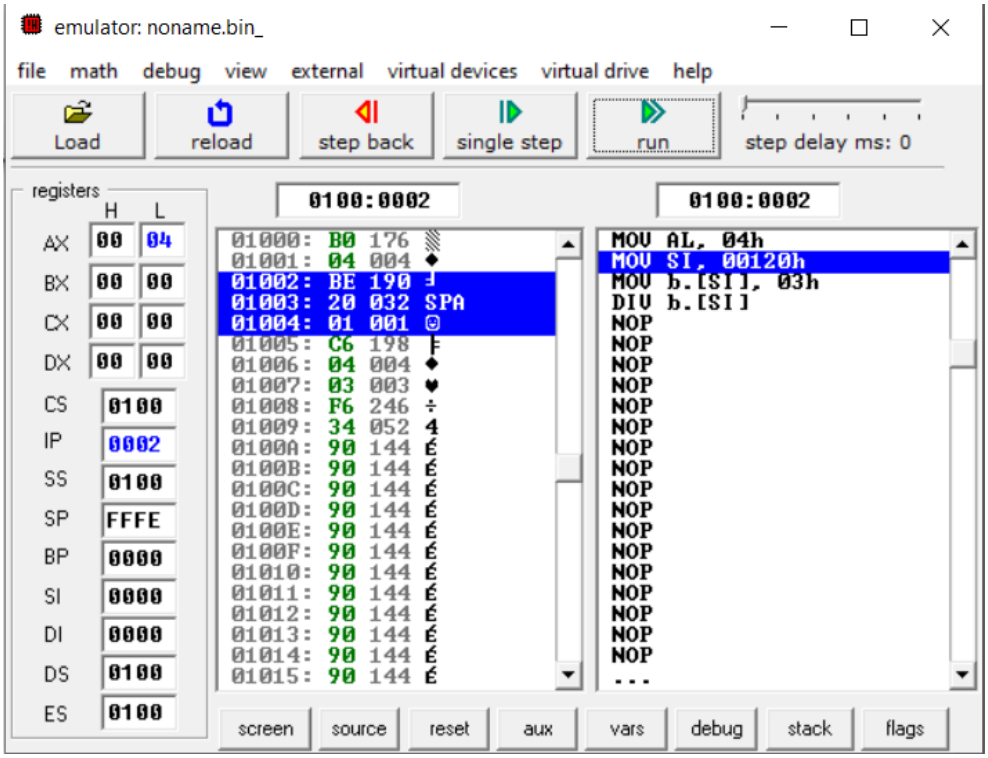


Fig 2.19: Emulator output for Assembly Language Program (After Step 1)

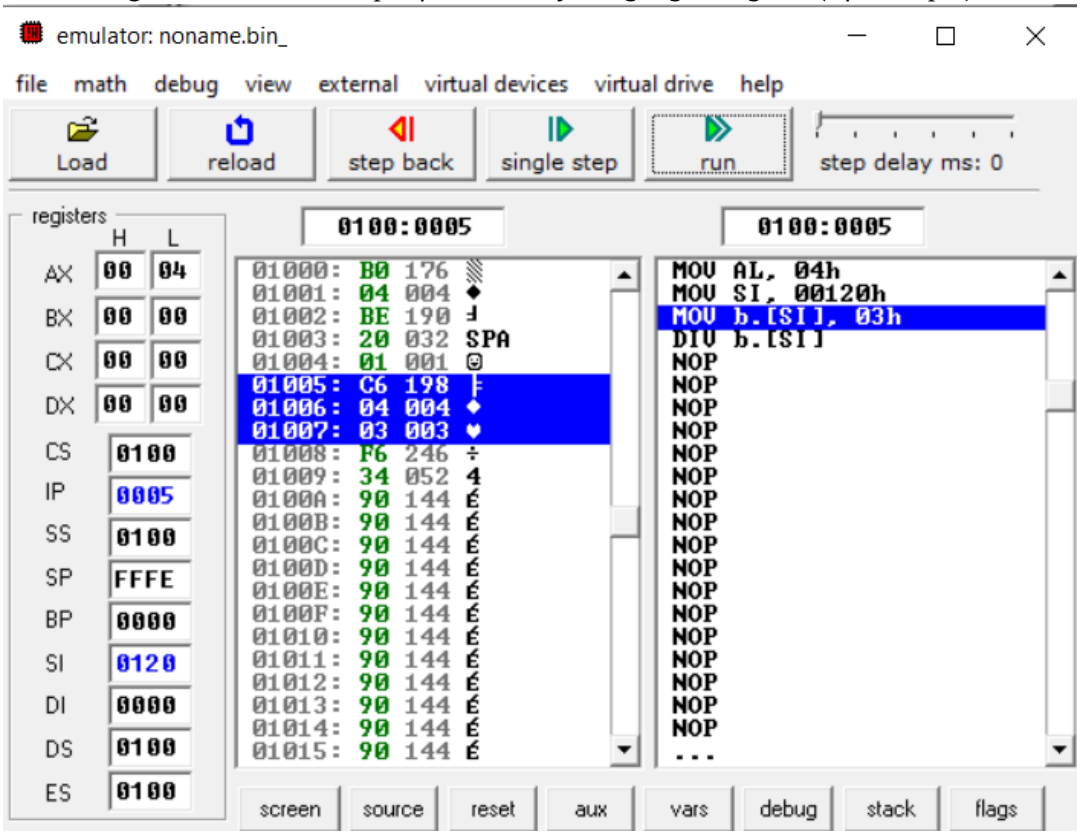


Fig 2.20: Emulator output for Assembly Language Program (After Step 2)

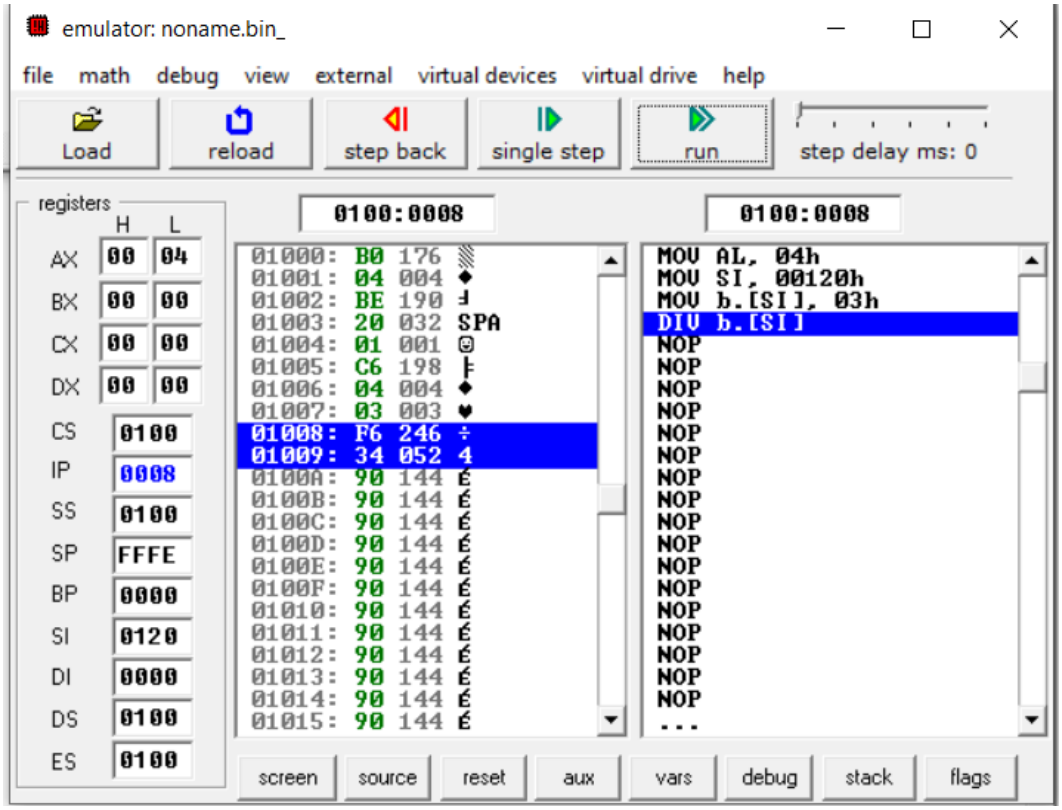


Fig 2.21: Emulator output for Assembly Language Program (After Step 3)

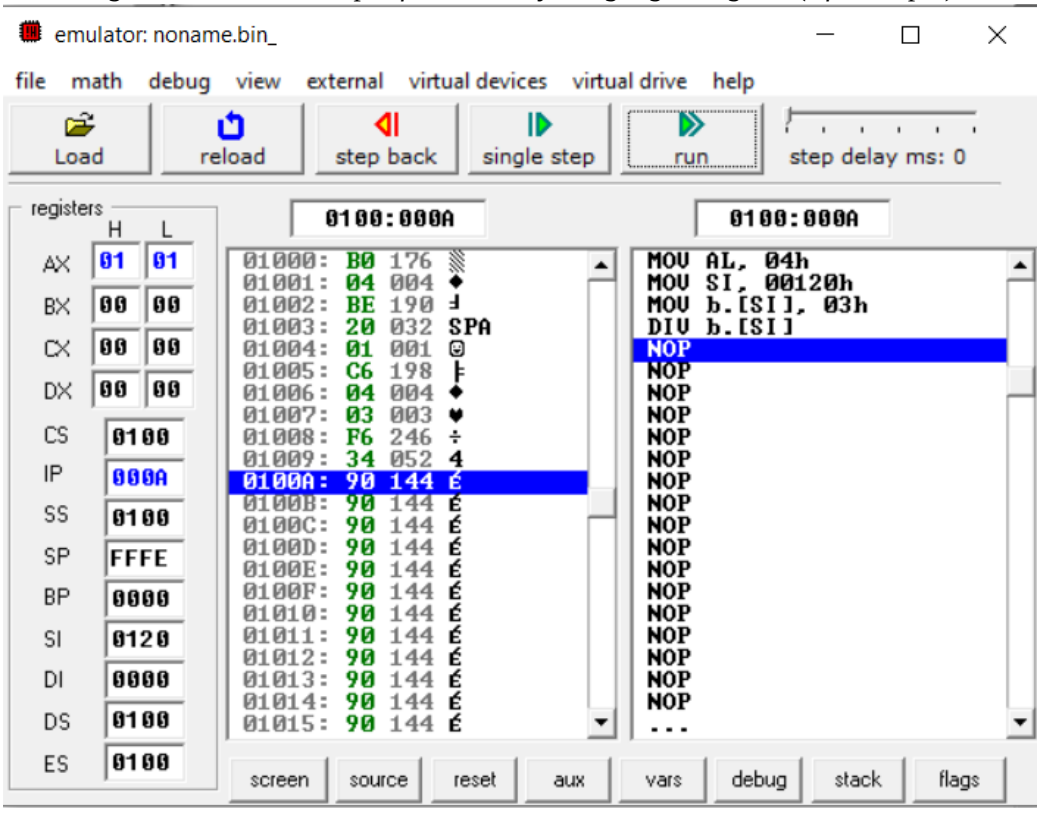


Fig 2.22: Emulator output for Assembly Language Program (After Step 4)

2.6 Discussion & Conclusion

In this experiment, the MDA-8086 kit used includes a central processor unit and other components. During this experiment, we became acquainted with the MDA-8086 microprocessor kit and the EMU program.

The assembly language is written on EMU 8086 to conduct arithmetic operations such as addition, subtraction, division, and multiplication, in various locations in our memory. This is due to the fact that we included the carry from the prior data transaction. MOV instructions were used to maneuver information from a memory location to a register. Then, by running the imitator step by step, the specified output was obtained. Thus, the offset was observed because of the RAM access. The experiment's aims are met, and the results are satisfactory. Finally, the experiment can be described as productive and successful.

Experiment No. 03

3.1 Experiment Name

Logical operation and Loop using Assembly Language Programming

3.2 Objectives

- To understand the structure of Assembly Language programming
- To learn about the microprocessor emulator "Emu 8086" and its operation
- To get acquainted with the logical operation using ALU
- To learn how to implement program in “MDA 8086” Trainer Board and interconnect it with “Emu 8086”

3.3 Theory

In assembly language programming, various logical operation is executed through exclusive instruction sets. In this experiment we will be using following operations and loops for study purpose.

3.3.1 Shift Operation: The shift operation simply changes the provided data bit in the register to the left or right. It comes in two varieties.

- **Shift Left (SHL):** The SHL instruction stands for “shift left”. This instruction moves the given register bits one at a time to the left for a positive integer.
- **Shift Right (SHR):** SHR is an abbreviation for "shift right." This instruction moves the given register bits one at a time to the right.
- **Shift Arithmetic Left (SAL):** The SAL is frequently used when numeric multiplication is required. In other words, shift binary one bit to the left while leaving the MSB untouched.
- **Shift Arithmetic Right (SAR):** SAR is quite similar to SAL with a slight change. It shifts binary one bit to the right while leaving the MSB untouched.

3.3.2 Rotate Operation: This instruction rotates the bits. There are four rotation instructions:

- **Left Rotation (ROL):** The ROL instruction indicates to rotate the bits one by one to the left. The only distinction between ROL and SHL is, in SHL, the value of D0 is replaced by another value, whereas in ROL, the value of D0 is replaced by the bit from position D7.
- **Right Rotation (ROR):** The ROR instruction means to rotate the bits to the right one at a time. The sole difference between ROR and SHR is that in SHR, the bit of position D7 is replaced with another value.
- **Left Rotation with Carry (RCL):** The bits in the operand are rotated through the carry flag to the left using RCL. The most significant bit, together with the carry flag, is relocated to the least significant bit by the RCL instruction.
- **Right Rotation with Carry (RCR):** The bits in the operand are rotated through the carry flag using RCR. The least significant bit, together with the carry flag, is relocated to the most significant bit by the RCR instruction.

3.3.3 AND

Only if both of its inputs are true does the AND logic function return true. If one of the inputs is false, the output will be false as well.

3.3.4 OR

In OR operation, if one of the inputs is true, function return true. If one of the inputs is false, the output will be false as well.

3.3.5 X- OR

XOR compares two input bits and generates one output bit. The logic is simple. If the bits are the same, the result is true. If the bits are different, the result is false.

We will also implement looping operation in this experiment. Through this instruction, we will execute operation for the number of times defined before the loop

3.4 Apparatus

- Emu 8086 - Microprocessor Emulator

3.5 Emulator Code & output

- **SHL**

```
MOV CL, 2; COUNTER
MOV AX, 0B3H; MOVE 0B3H TO AX
SHL AX, CL; SHIFT LEFT
```

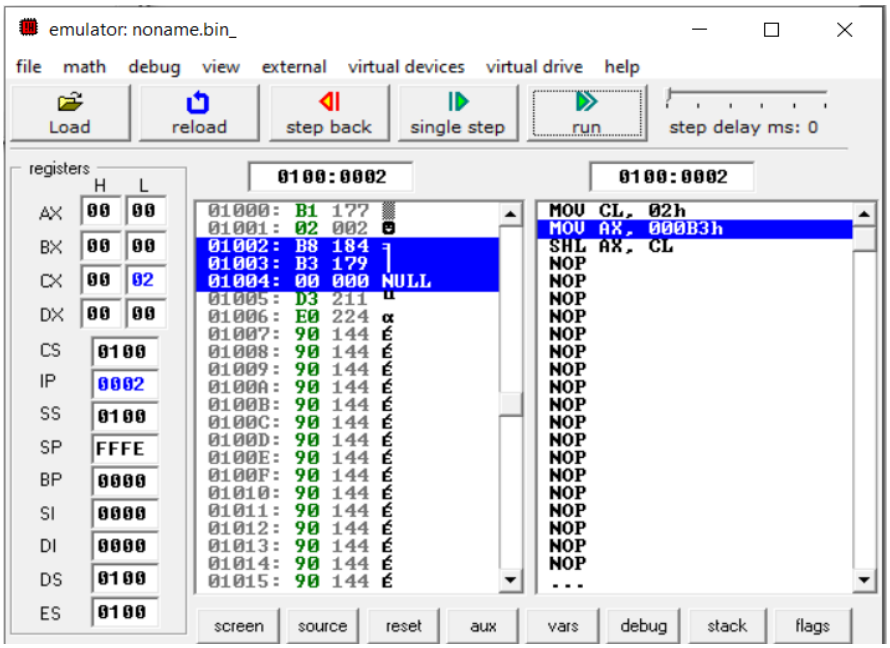


Fig 3.1: Emulator output for SHL (After Step 1)

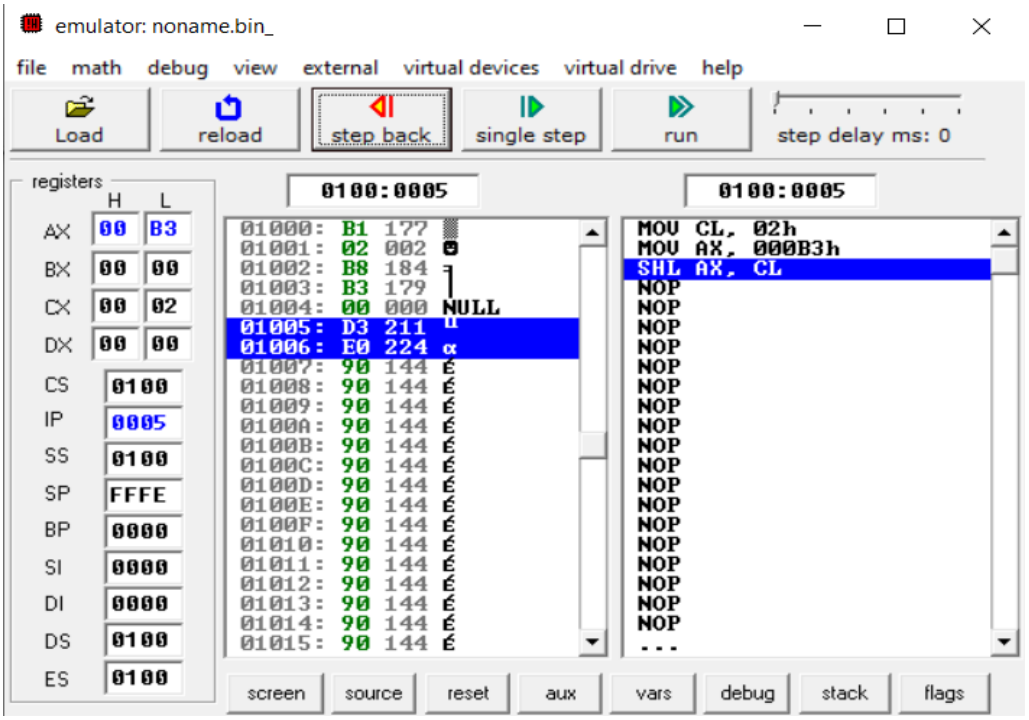


Fig 3.2: Emulator output for SHL (After Step 2)

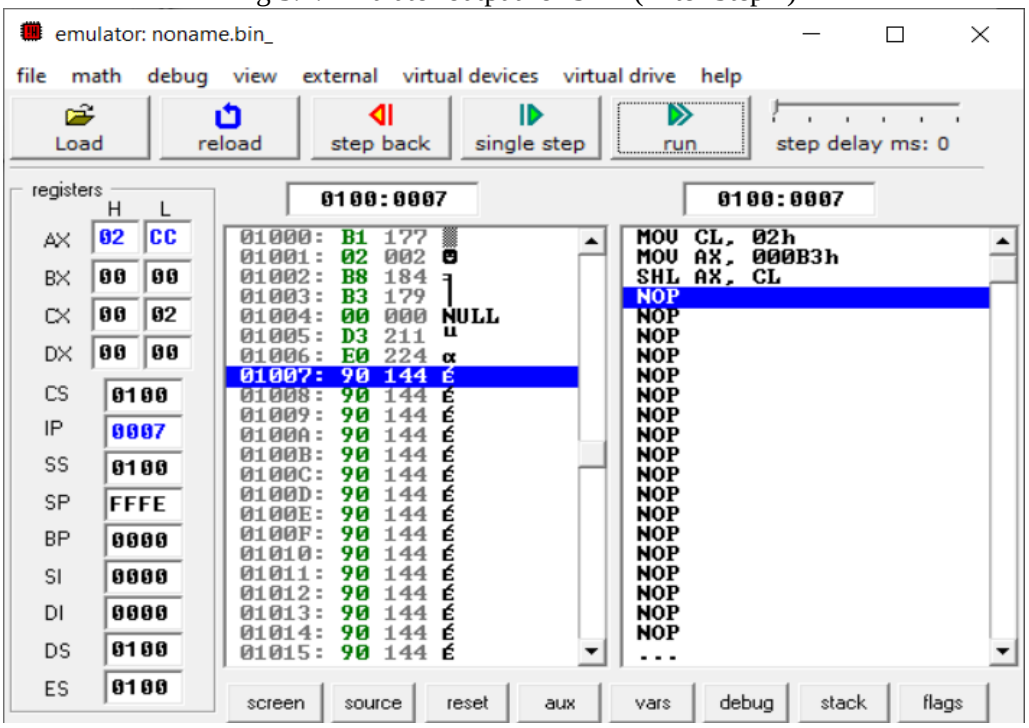


Fig 3.3: Emulator output for SHL (After Step 3)

- **SHR**

```
MOV CL, 2; COUNTER
MOV AX, 0B3H; MOVE 0B3H TO AX
SHR AX, CL; SHIFT LEFT
```

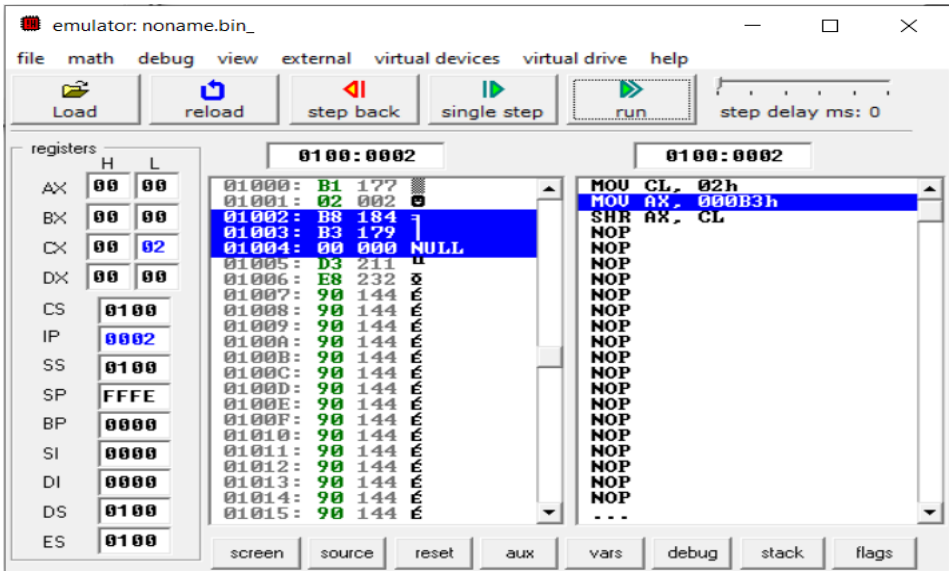


Fig 3.4: Emulator output for SHR (After Step 1)

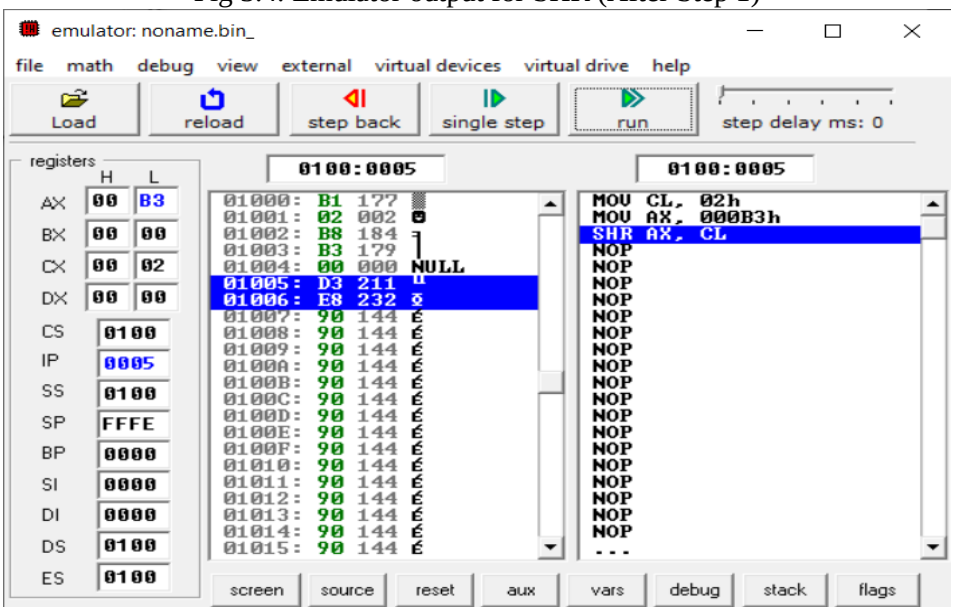


Fig 3.5: Emulator output for SHR (After Step 2)

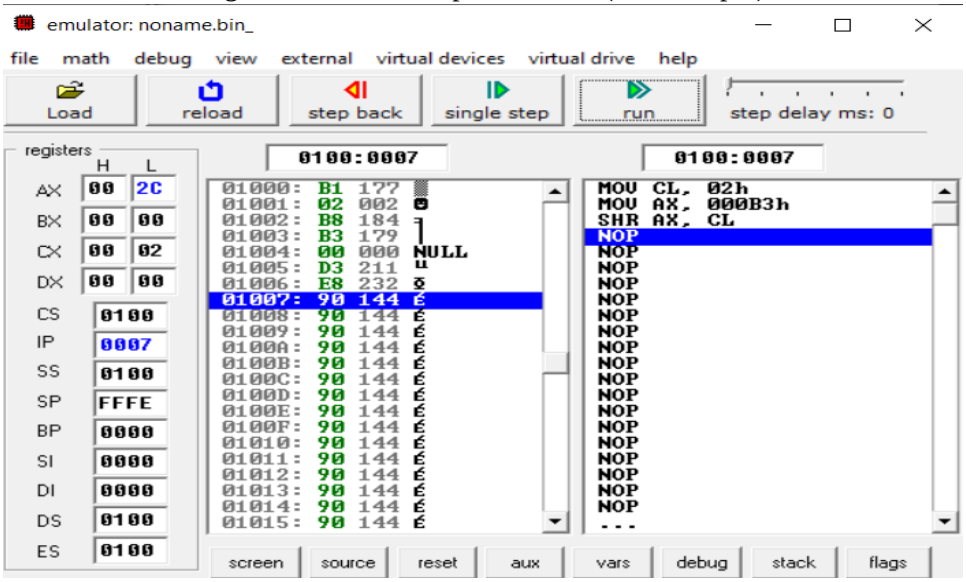


Fig 3.6: Emulator output for SHR (After Step 3)

- **SAL**

```
MOV CL, 2; COUNTER
MOV AX, 0B3H; MOVE 0B3H TO AX
SAL AX, CL; SHIFT ARITHAMTIC LEFT
```

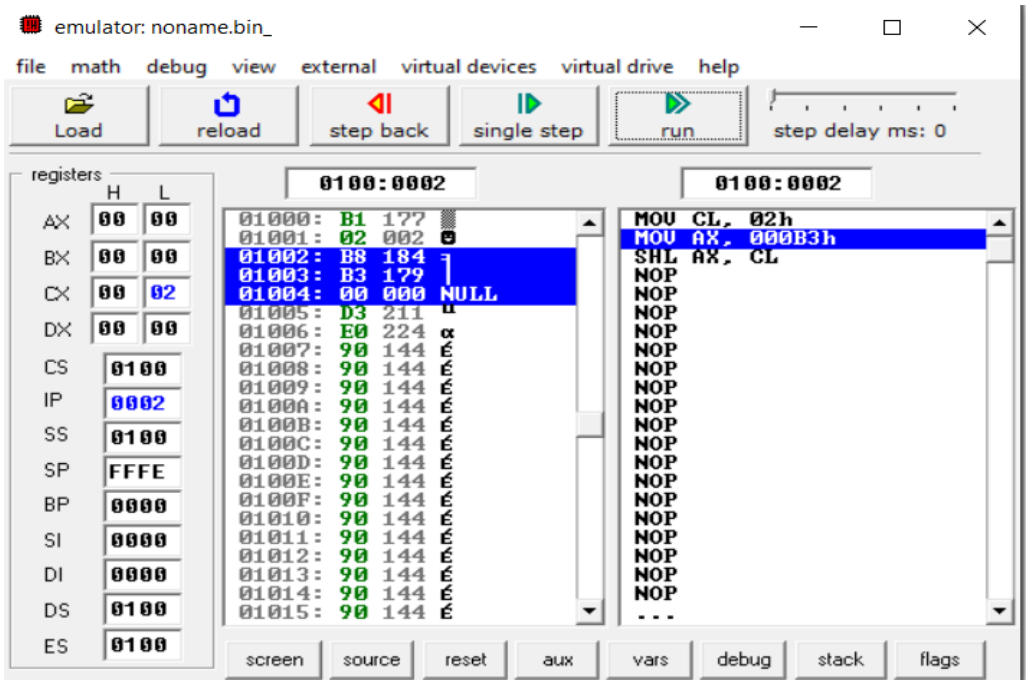


Fig 3.7: Emulator output for SAL (After Step 1)

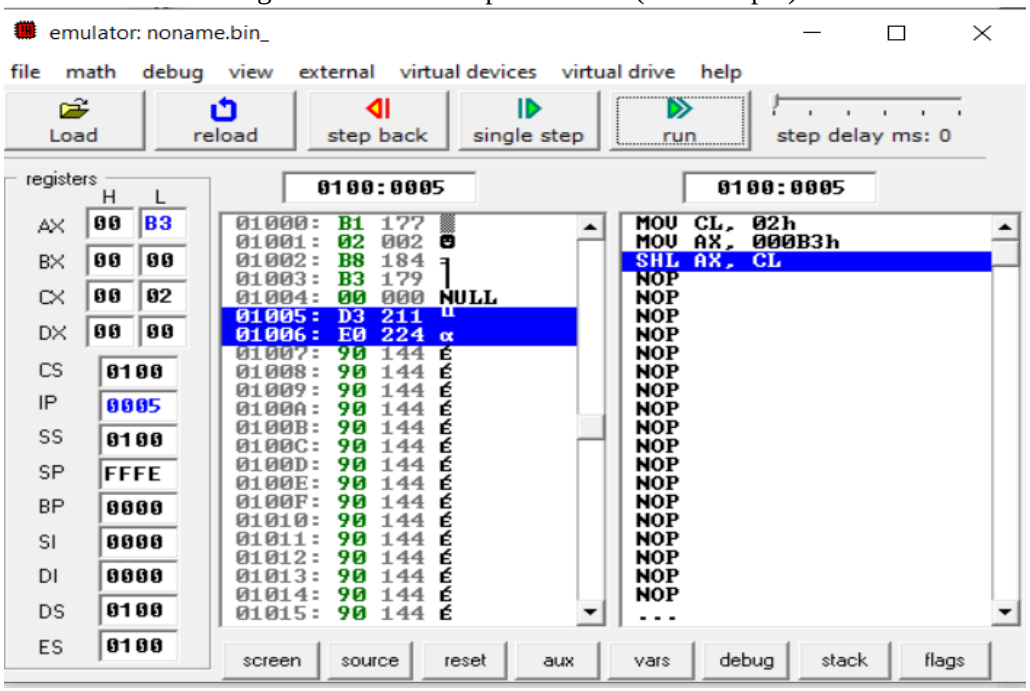


Fig 3.8: Emulator output for SAL (After Step 2)

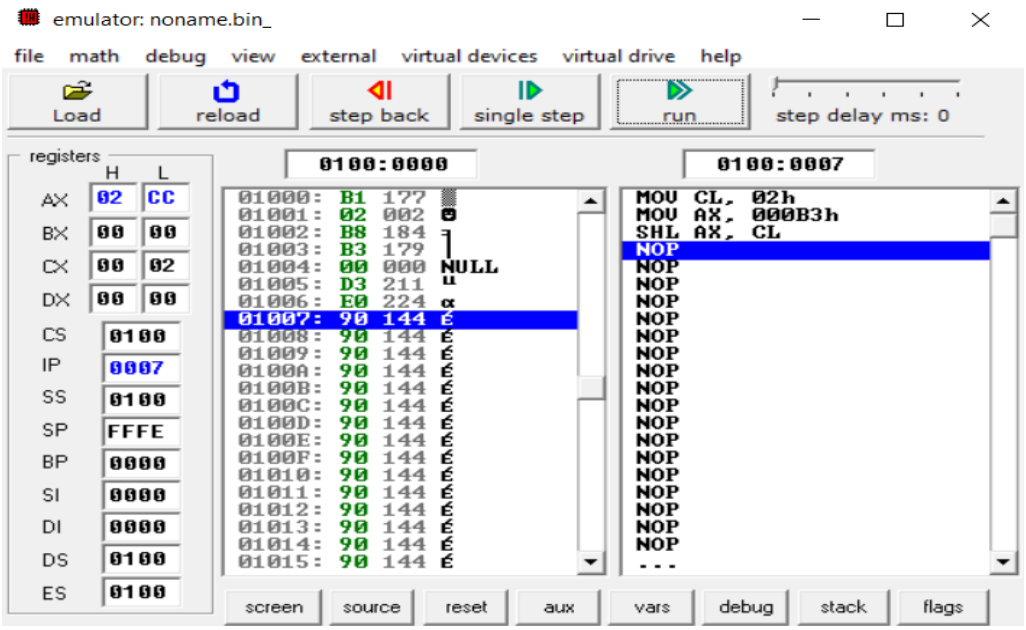


Fig 3.9: Emulator output for SAL (After Step 3)

- **SAR**

```
MOV CL, 2; COUNTER
MOV AX, 0B3H; MOVE 0B3H TO AX
SAR AX, CL; SHIFT ARITHAMTIC LEFT
```

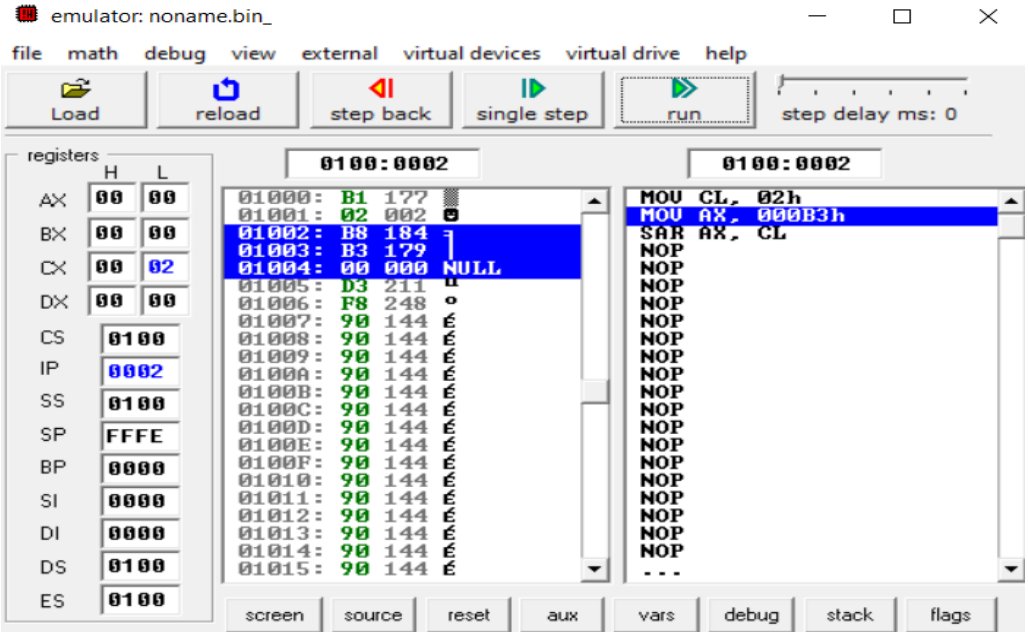


Fig 3.10: Emulator output for SAR (After Step 1)

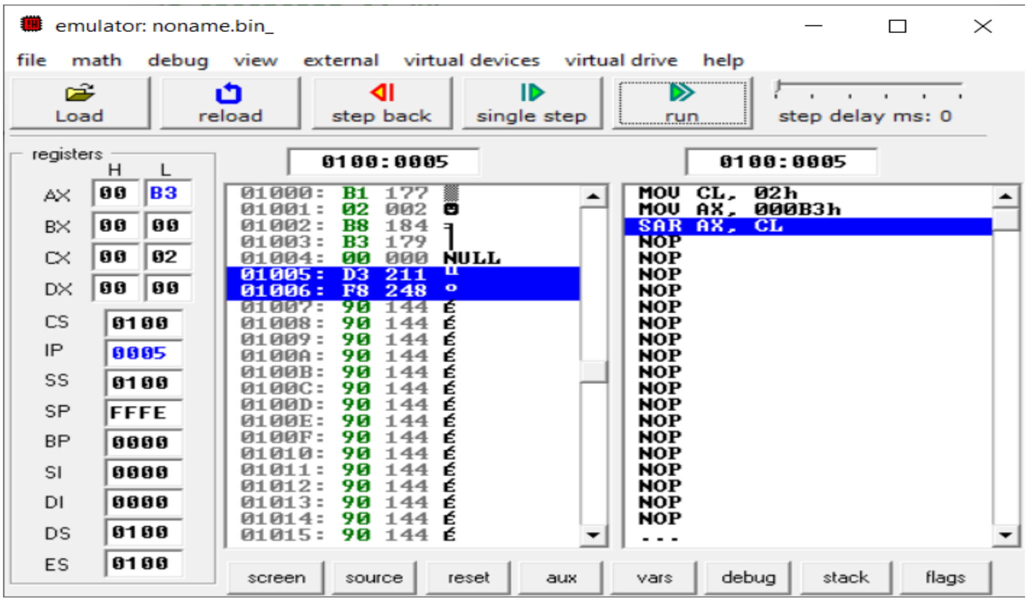


Fig 3.11: Emulator output for SAR (After Step 2)

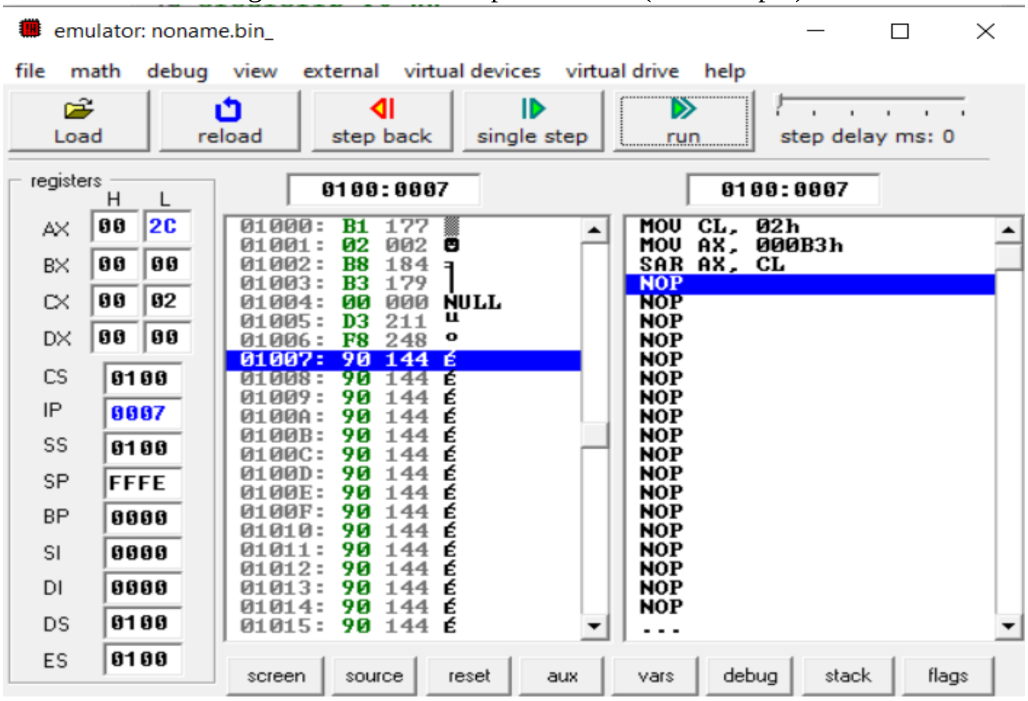


Fig 3.12: Emulator output for SAR (After Step 3)

- **ROL**

MOV CL, 2; COUNTER
MOV AX, 0B3H; MOVE 0B3H TO AX
ROL AX, CL; ROTATE LEFT

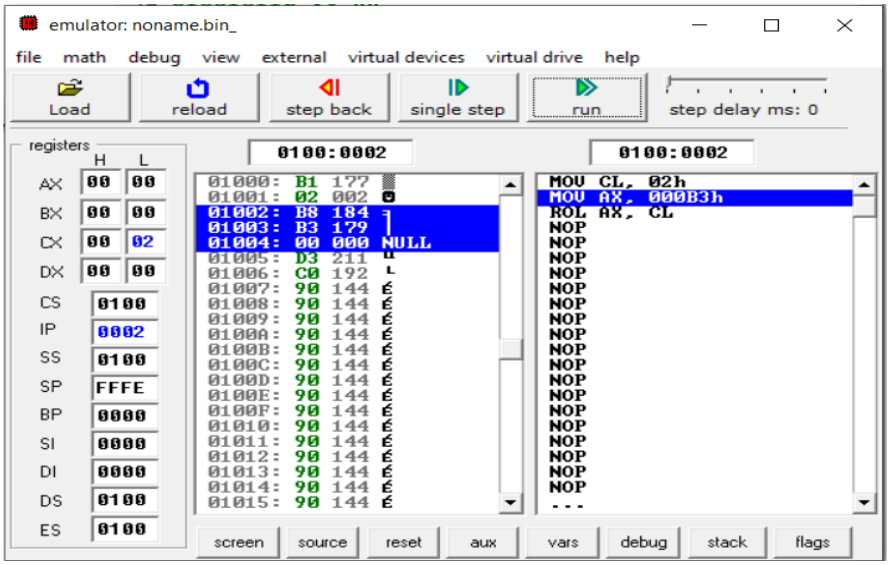


Fig 3.13: Emulator output for ROL (After Step 1)

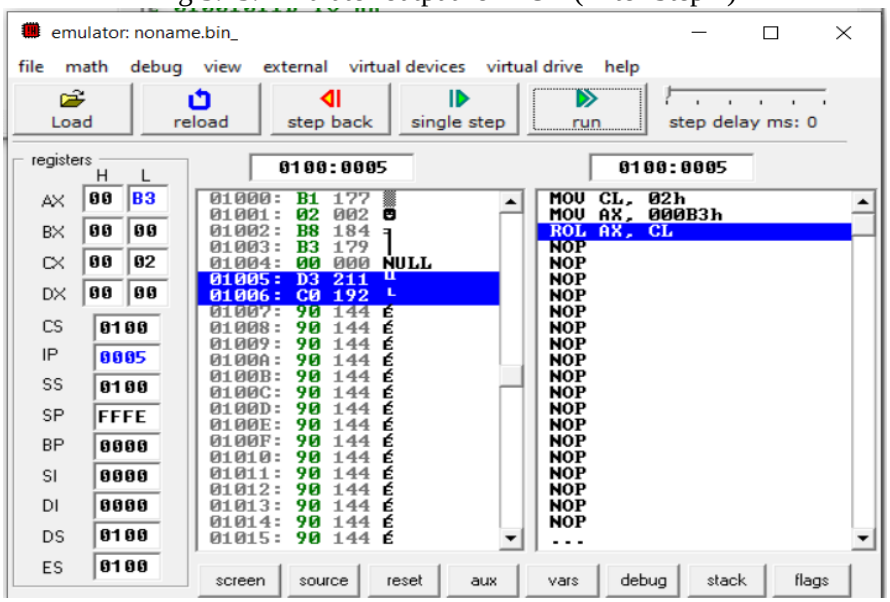


Fig 3.14: Emulator output for ROL (After Step 2)

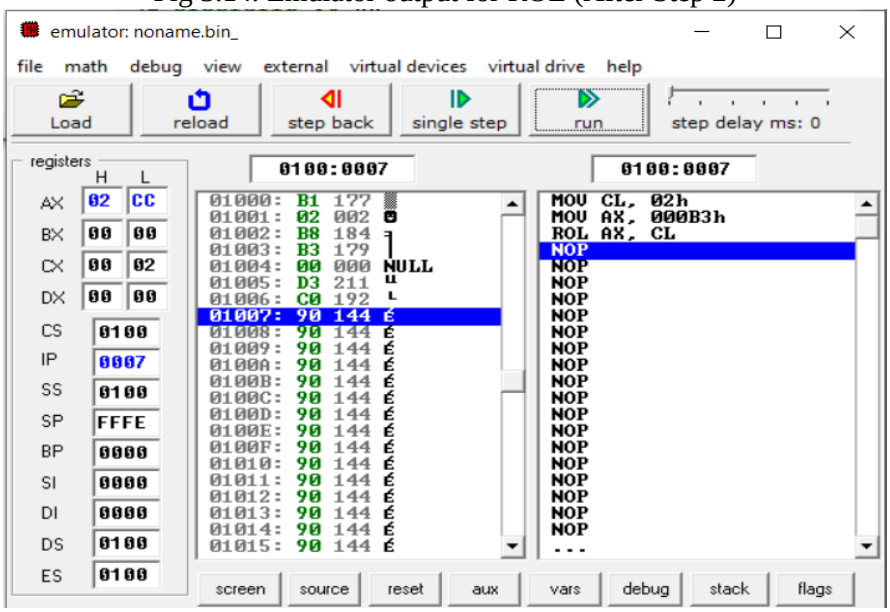


Fig 3.15: Emulator output for ROL (After Step 3)

- **ROR**

```
MOV CL, 2; COUNTER
MOV AX, 0B3H; MOVE 0B3H TO AX
ROR AX, CL; ROTATE RIGHT
```

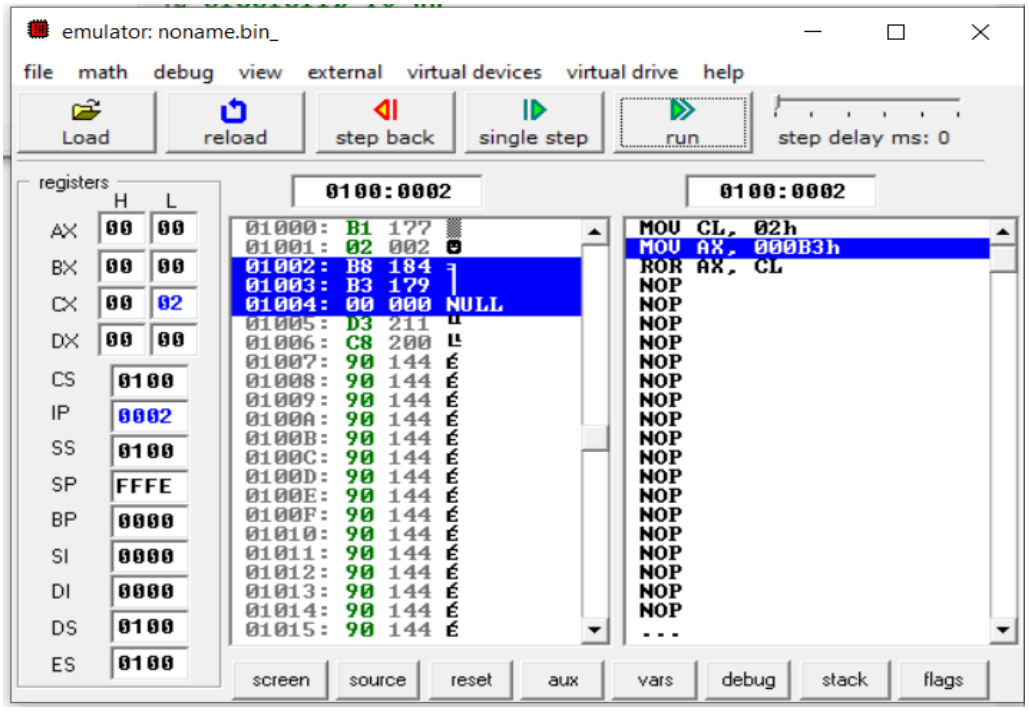


Fig 3.16: Emulator output for ROR (After Step 1)

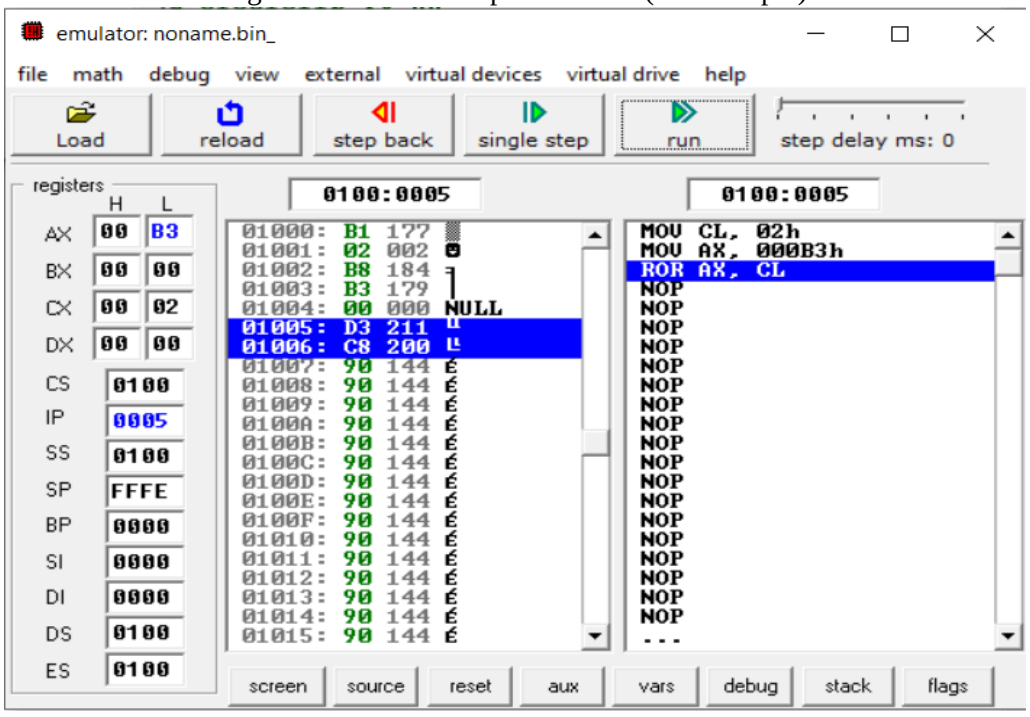


Fig 3.17: Emulator output for ROR (After Step 2)

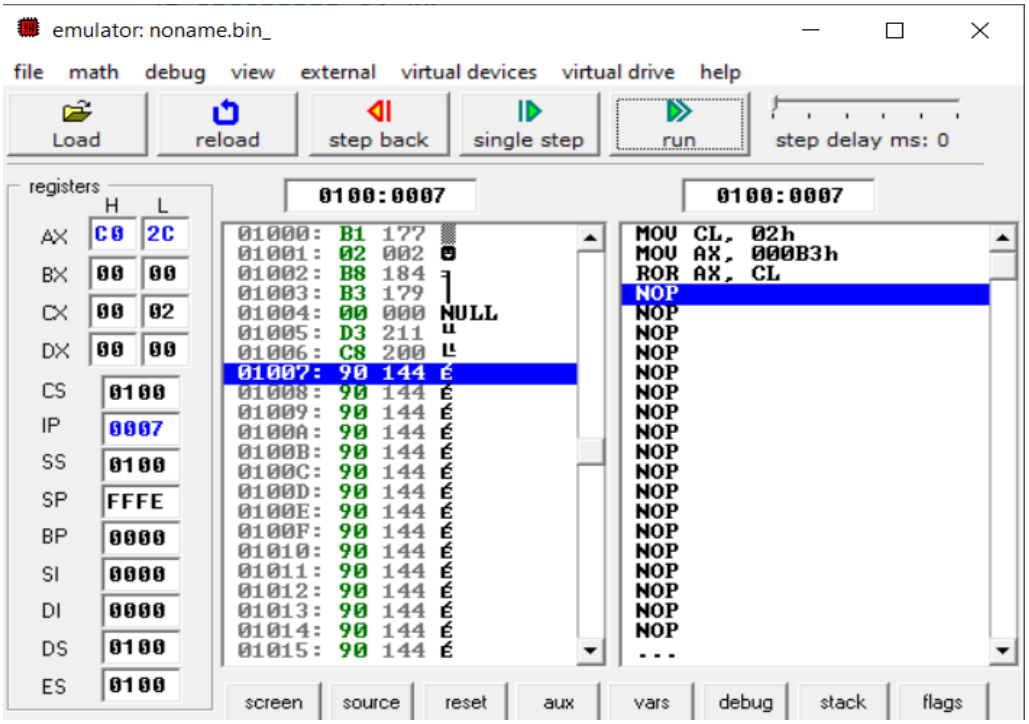


Fig 3.18: Emulator output for ROR (After Step 3)

- **RCL**

```
MOV CL, 2; COUNTER
MOV AX, 0B3H; MOVE 0B3H TO AX
RCL AX, CL; ROTATE WITH CARRY TO LEFT
```

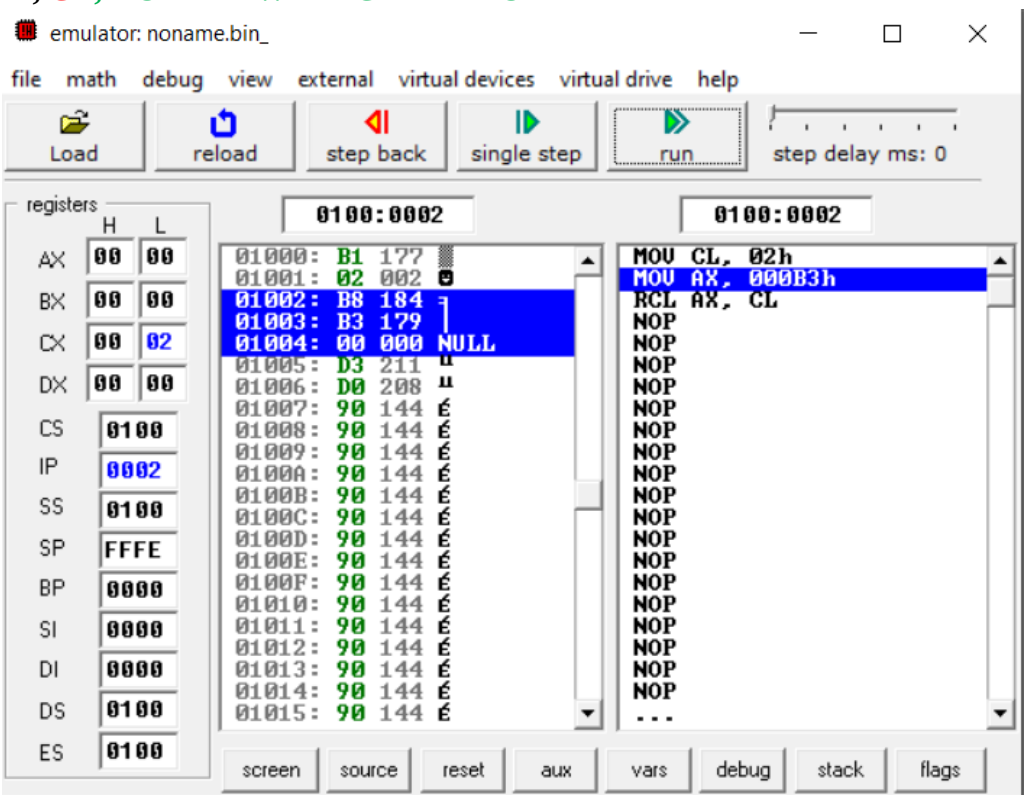


Fig 3.19: Emulator output for RCL (After Step 1)

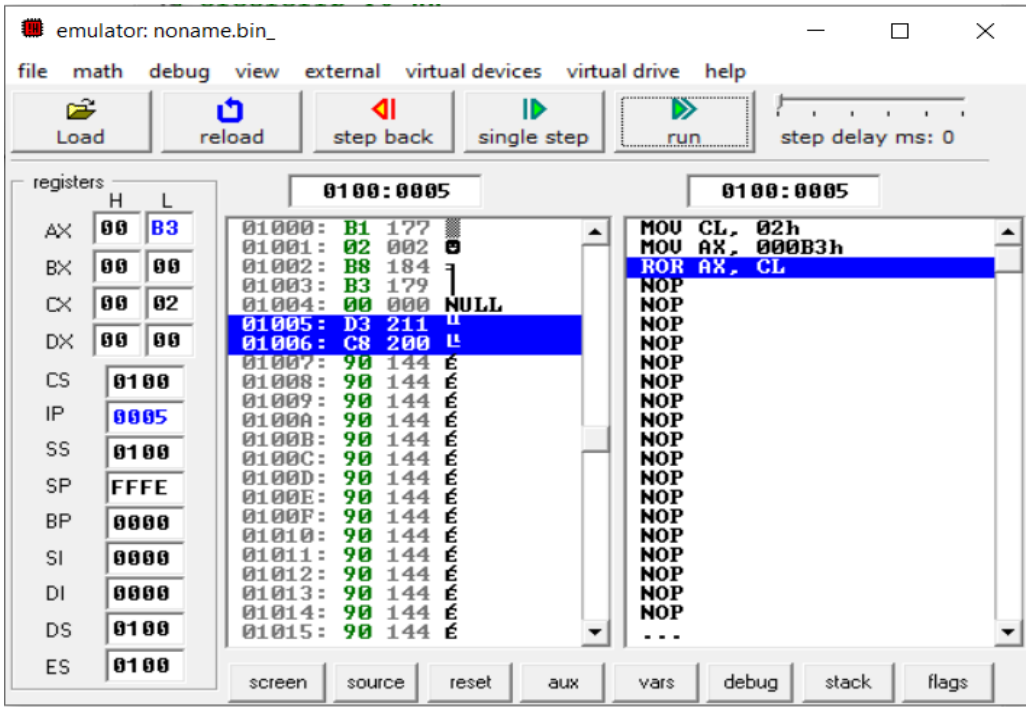


Fig 3.20: Emulator output for RCL (After Step 2)

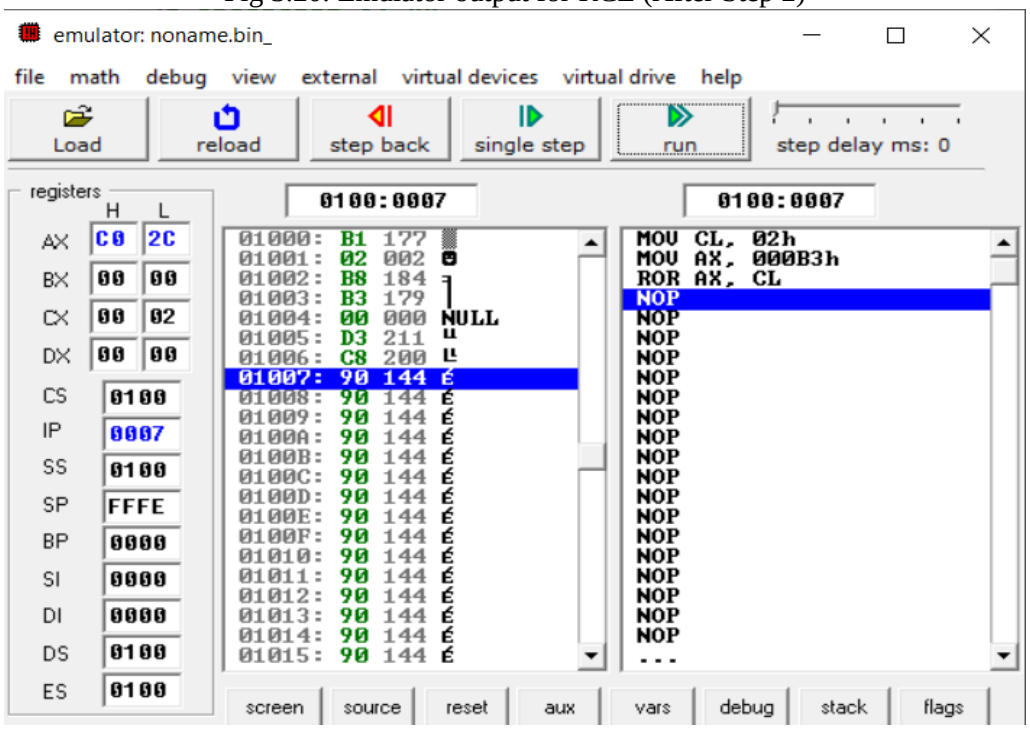


Fig 3.21: Emulator output for RCL (After Step 3)

- **RCR**

```
MOV CL, 2; COUNTER
MOV AX, 0B3H; MOVE 0B3H TO AX
RCR AX, CL; ROTATE WITH CARRY TO RIGHT
```

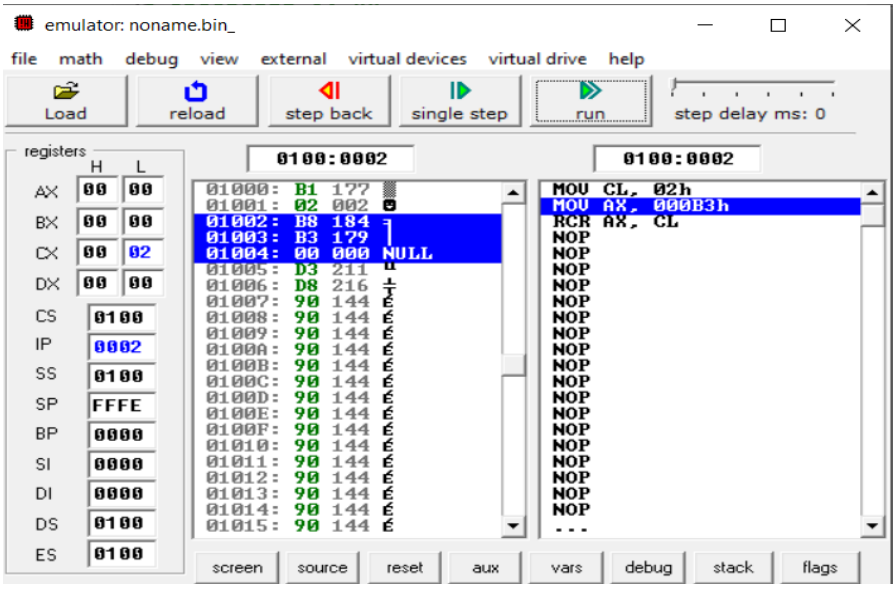


Fig 3.22: Emulator output for RCR (After Step 1)

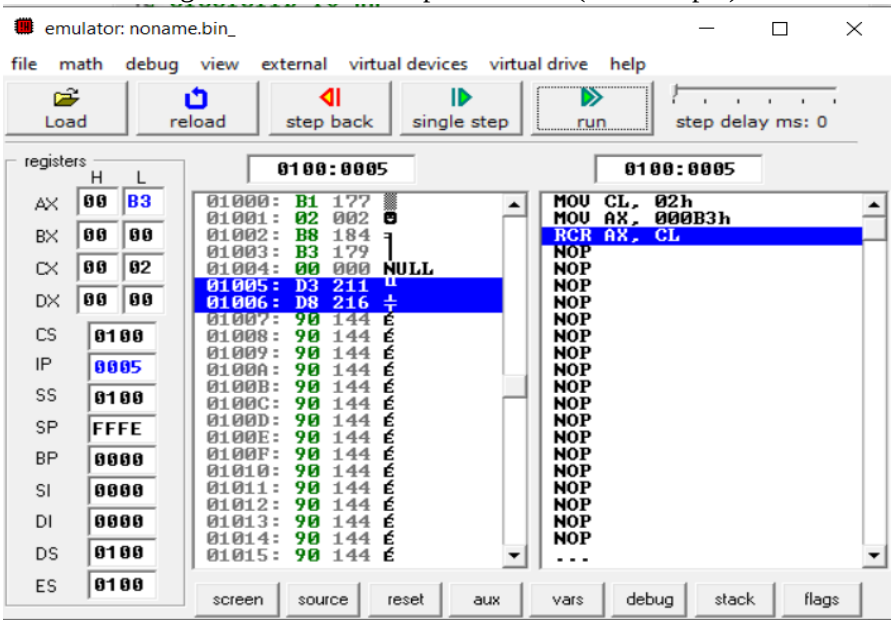


Fig 3.23: Emulator output for RCR (After Step 2)

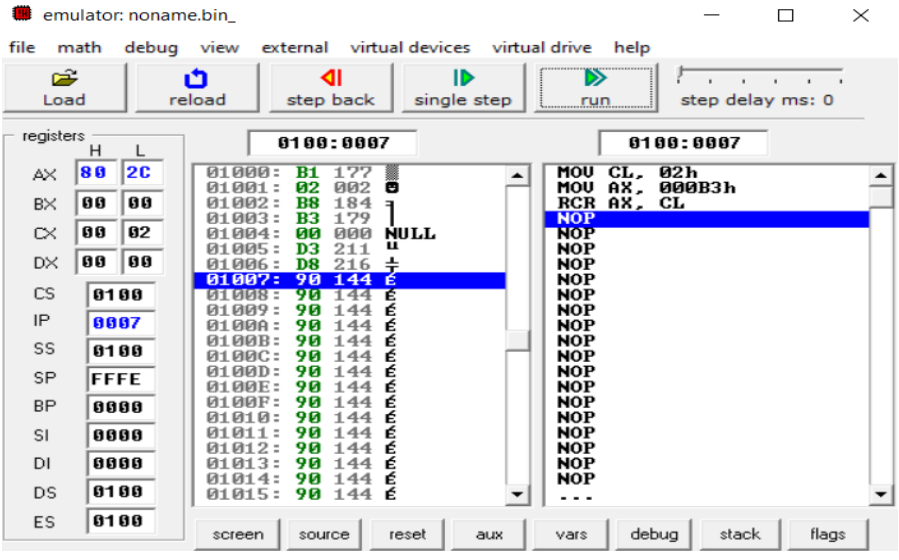


Fig 3.24: Emulator output for RCR (After Step 3)

- **AND**

MOV AX, 5
MOV BX, 5
AND AX, BX

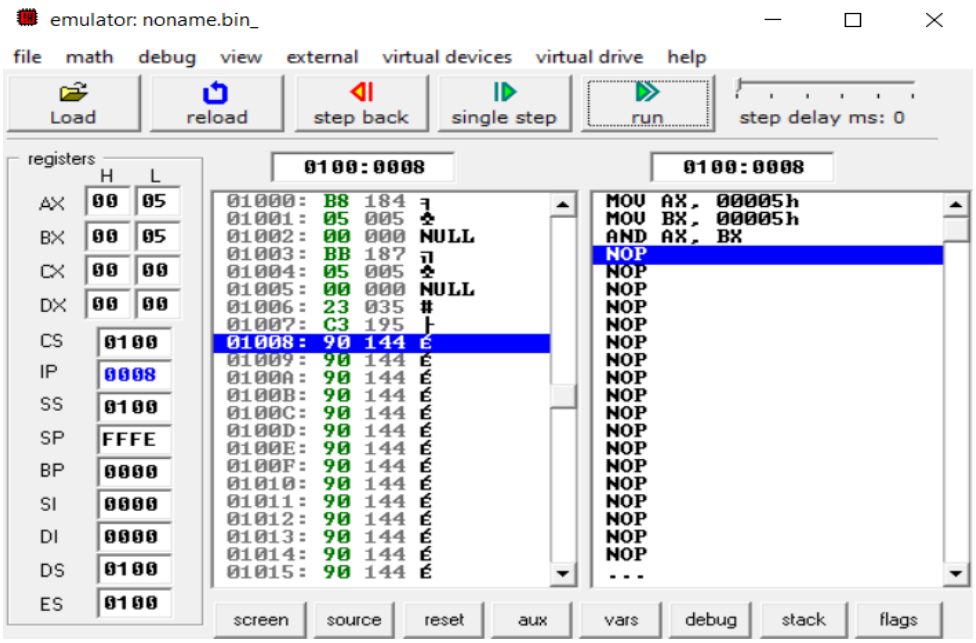


Fig 3.25: Emulator output for AND

- **OR**

MOV AX, 5
MOV BX, 5
OR AX, BX

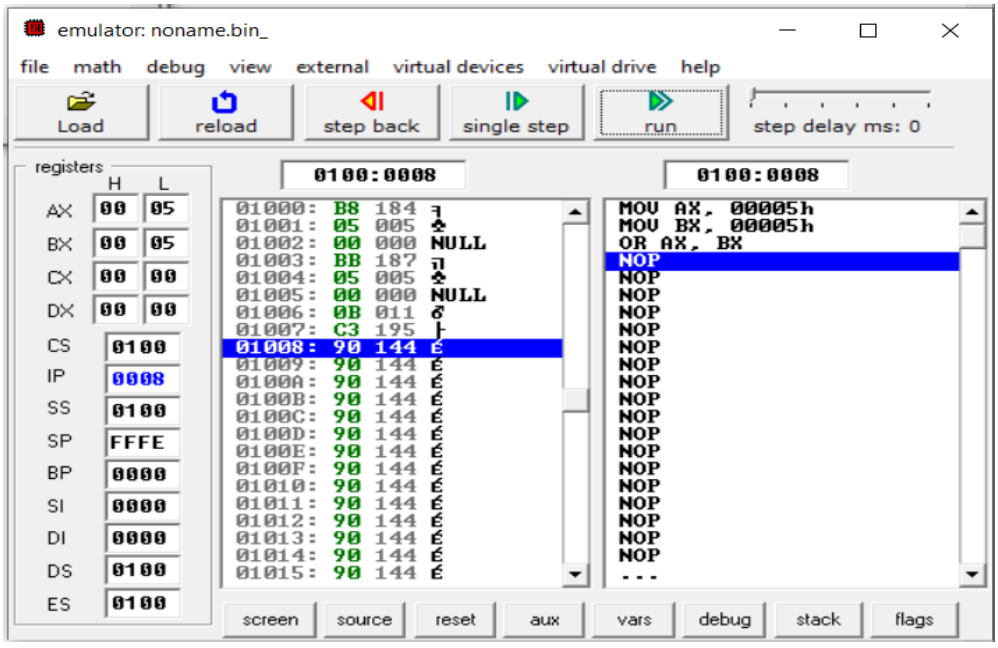


Fig 3.26: Emulator output for OR

- **XOR**

MOV AX, 5
MOV BX, 5
XOR AX, BX

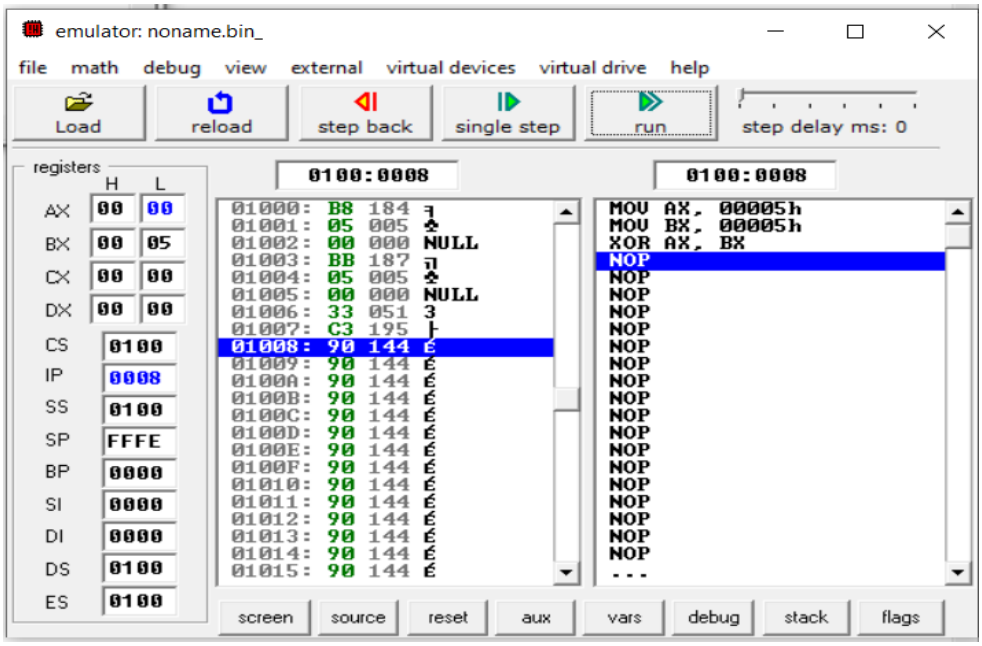


Fig 3.27: Emulator output for XOR

- **LOOP**

```
MOV CL, 5
MOV AL, 10
TOP:
DEC AL
LOOP TOP
```

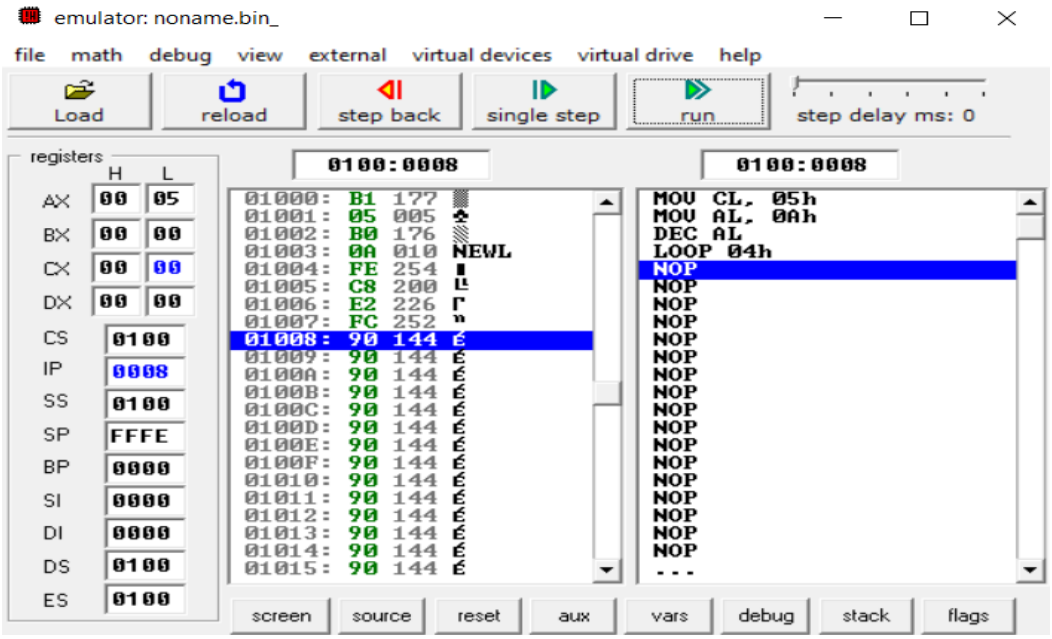


Fig 3.27: Emulator output for LOOP

3.6 Discussion & Conclusion

In this lab, we practiced assembly language programming on the emu8086 for 1-byte or 2-byte data. We also studied about arithmetic and shift-rotate programming languages.

The shift-left command moves the bit to the left, while the shift-right instruction moves it to the right. The only distinction between shift and rotate instructions is that rotate instructions

cycle the bits. While shift rotates the parts out, around goes out one side and comes in the other. either side, leaving the region where the rotated bits were either unmodified or zeroes.

We also observed the process of AND, OR, and X-OR operation in the program. Finally, the objective of the experiment was achieved.

Experiment No. 04

4.1 Experiment Name

Experimental Study of Stack Operation and Introduction to Procedures

4.2 Objectives

- To understand the structure of Assembly Language programming
- To learn about the microprocessor emulator "Emu 8086" and its operation
- To get acquainted with the stack operation and its implementation

4.3 Theory

The Assembly language is a low-level computer programming language that consists primarily of symbolic versions of a computer's machine language.

A stack is essentially a storage device that stores data in the LIFO (last in, first out) order. It is a memory unit with a Stack Pointer address register (SP). Stacking is broken down into two operations:

- **POP:** Deletion (decrements SP); removes the top word to the stack
- **PUSH:** Insertion (increments SP); adds a new top word to the stack

Addresses and data are saved in the stack when the CPU branches to a procedure. In RAM, a LIFO (last in, first out) data structure is implemented. This stack was then pushed to the top with the return address. In addition, the stack is used to swap the values of two registers and register pairs.

To write a program, a stack segment is required after ".MODEL" segment.

A ".STACK" segment is used to set a block of memory to store the stack.

After that a data segment ".DATA" is declared followed by a ".CODE" segment which by the way contains instructions of the program.

Then "MAIN PROC" segment acts as an entry point to the program. In some other cases, they may call other procedures, or themselves. Theses are mainly of two kinds: NEAR and FAR. NEAR segment is the same code segment as the calling program. But FAR is in different segment.

This segment is ended with "MAIN ENDP" where other procedures go. Both PROC and ENDP are pseudo-ops that delineate the procedure.

"END MAIN" segment ends the program and must be followed by the name of the main procedure.

4.4 Apparatus

- Emu 8086 - Microprocessor Emulator

4.5 Emulator Code

```
.MODEL SMALL
.STACK 100
.DATA
.VAR1 DB 12H
.CODE
MAIN PROC
MOV SP, 0101H
MOV AX, 1234H
PUSH AX
MOV BX, 4321H
PUSH AX
POP AX
POP BX
MAIN ENDP
END MAIN
```

4.6 Output

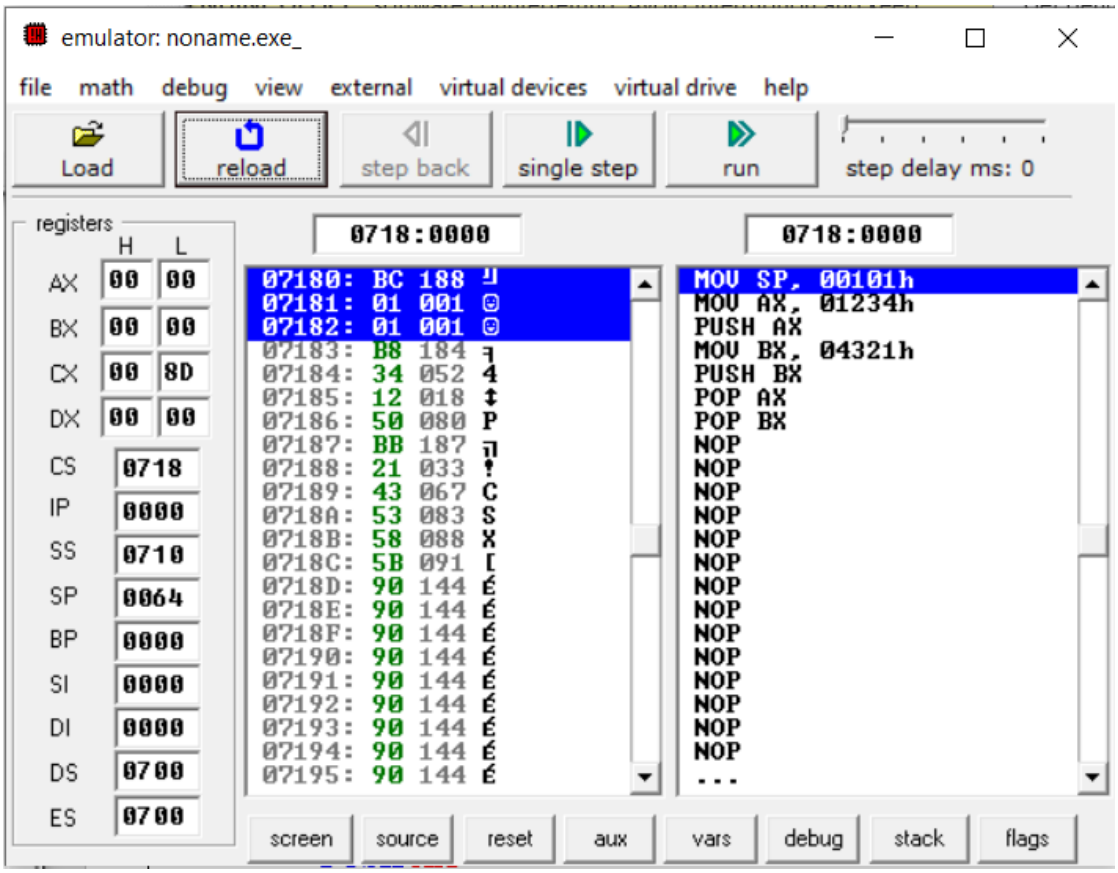


Fig 4.1: Emulator output for ALU for Stack operation (After Step 0)

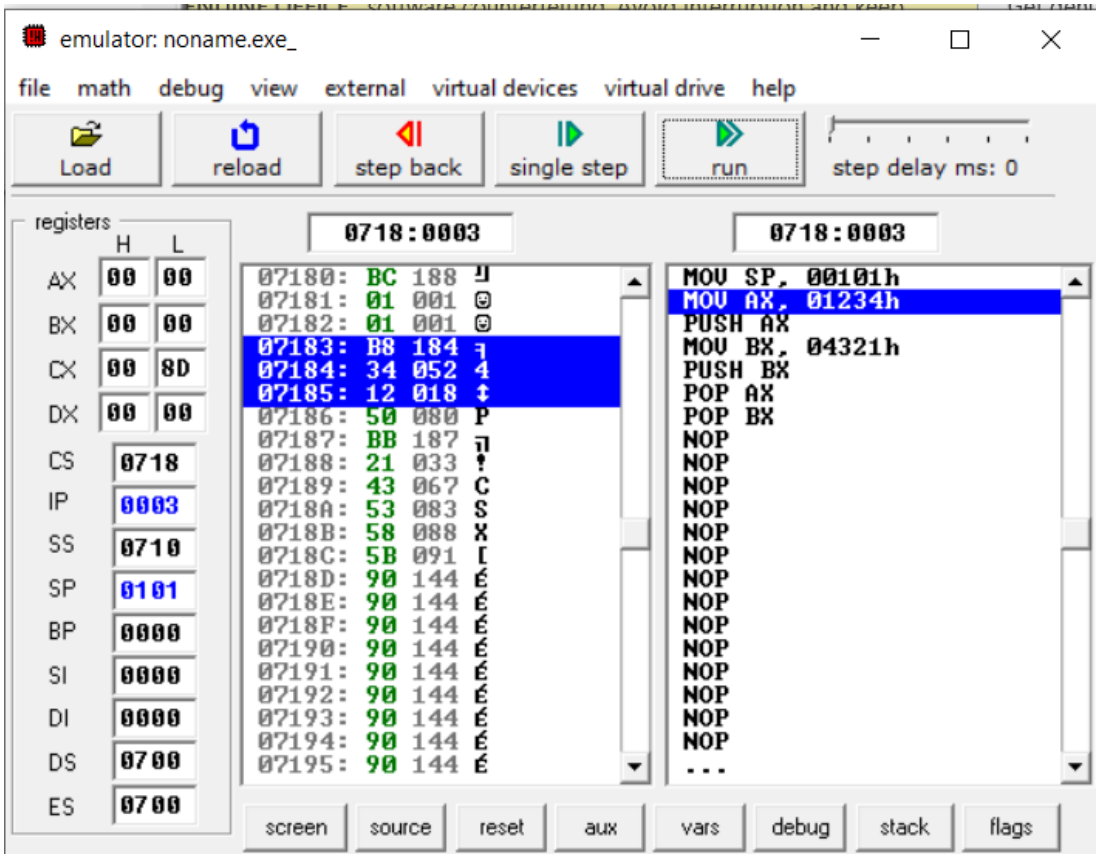


Fig 4.2: Emulator output for ALU for Stack operation (After Step 1)

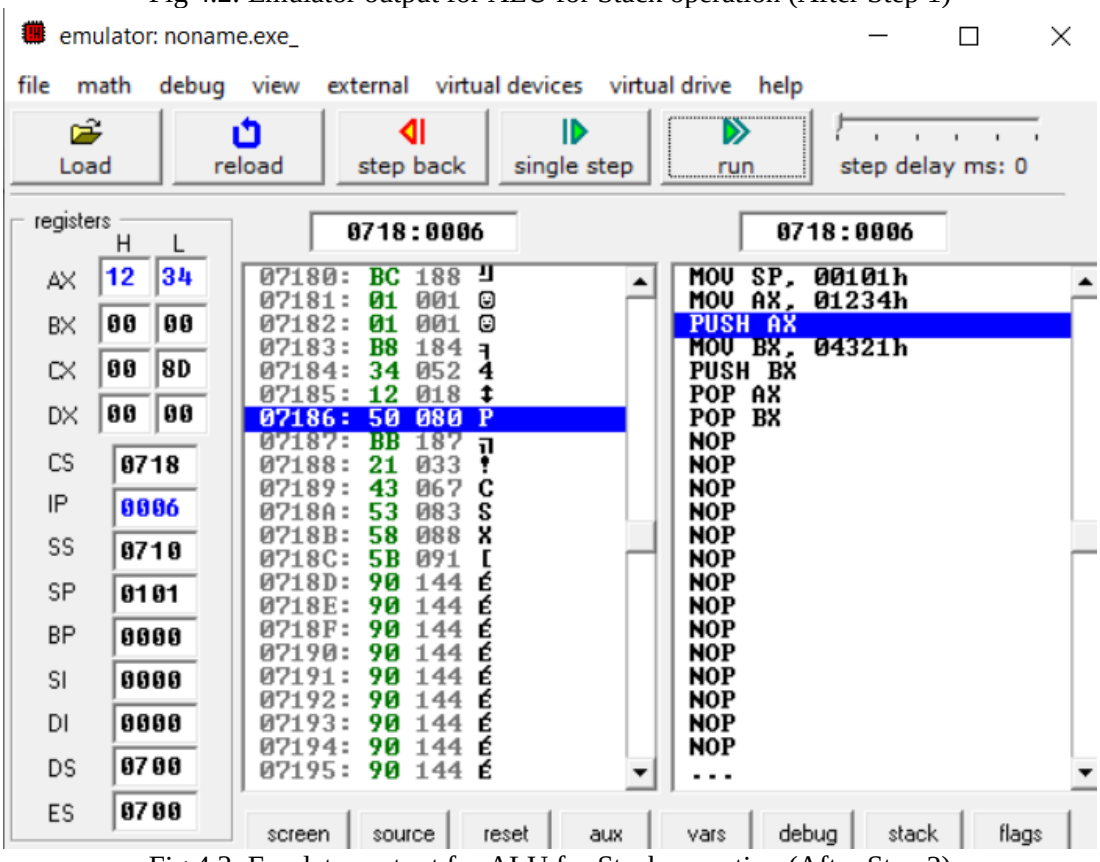


Fig 4.3: Emulator output for ALU for Stack operation (After Step 2)

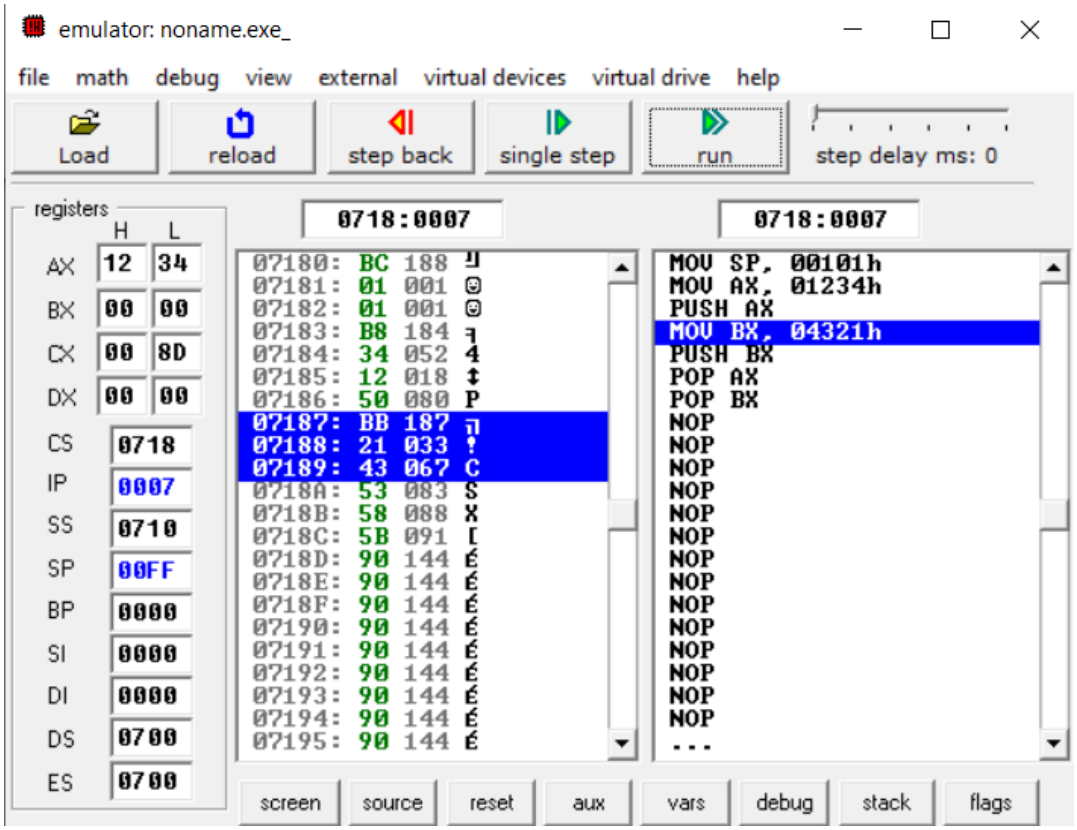


Fig 4.4: Emulator output for ALU for Stack operation (After Step 3)

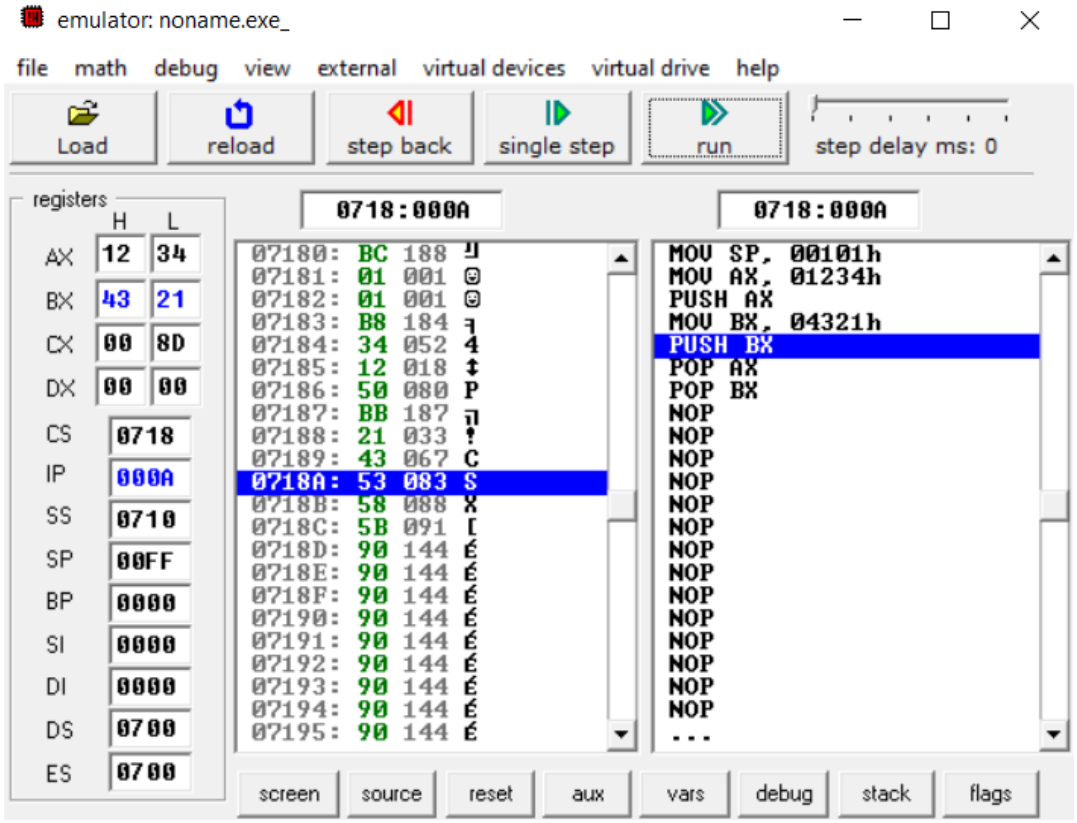


Fig 4.5: Emulator output for ALU for Stack operation (After Step 4)

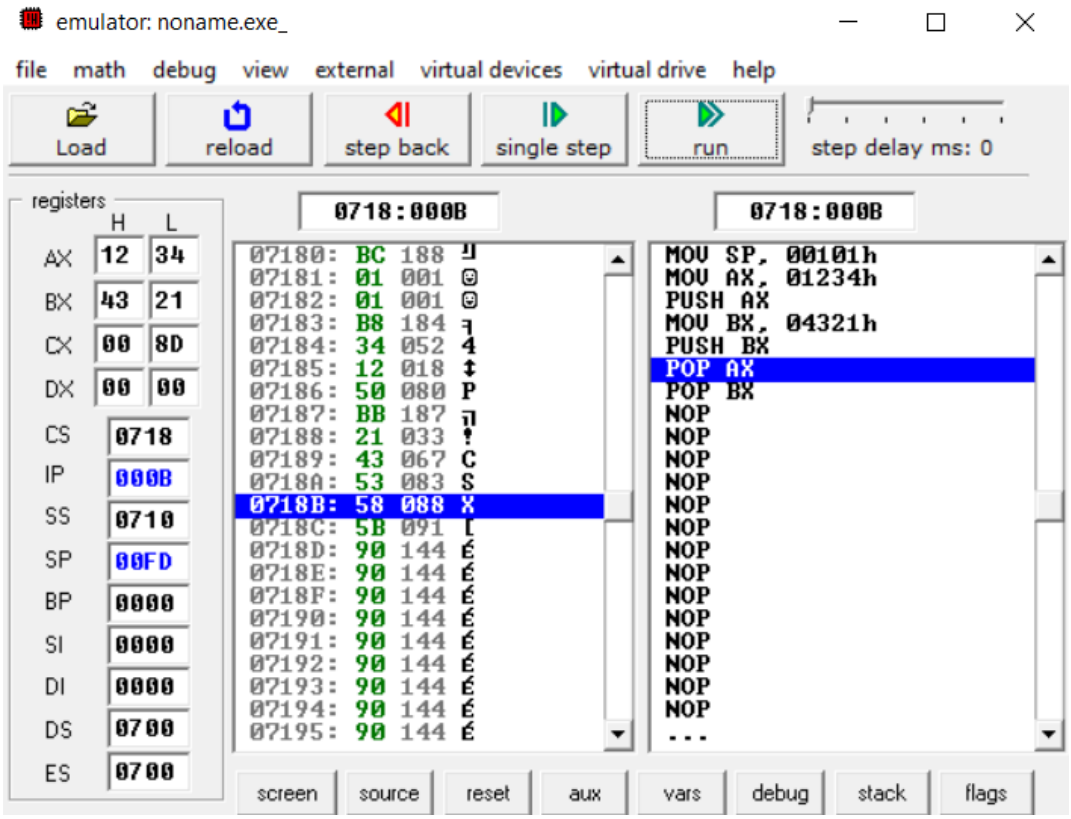


Fig 4.6: Emulator output for ALU for Stack operation (After Step 5)

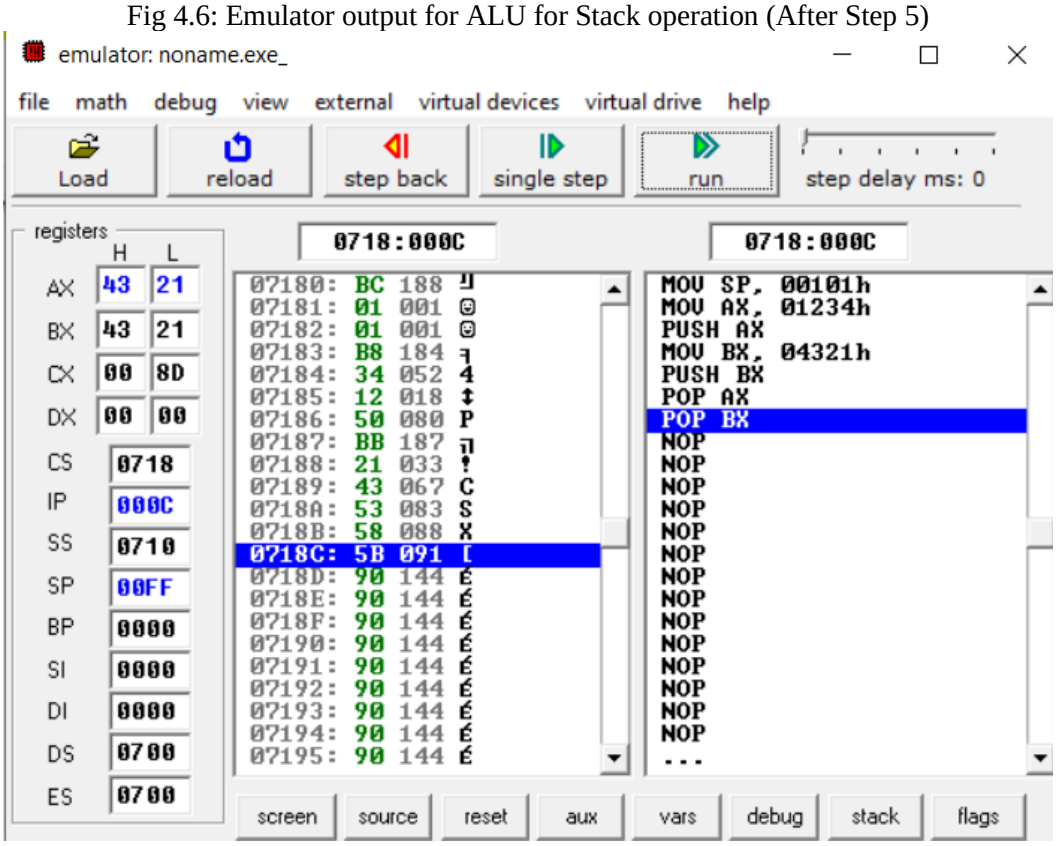


Fig 4.7: Emulator output for ALU for Stack operation (After Step 6)

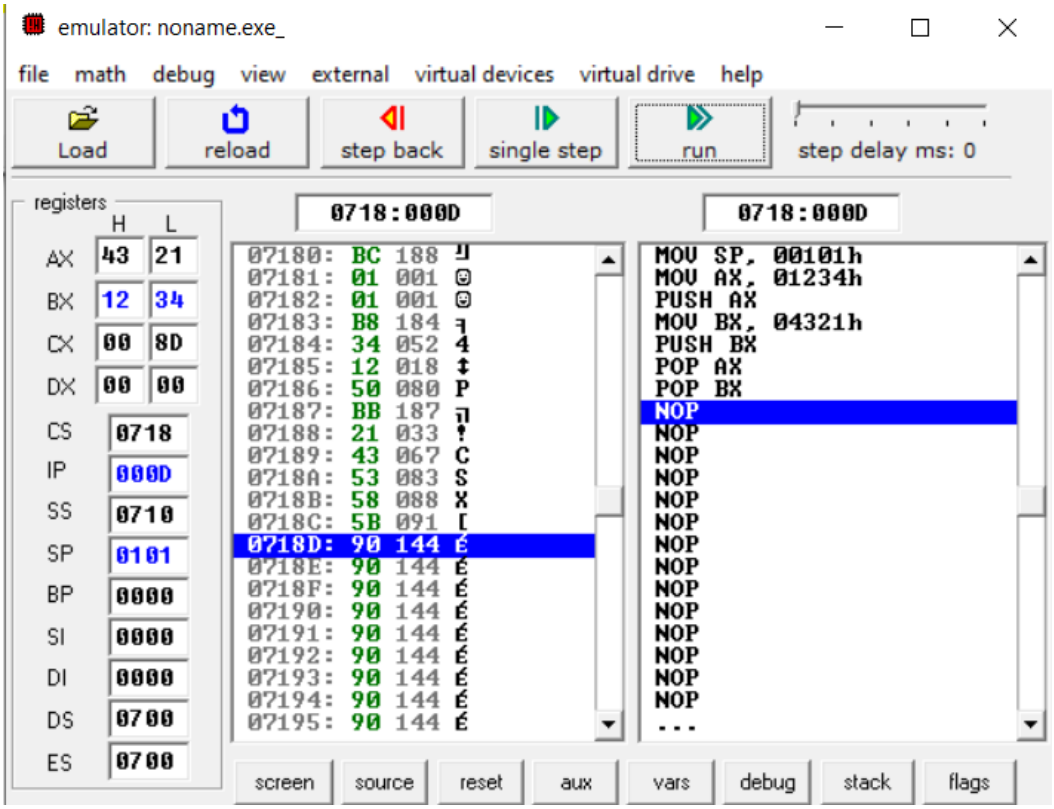


Fig 4.8: Emulator output for ALU for Stack operation (After Step 7)

4.7 Discussion & Conclusion

In this experiment, we learned about the techniques for building an assembly language program. We understand the procedure code and how the stack operation works.

Inserting an element into the stack is known as a "push" & "pop" operation and the new element is positioned at the top of the stack since there is only one other location where it can be added: the very top of the stack.

We also become acquainted with the term 'pseudo-ops' and their operations. Finally, we utilized all of these practically. Thus, the objective of the experiment was achieved.

Experiment No. 05

5.1 Experiment Name

Experimental study of String operation using assembly language

5.2 Objectives

- To understand the structure of Assembly Language programming
- To learn about the microprocessor emulator "Emu 8086" and its operation
- To get acquainted with the string operation and its implementation

5.3 Theory

A memory string or string is essentially a byte or word array in the 8086-assembly language. String instructions are thus intended for array processing. The string instructions' tasks can be completed out using the register indirect addressing mode. Each string instruction may require a source, a destination, or both operands.

In string operations, the direction of action is chosen by the direction flag (DF). The direction flag determines the action direction in string operations (DF). These operations are carried out by SI and DI in this location.

If DF = 0, the instruction "CLD" is executed, and SI and DI proceed in the direction of increasing memory addresses (from left to right across the string), If DF = 1, the instruction STD is issued, and SI and DI proceed in the direction of decreasing memory addresses (from right to left),

MOVSB, MOVSW, REP, STOSB, LODSB, STASB, and CMPSB are some more string commands.

- **MOVSB**: This MOV instruction is used to copy the contents of one string into another string. The MOVSB instruction copies the contents of the byte addressed by DS:SI, to the byte addressed by ES:DI.
- **MOVSW**: MOVSW is a function that moves a word from the source string to the destination string. It expects DS:DI to point to a source string word and ES:DS to point to a destination string, just like MOVSB. SI and DI are both increased by 2 if DF is 0 and decreased by 2 if DF is 1.
- **REP**: MOVSB transfers only one byte from the source string to the destination string. Before executing the REP prefix, we must first initialize CX to the number n of bytes in the source string, which causes MOVSB to be executed n times in order to relocate the entire string. After each MOVSB, CX is reduced until it reaches zero.
- **CLD**: For a clear direction flag, set DF to 0, which causes the operation to run from left to right.
- **STD**: For set direction flagging, DF = 1, causing the procedure to proceed from right to left.
- **STOSB**: Stores string bytes and transfers the contents of the AL register to the byte specified by ES:DI. DI is calculated as increment DF = 0 DF=0 or decrement DF = 1 DF=1.

- **STOSW**: Saves a string word and copies the contents of the AL register to the byte specified by ES:DI. DI is calculated as increment DF = 0 DF=0 or decrement DF = 1 DF=1.
- **LODSB**: This instruction is used to transfer the byte addressed by DS:SI into AL. Then, depending on whether DF is zero or one, SI is increased or decreased. The word form converts the word addressed by DS, SI, into AX, with SI increasing by 2 if DF is zero and decreasing by 2 if DF is one. LODSB may analyze the characters in a string. loading a byte string
- **LODSW**: Load string word; the other operation is well known to LODSB.
- **CMPSW**: String words are compared.
- **CMPSB**: string byte comparison

5.4 Apparatus

- Emu 8086 - Microprocessor Emulator

5.5 Emulator Code & Output

5.5.1 Duplicate a string and print it

```
.MODEL SMALL
.STACK 100
.DATA
STRING1 DB 'ASHRAF'
STRING2 DB 6 DUP (?)
.CODE
    MAIN PROC NEAR
        MOV AX, @DATA
        MOV DS, AX
        MOV ES, AX
        LEA SI, STRING1
        LEA DI, STRING2
        CLD
        MOV CL,6
        REP MOVSB
        MAIN ENDP
    END MAIN
```

Output

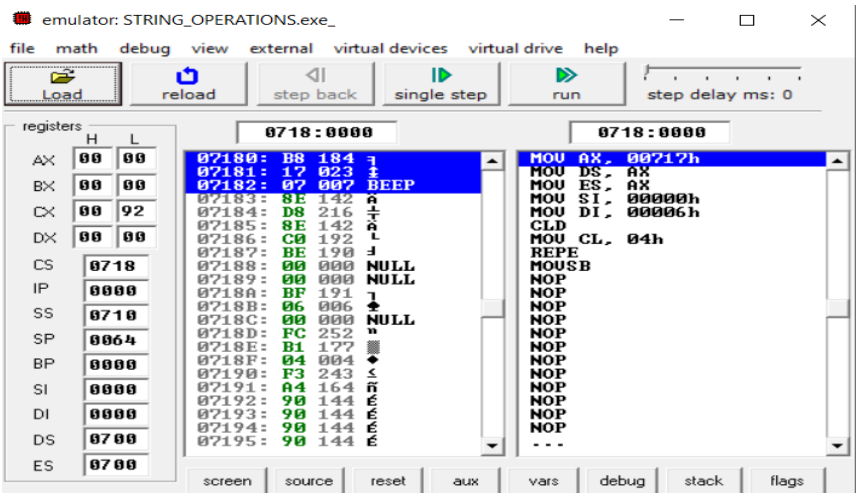


Fig 5.1.1: Emulator output for ALU for string operation (After Step 0)

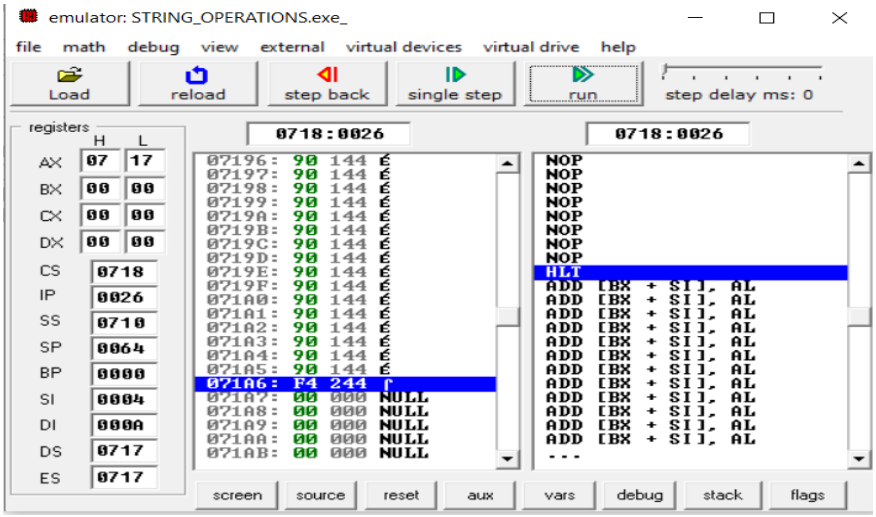


Fig 5.1.6: Emulator output for ALU for string operation (After Step 5)

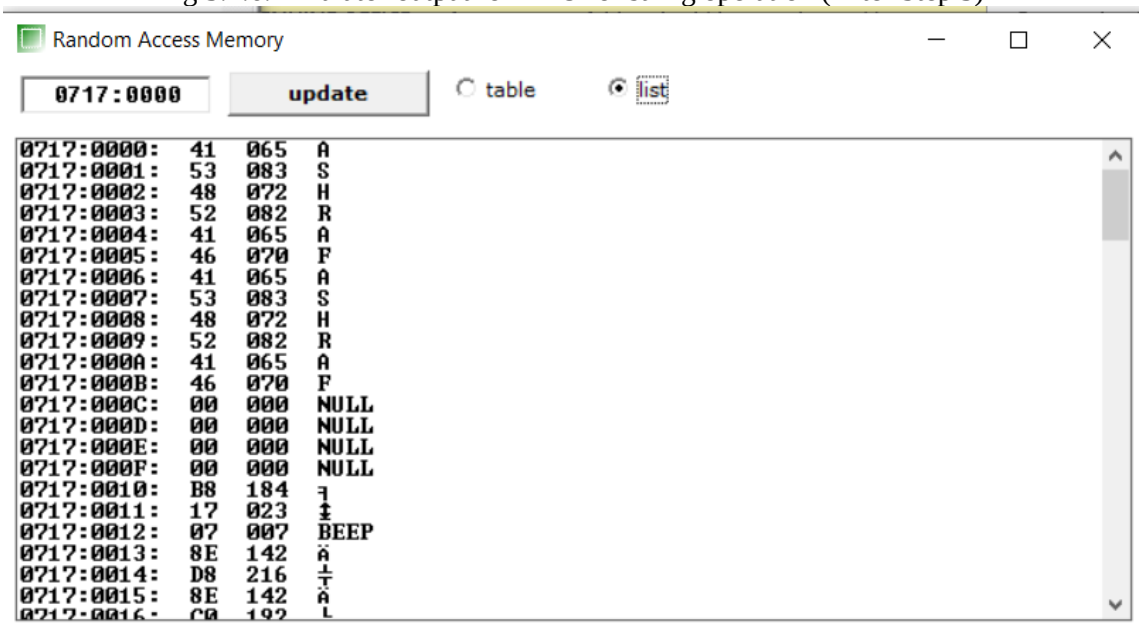


Fig 5.1.3: Memory output for ALU for string operation (final)

5.5.2 The same as Task Just this time, the copied phrase will begin with 0000H and the term that will be duplicated will begin after the copied term.

```
.MODEL SMALL
.STACK 100
.DATA
STRING2 DB 8 DUP(?)
STRING1 DB 'EEE_RUET'
.CODE
    MAIN PROC NEAR
        MOV AX,@DATA
        MOV DS,AX
        MOV ES,AX
        LEA SI,STRING1
        LEA DI,STRING2
        CLD
        MOV CL,8
```

```
        REP
        MOVSB
        MAIN ENDP
    END MAIN
```

Output

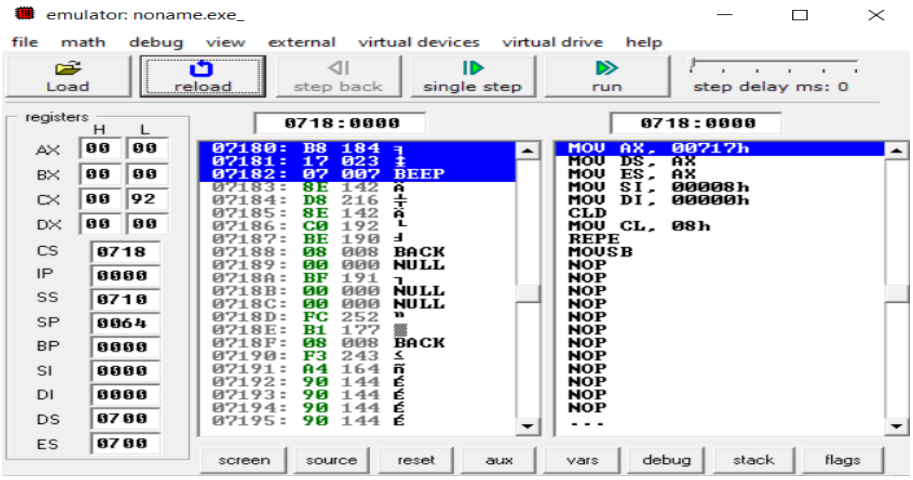


Fig 5.2.1: Emulator output for ALU for string operation (After Step 0)

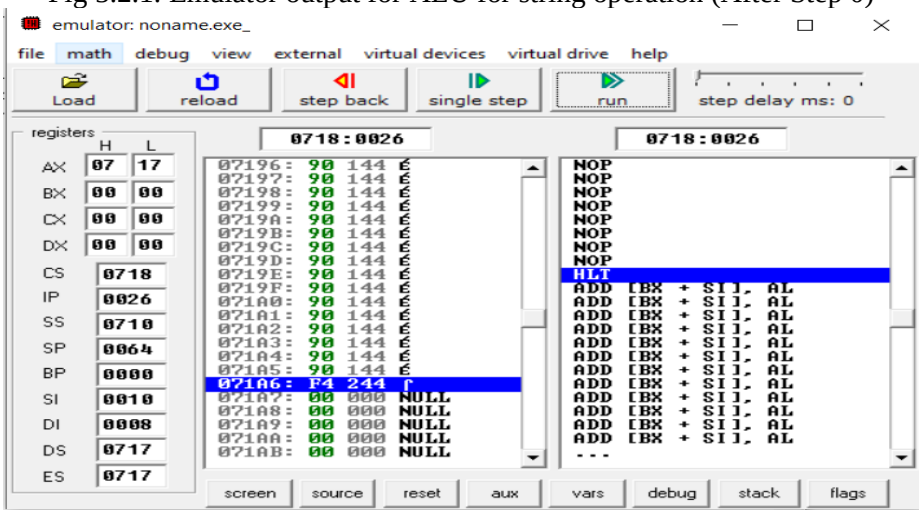


Fig 5.2.2: Emulator output for ALU for string operation (After final step)

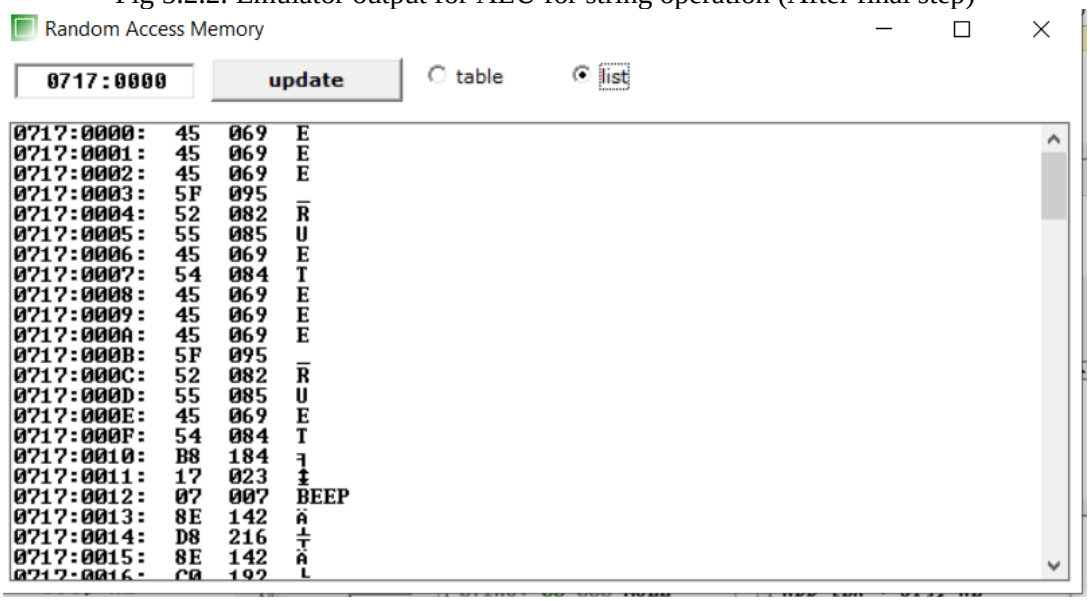


Fig 5.2.3: Memory output for ALU for string operation (final)

5.5.3 String correction of 'HLLO' to 'HELLO'

```
.MODEL SMALL
.STACK 100
.DATA
STRING1 DB 'HLLO'
.CODE
    MAIN PROC NEAR
        MOV AX,@DATA
        MOV DS,AX
        MOV ES,AX
        LEA SI,STRING1+3
        LEA DI,STRING2+4
        STD
        MOV CL,3
       REP MOVSB
       MOV AL,'E'
        STOSB
        MAIN ENDP
     END MAIN
```

Output

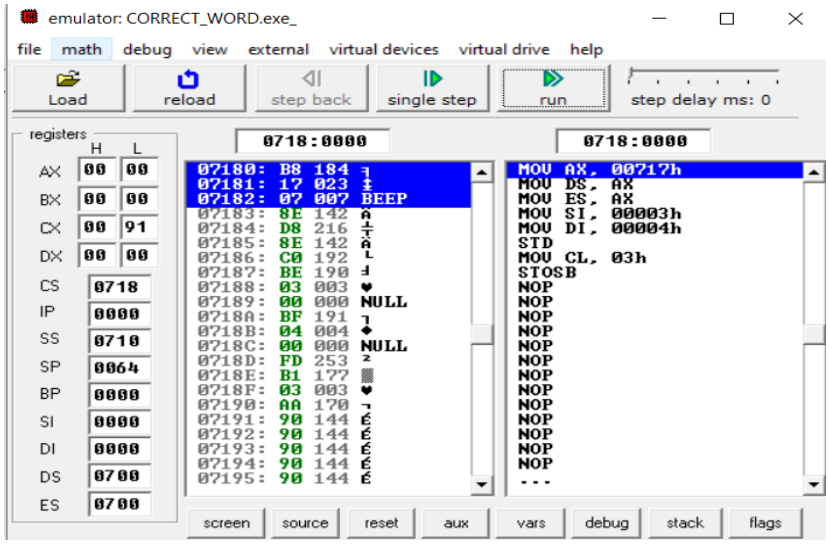


Fig 5.3.1: Emulator output for ALU for string operation (After Step 0)

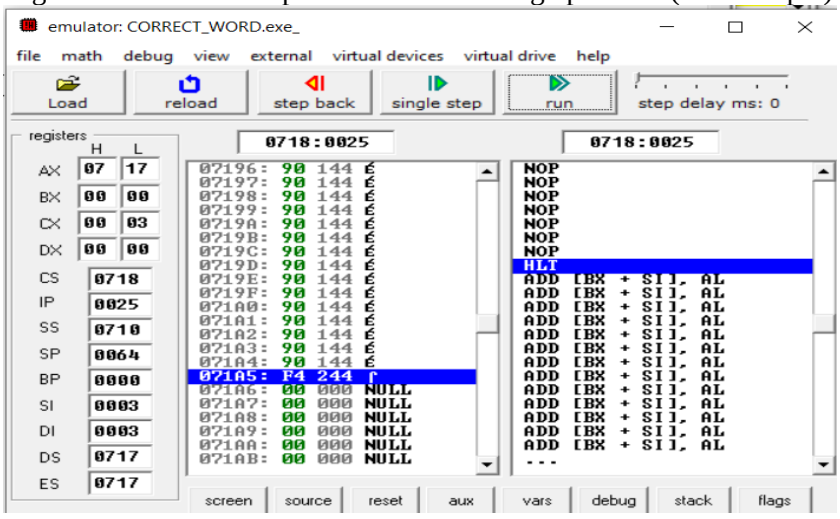


Fig 5.3.2: Emulator output for ALU for string operation (After final step)

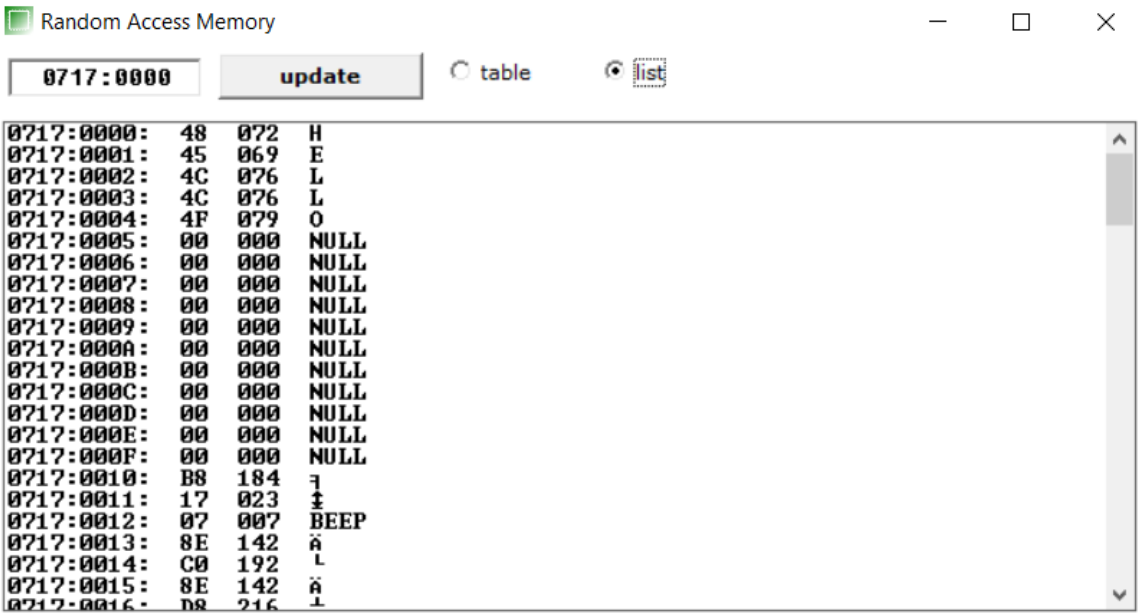


Fig 5.3.3: Memory output for ALU for string operation (final)

5.6 Discussion & Conclusion

In this experiment, we learned about the techniques for building an assembly language program. We understand the procedure code and how the string operation and some of its instructions work. An experimental test of the string's functionality was performed using the well-known application emu8086.

Finally, we utilized all of these practically. The results of the experiment and our manual computation were comparable. Thus, the objective of the experiment was achieved.

Experiment No. 06

6.1 Experiment Name

Familiarization with serial monitor mode of MDA 8086 trainer kit

6.2 Objectives

- To get acquainted with the "MDA 8086" Trainer Board and its operation
- To learn how to implement program in “MDA 8086” Trainer Board and interconnect it with “Emu 8086”

6.3 Theory

The MDA 8086 consists of a central processing unit (CPU), ROM, SRAM, display, keyboard, speaker, DOT matrix LED, A/D & D/A converter, stepping motor. It also has a 16-bit microprocessor, a 20-bit address bus allows it to directly access 220 bits, or 1 MB, of memory. The 8086 has fourteen sixteen-bit registers and clock frequency (5 to 10 MHz)

An 8086 MDA kit is available in two configurations-

1. Kit mode: Commands are entered using the kit's keyboard, and the results are displayed on the kit's monitor. Machine codes are captured using the emu8866 software.

2. PC mode or serial monitor mode: A serial monitor is the basic monitor application for MDA-8086 and computer data transfer.

In serial monitor mode, the monitor starts working as soon as the power is turned on. It features a memory-checking method in addition to all of the key functions. The MDA-80886 kit was supplied the machine codes (produced by Emu 8086 software) to execute the operations in kit machine mode.

The program code should be written in Notepad and saved as an ASM file. Microsoft Macro Assembler (MASM) software is used to transform an ASM file. The LOD18C software is used. ASM files can be created from OBJ files. Using the 'Comm' software, the code is then loaded into the MDA 8086 trainer kit.

6.4 Apparatus

- MDA 8086 - Trainer Board

6.5 Working procedures

Step 1. We connected MDA 8086 to the designated PC and open ASM8086. This will pop up a file directory screen on the monitor.

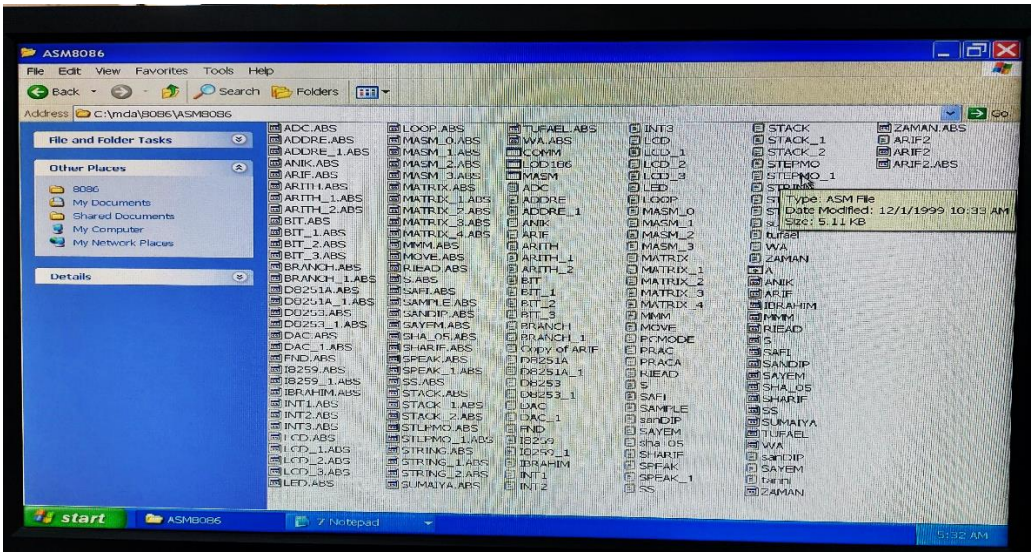


Fig. 6.1: Opening file directory

Step 2. In Notepad's extended mode, we wrote a program and saved it as "filename.asm" format.

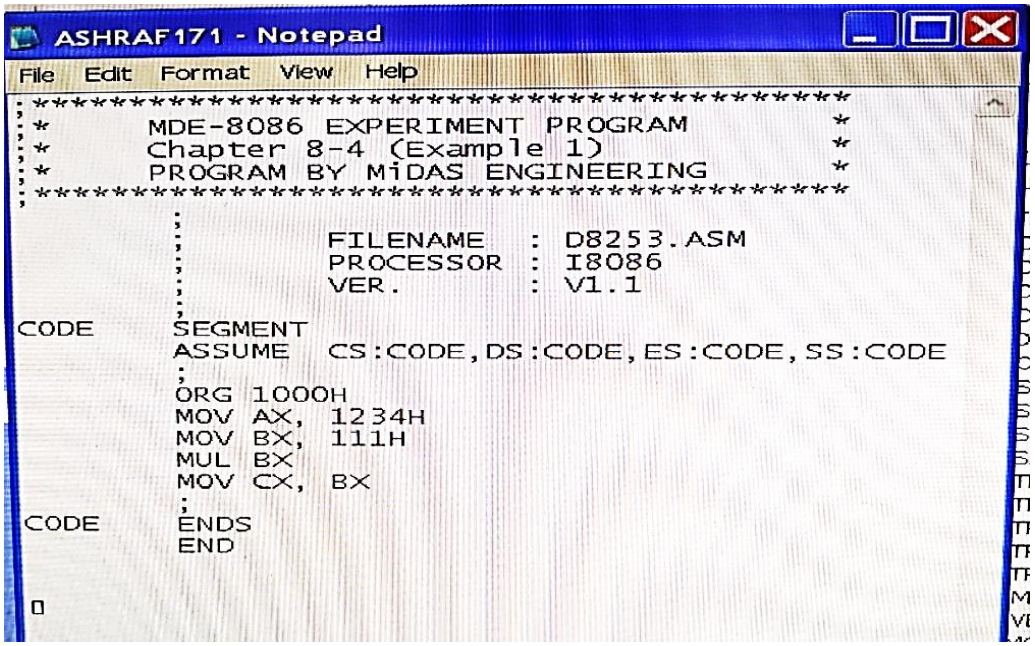


Fig. 6.2: Writing program on notepad

Step 3. Next, we launched the ‘MASM.exe’ software and load the ‘.asm’ file and convert it to ‘.obj’ file format.

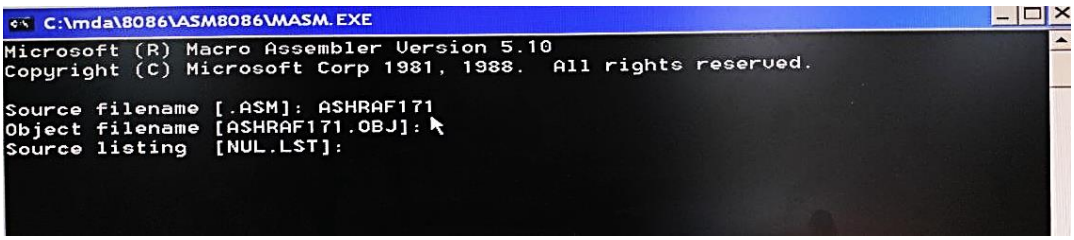


Fig. 6.3: Load the ‘.asm’ file and convert it to ‘.obj’ file format.

Step 4. Then we loaded the ".obj" file into the "LOD186.exe" software, and the software will execute the ".abs" file, which turns the machine code into executable form.

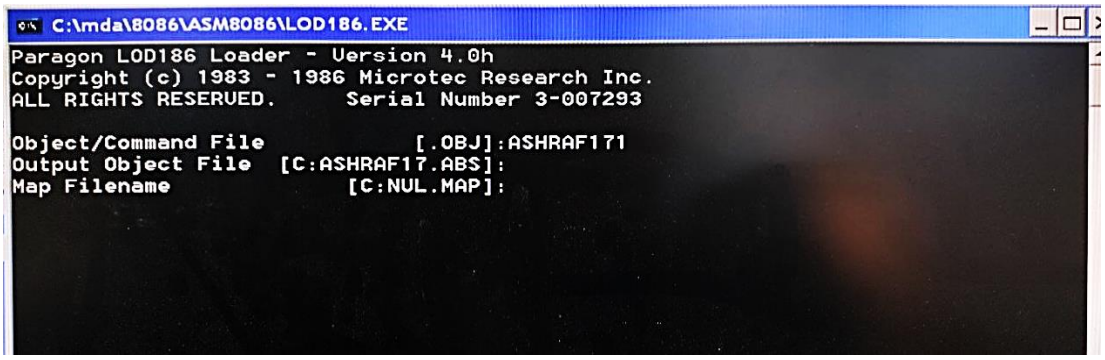


Fig. 6.4: Turn '.obj' file to '.abs' file

Step 5. Then, we selected the serial port from the 'COMM.exe' file.

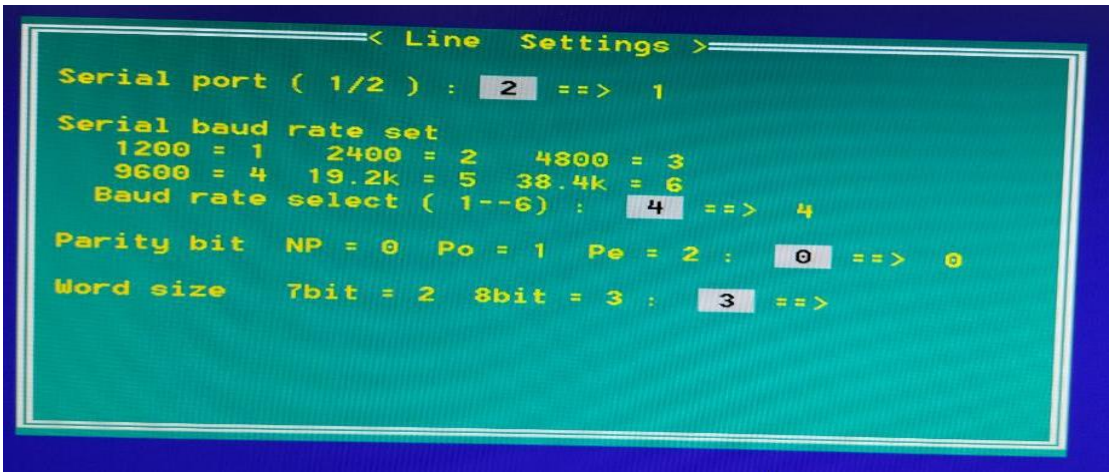


Fig. 6.5: Select serial port

Step 6. The 8086 MDA kit's reset button was pressed.

Fig. 6.6: Reset the kit

Step 7. After that, load the '.abs' file and press T for single step execution until final output is obtained.

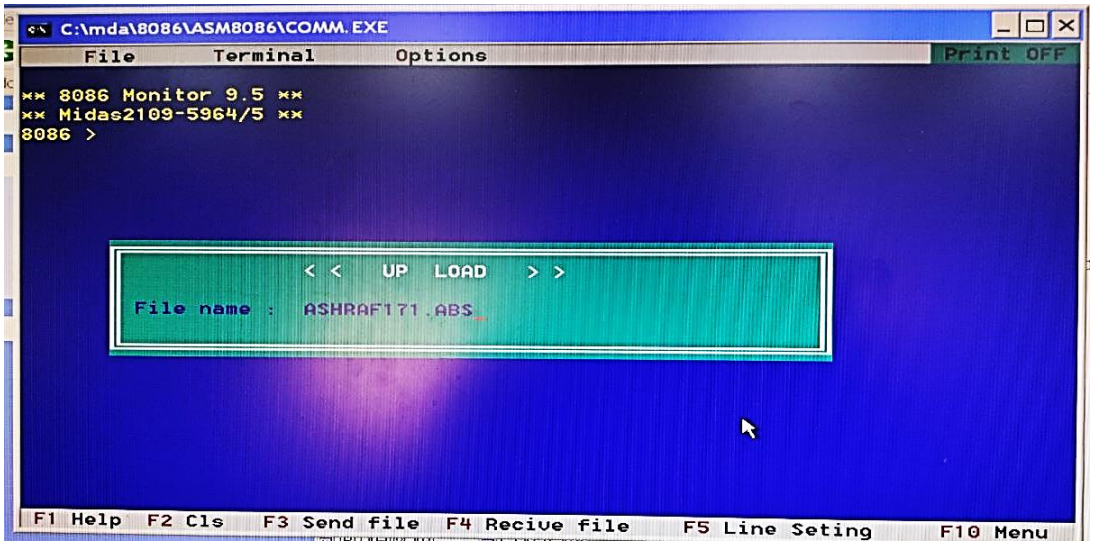


Fig. 6.7: Load the file

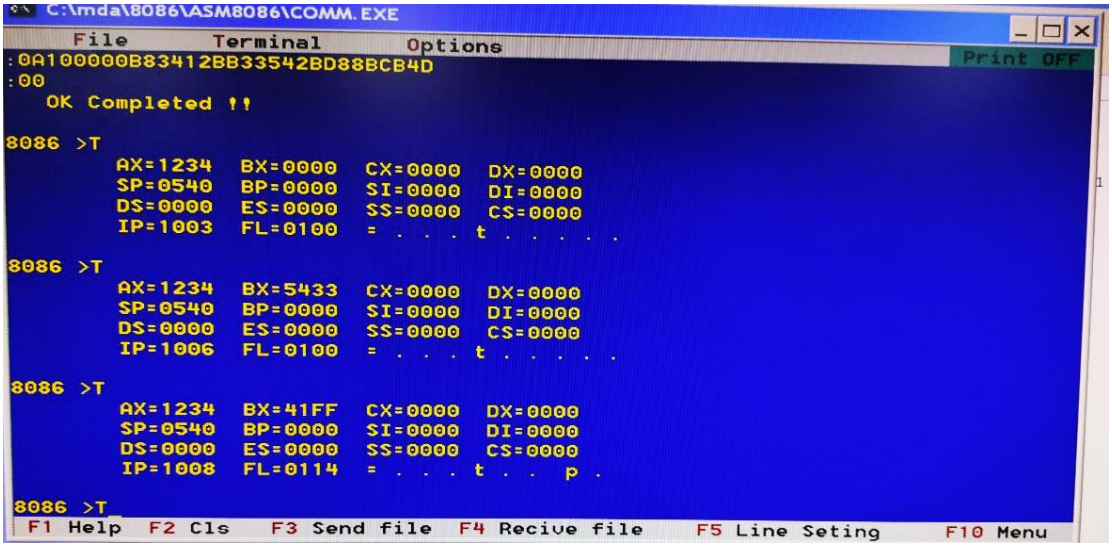


Fig. 6.8: After single step executing several times

6.6 Discussion & Conclusion

The procedure of working in serial monitor mode or PC mode with the 8086 MDA kit was introduced in this experiment. In this case, we used the MDA 8086 kit's direct monitor mode. We used code to perform the multiplication of two numbers.

A program was developed in notepad and saved as '**.asm**' file, which was then translated to '**.obj**' using Microsoft Macro Assembler. The '.obj' file was then translated into a '**.abs**' file using the LOD186 software. The '**.abs**' file was then executed by following the instructions, and the output was observed using both single-step execution and direct execution.

Experiment No. 07

7.1 Experiment Name

8255 PPI interfacing: 7 - segment display

7.2 Objectives

- To get acquainted with the "MDA 8086" Trainer Board and its operation
- To learn how to implement program in “MDA 8086” Trainer Board and interconnect it with “Emu 8086”

7.3 Theory

A serial monitor mode is one of the configurations of 8086 MDA kit. Here, the monitor starts working as soon as the power is turned on. The program code should be written in Notepad and saved as an ASM file, which is transformed to OBJ files. Using the 'Comm' software, the code is then loaded into the MDA 8086 trainer kit.

For this experiment, we applied 8255 interfacing in 7 – segment decoder. Here, the LED, has seven segments, is used as a highly frequent output device. Furthermore, we have eight segments in an LED display, which contains '.', which is character 8 with a decimal point, dp directly next to it. The segments are denoted as 'a, b, c, d, e, f, g, and dp.' Furthermore, these are LEDs, or a series of Light Emitting Diodes.

7.4 Apparatus

- MDA 8086 - Trainer Board

7.5 Experimental problem no. 01

```
CODE SEGMENT
        ASSUME CS: CODE, DS: CODE, SS: CODE, ES: CODE
        ORG 1000H
        PORTA EQU 19H
        CONTRL EQU 1FH
        MOV AL, 100000000B
        OUT CONTRL, AL
        MOV AL, 100000000B
        OUT PORTA, AL
        CODE ENDS
END
```

7.6 Output procedures

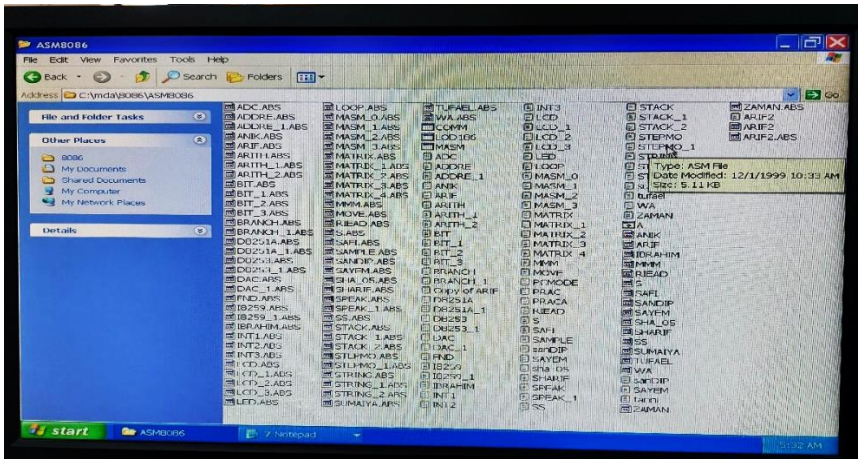


Fig. 7.1: Opening file directory

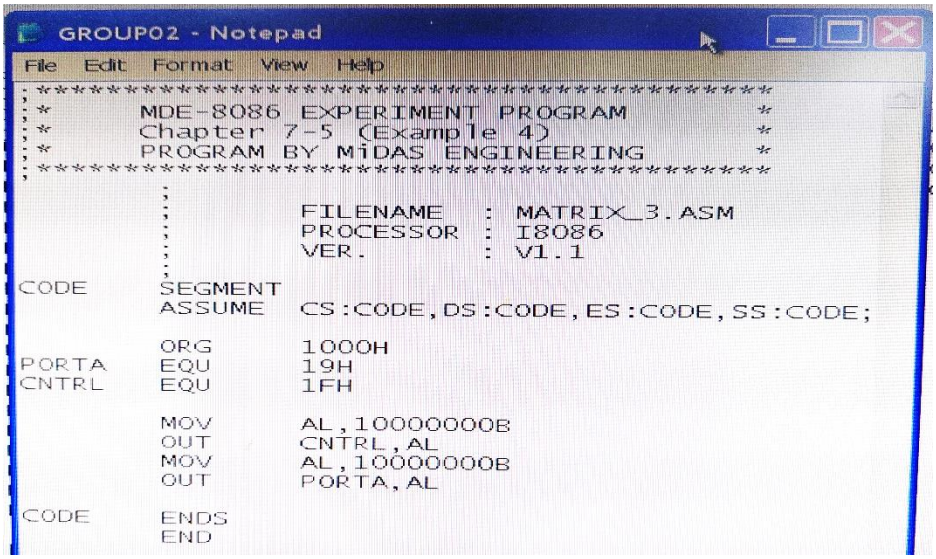


Fig. 7.2: Writing program on notepad

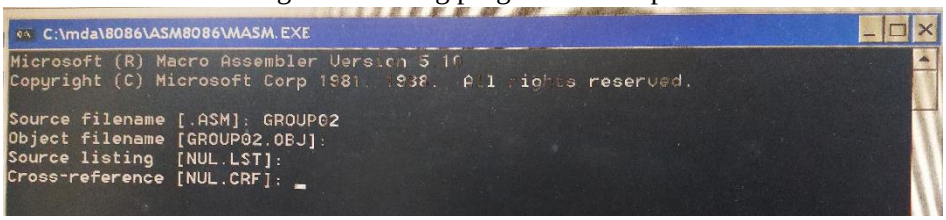


Fig. 7.3: Load the '.asm' file and convert it to '.obj' file format.

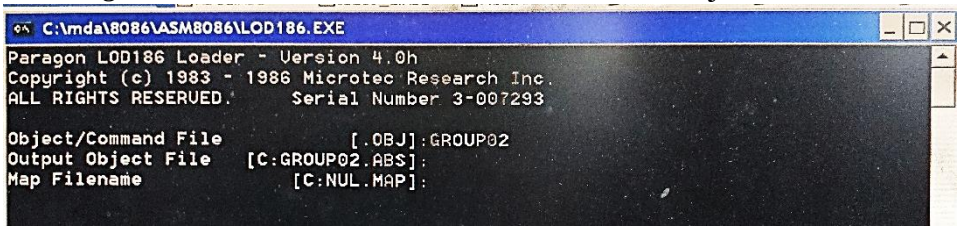


Fig. 7.4: Turn '.obj' file to '.abs' file

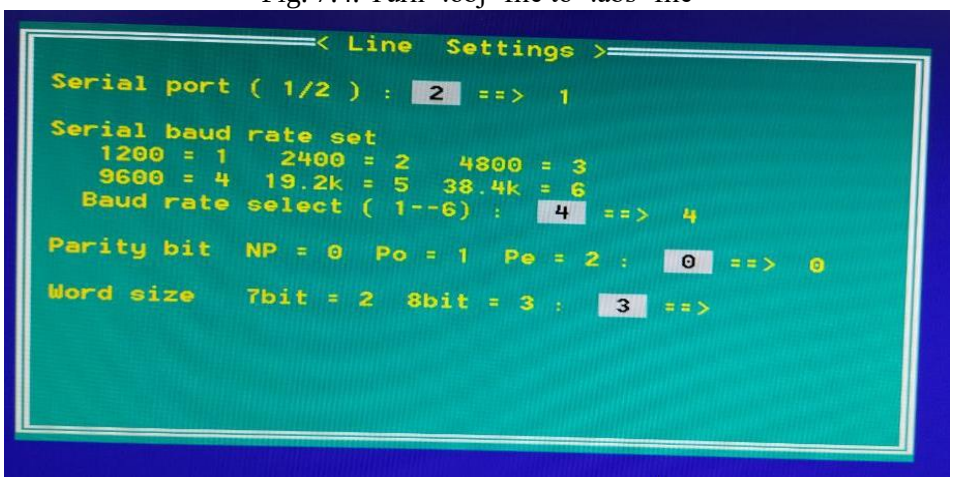


Fig. 7.5: Select serial port

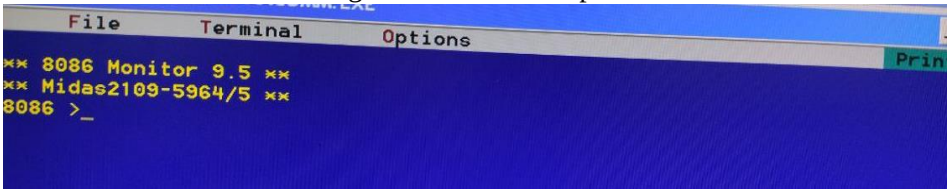


Fig. 7.6: Reset the kit

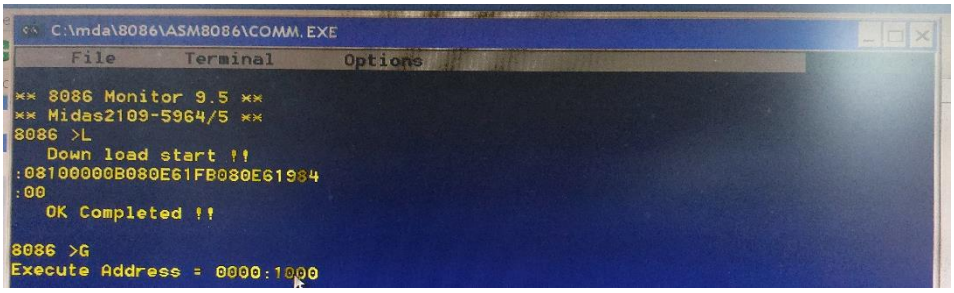


Fig. 7.8: Load the file

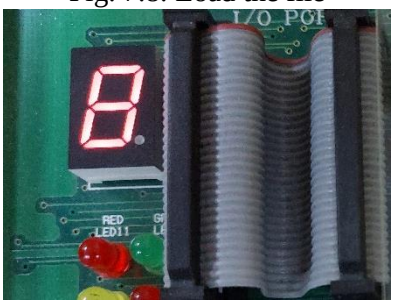


Fig. 7.9: Output

7.7 Experimental problem no. 02

```
CODE SEGMENT
      ASSUME CS: CODE, DS: CODE, SS: CODE, ES: CODE
      ORG 1000H
      PORTA EQU 19H
      CONTRL EQU 1FH
      MOV AL, 10000000B
      OUT CONTRL, AL
      MOV AL, 11111001B
      OUT PORTA, AL
      CALL DELAY
      MOV AL, 10000000B
      OUT PORTA, AL
      CALL DELAY
      MOV AL, 11000000B
      OUT PORTA, AL
      CALL DELAY
      MOV AL, 11111001B
      OUT PORTA, AL
      CALL DELAY
      MOV AL, 11111000B
      OUT PORTA, AL
      CALL DELAY
      MOV AL, 11111001B
      OUT PORTA, AL
      CALL DEALY
      DELAY PROC
      MOV CX, 0FFFFH
      LOOP1;
      NOP
      NOP
      NOP
      LOOP LOOP1
```

```
        RET
        DELAY ENDP
        CODE ENDS
END
```

7.8 Output procedures

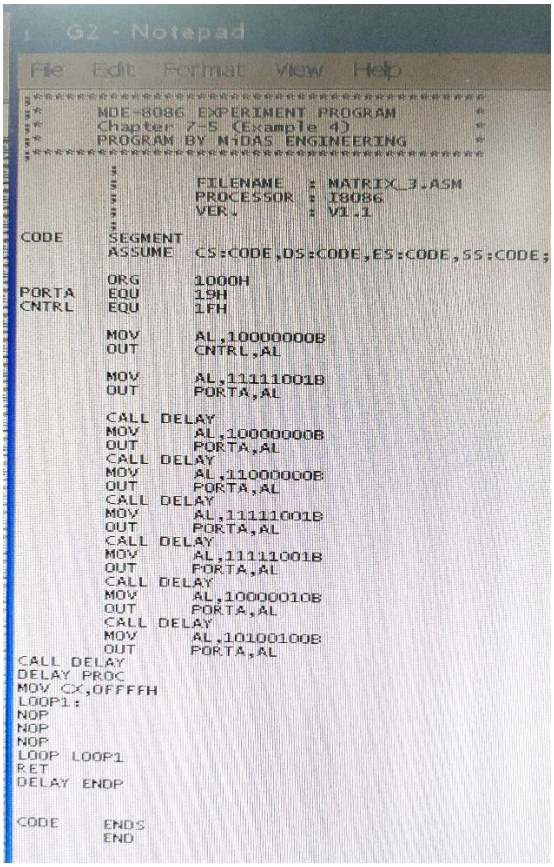


Fig. 7.10: Writing program on notepad

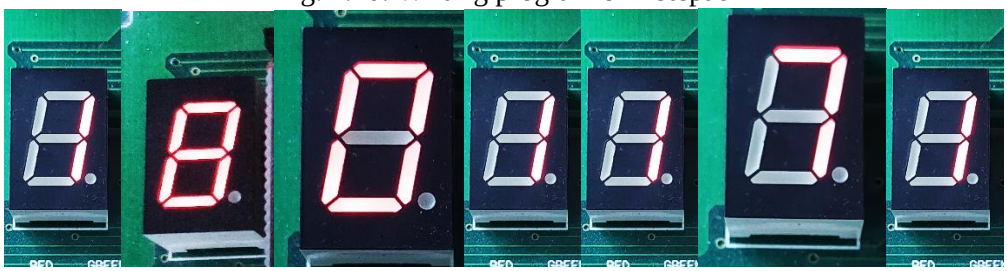


Fig. 7.10: 1801171 as output

7.9 Discussion & Conclusion

The procedure of working in serial monitor mode or PC mode with the 8086 MDA kit was introduced in this experiment. In this case, we used the MDA 8086 kit's direct monitor mode. We used code to perform the multiplication of two numbers.

A program was developed in notepad and saved as '.**asm**' file, which was then translated to '.**obj**' using Microsoft Macro Assembler. The '.obj' file was then translated into a '.**abs**' file using the LOD186 software. The '.**abs**' file was then executed by following the instructions, and the output was observed using both single-step execution and direct execution.

Experiment No. 08

8.1 Experiment Name

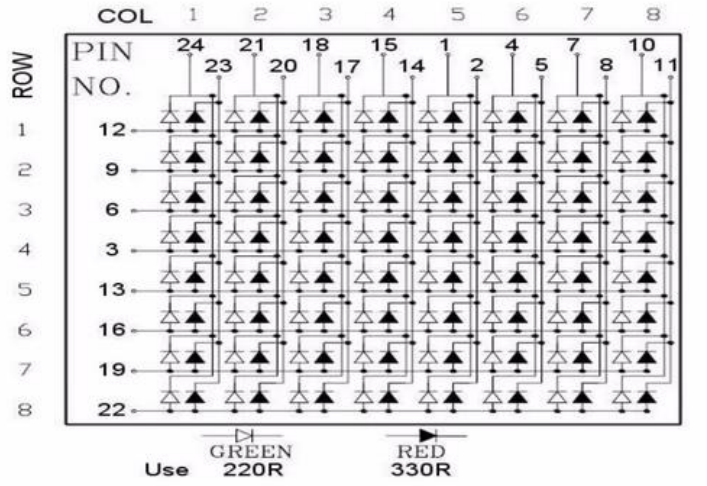
8255 PPI interfacing: Dot matrix

8.2 Objectives

- To get acquainted with the "MDA 8086" Trainer Board and its operation
- To understand the operation of Dot matrix in 8255 PPI interfacing
- To learn how to implement program in “MDA 8086” Trainer Board and interconnect it with “Emu 8086”

8.3 Theory

A dot Matrix consists of an array of LED's which are inter connected such that the positive terminal (anode) of each LED in the same column are connected together and the negative terminal (cathode) of each LED in the same row are connected together.



Here, the 8255 port address in accordance with the dot matrix are as follows,

Port name	Port address
Port A	18H
Port B	1AH
Port C	1CH
Control register	1EH

8.4 Apparatus

- MDA 8086 - Trainer Board

8.5 Code for column wise operation

```
CODE SEGMENT
      ASSUME CS: CODE, DS: CODE, SS: CODE, ES: CODE
CNTRL EQU 1EH
PORTC EQU 1CH
PORTB EQU 1AH
PORTA EQU 18H
      ORG 1000H
      MOV AL, 100000000B
      OUT CONTRL, AL
```

```
        MOV AL, 100000000B
        OUT PORTB, AL
        MOV AL, 000000001B
        L1;
        OUT PORTC, AL
        ROL AL, 1
        CALL TIMER
        JMP L1
        INT
TIMER:
        MOV CX, 0FFFFH
        LOOP2:
        NOP
        NOP
        NOP
        NOP
        LOOP LOOP2
        RET
        CODE ENDS
END
```

8.6 Output for column wise operation

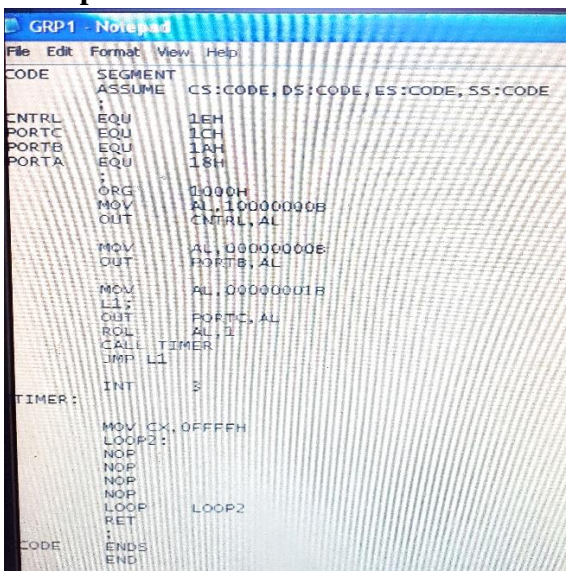


Fig. 8.1: Writing program on notepad

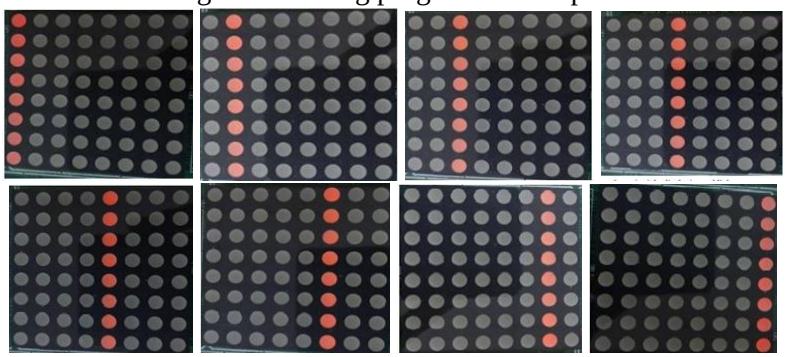


Fig. 8.2: Output

8.7 Code for row wise operation

```
CODE SEGMENT
        ASSUME CS: CODE, DS: CODE, SS: CODE, ES: CODE
```

```
CNTRL EQU 1EH
PORTC EQU 1CH
PORTB EQU 1AH
PORTA EQU 18H
ORG 1000H
MOV AL, 100000000B
OUT CONTRL, AL
MOV AL, 11111111B
OUT PORTC, AL
MOV CL, 8
MOV AL, 01111111B
L1;
OUT PORTB, AL
ROL AL, 1
CALL TIMER
JMP L1
INT
TIMER:
      MOV CX, 0FFFFH
      LOOP2:
      NOP
      NOP
      NOP
      NOP
      LOOP LOOP2
      RET
      CODE ENDS
END
```

8.8 Output for row wise operation

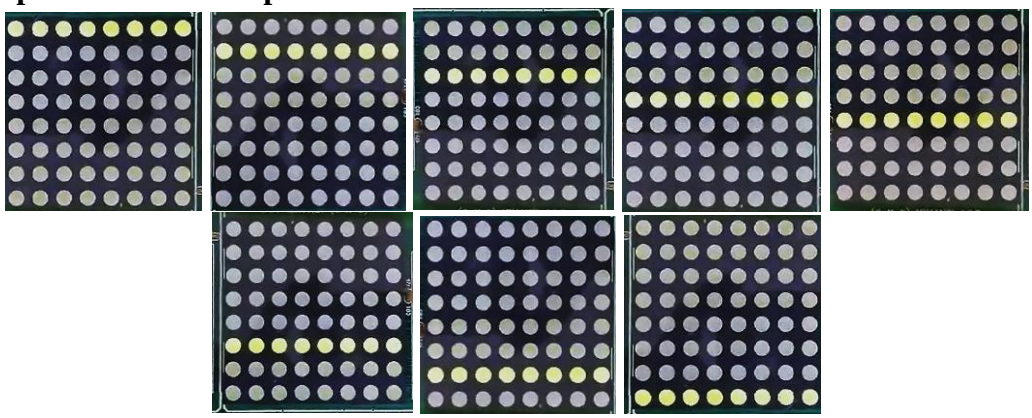


Fig. 8.3: Output

8.9 Discussion & Conclusion

The procedure of working in serial monitor mode or PC mode with the 8086 MDA kit was introduced in this experiment. We used code to perform the dot matrix. A program was developed in notepad and saved as '.**asm**' file, which was then translated to '.**obj**' which was then translated into a '.**abs**' file. This was then executed by following the instructions, and the output was observed using both single-step execution and direct execution.

By using programming, the row-wise LEDs were turned on after the column-wise LEDs. Therefore, it may be concluded from all of the foregoing talks that the experiment was a success.

Experiment No. 09

9.1 Experiment Name

8255 PPI interfacing: LED

9.2 Objectives

- To get acquainted with the "MDA 8086" Trainer Board and its operation
- To understand working procedure of LED interfacing
- To learn how to implement program in “MDA 8086” Trainer Board and interconnect it with “Emu 8086”

9.3 Theory

For this experiment, we applied 8255 interfacing in LED. Four LEDs are connected to Port B's bottom four pins. Typically, the ground is connected to LED cathodes. The 8255 microcontrollers have four general-purpose I/O ports that can be configured as input or output. By designating the port pins as output, the state of the port pins can be managed and modified to high or low. When the port is configured as an input, reading the pins will show the voltage state of the pins. The port pins must be configured as outputs in order for the LED to flash.

Port name	Port address
Port A	18H
Port B	1AH
Port C	1CH
Control register	1EH

9.4 Apparatus

- MDA 8086 - Trainer Board

9.5 Experimental problem no. 01

```
CODE SEGMENT
ASSUME CS: CODE, DS: CODE, ES: CODE, SS: CODE
ORG 1000H
PORTA EQU 1BH
CNTRL EQU 1FH
MOV AL,10000000B
OUT CNTRL, AL
MOV CL,5
L1:
MOV AL,00000001B
OUT PROTB, AL
CALL DELAY
MOV AL,00000010B
OUT PROTB, AL
CALL DELAY
MOV AL,000001000B
OUT PROTB, AL
CALL DELAY
```

```
MOV AL,000000100B
OUT PROTB, AL
CALL DELAY
LOOP L1
DELAY PROC
MOV CX,0FFFFH
LOOP1:
NOP
NOP
NOP
NOP
LOOP LOOP1
RET
DELAY ENDP
CODE ENDS
END
```

9.6 Output as clockwise direction in Z pattern

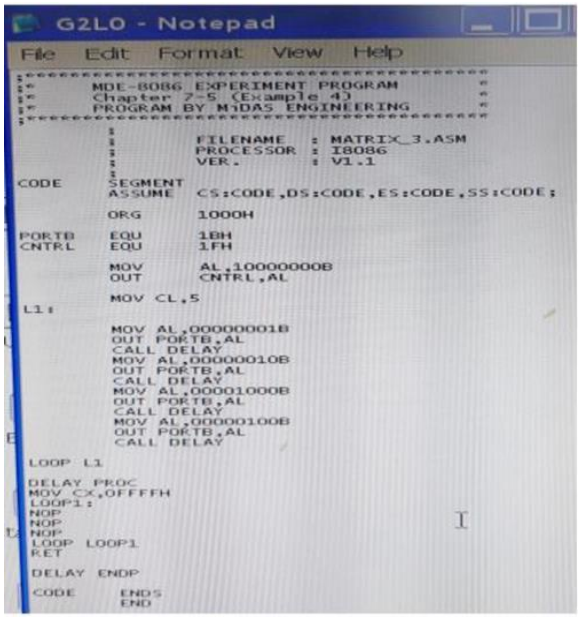


Fig. 9.1: Writing program on notepad

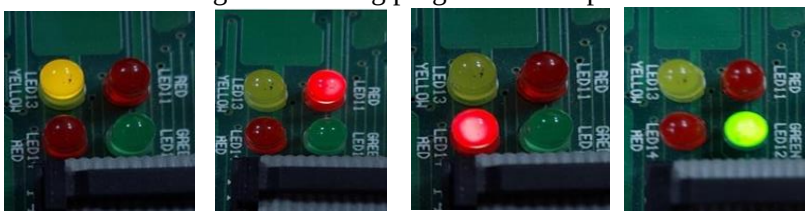


Fig. 9.2: Output

9.7 Discussion & Conclusion

In this experiment, we used code to perform the LED interfacing. A program was developed in notepad and saved as **'.asm'** file, which was then translated to **'.obj'** and later into a **'.abs'** file. This was then executed and the output was observed using direct execution.

Here, there were two more types of patterns available on the LED interface of the 8086 kits. Here, using programming, we activated the LEDs in two different directions: clockwise & z-pattern. Therefore, it may be concluded from all of the foregoing talks that the experiment was a success.

Experiment No. 10

10.1 Experiment Name

LED ON/OFF using 8253, 8255 & 8259

10.2 Objectives

- To get acquainted with the "MDA 8086" Trainer Board and its operation
- To understand working procedure of LED ON/OFF using 8253, 8255, and 8259
- To learn how to implement program in “MDA 8086” Trainer Board and interconnect it with “Emu 8086”

10.3 Theory

The **8255** is a **Programmable Peripheral Interface**, is a general purpose programmable I/O device designed to interface the CPU with its outside world such as ADC, DAC, keyboard etc.

On the contrary, the **8253** is a **Programmable Timer Interval IC** which are designed for microprocessors to perform timing and counting functions using three 16-bit registers.

The **8259** is a **Priority/Programmable Interrupt Control IC** which combines the multi-interrupt input sources into a single interrupt output.

For this experiment, in order to turn on or off the LEDs concurrently with the specified time delay, the 8086 will control the 8255 PPI. The 8255 PPI IC's Port B is linked to the LEDs in the following way:

Port name	LED no.
PB_0	11
PB_1	12
PB_2	13
PB_3	14

The LEDs will be on and off in the following sequence by turning on each separately,

LED-11(PB0) -- LED-12(PB1) -- LED-13(PB2) -- LED-14(PB3)

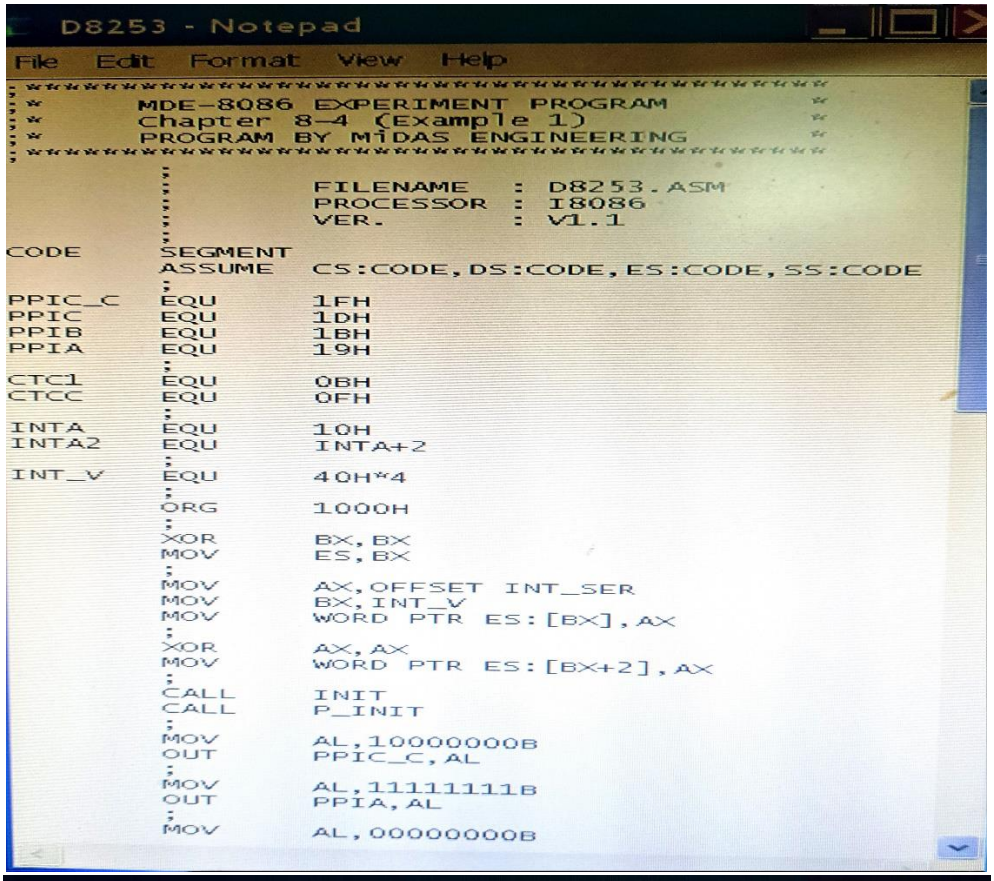
The MDA 8086 kit contains I/O mapped memory. So, to communicate with the peripherals, the commands "in" and "out" are needed. The 8255 PPI-CS-2 is used to connect the LEDs. So, port addresses for 8255, 8253 PTIC, and 8259 PICIC respectively are,

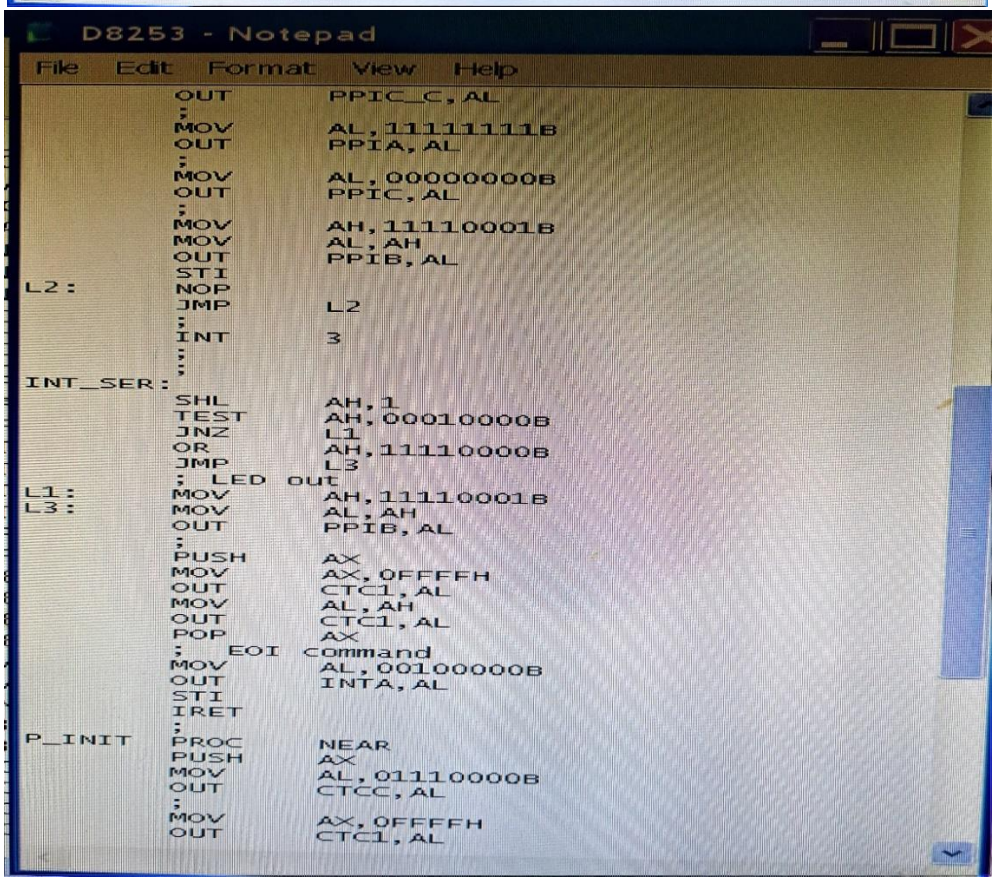
8255		8253		8259	
Port name	**Port address**	**Port name**	**Port address**	**Port name**	**Port address**
Port A	18H	Counter - 0	09H	INTA (Command Register)	10H
Port B	1AH	Counter - 1	0BH		
Port C	1CH	Counter - 2	0DH	$INTA_2$ (Data Register)	12H
Control register	1EH	Control register	0FH		

10.4 Apparatus

- MDA 8086 - Trainer Board

10.5 Code and Output as Z pattern


D8253 - Notepad
File Edit Format View Help
;***
;* MDE-8086 EXPERIMENT PROGRAM   *
;* Chapter 8-4 (Example 1)   *
;* PROGRAM BY MIDAS ENGINEERING   *
;***
;
; FILENAME : D8253.ASM
; PROCESSOR : I8086
; VER.   : V1.1
;
CODE SEGMENT
ASSUME CS:CODE,DS:CODE,ES:CODE,SS:CODE
;
PPIC_C EQU 1FH
PPIC EQU 1DH
PPIB EQU 1BH
PPIA EQU 19H
;
CTC1 EQU 0BH
CTCC EQU 0FH
;
INTA EQU 10H
INTA2 EQU INTA+2
;
INT_V EQU 40H*4
;
ORG 1000H
;
XOR BX,BX
MOV ES,BX
;
MOV AX,OFFSET INT_SER
MOV BX,INT_V
MOV WORD PTR ES:[BX],AX
;
XOR AX,AX
MOV WORD PTR ES:[BX+2],AX
;
CALL INIT
CALL P_INIT
;
MOV AL,10000000B
OUT PPIC_C,AL
;
MOV AL,11111111B
OUT PPIA,AL
;
MOV AL,00000000B


D8253 - Notepad
File Edit Format View Help
OUT PPIC_C,AL
;
MOV AL,11111111B
OUT PPIA,AL
;
MOV AL,00000000B
OUT PPIC,AL
;
MOV AH,11110001B
MOV AL,AH
OUT PPIB,AL
STI
L2: NOP
JMP L2
;
INT 3
;;
;
INT_SER:
SHL AH,1
TEST AH,00010000B
JNZ L1
OR AH,11110000B
JMP L3
; LED out
L1: MOV AH,11110001B
L3: MOV AL,AH
OUT PPIB,AL
;
PUSH AX
MOV AX,0FFFFH
OUT CTC1,AL
MOV AL,AH
OUT CTC1,AL
POP AX
; EOI command
MOV AL,00100000B
OUT INTA,AL
STI
IRET
;
P_INIT PROC NEAR
PUSH AX
MOV AL,01110000B
OUT CTCC,AL
;
MOV AX,0FFFFH
OUT CTC1,AL

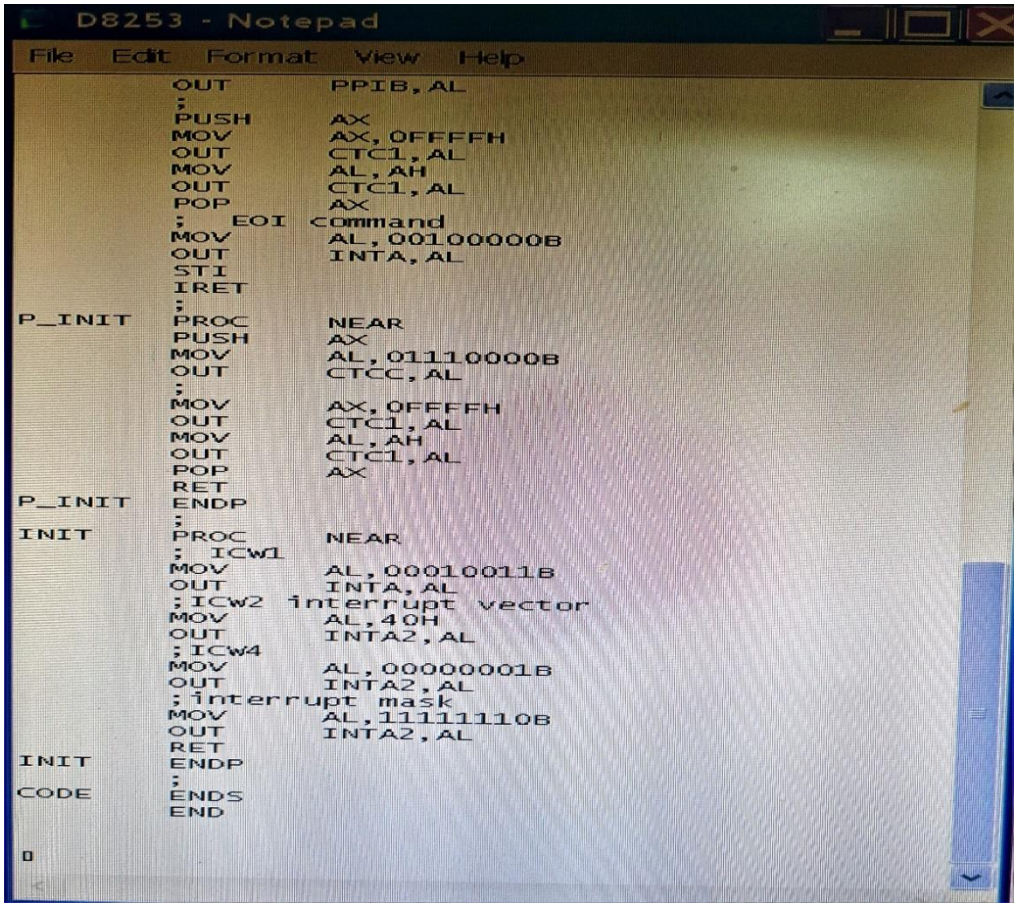


Fig. 9.1: Writing program on notepad

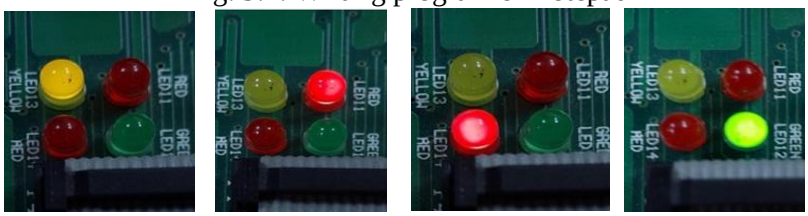


Fig. 9.2: Output

10.6 Discussion & Conclusion

In this experiment, we used code to perform the LED interfacing in 8255, 8253, and 8259. A program was developed in notepad and saved as **'.asm'** file, which was then translated to **'.obj'** and later into a **'.abs'** file. This was then executed and the output was observed using direct execution.

To turn ON and OFF each LED sequentially and concurrently with a predetermined interval, the 8253 PTI IC provided the necessary time delay and pushed the pin IR0 of the 8259 PIC IC with an interrupt. The 8255 PPI IC, which is coupled to the LEDs, was managed by the 8086, which received this interrupt. The 8086, which was in charge of the associated 8255 LEDs, lighted them up one at a time while maintaining the required time delay.

Thus, the experiment was a success.