PANTECH SOLUTIONS®
Technology Beyond the Dreams

MICRO CONTROLLER BOARDS

PS-8086 Trainer Kit

USER MANUAL
& TECHNICAL REFERENCE

Contents

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

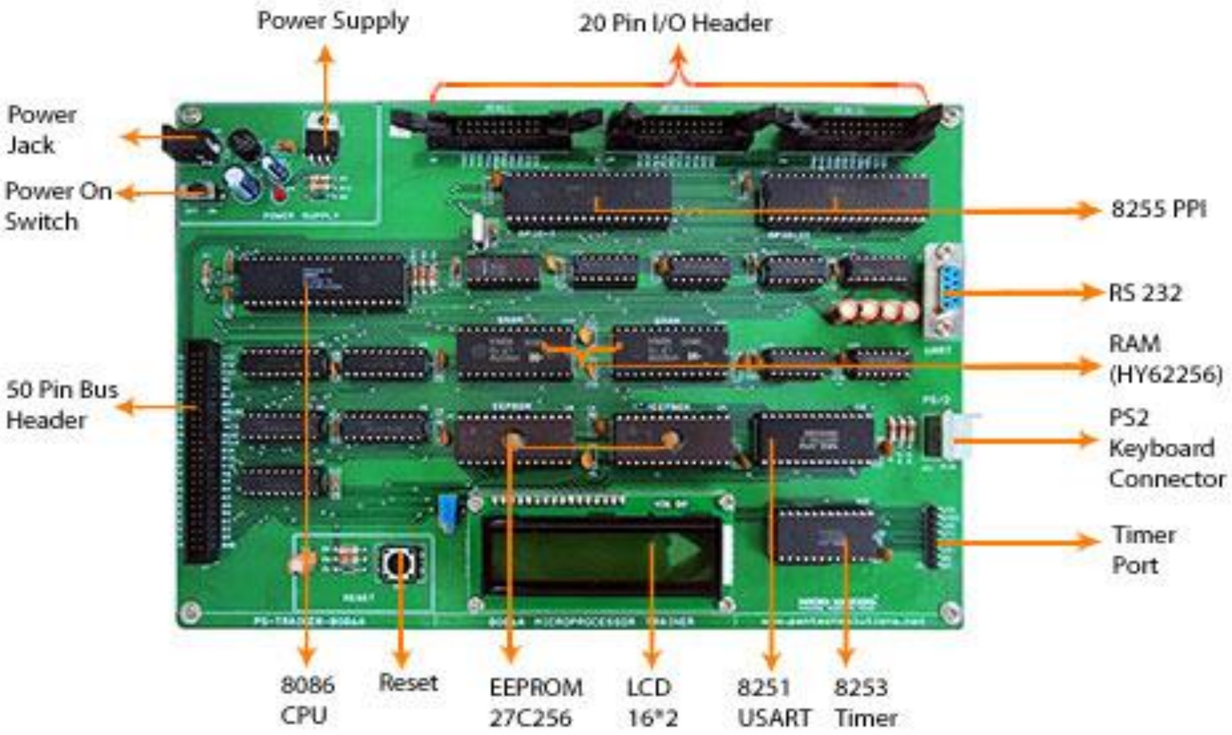
The **PS-8086** board which demonstrates the capabilities of the 40-pin **8086** (various families) Sample programs are provided to demonstrate the unique features of the supported devices.

The **PS-8086** Kit comes with the following:

1) **PS-8086** Board
2) Sample devices (**INTEL 8086/NEC 8086**)
3) Cross cable (**RS232**)
4) CD-ROM, which contains:
   a) Sample programs
   b**)** **PS-8086** Board User manual
5) Keyboard (101 keys)

Note: If you are missing any part of the kit, please contact our support executive

1.2 PS – 8086 BOARD OVERVIEW



The **PS – 86A** board is based on Intel **8086** Microprocessor, which operates at **6.144 MHz** using the crystal of **18.432**. The board can operate using the **101/104** PC keyboard supplied along with the trainer kit and 2 Line by 16-character LCD display or from the PC (using the Terminal Emulation Software). Microprocessor's Address, Data and Control bus pins are brought to the 50 pin FRC connector. **PS -86A** is equipped with powerful software monitor in two-**27C256 EPROM**.

The monitor supports Video terminal **RS232C** interface, local 101keyboard and LCD display. The board has 64KB CMOS static RAM (type **62256)**. **PS -86A** works on +**9V DC**.

1.3 PS – 8086 SPECIFICATIONS

1. **8086** Microprocessor operating at **18.432 MHz**
2. **16KB** powerful software monitor two **27C256 EPROM**
3. Three 16-bit programmable timers from **8253**
4. **48** programmable I/O lines from two nos. of **8255**
5. Serial interface using **8251**
6. **50** pin FRC connector for system bus expansion
7. **20** pin FRC connector for user interface from **8255**
8. **9** pin **D** type connectors for **RS 232** interface
9. Six different selectable baud rates from **150** to **9600**
10. **101** PC type keyboard for entering user address/data and for commands
11. Built in **line-by-line** assemble and disassemble
12. User friendly software monitor for loading and executing programs with break point facility

CHAPTER – 2: SYSTEM DESCRIPTION

2.1 HARDWARE

PROCESSOR CLOCK FREQUNCY:

8086 operates at 18.432 MHz clock.

MEMORY:

Monitor EPROM: 0000 –FFFF (SEGMENT)

System RAM: 0000 –FFFF (SEGMENT)

1000 – 3FFF (Reserved For Monitor program)

User RAM Area: 1100 – 3FFF

ALLOCATION OF EPROM:

START ADDRESS	END ADDRESS	SOCKET NO	IC USED	TOTAL CAPACITY
0000	FFFF	U9 U8	27256 27256	32 K BYTE 32 K BYTE

ALLOCATION OF RAM:

START ADDRESS	END ADDRESS	SOCKET NO	IC USED	TOTAL CAPACITY
0000	FFFF	U10 U11	62256 62256	32 K BYTE 32 K BYTE

PARALLEL INTERFACE:

8255 - Programmable peripheral interface.

SYSTEM MAPPING: I/O mapped I/O.

The following are the I/O addresses for 8255(GPIO I):

SOCKET.NO	FUNCTION	ADDRESS	CONNECTOR.NO
	CONTL REG	FF26	
U22	PORT A	FF20	J8
	PORT B	FF22	GPIO I
	PORT C	FF24	J9(GPIO I&GPIOII)

The following are the I/O addresses for 8255(GPIO II):

SOCKET.NO	FUNCTION	ADDRESS	CONNECTOR.NO
	CONTL REG	FF36	
U16	PORT A	FF30	J6
	PORT B	FF32	GPIO II
	PORT C	FF34	J9(GPI0 I&GPIOII)

TIMER INTERFACE:

8253 - Programmable Interval Timer:

SYSTEM MAPPING: I/O mapped I/O.

CHANNEL 2:

Input clock : 3 MHz
Output clock: Depends on selection of baud rate.
Used for : Baud rate generation for 8521 USART.

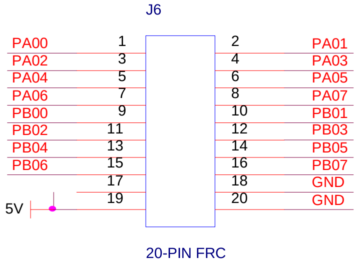
I/O ADDRESS:

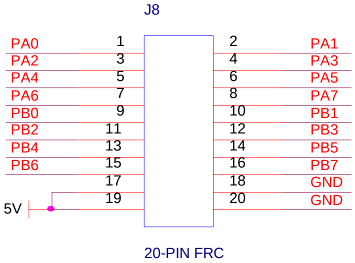
SOCKET.NO	FUNCTION	ADDRESS	CONNECTOR.NO
U12	CONTL REG CHENNAL 0 CHENNAL 1 CHANNEL 2	FF06 FF00 FF02 FF04	J2

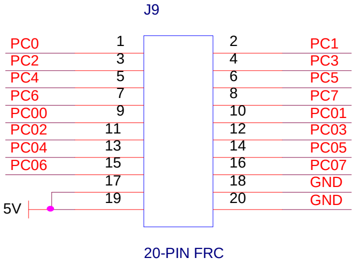
2.2 CONNECTOR DETAILS

1) 20 PIN EXPANSION CONNECTORS:

The 20 Pin FRC connector is used to interconnect with the **Interface cards** like **ADC, DAC, SWITCH/LED, RELAY buzzer** Interfaces etc. P**in details** are given below

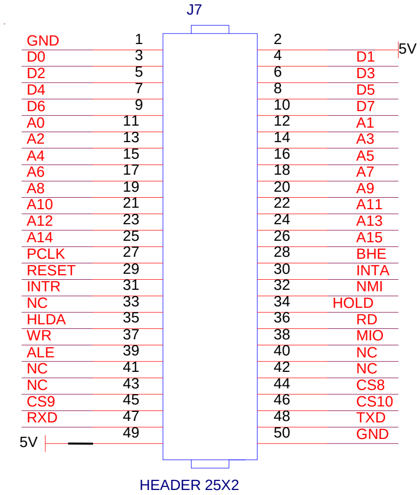




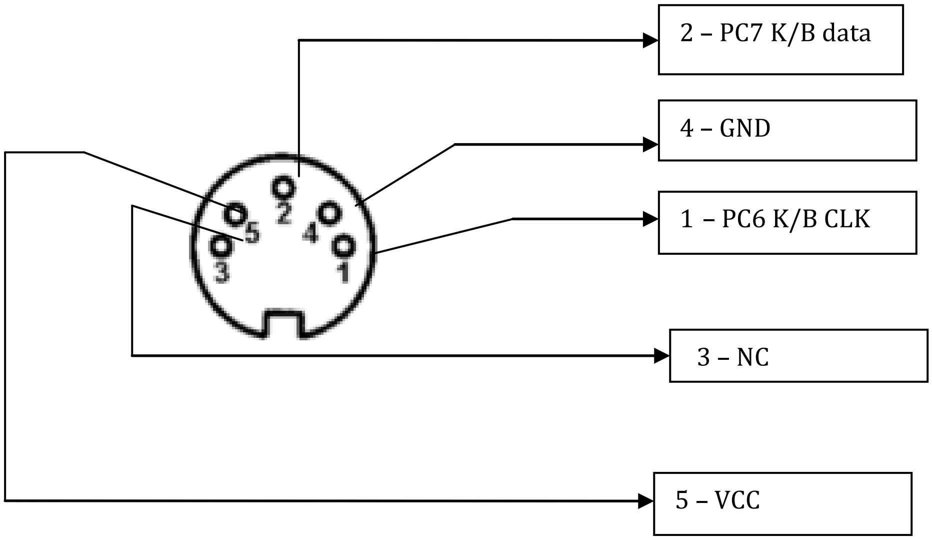


2) 50 PIN EXPANSION CONNECTOR:

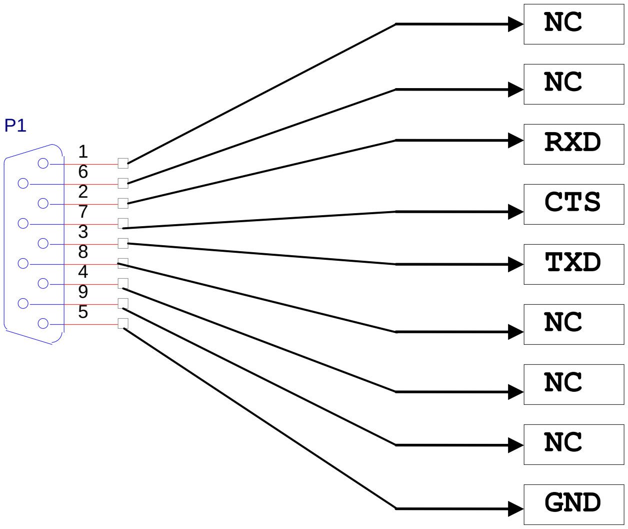
The 50 Pin FRC connector is used to interconnect with the **Interface cards** like 8255, 8279, 8253/8251, 8259, 8257 and the **pin details** are given below



3) KEYBOARD CONNECTOR:



4) 9PIN ‘D’ TYPE (FEMALE):



8251 - Universal Synchronous / Asynchronous Receiver / Transmitter.

RS232 Bridge Converter

BAUD CLOCK:

Baud clock for 8251 is programmable, provided by Channel 2 of 8253

INPUT CLOCK FOR 8251:

3.072 MHz

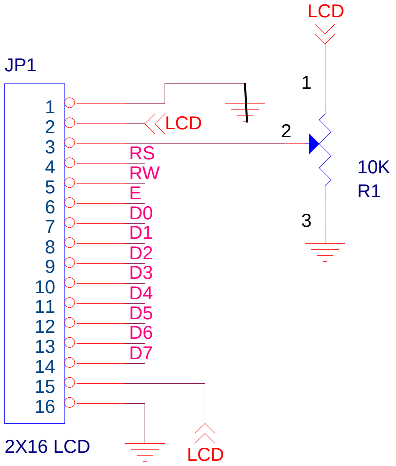
DRIVERS USED:

MAX 232 is used for transmitting receiving of characters.

8251 Uart I/O Address:

SOCKET.NO	FUNCTION	ADDRESS	CONNECTOR.NO
U15	8251 CONTL REG 8251 DATA	FF10 FF12	D2(SKT)

5) LCD Interface:



Device used: 16 × 2 / 20 × 4 LCD module

System Mapping: I/O mapped I/O.

SOCKET.NO	FUNCTION	ADDRESS	CONNECTOR.NO
----	LCD COMMAND LCD DATA	FF40 FF42	-----

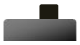
6) RESET:

This key is located in the main 8086 board. On depressing this key the program starts executing from the beginning or reset address 0000. On power on reset it. Display **PS - 86** in local LCD display.

2.3 POWER SUPPLY DETAILS:

PS trainer kit will work at 0 – 5v (1 amp) from the PS power supply. Provision is made in PS power supply to bring out on the front panel DC regulated voltage output for interfacing with add-on cards.

+5V **1 amp**

POWER SWITCH		Supply Turned OFF
		Supply Turned ON

2.4 KEYBOARD DETAILS

101 PC type keyboard is interfaced to Microcontroller through its port pin. Communication between keyboard and Microcontroller takes place using 2 wires – one for serial clock and serial data **(P1.6 and P1.7).**

CHAPTER – 3 COMMANDS AND KEYS

3.1 Reset

This key is located in the main PS-86A board .On depressing this key the programs. Starts executing from the beginning or reset address 0000. On power on reset it. Displays **PS- 86A** in local LCD display

```
PS -86
 !!!!
```

3.2 H (HELP MENU)

This key is used go PS- 86A help menu and it will display the following commands.

KEY	FUNCTIONS
A <BEG>	ASSEMBLE
B	BAUD RATE
D <BEG>	DISASSEMBLE
E <BEG><END>	EXAMINE
G <BEG>	EXECUTE
H	HELP COMMANDS
I <INSERT>	INTERNAL RAM
L <OFFSET>	DOWN LODE
M <ADDR>	MODIFY
N	NORMAL MODE
Q	QUIT
R <REG>	REGISTER DISPLAY
S	SERIAL TRANSFER
T <START><END><DS>	BLOCK TRENSFER
U <BEG><END>	UP LODE
X	DELETE BLACK MEMORY
?	INSTRUCTIONS

CHAPTER – 4 OPERATING INSTRUCTIONS

4.1 POWER ON

Connect the PS – 8051 board to the power having the following specifications.

+9V DC 1 Amp

Switch on the power supply after ensuring the correct voltages. Following message will appear on the LCD display.

```
PS -- 86
 ! ! ! !
```

On power on or after reset the display shows **PS – 86 as** a sign on message. The prompt character – is displayed in the next line informing the user, that the board is ready to accept the commands.

4.2 Instruction

1) PROGRAM ENTRY USING ASSEMBLER:

ENTERING MNEMONICS

Example:

Press H for help **A1100**	Enter the starting Address

Enter Key ↵

User program starts from address 1100 and displays the following and waits for the user data to be typed in the second line

Example:

```
0000 : 1100:
MOV AX,1212
```

Enter the mnemonics

Enter Key ↵

```
0000 : 1103:
MOV BX,1212
```

Enter the mnemonics

Enter Key ↵

Program end.

Exit Command: Double Enter you get the main menu

```
        PS
86
_
```

2) PROGRAM ENTRY USING OPCODE:

Modify Memory

```
Press  H  for
help
_M1100
```

Enter the starting Address

Enter Key ↵

```
0000:1100:
      18 _
```

```
0000:1100:
      18 B8_
```

Enter the opcode

Enter the Space Bar Key

```
0000:1101:
      34 12_
```

Enter the opcode

Enter the Space Bar Key

Program end. Exit Command:

Double Enter you get the Main Menu

ENTERING ‘G‘EXECUTING COMMAND

```
      PS
86
_G1100
```

Enter starting address

Enter key ↵

After executing display

```
      PS
86
_G1100
```

Executing display

To EXIT Execution Mode PRESS ’RESET ‘Switch

4.3 ENTERING RESULT COMMAND:

```
Press H for
help
_M
<address>
----------
0000:1200:
```

Enter the Memory Location

Enter Key ↵

```
24 _
```

You get the output

8-bit Data

4.4 DISASSEMBLER

Disassemble converts the hex byte stored in the memory into equivalent mnemonics. To enter into disassemble mode, type D in the command mode followed by the memory address.

Example:

```
Press H for help
_D1100
```

Enter the starting address

Enter Key ↵

```
1100: B8 12 12
MOV AX,1212
```

Enter the Space Bar Key

```
1103: BB 12 12
MOV AX,1212
```

Enter the space bar key

4.5 M (Modify External Memory):

Using this command the user can display/modify any external memory address.

Modify External memory

```
Press H for
help
_M1100
```

Enter the starting Address

4.6 R (Register Display)
Example:

```
Press H for
help
_R
```

Enter the starting Address

Enter Key ↵

```
AX=1104
```

Enter the Space Bar Key

```
 BX=1204
```

Enter the space bar to see the remaining registers

4.7 T (Transfer Command)

Example:

Press **‘T ‘**

The source segment addresses 0000. The above command transfer the memory content starting from source start address 1100 to destination start address 1200 till source end address 1500 is reached.

Src seg address	0000
Starting address	1100
End address	1200
Destination address	1500

```
 Block
Transfer ↵
Src      seg   :
0000
```

Enter Key

start : 1100	Enter the 1100 address
end : 1200	Enter the 1200address

Enter Key ↵ for exit command

dest : 0 :

1500

Enter Key ↵

Transfer Complete

Enter Key ↵ for exit command

4.8 N (Local Mode)

When this key is depressed on PC keyboard, the PS – 8051 Kit starts working through local 101 keyboard. Serial communication is disabled. Following message will appear in the LCD display.

```
     !        NORMAL
MODE  !
```

4.9 B (baud rate)

Press the **‘B ‘**

```
Cur   BAUD  :
2400
   150
```

Enter the Space Bar Key

```
Cur   BAUD  :
2400
   9600
```

Enter Key ↵ SET the 9600 baud rate

Baud rates : 150, 300, 600, 1200, 2400, 4800, **9600**

When using the serial Communication.

4.10 S (Serial Mode Key)

When this key is depressed the system start communicating through connector.

All keys are disabled except reset.

! Serial Mode!

The system displays the message SERIAL MODE. To come back to LCD mode (Normal Mode) user has to press the 'N' key in the computer keyboard otherwise press the Reset button.

4.11 Programming The 8086 Trainer Kit:

PROCEDURE 1: TO ENTER THE MNEMONICS

1) Initially connect the **9V** adaptor to **J10** connector

2) Switch **ON** the **PS-8086** kit using slide Switch **SW1**

3) "**PS - 86**" will be displayed on the LCD

4) Connect the **Keyboard** in **PS**/2 connector

5) Depress "**A**" starting address of the program for Ex: **A1100**

   For ex: **A1100** enter key

   Type the mnemonics **MOV AX, 1212press** Enter key

Type the mnemonics **MOV BX, 1212 press** Enter key and continue the same procedure till the end of the program

ADDRESS	**OPCODES**	**MNEMONICS**
1100	B8 12 12	MOV AX,1212
1103	BB 12 12	MOV BX,1212
1106	01 D8	ADD AX,BX
1108	BE 00 12	MOV SI,**1200**
110B	89 04	MOV [SI],AX
110D	F4	HLT

6) To verify the code depress **D** starting address and depress space bar to see next memory location

   For Ex: **D1100** and press spacebar till the end of the program

7) To execute the program Depress “G staring address for Ex: **G1100.**

8) To see the result depress “M result address” for Ex: **M1200.**

9) To view the output in the Register depress **‘R’** and press enter key in keyboard.

PROCEDURE 2: TO ENTER THE OPCODE

Follow the same procedure till step 4

1) Depress “**M**” starting address of the program for Ex: **M1100**

   For ex: **M1100** press enter

   Type the opcode B8 space bar

   Type the opcode 12 space bar and continue the same till the end of the program

ADDRESS	OPCODES	MNEMONICS
1100	B8 12 12	MOV AX,1212
1103	BB 12 12	MOV BX,1212
1106	01 D8	ADD AX,BX
1108	BE 00 12	MOV SI,1200
110B	89 04	MOV [SI],AX
110D	F4	HLT

2) To view the code depress **D** starting address and depress space bar to see next memory location

For Ex: **D1100** and press spacebar till the end of the program

3) To execute the program Depress "G staring address for Ex: **G1100.**

4) To see the result depress "M result address" for Ex: **M1200.**

5) To view the output in the Register depress **'R'** and press enter key in keyboard

Note: 1) **"M"** is used for displaying the result, for Ex: **M8500**

2) **"M"** is used to entering the Opcode.

3) **"M"** is used for entering the data.

Note: There are two ways to enter the program

1) Mnemonics method
2) Opcode method

Sample program is given to enter the program in both the methods

CHAPTER – 5 PROGRAMMING DETAILS

PROGRAMMING 8086 OVERVIEW

- The 8086 Microprocessor uses a multiplexed 16 bit address and address bus
- During the first clock of machine cycle the 16 bit address s sent out on address/data bus
- These 16 bit addresses may be latched externally by the address latch enable signals(ALE)
- 8086 Microprocessor can access 1024kb of external memory using its 20 bit address and memory read/write signals
- The 8086 provide s0, s1 and s2 signals for bus control.
- The 8086 Microprocessor has a 16 bit program counter (IP) and 16 bit stack pointer (sp)

It has following set of 16 bit Registers:

AX –Accumulator

BX, CX, DX (These four register can be used as two 8 bit register individually)

Index Register

SI → Source index

DI → Destination index

BP → Base pointer index

Segment Register

CS →	Code segment register
DS →	Data segment register
ES →	Extra segment register
SS →	Stack segment register
FL →	Flag register

Interrupts:

The 8086 have two interrupt

- External mask able interrupt (INTR)
- Non mask able interrupt (NMI)

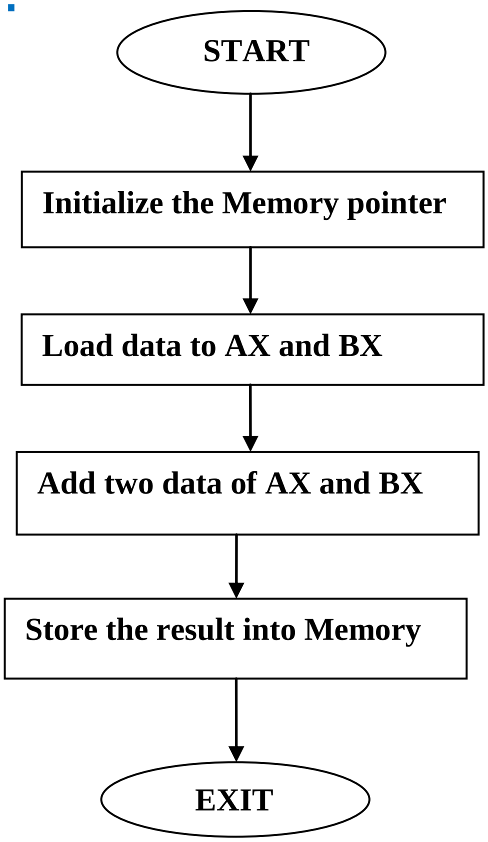
BREAK POINT DISPLAY IN LOCAL MODE:

When break point is encountered, all the register values are saved and the Acc. **“AX=XXXX** “Value is displayed in the LCD display. Now use SPACE key to check register values one by one

CHAPTER 6: EXAMPLE PROGRAMS

6.1 Addition Of Two Bytes Of Data

FLOW CHART:


START
Initialize the Memory pointer
Load data to AX and BX
Add two data of AX and BX
Store the result into Memory
EXIT

ALGORITHM:

1. Initialize the pointer to the memory for data and result.
2. Load the data into AX, BX.
3. Add the two data of AX and BX registers.
4. Store the result into Memory from AX registers.

INPUT:

1. Input data’s (2 byte) are loaded into Memory address 1500.
2. LSB in 1500, MSB in 1501 – 1^{st} data.
3. LSB in 1502, MSB in 1503 – 2^{nd} data.

Output:

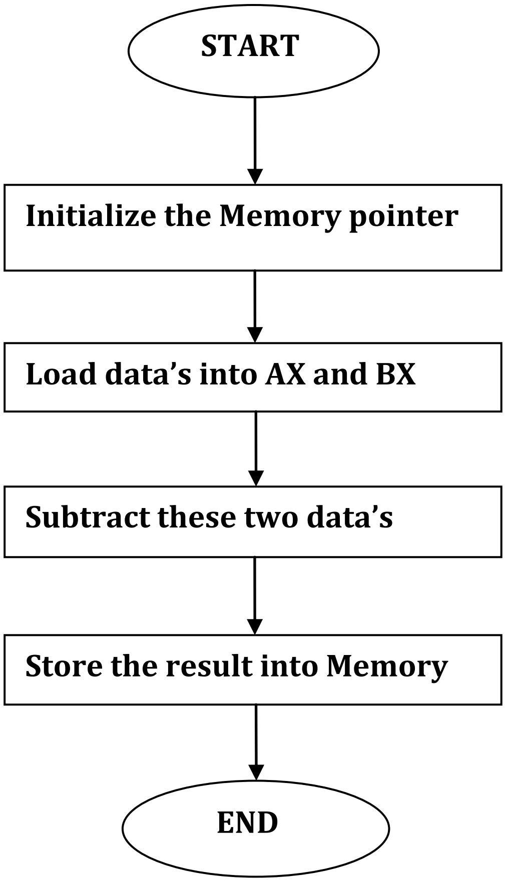
1. Result stored in Memory address 1520.
2. LSB in 1520, MSB in 1521.

Program

ADDRESS	OPCODE	MNEMONICS	COMMENTS
1100	BE 00 15	MOV SI, 1500	Move 1500 into SI pointer
1103	AD	LODSW	Load the first data into AX
1104	89 C3	MOV BX, AX	Move AX value into BX
1106	AD	LODSW	Load the second data into AX
1107	01 C3	ADD BX, AX	Add BX and AX registers
1109	BF 20 15	MOV DI, 1520	Load 1520 address location into DI
110C	89 1D	MOV [DI], BX	Store BX value into memory
110E	74	HLT	HALT

6.2 SUBTRACTION OF TWO BYTES OF DATA

FLOW CHART:


START
Initialize the Memory pointer
Load data's into AX and BX
Subtract these two data's
Store the result into Memory
END

ALGORITHM:

1. Initialize the pointer to the memory for data and result.
2. Load the two data's into AX, BX.
3. Subtraction of these two bytes of data.
4. Store the result into Memory address 1520.

Input:

1. Input data's (2 byte) are loaded into Memory address 1500.
2. LSB in 1500, MSB in 1501 – 1st data.
3. LSB in 1502, MSB in 1503 – 2nd data.

OUTPUT:

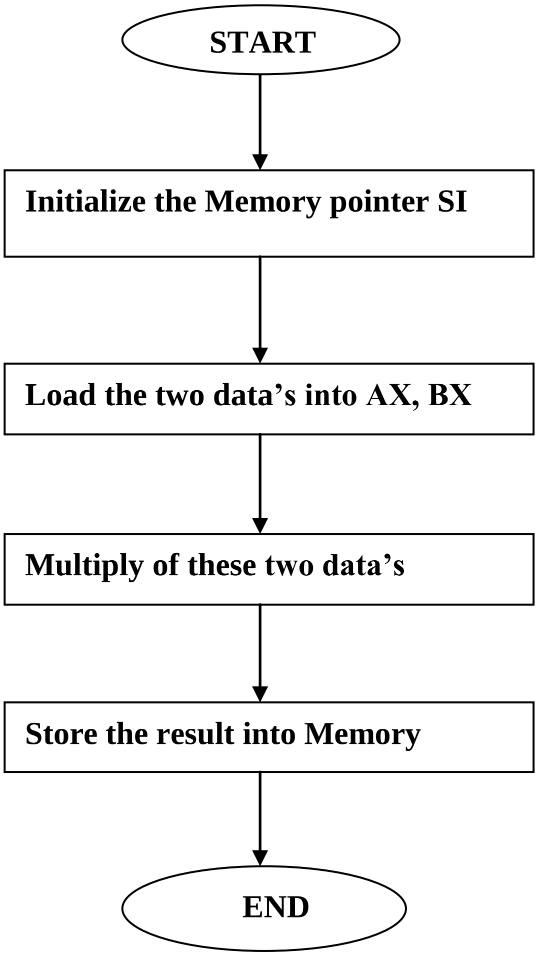
1. Result stored in Memory address 1520.
2. LSB in 1520, MSB in 1521.

Program:

ADDRESS	OPCODE	MNEMONICS	COMMENTS
1100	BE 00 15	MOV SI,1500	Load 1500 into SI
1103	AD	LODSW	Load the first data
1104	89 C3	MOV BX, AX	Move AX value into BX
1106	AD	LODSW	Load the second data
1107	01 C3	SUB BX, AX	subtract AX from BX
1109	BF 20 15	MOV DI, 1520	Load 1520 address into DI
110C	89 1D	MOV [DI],BX	Load BX value into DI
110E	CC	INT 3	Break point

6.3 MULTIPLICATION OF TWO BYTE DATA

FLOW CHART:


START
Initialize the Memory pointer SI
Load the two data's into AX, BX
Multiply of these two data's
Store the result into Memory
END

ALGORITHM:

1. Initialize the pointer to the memory for data and result.
2. Load the multiplier value into AX register.
3. Load multiplicand value in BX register.
4. Multiply of these two data's.
5. Store the result into Memory address 1520.

INPUT:

4. Input data's (2 byte) are loaded into Memory address 1500.

5. Load the multiplier value in 1500.
6. Load the multiplicand value in 1502.

OUTPUT:

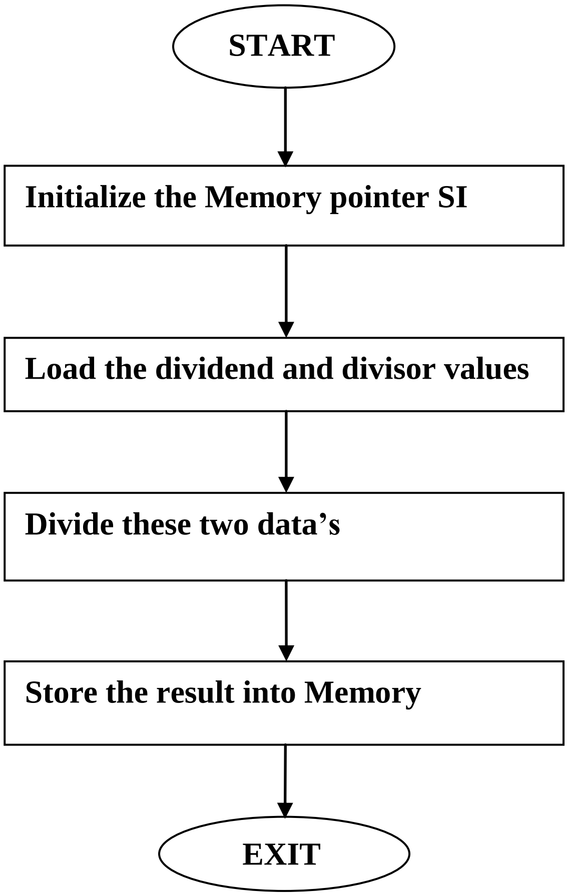
1. Result stored in Memory address 1520.

Program:

ADDRESS	OPCODE	MNEMONICS	COMMENTS
1100	BE 00 15	MOV SI,1500	Load 1500 into SI
1103	AD	LODSW	Load the multiplicand value
1104	89 C3	MOV BX, AX	Load AX value into BX
1106	AD	LODSW	Load the multiplier value
1107	F7 E3	MUL BX	Multiply two data
1109	BF 0 5 15	MOV DI, 1520	Load 1520 address into DI
110C	89 05	MOV [DI], AX	Store AX value into DI
110E	47	INC DI	Increment the DI
110F	47	INC DI	Increment the DI
1110	89 15	MOV [DI], BX	Store BX value into DI
1112	CC	INT 3	Break point

6.4 DIVISION (2 BYTE/ 1 BYTE)

FLOW CHART:


START
Initialize the Memory pointer SI
Load the dividend and divisor values
Divide these two data's
Store the result into Memory
EXIT

ALGORITHM:

1. Initialize the pointer to the memory for result.
2. Load the dividend value into AX register.
3. Load the divisor value into BX register.
4. Divide these two data's.
5. Store the result into Memory address 1520.

INPUT:

1. Dividend value loaded into AX register.
2. Divisor value loaded into BX register.

Output:

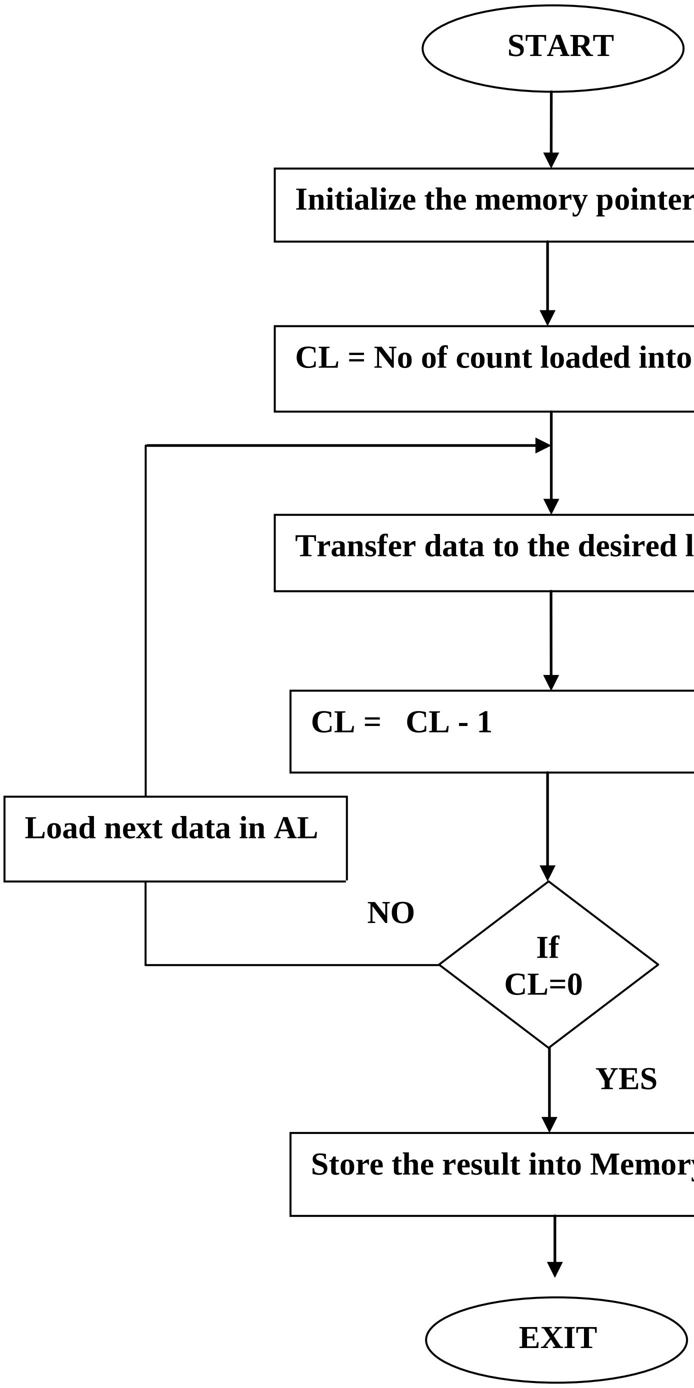
1. Result stored into 1520 address.
2. Quotient stored into 1522 address.
3. Remainder stored into 1523 address.

Program:

ADDRESS	OPCODE	MNEMONICS	COMMENTS
1100	BA 00 00	MOV DX, 0000	Clear DX registers
1103	B8 FD FF	MOV AX, FFFD	Load the dividend in AX
1106	B9 0F 00	MOV BX, 0F	Load the divisor value in BX
1109	F7 F1	DIV BX	Divide the two data’s
110B	BF 00 15	MOV DI, 1520	Load 1520 address into DI
110E	88 05	MOV [DI], AL	Load AL value into DI
1110	47	INC DI	Increment DI
1111	88 25	MOV [DI], AH	Load AH value into DI
1113	47	INC DI	Increment DI
1114	89 15	MOV [DI], DX	Load DX value into DI
1116	CC	INT3	Break point

6.5 BLOCK MOVE FROM ONE LOCATION TO ANOTHER

FLOW CHART:


START
Initialize the memory pointer
CL = No of count loaded into AL
Transfer data to the desired location
CL =   CL - 1
Load next data in AL
NO
If
CL=0
YES
Store the result into Memory
EXIT

ALGORITHM:

1. Initialize the pointer to the memory where data to be transformed.
2. Load the AL register with the data from memory.

3. Initialize destination pointer to the memory where data to stored.
4. Store data from AL register.

INPUT:

- Input data from address 1500 which is pointed SI, transferred to the desired Location.
- Number of byte in CL.

Output:

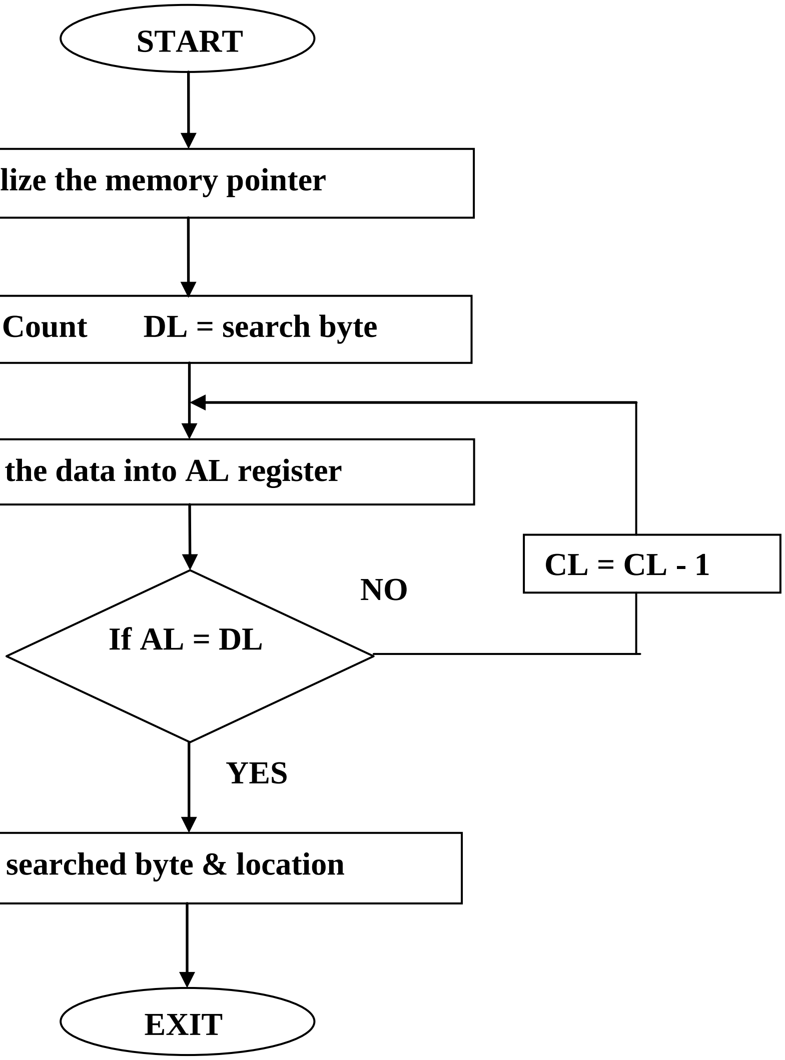
- Output – data in address 1550 is the moved data.

PROGRAM:

ADDRESS	OPCODE	MNEMONICS	COMMENTS
1100	B1 08	MOV CL, 08	Load 08 value into CL
1102	BE 00 14	MOV SI, 1500	Load 1500 into SI
1105	BF 50 14	MOV DI, 1550	Load 1550 into DI
1108	AC	LODSB	Load the data in AL Register
1109	88 05	MOV [DI], AL	Store the result in specified Location
110B	47	INC DI	Increment the pointer
110C	FE C9	DEC CL	Decrement the pointer
110E	75 F8	JNZ 1108	Loop continues until the counter is zero
1110	CC	INT 3	Break point

6.6 SEARCHING A BYTE

Flow Chart:


START
Initialize the memory pointer
CL = Count DL = search byte
Load the data into AL register
CL = CL - 1
NO
If AL = DL
YES
Store searched byte & location
EXIT

Algorithm:

1. Initialize the pointer to the memory for storing data and result.
2. Load DL with search byte.
3. Load CL with count.

4. Load AL with data from memory. Compare AL with DL if its equal store the result else decrement counts go to step2.
5. Store the result.

INPUT:

1. (Search the byte) A in 50 locations from 1500.

Output:

1. Store the result byte in 1600.

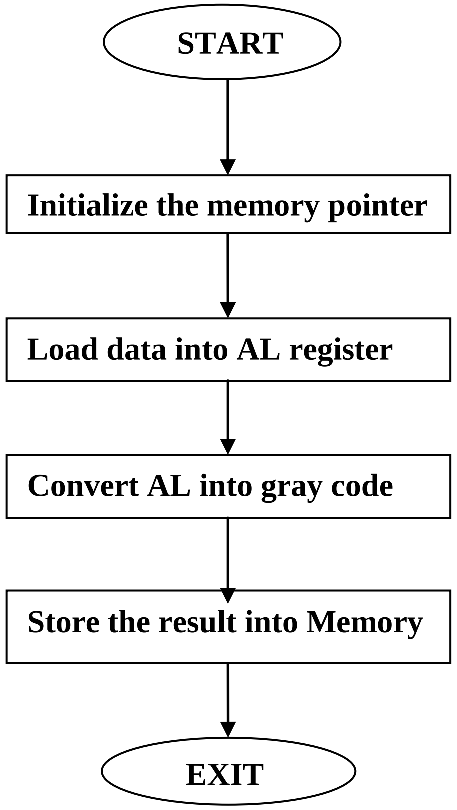
PROGRAM:

ADDRESS	OPCODE	MNEMONICS	COMMENTS
1100	BF 00 13	MOV DI, 1600	Load 1600 into DI
1103	BE 00 12	MOV SI, 1500	Load 1500 into SI
1106	B1 50	MOV CL, 50	Load 50 into CL
1108	B2 0A	MOV DL, 0A	Load 10 into DL
110A	AC	LODSW	Load CL register with the count
110B	38 C2	CMP DL, AL	Compare DL and AL register values
110D	FE C9	DEC CL	Decrement CL register
110F	75 05	JZ 1114	If count is zero then jump into 1114
1111	75 F7	JNZ 110A	If count is not zero then jump into 110A
1113	F4	HLT	
1114	88 05	MOV [DI], AL	Load AL value into DI

1116	4E	DEC SI	Decrement SI register
1117	89 F3	MOV BX, SI	Load SI value into BX
1119	47	INC DI	Increment DI
111A	88 1D	MOV [DI], BL	Store BL value into DI
111C	47	INC DI	Increment DI
111D	88 3D	MOV [DI], BH	Store BH value into DI
111F	CC	INT 3	Break point

6.7 GRAY CODE CONVERSION (Look Up Table)

Flow Chart:


START
Initialize the memory pointer
Load data into AL register
Convert AL into gray code
Store the result into Memory
EXIT

ALGORITHM:

1. Load the memory with truth table of gray codes.

2. Initialize the pointer to the memory for data and result.
3. Load AL with the data from memory.
4. Convert gray code for that data.
5. Store the result into Memory.

INPUT : Data in 1500.

OUTPUT : Result in 1501.

Lookup Table : Start from 1600.

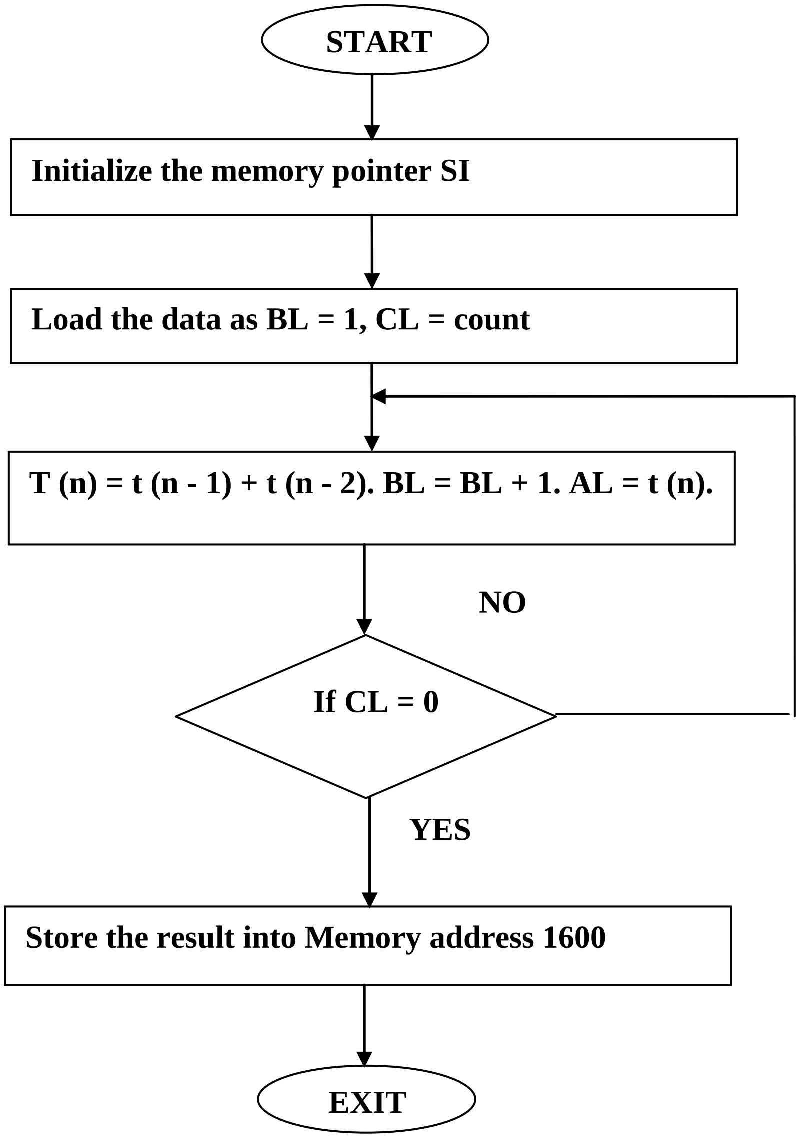
The look up table is provided by hex or of two bits in a byte the value ranges from 00 to 0f. 1600 - 00 01 03 02 06 07 05 04 0c 0d 0f 0e 0a 0b 09 08.

Program:

ADDRESS	OPCODE	MNEMONICS	COMMENTS
1100	BB 00 12	MOV BX, 1600	Load 1200 into BX
1103	BE 50 11	MOV SI, 1500	Load 1500 into SI
1106	AC	LODSB	Load the accumulator with the data
1107	D7	XLAT	Check gray code for that data
1108	BF 51 11	MOV DI, 1501	Load 1501 address into DI
110B	88 05	MOV [DI], AL	Store the gray code of the given data
110D	CC	INT3	Break point

6.8 SUM OF N CONSECUTIVE NUMBERS

FLOW CHART:


START
Initialize the memory pointer SI
Load the data as BL = 1, CL = count
T (n) = t (n - 1) + t (n - 2). BL = BL + 1. AL = t (n).
NO
If CL = 0
YES
Store the result into Memory address 1600
EXIT

ALGORITHM:

1. Load the value of n.
2. t (n) = t (n - 1) + t (n - 2).
3. t (n - 1) = t (n - 2) + 1.

4. n = n - 1.
5. if n > 0 continue else go to step2.
6. Initialize the pointer to memory for storing the result.
7. Store result.

INPUT : Load the value of n into CL.

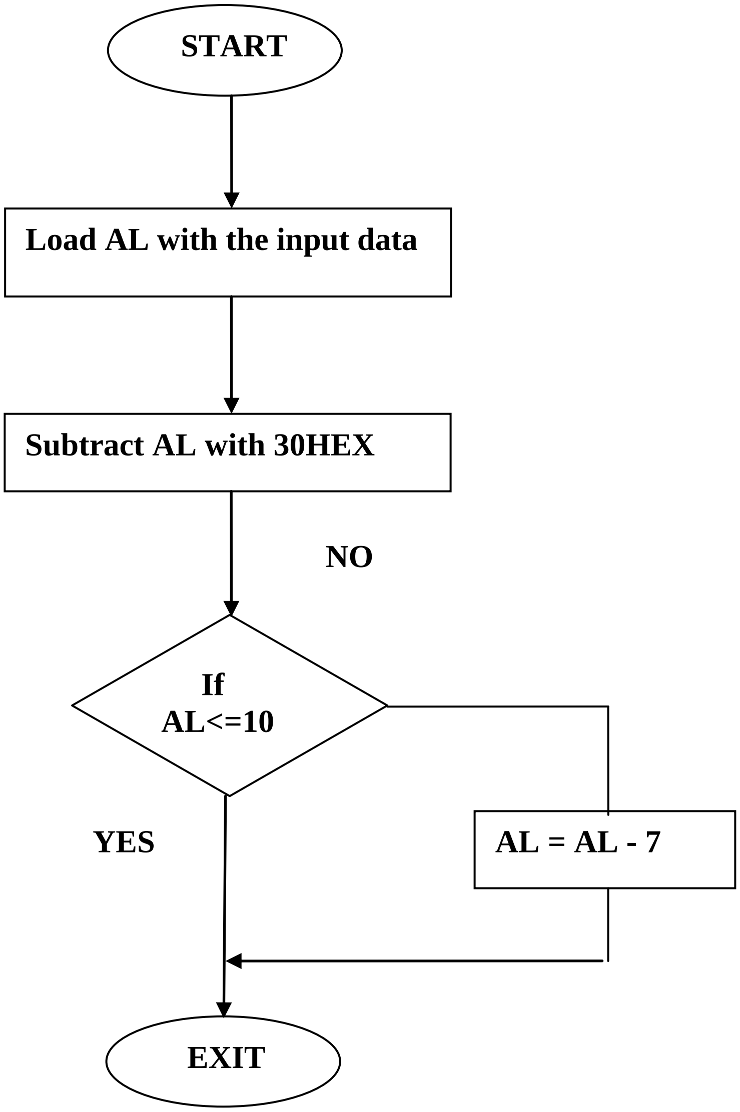
OUTPUT : Result is stored in 1600.

PROGRAM:

ADDRESS	OPCODE	MNEMONICS	COMMENTS
1100	B1 O4	MOV CL,04	Load CL with value 04
1102	B0 00	MOV AL,00	Initialize 00 value into AL
1104	B3 01	MOV BL,01	Initialize 01 value into BL
1106	00 D8	ADD AL,BL	Add previous and next value
1108	FE C3	INC BL	Increment BL
110A	FE C9	DEC CL	Decrement CL
110C	75 F8	JNZ 1106	Loop executes until the desired value of n is reached
110E	BF 00 20	MOV DI,1600	Store the result in 1600
1111	89 05	MOV [DI],AX	Load AX value into DI
1113	CC	INT3	Break point

6.9 ASCII TO HEX CODE CONVERSION

FLOW CHART:



Algorithm:

1. Load the input data in AL register.
2. Subtract 30 from AL register value.
3. If data is less than or equal to 16 terminate the program.
4. Else subtract 7 from AL register value.
5. Result stored in AL register.

INPUT : Data input in AL register.

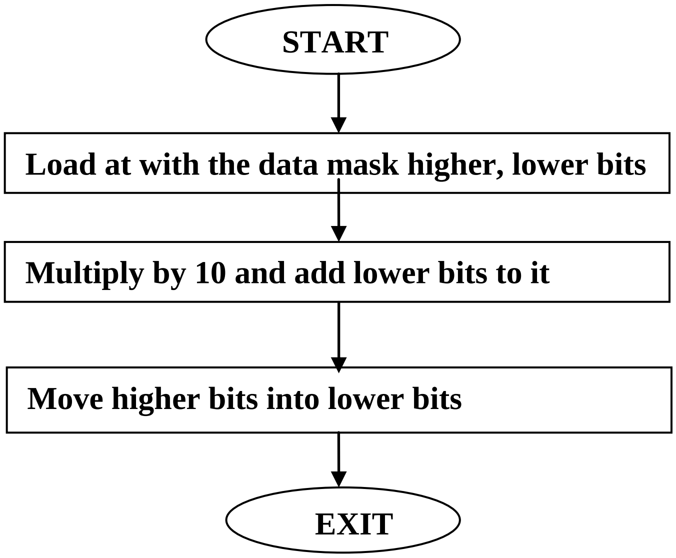
OUTPUT : Data output in AL register.

PROGRAM:

ADDRESS	OPCODE	MNEMONICS	COMMENTS
1100	B0 31	MOV AL,31	Get data 31 into AL
1102	2C 30	SUB AL,30	Subtract 30 with the AL
1104	3C 10	CMP AL,10	If data is less than or equal to 16 go to 110C
1106	72 04	JB 110C	If 1st operand is below the 2nd operand then short jump into 110C
1108	74 02	JZ 110C	If count zero then jump into to 110C
110A	2C 07	SUB AL,07	Else subtract 7 from AL register value
110C	CC	INT 3	Break point

6.10 BCD TO HEXA DECIMAL CONVERSION

FLOW CHART:


START
Load at with the data mask higher, lower bits
Multiply by 10 and add lower bits to it
Move higher bits into lower bits
EXIT

ALGORITHM:

1. Load the data in AL register.
2. Separate higher nibbles and (in) lower nibbles.
3. Move the higher nibbles (in) to lower nibbles position.
4. Multiply AL by 10.
5. Add lower nibbles.
6. Store the result into Memory.

INPUT:

Data in AL register.

OUTPUT:

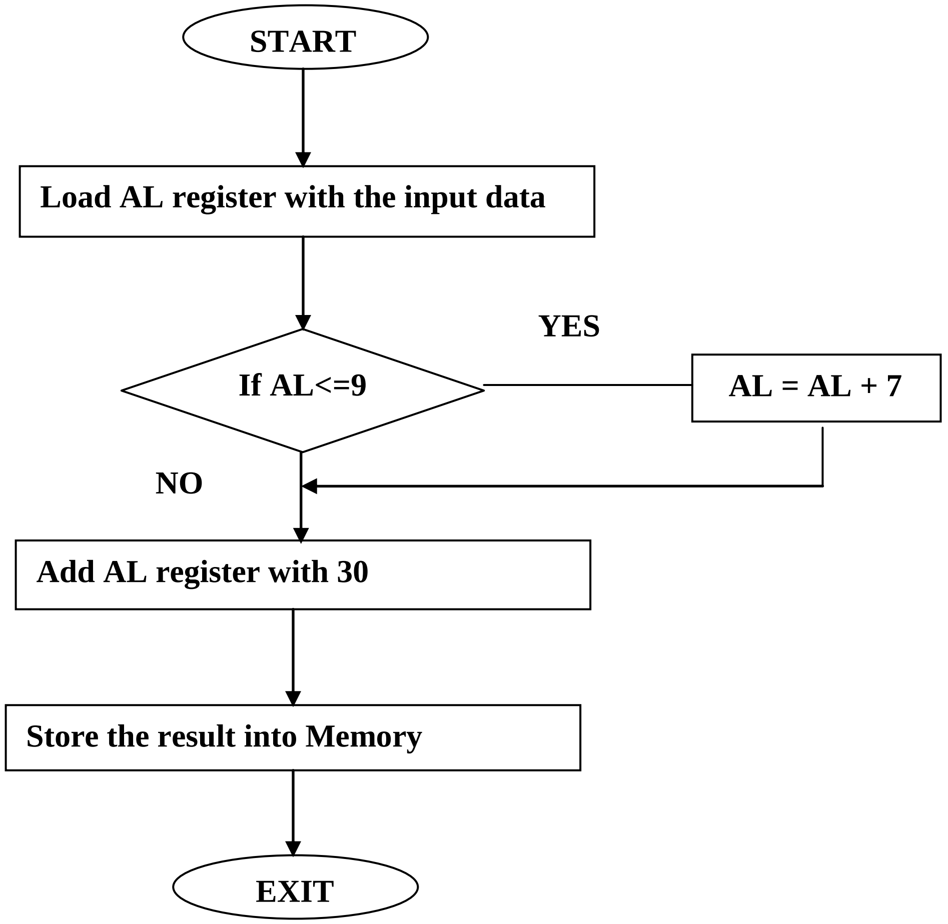
Result in AL register.

PROGRAM:

ADDRESS	OPCODE	MNEMONICS	COMMENTS
1100	B0 10	MOV AL,10	Load register AL with the data 10
1102	88 C4	MOV AH,AL	Load AL value into AH
1104	80 E4 OF	AND AH,0F	Mask higher bits
1107	88 E3	MOV BL,AH	Load AH value into BL
1109	24 F0	AND AL,F0	Mask lower bits
110B	B1 O4	MOV CL,04	Load 04 value into CL
110D	D2 C8	ROR AL,CL	Rotate the data from last 4bits to first 4 bits
110F	B7 0A	MOV BH,0A	Load 10 value into BH
1111	F6 E7	MUL BH	Multiply by 10
1113	00 D8	ADD AL,BL	Add lower nibble to the multiplied data
1115	CC	INT3	Break point

6.11 HEXA DECIMAL TO ASCII CODE

FLOW CHART:


START
Load AL register with the input data
If AL<=9
YES
AL = AL + 7
NO
Add AL register with 30
Store the result into Memory
EXIT

ALGORITHM:

1. Load AL with the input data.
2. Check If (AL<=9) then add 30 with AL register.
3. Else add 7 with AL register.
4. Result stored into AL register.

INPUT: Data in AL register.

OUTPUT:

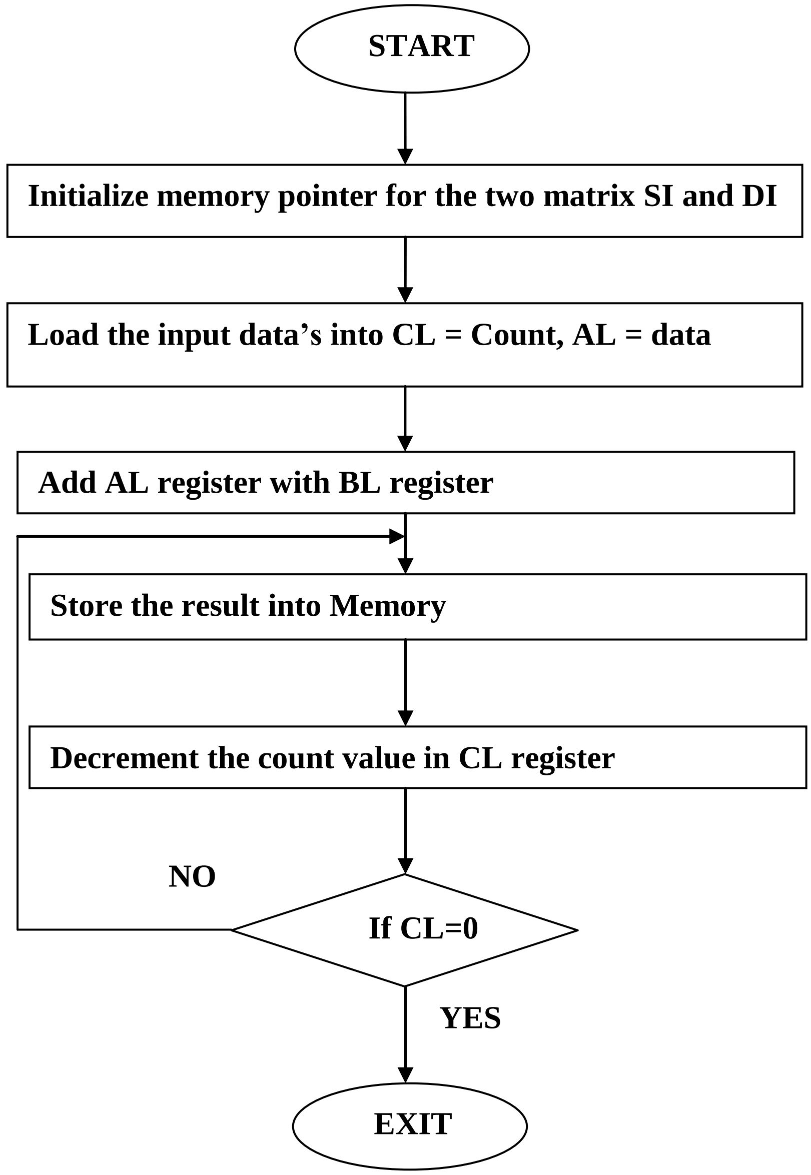
Result in AL register.

PROGRAM:

ADDRESS	OPCODE	MNEMONICS	COMMENTS
1100	B0 0A	MOV AL,0A	Load register AL with the data 10
1102	3C 09	CMP AL,09	If data less than 9 add 30 to the data
1104	74 04	JZ 110A	If count is zero then go to 110A
1106	72 02	JB 110A	If 1st operand is below than 2nd operand then short jump into 110A
1108	04 07	ADD AL,07	Else Add AL with 07
110A	04 30	ADD AL,30	add 30 with AL
110C	CC	INT3	Break point

6.12 MATRIX ADDITION

FLOW CHART:


START
Initialize memory pointer for the two matrix SI and DI
Load the input data's into CL = Count, AL = data
Add AL register with BL register
Store the result into Memory
Decrement the count value in CL register
NO
If CL=0
YES
EXIT

ALGORITHM:

1.Initialize the pointer to memory for data and result.

2.Load CL with count.

3.Add two matrices by each element.

4.Process continues until CL is 0.

5.Store the result into Memory**.**

INPUT:

Data in 2000 consecutive location as rows and columns for first matrix.

Data in 3000 consecutive location as rows and columns for second matrix.

OUTPUT:

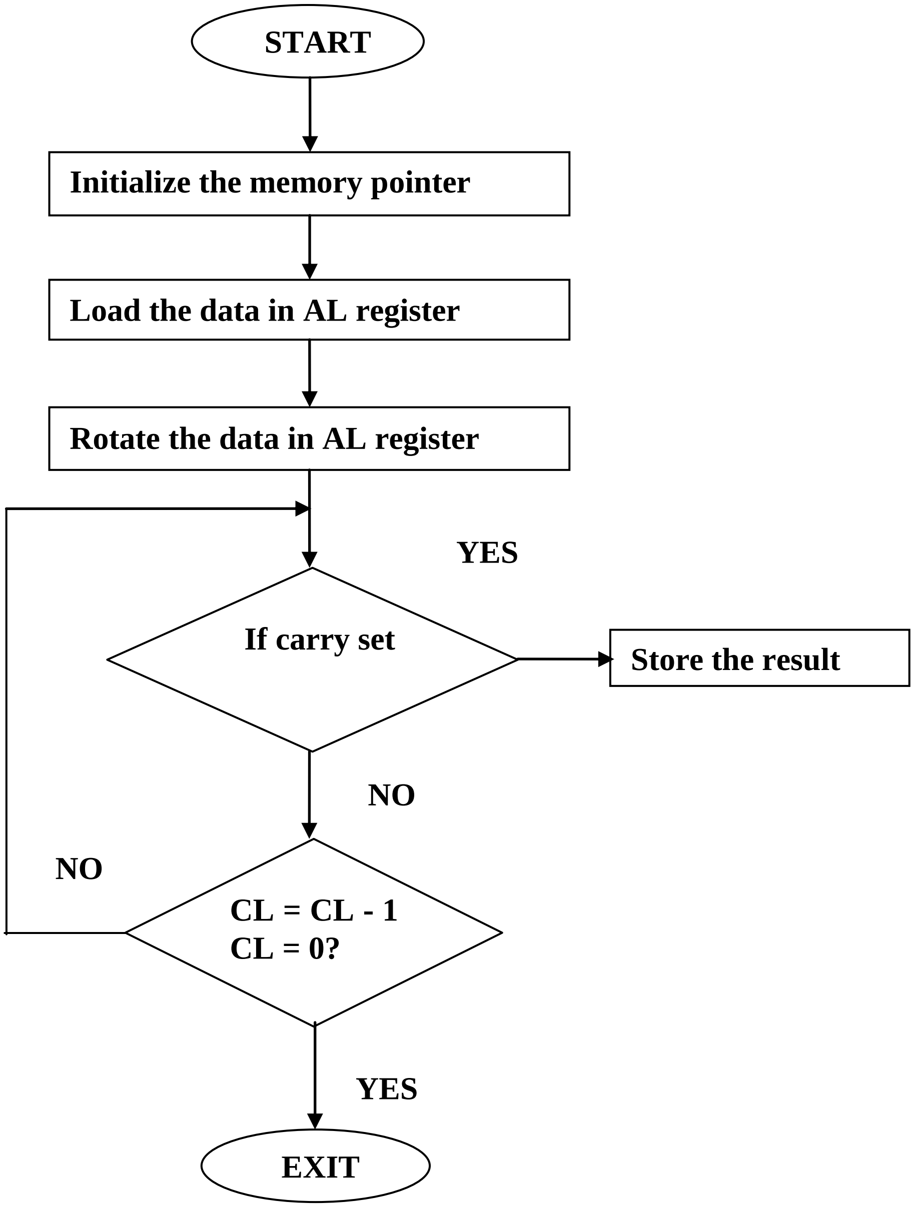
Data in 3000 with 9 entries.

PROGRAM:

ADDRESS	OPCODE	MNEMONICS	COMMENTS
1100	B1 09	MOV CL, 09	Initialize 09 into CL register
1102	BE 00 20	MOV SI, 2000	Load 2000 into SI for 1st matrix
1105	BF 00 30	MOV DI, 3000	Load 3000 into DI for 2nd matrix
1108	8A 04	MOV AL, [SI]	Load AL with data of first matrix
110A	8A 1D	MOV BL, [DI]	Load BL with data of second matrix
110C	00 D8	ADD AL, BL	Add two data of AL and BL
110E	88 05	MOV [DI], AL	Store AL with data into DI
1110	47	INC DI	Increment DI
1111	46	INC SI	Increment SI
1112	FE C9	DEC CL	Decrement CL
1114	75 F2	JNZ 1108	Loop continues until all elements of Matrix to added
1116	CC	INT3	Break point

6.13 SEPERATING ODD AND EVEN

FLOW CHART:


START
Initialize the memory pointer
Load the data in AL register
Rotate the data in AL register
YES
If carry set
Store the result
NO
NO
CL = CL - 1
CL = 0?
YES
EXIT

ALGORITHM:

1. Initialize the pointer to memory for data and result.
2. Loaded the data in AL register from memory.

3. Rotate the AL register by one bit.
4. If carry flag is set then go to step2.
5. Store the even number as a result into the Memory.

INPUT:

Data in 2000 (mixer of odd and even numbers).
Count: number of bytes in CL.

OUTPUT:

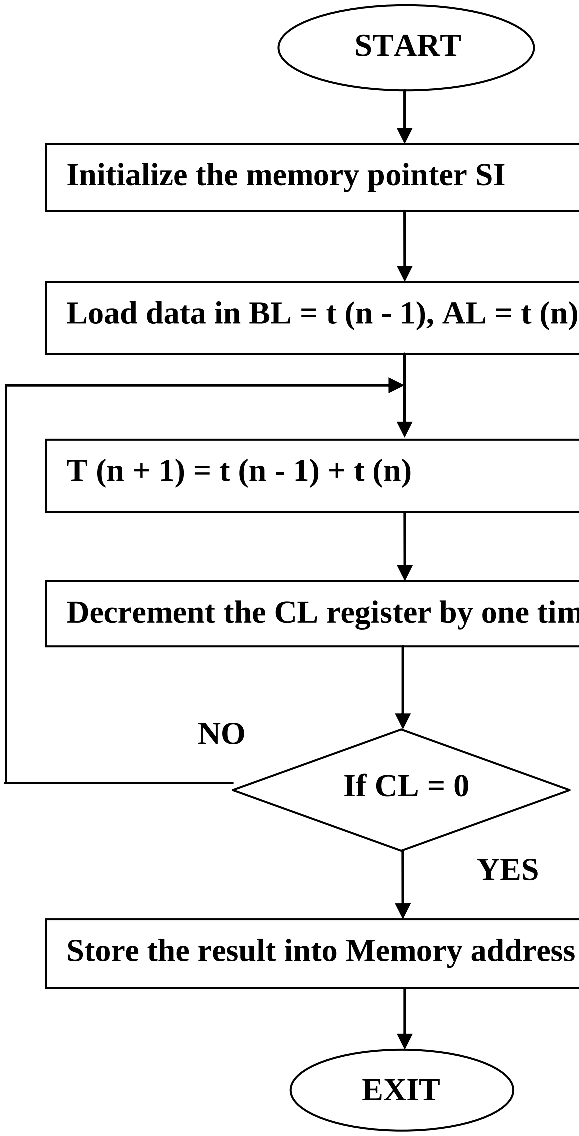
Even numbers stored in 3000.

PROGRAM:

ADDRESS	OPCODE	MNEMONICS	COMMENTS
1100	B1 08	MOV CL, 08	Initialize 08 into CL
1102	BE 00 20	MOV SI, 2000	Load 2000 address into SI
1105	BF 00 30	MOV DI, 3000	Load 3000 address into DI
1108	AC	LODSB	Load the counter value
1109	D0 C8	ROR AL,1	Rotate AL in one time
110B	72 FB	JB 1108	If carry occurs go to L1 (odd Data)
110D	D0 C0	ROL AL, 1	Else rotate by left to get original data
110F	88 05	MOV [D1], AL	Store the even data
1111	47	INC DI	Increment DI
1112	FE C9	DEC CL	Decrement CL
1114	75 F2	JNZ 1108	Loop executes until counter is zero
1116	CC	INT3	Break point

6.14 FIBONACCI SERIES

FLOEW CHART:


START
Initialize the memory pointer SI
Load data in BL = t (n - 1), AL = t (n) CL=count
T (n + 1) = t (n - 1) + t (n)
Decrement the CL register by one time
NO
If CL = 0
YES
Store the result into Memory address 2000
EXIT

ALGORITHM:

1. Initialize the pointer to memory for storing result.
2. Number of the counts loaded into CL register.

3. T (n + 1) = t (n) + t (n - 1).
4. Repeat the above process until count is 0.

INPUT: Load number of terms in CL.

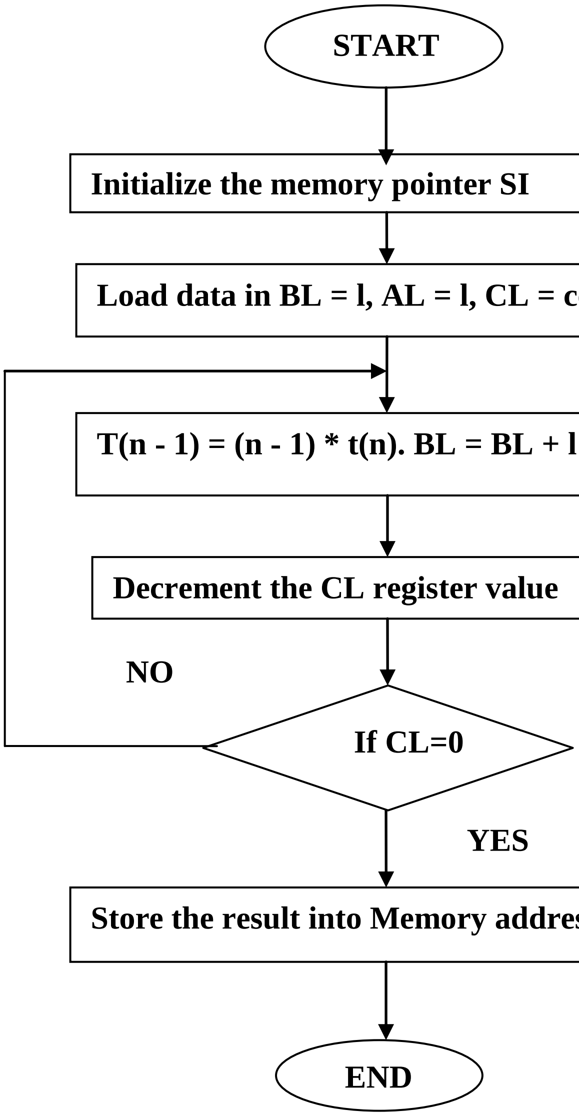
OUTPUT: Result in 2000 (clear the memory from 2000 by 00 before executing the program).

PROGRAM:

ADDRESS	OPCODE	MNEMONICS	COMMENTS
1100	B1 10	MOV CL, 10	Initialize 10 into CL register
1102	B3 00	MOV BL, 00	Initialize 00 into BL register
1104	B2 01	MOV DL, 01	Initialize 01 into DL register
1106	BF 00 20	MOV DI, 2000	Load 2000 into DI
1109	88 D0	MOV AL, DL	Move DL value into AL
110B	00 D8	ADD AL, BL	Add BL value with AL register
110D	88 05	MOV [DI],AL	Store AL value into DI.
110F	47	INC DI	Increment DI
1110	88 D3	MOV BL, DL	Move DL value BL register
1112	88 C2	MOV DL, AL	Move AL value DL register
1114	FE C9	DEC CL	Decrement CL
1116	75 F3	JNZ110B	If count is zero then go to 110B
1118	CC	INT3	Breakpoint

6.15 FACTORIAL OF A NUMBER

FLOW CHART:


START
Initialize the memory pointer SI
Load data in BL = l, AL = l, CL = count
T(n - 1) = (n - 1) * t(n). BL = BL + l
Decrement the CL register value
NO
If CL=0
YES
Store the result into Memory address 2000
END

n!=n*(n-1)*(n-2)*…………..*1

ALGORITHM:

1. Load the counter with value of n into CL register.

2. T (n) = t (n - 1) * t (n - 2).
3. Repeat the process until n becomes to store result.
4. Initialize the pointer to memory to store result.
5. Store the result into Memory address 2000.

INPUT:

Load the value of n into CL register.

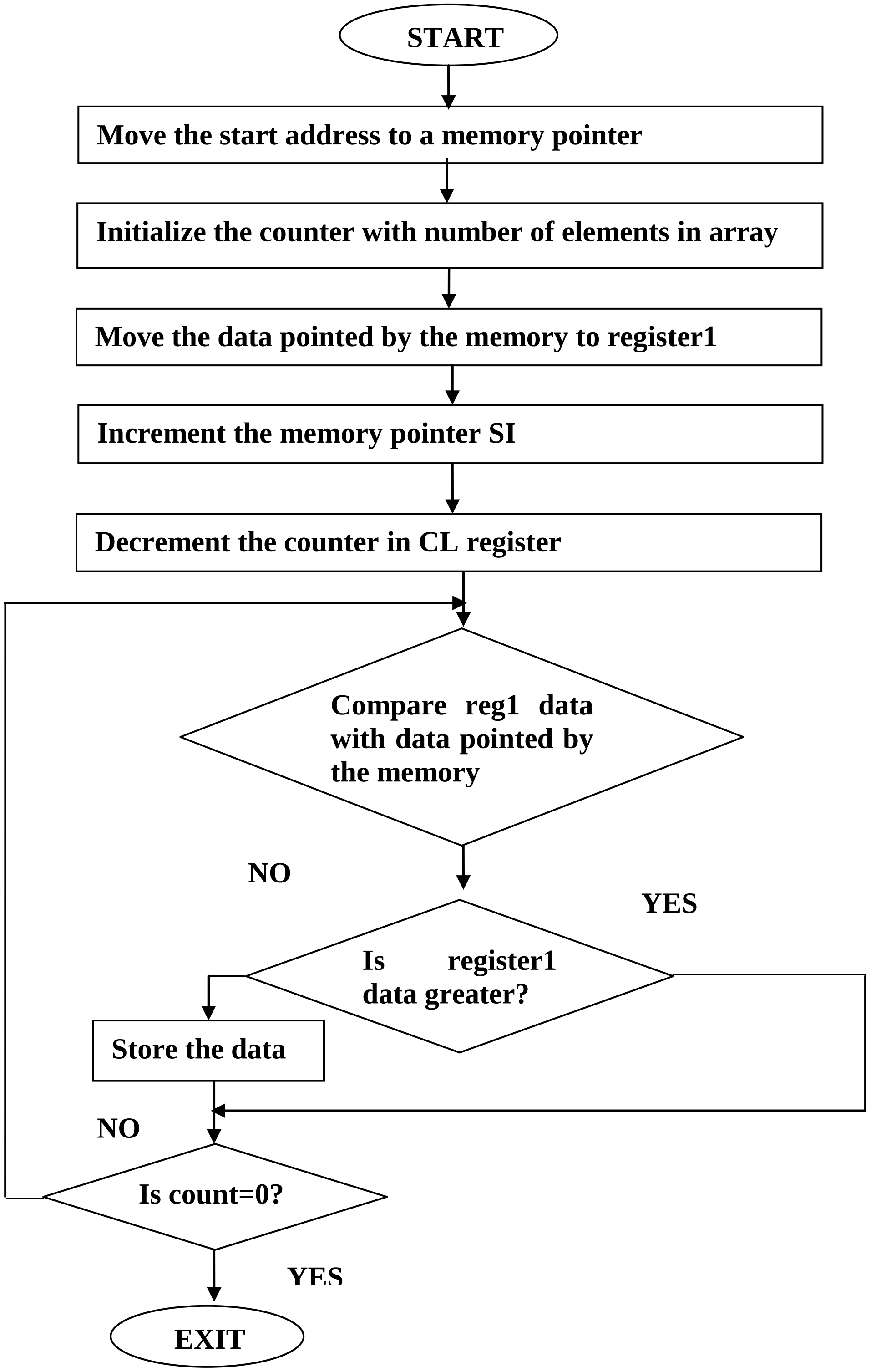
OUTPUT:

Result stored in Memory address 2000.

PROGRAM:

ADDRESS	OPCODE	MNEMONICS	COMMENTS
1100	B1 04	MOV CL, 04	Load the value of 04 in CL
1102	B0 01	MOV AL, 01	Initialize 01 into AL
1104	B3 01	MOV BL, 01	Initialize 01 into BL
1106	F6 E3	MUL BL	Multiply previous value by next Value
1108	FE C3	INC BL	Increment BL
110A	FE C9	DEC CL	Decrement CL
110C	75 F8	JNZ 1106	Loop continues until count is Zero
110E	BF 00 20	MOV DI, 2000	Load 2000 address into DI
1111	89 05	MOV [DI], AX	Store AX value into DI
1113	CC	INT3	Break point

6.16 FIND THE LARGEST NUMBER IN AN ARRAY


START
Move the start address to a memory pointer
Initialize the counter with number of elements in array
Move the data pointed by the memory to register1
Increment the memory pointer SI
Decrement the counter in CL register
Compare reg1 data with data pointed by the memory
NO
YES
Is register1 data greater?
Store the data
NO
Is count=0?
YES
EXIT

ALGORITHM:

1. Take the first number of the array.
2. Compare with next number.
3. Take the bigger one of the them.
4. Decrement the count in CL register.
5. If the count is not zero then continue from step 2.
6. Store the result into Memory address 9500.

INPUT:

Enter the size of array (count) in 9000.
Enter the data starting from 9001.

OUTPUT:

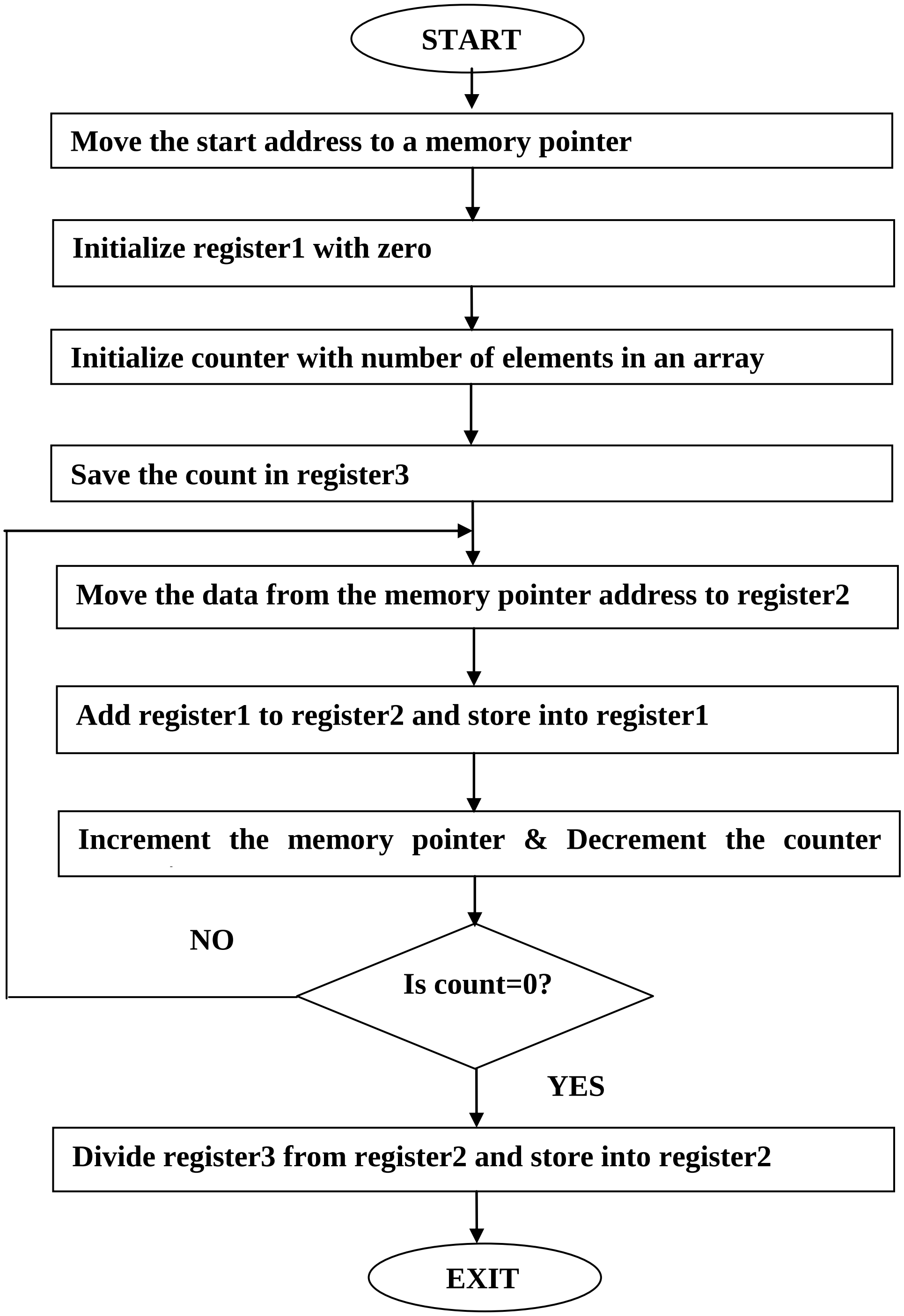
Result is stored in 9500.

PROGRAM:

ADDRESS	OPCODE	MNEMONICS	COMMENTS
1100	BE 00 90	MOV SI,9000	Load 9000 address into SI
1103	8A 0C	MOV CL,[SI]	Load SI value into CL
1105	46	INC SI	Increment SI
1106	8A 04	MOV AL,[SI]	Move the first data in AL
1108	FE C9	DEC CL	Reduce the count
110A	46	INC SI	Increment SI
110B	3A 04	CMP AL,[SI]	if AL> [SI] then go to jump1 (no swap)
110D	73 02	JNB 1111	If count is zero then jump into 1111
110F	8A 04	MOV AL,[SI]	Else store large no in to AL
1111	FE C9	DEC CL	Decrement the count
1113	75 F5	JNZ 110A	If count is not zero then jump into 110A
1115	BF 00 95	MOV DI,9500	Else store the biggest number at 9500
1118	88 05	MOV [DI],AL	Store the AL value into DI
111A	CC	INT3	Break point

6.17 AVERAGE OF AN ARRAY

FLOW CHART:


START
Move the start address to a memory pointer
Initialize register1 with zero
Initialize counter with number of elements in an array
Save the count in register3
Move the data from the memory pointer address to register2
Add register1 to register2 and store into register1
Increment the memory pointer & Decrement the counter
NO
Is count=0?
YES
Divide register3 from register2 and store into register2
EXIT

ALGORITHM:

1. Add the bytes one by one up to the count (CL).
2. Then divide the total with the count.

INPUT:

- Size of array (count) in CL = 6 (see the program).
- Enter the data starting from 9000h.

OUTPUT:

- Average is stored in AX register.
- Quotient in AL and the reminder in AH.

PROGRAM:

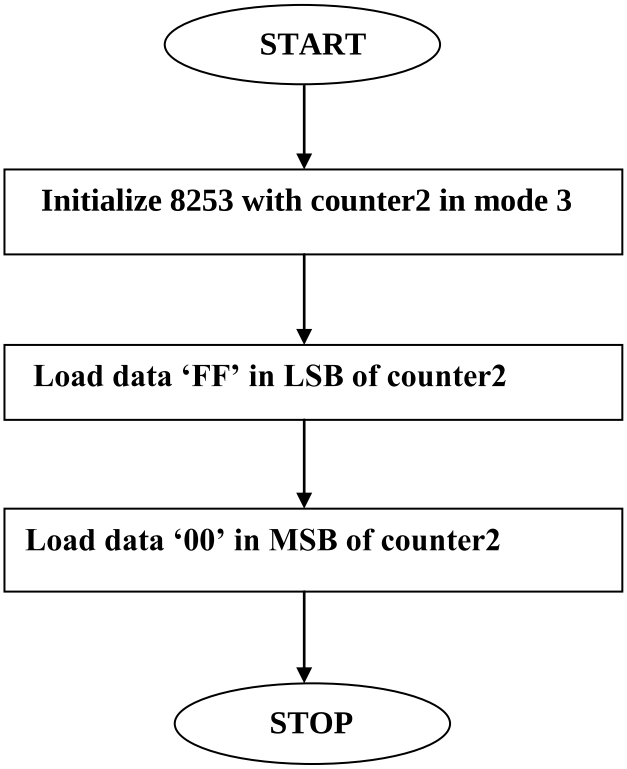
ADDRESS	OPCODE	MNEMONICS	COMMENTS
1100	BB 00 00	MOV BX,0000	Load 0000 into BX
1103	BE 00 90	MOV SI,9000	Array start address
1106	B8 00 00	MOV AX,0000	Load 0000 into AX
1109	B1 06	MOV CL,06	Initialize 06 into CL register
110B	88 CD	MOV CH,CL	Load the count value into CH
110D	8A 1C	MOV BL,[SI]	Get the data byte
110F	00 D8	ADD AL,BL	Add the data byte
1111	46	INC SI	Increment the SI pointer
1112	FE C9	DEC CL	Check the count
1114	75 F7	JNZ 110D	If count is not zero then go to 110D
1116	F6 F5	DIV CH	Find the average by sum/count
1118	CC	INT3	Break point

6.18 GENERATE SQUARE WAVE

I/O ADDRESS FOR 8253 /8254:

Counter 0 →	FF00
Counter 1 →	FF02
Counter 2 →	FF04
Counter reg →	FF06

FLOW CHART:


START
Initialize 8253 with counter2 in mode 3
Load data 'FF' in LSB of counter2
Load data '00' in MSB of counter2
STOP

PROGRAM:

ADDRESS	OPCODE	MNEMONICS	COMMENTS
1100	B0 B7	MOV AL,36	Load 36 into AL for generating SQUARE
1102	BA 06 FF	MOV DX,FF06	Load FF06 into DX
1105	EE	OUT DX,AL	Send the data to the timer
1106	B0 02	MOV AL,FF	Load LSB count in the AL
1108	BA 04 FF	MOV DX,FF04	Port address in DX
110B	EE	OUT DX,AL	Output the AL contents to CLK 2
110C	B0 00	MOV AL,00	Load MSB count in the AL
110E	BA 04 FF	MOV DX,FF04	Load FF04 into DX
1111	EE	OUT DX,AL	Output the AL content to CLK 2
1112	CC	INT3	Break point

6.19 DESCENDING ORDER

ALGORITHM:

1. Get the first data and compare with the second data.
2. If the two data are in descending order then no swap.
3. Else swap the data byte by descending order and then again compare the other data bytes up to the count.
4. Do the above the array is a ranged in descending order.
5. Finally the array is arranged in ascending order.

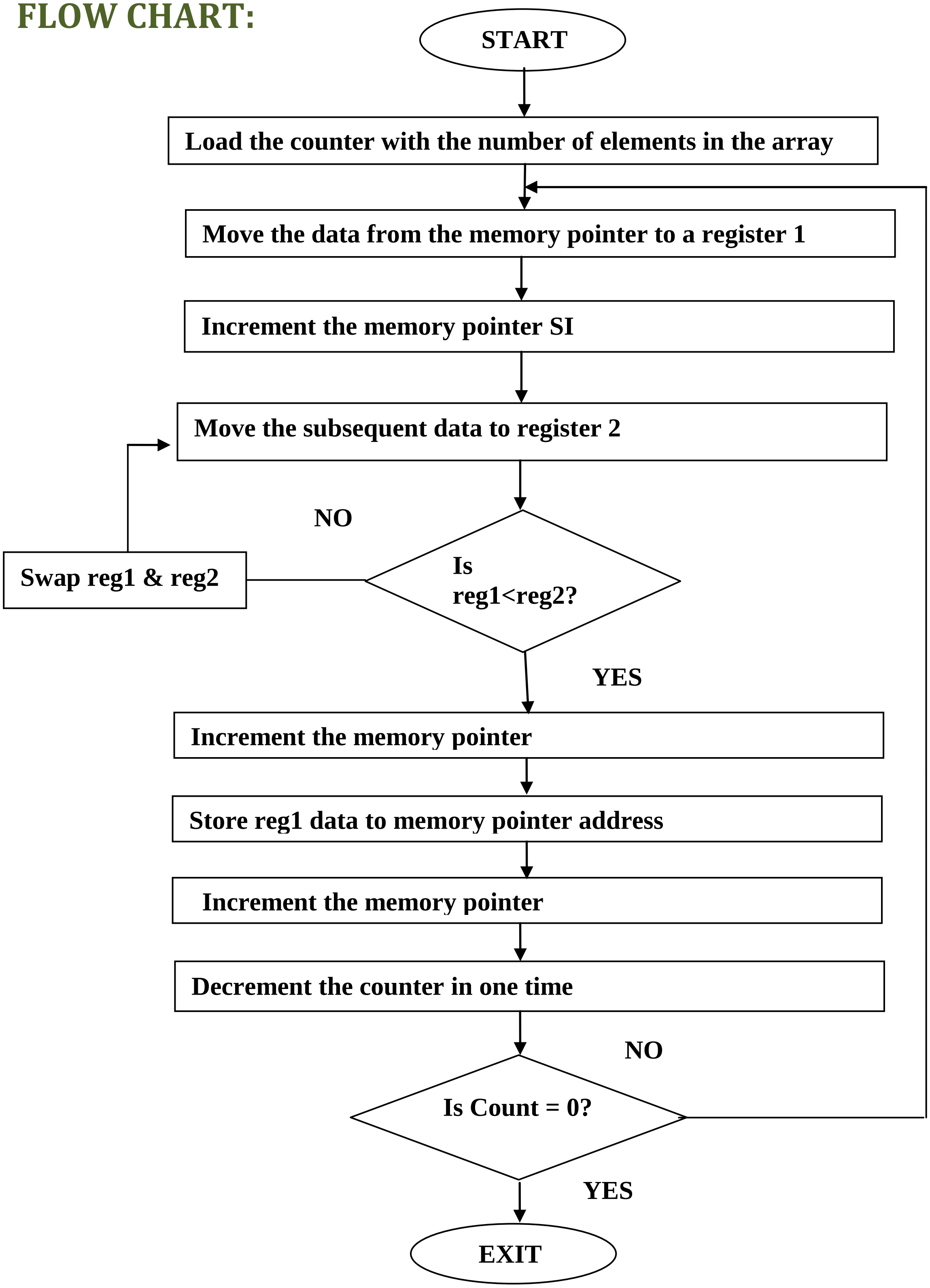
INPUT:

Enter the count in location 9000.
Enter the data location starting from 9001.

OUTPUT:

Result in descending order in the location 9001.

FLOW CHART:


START
Load the counter with the number of elements in the array
Move the data from the memory pointer to a register 1
Increment the memory pointer SI
Move the subsequent data to register 2
NO
Swap reg1 & reg2
Is reg1<reg2?
YES
Increment the memory pointer
Store reg1 data to memory pointer address
Increment the memory pointer
Decrement the counter in one time
NO
Is Count = 0?
YES
EXIT

PROGRAM:

ADDRESS	OPCODE	MNEMONICS	COMMENTS
1100	BE 00 90	MOV SI, 9001	Load 9000 into SI
1103	8A 0C	MOV CL, [SI]	Load SI value into CL
1105	BE 00 90	MOV SI, 9000	get the count
1108	8A 14	MOV DL, [SI]	Load SI count value into DL
110A	46	INC SI	Increment the pointer
110B	8A 04	MOV AL, [SI]	first data in AL
110D	FE CA	DEC DL	Decrement DL
110F	74 16	JZ 1127	If count is zero then jump into 1127
1111	46	INC SI	Increment SI
1112	8A 1C	MOV BL, [SI]	Load SI count value into BL
1114	3A C3	CMP AL, BL	if al > bl go to (jump1)
1116	72 07	JB 111F	
1118	4E	DEC SI	Decrement SI
1119	88 04	MOV [SI],AL	Load ACC value in SI
111B	88 D8	MOV AL, BL	Store the greatest data
111D	EB 03	JMP 1122	Jump into 1122
111F	4E	DEC SI	Decrement SI
1120	88 1C	MOV [SI], BL	Store the smallest data in memory
1122	46	INC SI	Increment SI
1123	FE CA	DEC DL	Decrement DL
1125	75 EA	JNZ 1111	If count is not zero then jump into 1111
1127	88 04	MOV [SI], AL	Load AL value into SI
1129	FE C9	DEC CL	Decrement CL
112B	75 D8	JNZ 1105	If count is not zero then jump into 1105
112D	CC	INT3	Break point

6.20 ASCENDING ORDER

ALGORITHM:

1. Get the first data and compare with the second data.
2. If the two data are in ascending order then no swap.
3. Else swap the data byte by ascending order and then again compare the other data bytes up to the count.
4. Do the above the array is arranged in ascending order.
5. Finally the array is arranged in ascending order.

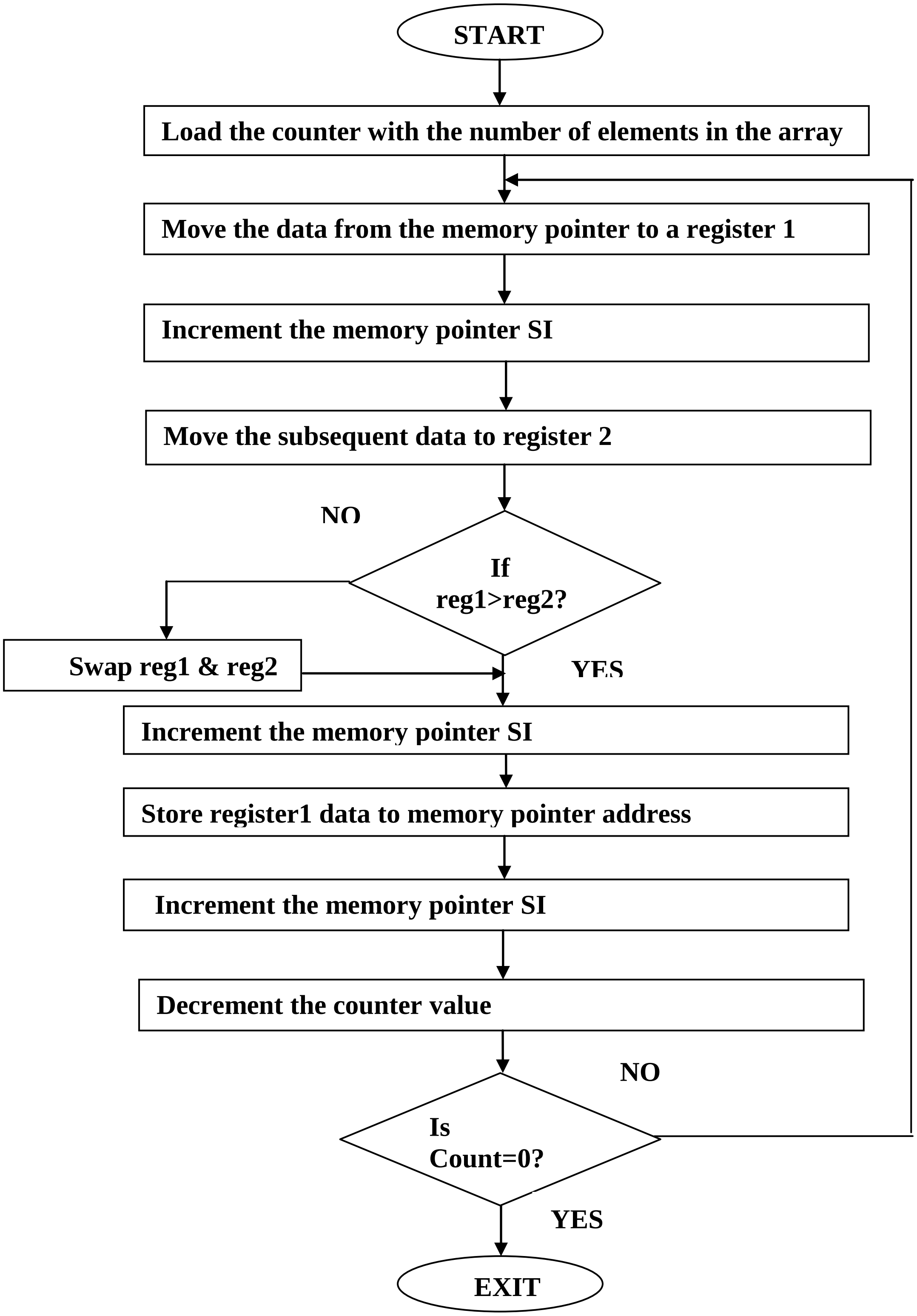
INPUT:

Enter the count in location 9000.
Enter the data location starting from 9001.

OUTPUT:

Result in ascending order in the location 9001.

FLOW CHART:


START
Load the counter with the number of elements in the array
Move the data from the memory pointer to a register 1
Increment the memory pointer SI
Move the subsequent data to register 2
NO
If reg1>reg2?
Swap reg1 & reg2
YES
Increment the memory pointer SI
Store register1 data to memory pointer address
Increment the memory pointer SI
Decrement the counter value
NO
Is Count=0?
YES
EXIT

PROGRAM:

ADDRESS	OPCODE	MNEMONICS	COMMENTS
1100	BE 00 90	MOV SI, 9000	Load 9000 into SI
1103	8A 0C	MOV CL, [SI]	Load SI value into CL
1105	BE 00 90	MOV SI, 9000	Get second data
1108	8A 14	MOV DL, [SI]	Load SI second data into DL
110A	46	INC SI	Increment SI
110B	8A 04	MOV AL, [SI]	Load SI value into AL
110D	FE CA	DEC DL	Decrement DL
110F	74 16	JZ 1127	If count is zero then go to 1127
1111	46	INC SI	Increment SI
1112	8A 1C	MOV BL, [SI]	Load SI value into BL
1114	38 D8	CMP AL, BL	if AL > BL go to (jump1)
1116	72 07	JNB 111F	
1118	4E	DEC SI	Decrement SI
1119	88 04	MOV [SI],AL	Load AL value into SI
111B	88 D8	MOV AL, BL	Load BL value into AL
111D	EB 03	JMP 1122	
111F	4E	DEC SI	Decrement SI
1120	88 1C	MOV [SI], BL	Load BL value into SI
1122	46	INC SI	Increment SI
1123	FE CA	DEC DL	Decrement DL
1125	75 EA	JNZ 1111	If count is not zero then go to 1111
1127	88 04	MOV [SI], AL	Load AL value into SI
1129	FE C9	DEC CL	Decrement CL
112B	75 D8	JNZ 1105	If count is not zero then go to 1105
112D	CC	INT3	Breakpoint

ADDITIONAL PROGRAMS ON 8086

1) COMPARE STRING

ADDRESS	MNEMONICS
1100	LEA SI, [1200]
1104	LEA DI, [1300]
1108	MOV CX, 0003H
110b	CLD
110c	REPE CMPSB
110e	JNZ NOTEQUAL
1110	MOV AL, 01
1112	MOV [1400], AL
1115	HLT
1116	NOTEQUAL: MOV AL, 00
1118	MOV [1400], AL
111b	HLT

CONDITION 1: (SAME STRING IN DATA1 AND DATA2)

1ST INPUT		2ND INPUT	
1200	11	1300	11
1201	22	1301	22
1202	33	1302	33

OUTPUT: 1400 : 01

CONDITION 2: (DIFFERENT STRING IN DATA1 AND DATA2)

1ST INPUT		2ND INPUT	
1200	11	1300	44
1201	22	1301	55
1202	33	1302	66

OUTPUT: 1400 :

2) MOV STRING PROGRAM

ADDRESS	OPCODE
1100	MOVCX,[1500]
1104	LEA SI,[1600]
1108	LEA DI,[1700]
110c	CLD
110d	REP MOVSB
110f	HLT

INPUT LOCATION

COUNT INPUT		DATA INPUT	
1500	03	1601	22
1601	11	1602	33

OUT LOCATION

OUTPUT	
1700	11
1701	22
1703	33

3) ONE'S COMPLEMENT OF A 16-BIT NUMBER

OBJECTIVE:

To find the one's complement of the data in register pair AX and store the result at 1400.

THEORY:

In the one's complement of a binary number the ones are changed to zeros and vice versa. It is one way of representing negative numbers. All negative numbers start with a 1 at the

MSBit. For instance considering the hex number 5600 For ex:

5600 = 0101 0110 0000 0000

One's complement = 1010 1001 1111 1111

= A9FF

EXAMPLE:

The example given is to find the one's complement of 1234 and store it in memory location 1400.

Input :

Data: (AX) = 0001 0010 0011 0100 = 1234

Result: [1400] = 1110 1101 1100 1011 = EDCB

MEMORY ADDRESS	OPCODE	MNEMONICS
1100	C7 C0 34 12	MOVAX, 1234
1103	F7 D0	NOT AX
1106	89 06 00 14	MOV [1400],AX
110A	F4	HLT

PROCEDURE

i) Enter the above mnemonics into RAM memory from 1100 using the assembler command.

ii) Using GO command execute the program and enter 1100. This is the address from where execution of your program starts.

iii) Press ENTER key to start execution.

iv) Reset the kit using RESET key.

4) MASKING OFF BITS SELECTIVELY

OBJECTIVE

To clear 8 selected bits, the 2nd HN and the HN in a 16 bit number.

THEORY

The logical AND instruction is used for masking off bits. The bits which have to be cleared are to be AND with a logical zero and the other bits are to be high. Hence to achieve the above objective, AND with 0F0F.

EXAMPLE: The 16 bit number is at location 1200 and the result is at location 1400.

Input: [1200] = FF

[1201] = FF

Result: [1400] = 0F

[1401] = 0F

MEMORY ADDRESS	OPCODE	MNEMONICS
1100	8B 06 00 12	MOV BX,1200
1104	81 E0 0F0F	AND AX,0F0F
1108	89 06 00 14	MOV [1400],AX
110C	F4	HLT

PROCEDURE

The procedure outlined for previous exercises is to be followed for this program also.

5) COMPUTING A BOOLEAN EXPRESSION

OBJECTIVE

To obtain a Boolean expression F which has 4 terms and 8 variables A,B,C,D,E,F,G,H. F = {(AB'CDE' + A'BCD(BCD+EFGH)}

THEORY

Evaluation of Boolean expressions through minimization procedures is customary. But this example seeks to do the same using the 8086 registers. The 4 minterms are in FOUR 8 bit registers. Use of logical instructions to perform this is consequential. Don't care variables are represented by set bits.

The correspondence is, ABCDEFGH)))) D7 D6 D5 D4 D3 D2 D1 D0

EXAMPLE: Input: AL = 10110111B ------- B7

AH = 01111111B ------ 7F

BL = 11111111B ------ FF

BH = 11111111B ------ FF

Result: [1100] = 11111111B ------ FF

MEMORY ADDRESS	OPCODE	MNEMONICS
1100	C6 C0 B7	MOV AL, B7
1103	C6 C4 7F	MOV AH, 7F
1106	C6 C3 FF	MOV BL, FF
1108	C6 C7 FF	MOV BH, FF
110C	08 FB	OR BL, BH
110E	20 DC	AND AH, BL
1110	08 E0	OR AL, AH
1112	88 06 00 12	MOV [1200], AL
1116	F4	HLT

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