






Assembly Language Programming of 8085

Topics

1. Introduction
2. Programming model of 8085 
3. Instruction set of 8085 
4. Example Programs 
5. Addressing modes of 8085 
6. Instruction & Data Formats of 8085 

1. Introduction

- A **microprocessor** executes instructions given by the user
- Instructions should be in a language known to the **microprocessor**
- **Microprocessor** understands the language of 0's and 1's only
- This language is called **Machine Language**

- For e.g.

01001111

- Is a valid machine language instruction of 8085
- It copies the contents of one of the internal registers of 8085 to another

A Machine language program to add two numbers

00111110

;Copy value 2H in register A

00000010

00000110

;Copy value 4H in register B

00000100

10000000

;A = A + B

Assembly Language of 8085

- It uses English like words to convey the action/meaning called as MNEMONICS
- For e.g.
 - MOV to indicate data transfer
 - ADD to add two values
 - SUB to subtract two values

Assembly language program to add two numbers

```
MVI A, 2H ;Copy value 2H in register A  
MVI B, 4H ;Copy value 4H in register B  
ADD B      ;A = A + B
```

Note:

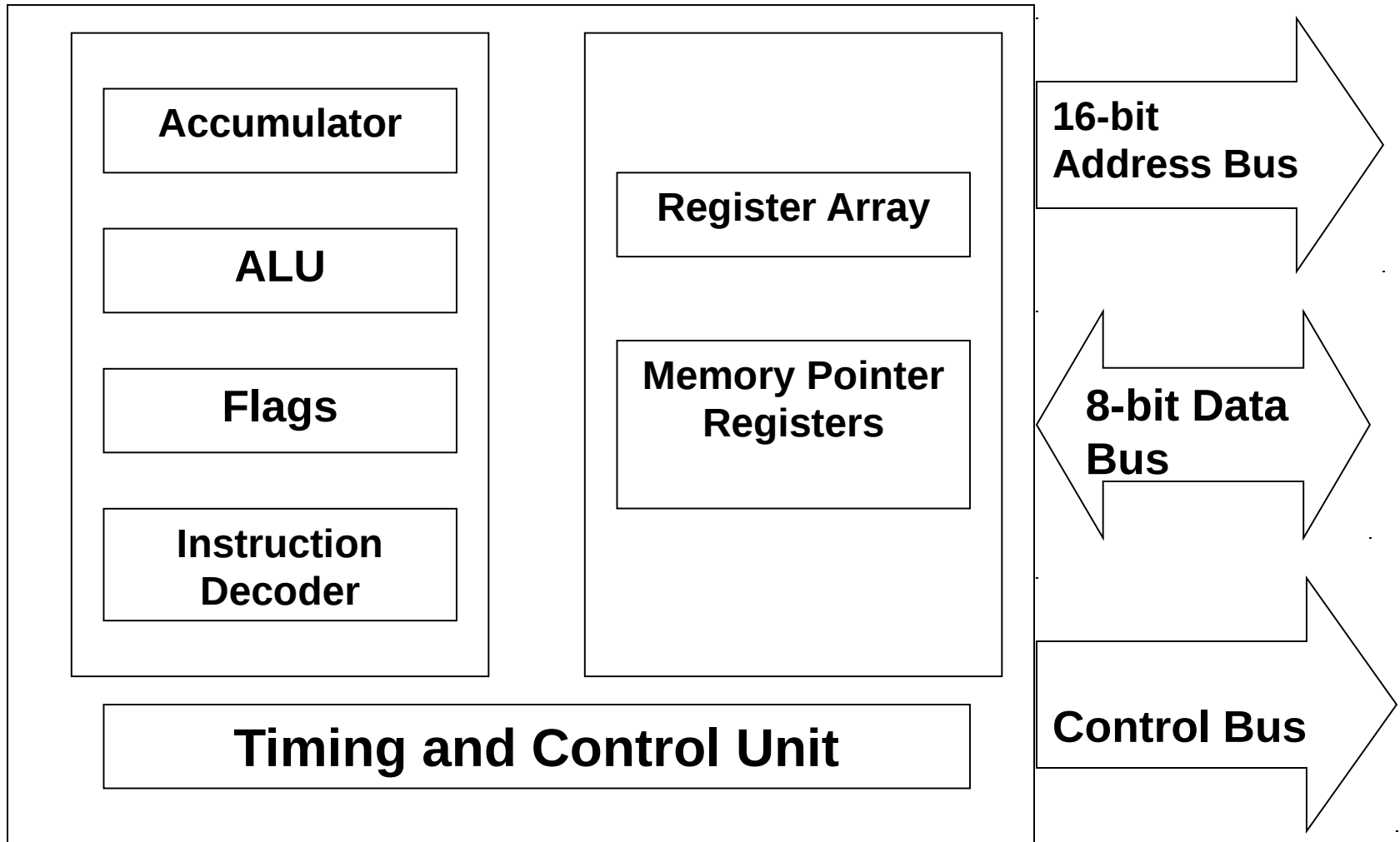
- Assembly language is specific to a given processor
- For e.g. assembly language of 8085 is different than that of Motorola 6800 microprocessor

Microprocessor understands Machine Language only!

- **Microprocessor** cannot understand a program written in Assembly language
- A program known as **Assembler** is used to convert a Assembly language program to machine language

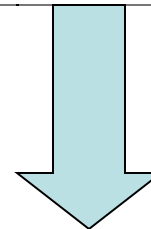
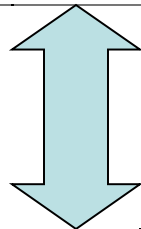


2. Programming model of 8085



Accumulator (8-bit)	Flag Register (8-bit)						
	S	Z		AC		P	CY
B (8-bit)	C (8-bit)						
D (8-bit)	E (8-bit)						
H (8-bit)	L (8-bit)						
Stack Pointer (SP) (16-bit)							
Program Counter (PC) (16-bit)							

8- Lines
Bidirectional



16- Lines
Unidirectional

Overview: 8085 Programming model

1. Six general-purpose Registers
2. Accumulator Register
3. Flag Register
4. Program Counter Register
5. Stack Pointer Register

1. Six general-purpose registers

- B, C, D, E, H, L
- Can be combined as register pairs to perform 16-bit operations (BC, DE, HL)

2. Accumulator – identified by name A

- This register is a part of ALU
- 8-bit data storage
- Performs arithmetic and logical operations
- Result of an operation is stored in accumulator

3. Flag Register

- This is also a part of ALU
- 8085 has five flags named
 - **Zero** flag (Z)
 - **Carry** flag (CY)
 - **Sign** flag (S)
 - **Parity** flag (P)
 - **Auxiliary Carry** flag (AC)

- These flags are five flip-flops in flag register
- Execution of an arithmetic/logic operation can **set** or **reset** these flags
- Condition of flags (set or reset) can be tested through software instructions
- **8085** uses these flags in decision-making process

4. Program Counter (PC)

- A 16-bit memory pointer register
- Used to sequence execution of program instructions
- Stores address of a memory location
 - where next instruction byte is to be fetched by the 8085
- when 8085 gets busy to fetch current instruction from memory
 - PC is incremented by one
 - PC is now pointing to the address of next instruction

5. Stack Pointer Register

- a 16-bit memory pointer register
- Points to a location in **Stack** memory
- Beginning of the stack is defined by loading a 16-bit address in stack pointer register

3. Instruction Set of 8085

- Consists of
 - 74 operation codes, e.g. MOV
 - 246 Instructions, e.g. MOV A,B
- 8085 instructions can be classified as
 1. Data Transfer (Copy)
 2. Arithmetic
 3. Logical and Bit manipulation
 4. Branch
 5. Machine Control

1. Data Transfer (Copy) Operations

1. **Load** a 8-bit number in a **R**egister
2. **Copy** from **R**egister to **R**egister
3. **Copy** between **R**egister and **Memory**
4. **Copy** between **Input/Output** Port and **A**ccumulator
5. **Load** a 16-bit number in a **R**egister pair
6. **Copy** between **R**egister pair and Stack **memory**

Example Data Transfer (Copy) Operations / Instructions

- | | |
|--|---------------------------------|
| 1. Load a 8-bit number 4F in register B | MVI B, 4FH |
| 2. Copy from Register B to Register A | MOV A,B |
| 3. Load a 16-bit number 2050 in Register pair HL | LXI H, 2050H |
| 4. Copy from Register B to Memory Address 2050 | MOV M,B |
| 5. Copy between Input/Output Port and Accumulator | OUT 01H
IN 07H |

2. Arithmetic Operations

1. **Addition** of two 8-bit numbers
2. **Subtraction** of two 8-bit numbers
3. **Increment/ Decrement** a 8-bit number

Example Arithmetic

Operations	/	Instructions
------------	---	--------------

- | | | |
|--|--|----------------|
| 1. Add a 8-bit number 32H to
Accumulator | | ADI 32H |
| 2. Add contents of Register B to
Accumulator | | ADD B |
| 3. Subtract a 8-bit number 32H
from Accumulator | | SUI 32H |
| 4. Subtract contents of Register
C from Accumulator | | SUB C |
| 5. Increment the contents of
Register D by 1 | | INR D |
| 6. Decrement the contents of
Register E by 1 | | DCR E |

3. Logical & Bit Manipulation Operations

1. **AND** two 8-bit numbers
2. **OR** two 8-bit numbers
3. **Exclusive-OR** two 8-bit numbers
4. **Compare** two 8-bit numbers
5. **Complement**
6. **Rotate** Left/Right Accumulator bits

Example Logical & Bit Manipulation Operations / Instructions

- | | |
|--|--------------|
| 1. Logically AND Register H with A ccumulator | ANA H |
| 2. Logically OR Register L with A ccumulator | ORA L |
| 3. Logically XOR Register B with A ccumulator | XRA B |
| 4. Compare contents of Register C with A ccumulator | CMP C |
| 5. Complement A ccumulator | CMA |
| 6. Rotate A ccumulator Left | RAL |

4. Branching Operations

These operations are used to control the flow of program execution

1.Jumps

- Conditional jumps
- Unconditional jumps

2.Call & Return

- Conditional Call & Return
- Unconditional Call & Return

Example Branching

Operations / Instructions

- | | |
|---|-------------------|
| 1. Jump to a 16-bit Address
2080H if Carry flag is SET | JC 2080H |
| 2. Unconditional Jump | JMP 2050H |
| 3. Call a subroutine with its 16-bit
Address | CALL 3050H |
| 4. Return back from the Call | RET |
| 5. Call a subroutine with its 16-bit
Address if Carry flag is RESET | CNC 3050H |
| 6. Return if Zero flag is SET | RZ |

5. Machine Control Instructions

These instructions affect the operation of the processor. For e.g.

HLT Stop program execution

NOP Do not perform any operation

4. Writing a Assembly Language Program

- Steps to write a program
 - Analyze the problem
 - Develop program Logic
 - Write an Algorithm
 - Make a Flowchart
 - Write program Instructions using Assembly language of 8085

Program **8085** in Assembly language to add two 8-bit numbers and store 8-bit result in register **C**.

1. Analyze the problem

- Addition of two 8-bit numbers to be done

2. Program Logic

- Add two numbers
- Store result in register **C**
- Example

10011001	(99H)	A
+00111001	(39H)	D
11010010	(D2H)	C

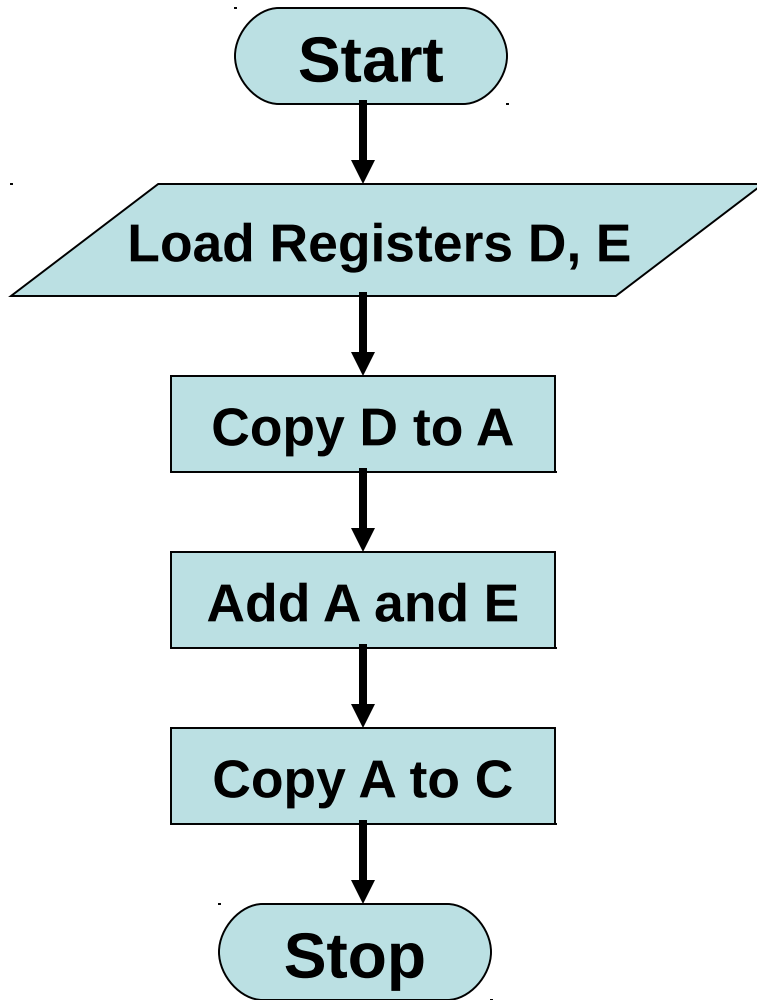
3. Algorithm

1. Get two numbers
2. Add them
3. Store result
4. Stop

Translation to 8085 operations

- Load 1st no. in register D
- Load 2nd no. in register E
- Copy register D to A
- Add register E to A
- Copy A to register C
- Stop processing

4. Make a Flowchart



- Load 1st no. in register D
- Load 2nd no. in register E

- Copy register D to A
- Add register E to A

- Copy A to register C

- Stop processing

5. Assembly Language Program

1. Get two numbers

- a) Load 1st no. in register D
- b) Load 2nd no. in register E

2. Add them

- a) Copy register D to A
- b) Add register E to A

3. Store result

- a) Copy A to register C

4. Stop

- a) Stop processing

```
MVI D, 2H
```

```
MVI E, 3H
```

```
MOV A, D
```

```
ADD E
```

```
MOV C, A
```

```
HLT
```

Program 8085 in Assembly language to add two 8-bit numbers. Result can be more than 8-bits.

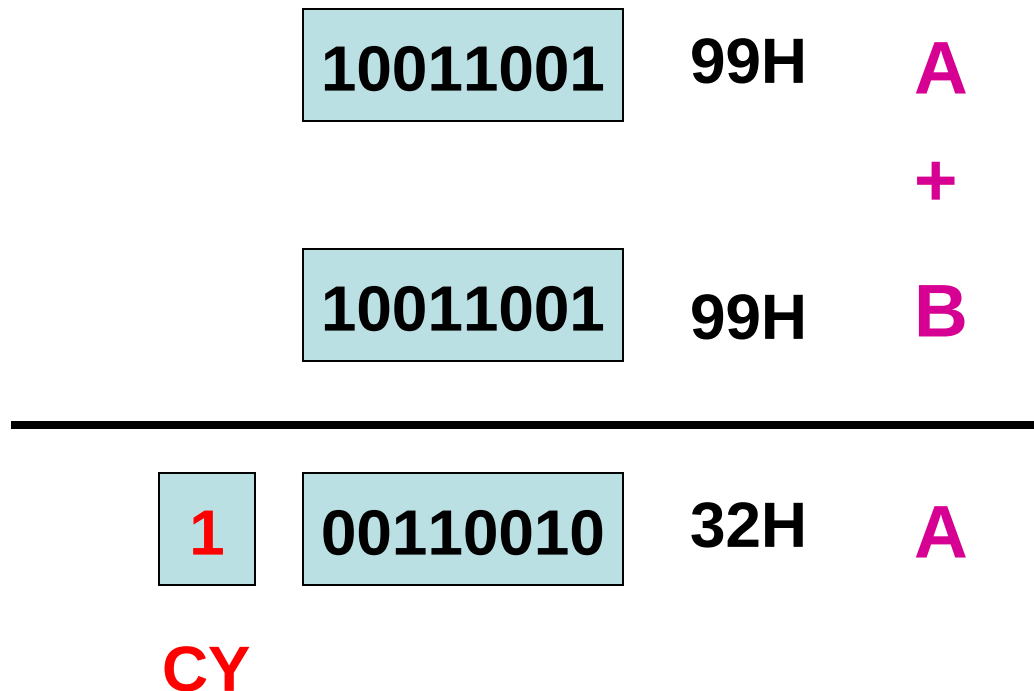
1. Analyze the problem

- Result of addition of two 8-bit numbers can be 9-bit
- Example

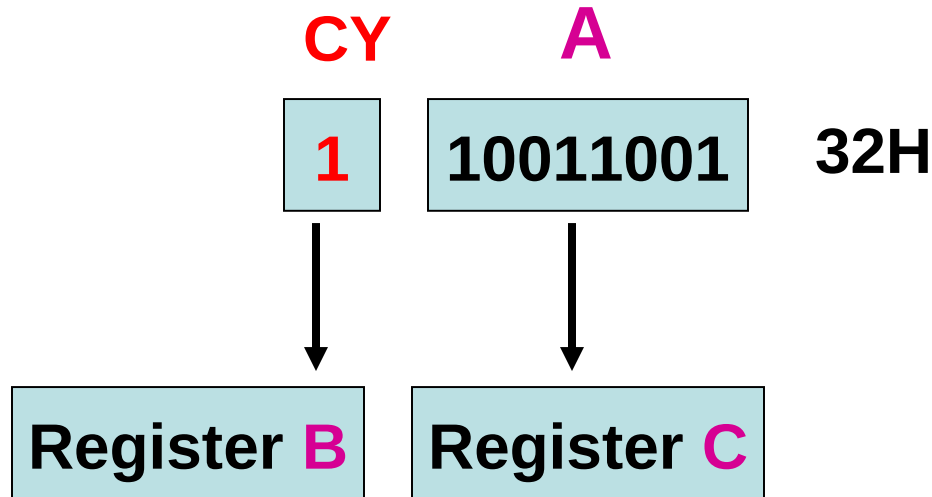
```
      10011001  (99H) A
    +10011001  (99H) B
    100110010 (132H)
```

- The 9th bit in the result is called CARRY bit.

- How 8085 does it?
 - Adds register **A** and **B**
 - Stores 8-bit result in **A**
 - SETS carry flag (CY) to indicate carry bit



- Storing result in Register memory



Step-1 Copy **A** to **C**

Step-2

- Clear register **B**
- Increment **B** by 1

2. Program Logic

1. Add two numbers
2. Copy 8-bit result in A to C
3. If CARRY is generated
 - Handle it
4. Result is in register pair BC

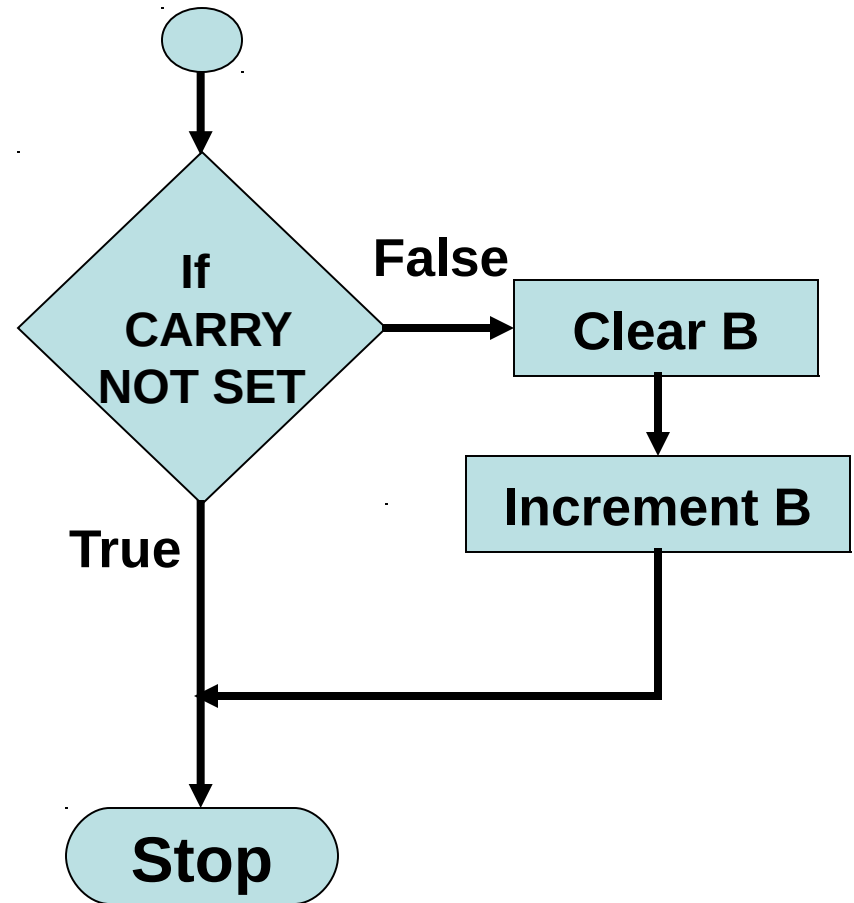
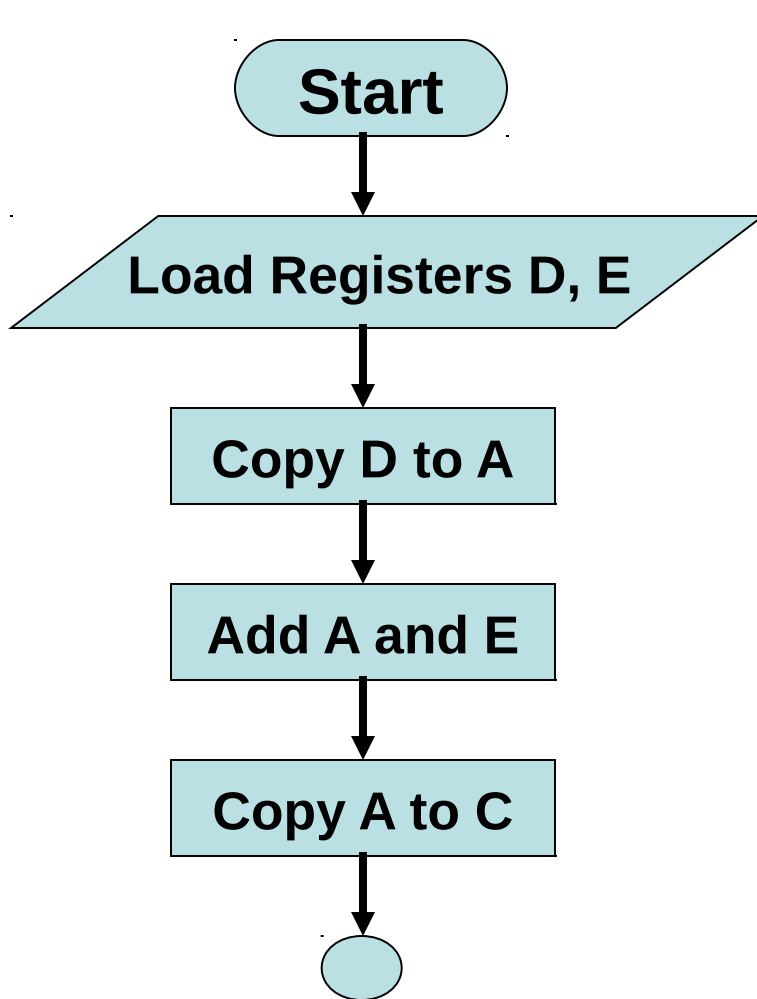
3. Algorithm

1. Load two numbers in registers D, E
2. Add them
3. Store 8 bit result in C
4. Check CARRY flag
5. If CARRY flag is SET
 - Store CARRY in register B
6. Stop

Translation to 8085 operations

- Load registers D, E
- Copy register D to A
- Add register E to A
- Copy A to register C
- Use Conditional Jump instructions
- Clear register B
- Increment B
- Stop processing

4. Make a Flowchart



5. Assembly Language Program

- Load registers D, E
- Copy register D to A
- Add register E to A
- Copy A to register C
- Use Conditional Jump instructions
- Clear register B
- Increment B
- Stop processing

```
MVI D, 2H
MVI E, 3H
MOV A, D
ADD E
MOV C, A
JNC END
MVI B, 0H
INR B
END: HLT
```

4. Addressing Modes of 8085

- Format of a typical Assembly language instruction is given below-

[Label:] Mnemonic [Operands] [;comments]

HLT

MVI A, 20H

MOV M, A ;Copy A to memory location whose address is stored in register pair HL

LOAD: LDA 2050H ;Load A with contents of memory location with address 2050H

READ: IN 07H ;Read data from Input port with address 07H

- The various formats of specifying operands are called addressing modes
- Addressing modes of 8085
 1. Register Addressing
 2. Immediate Addressing
 3. Memory Addressing
 4. Input/Output Addressing

1. Register Addressing

- Operands are one of the internal registers of 8085
- Examples-

MOV A, B

ADD C

2. Immediate Addressing

- Value of the operand is given in the instruction itself
- Example-

MVI A, 20H

LXI H, 2050H

ADI 30H

SUI 10H

3. **Memory** Addressing

- One of the operands is a memory location
- Depending on how address of memory location is specified, **memory** addressing is of two types
 - **Direct** addressing
 - **Indirect** addressing

3(a) Direct Addressing

- **16-bit** Address of the memory location is specified in the instruction directly

- Examples-

LDA 2050H ;load A with contents of memory location with address 2050H

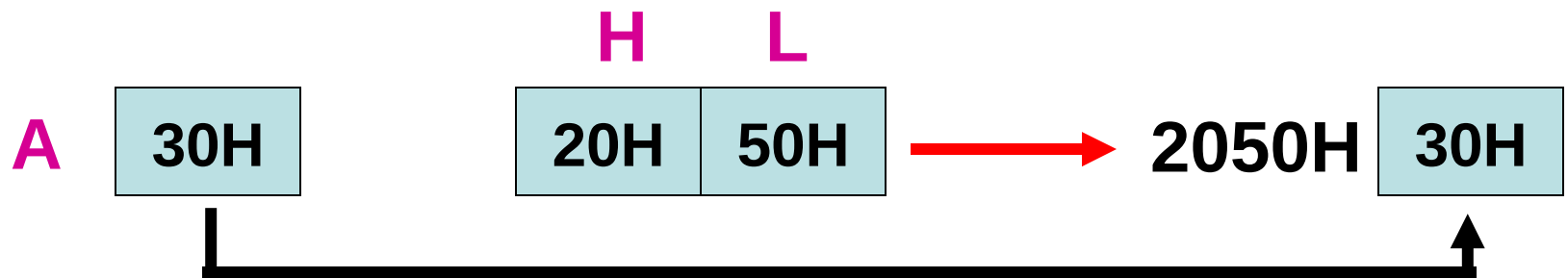
STA 3050H ;store A with contents of memory location with address 3050H

3(b) Indirect Addressing

- A **memory pointer** register is used to store the address of the memory location

- Example-

MOV M, A ; copy register A to memory location whose address is stored in register pair HL



4. Input/Output Addressing

- 8-bit address of the port is directly specified in the instruction
- Examples-

IN 07H

OUT 21H

5. Instruction & Data Formats

8085 Instruction set can be classified according to size (in bytes) as

1. 1-byte Instructions
2. 2-byte Instructions
3. 3-byte Instructions

1. One-byte Instructions

- Includes Opcode and Operand in the same byte
- Examples-

Opcode	Operand	Binary Code	Hex Code
MOV	C, A	0100 1111	4FH
ADD	B	1000 0000	80H
HLT		0111 0110	76H

1. Two-byte Instructions

- First byte specifies Operation Code
- Second byte specifies Operand
- Examples-

Opcode	Operand	Binary Code	Hex Code
MVI	A, 32H	0011 1110	3EH
		0011 0010	32H
MVI	B, F2H	0000 0110	06H
		1111 0010	F2H

1. Three-byte Instructions

- First byte specifies Operation Code
- Second & Third byte specifies Operand
- Examples-

Opcode	Operand	Binary Code	Hex Code
LXI	H, 2050H	0010 0001	21H
		0101 0000	50H
		0010 0000	20H
LDA	3070H	0011 1010	3AH
		0111 0000	70H
		0011 0000	30H

Separate the digits of a hexadecimal numbers and store it in two different locations

- LDA 2200H ; Get the packed BCD number
- ANI F0H ; Mask lower nibble

0100 0101 45

1111 0000 F0

0100 0000 40

- RRC
- RRC
- RRC ; Adjust higher digit as a lower digit.
- RRC 0000 0100 after 4 rotations

Contd.

- STA 2300H ; Store the partial result
- LDA 2200H ; Get the original BCD no.
- ANI 0FH ; Mask higher nibble

0100 0100 45

0000 1111 0F

0000 0100 05

- STA 2301H ; Store the result
- HLT ; Terminate program execution

Block data transfer

- MVI C, 0AH ; Initialize counter i.e no. of bytes
Store the count in Register C, ie ten
- LXI H, 2200H ; Initialize source memory pointer
Data Starts from 2200 location
- LXI D, 2300H ; Initialize destination memory pointer
- BK: MOV A, M ; Get byte from source memory block
i.e 2200 to accumulator.
- STAX D ; Store byte in the destination
memory block i.e 2300 as stored in
D-E pair
-

Contd.

- INX H ; Increment source memory pointer
- INX D ; Increment destination memory pointer
- DCR C ; Decrement counter to keep track of bytes moved
- JNZ BK ; If counter 0 repeat steps
- HLT ; Terminate program