Introduction to Microprocessor

As a result of development of VLSI (Very Large Scale Integr-ation) it is possible to fabricate the whole central Processing unit of a computer in a single chip, which is known as microprocessor.

It reduces the manufacturing cost,
increase the reliability,
lower the power consumption,
and minimise the size of the computer.

1971, Intel corporation, – Intel 4004 – 2300 transistors
Intel 8080
Intel 8085
Intel 8086
Intel 8088 etc. .....

The microprocessor consist of electronic logic circuits of semiconductors fabricated by using VLSI technique.

The microprocessor has a set of instructions designed internally, to manipulate data and communicate with the input and output devices.

Features of 8085 Microprocessor

① It is a 8-bit microprocessor : can accept 8 bit data simultaneously.

② Operates on single +5V D.C supply.

③ Designed using NMOS technology (N Type MOSFET)

④ It has 6200 transistors on single chip.

⑤ It operates on 3Mhz clock frequency.

⑥ It provides on chip clock generator, hence it does not require external clock generator.

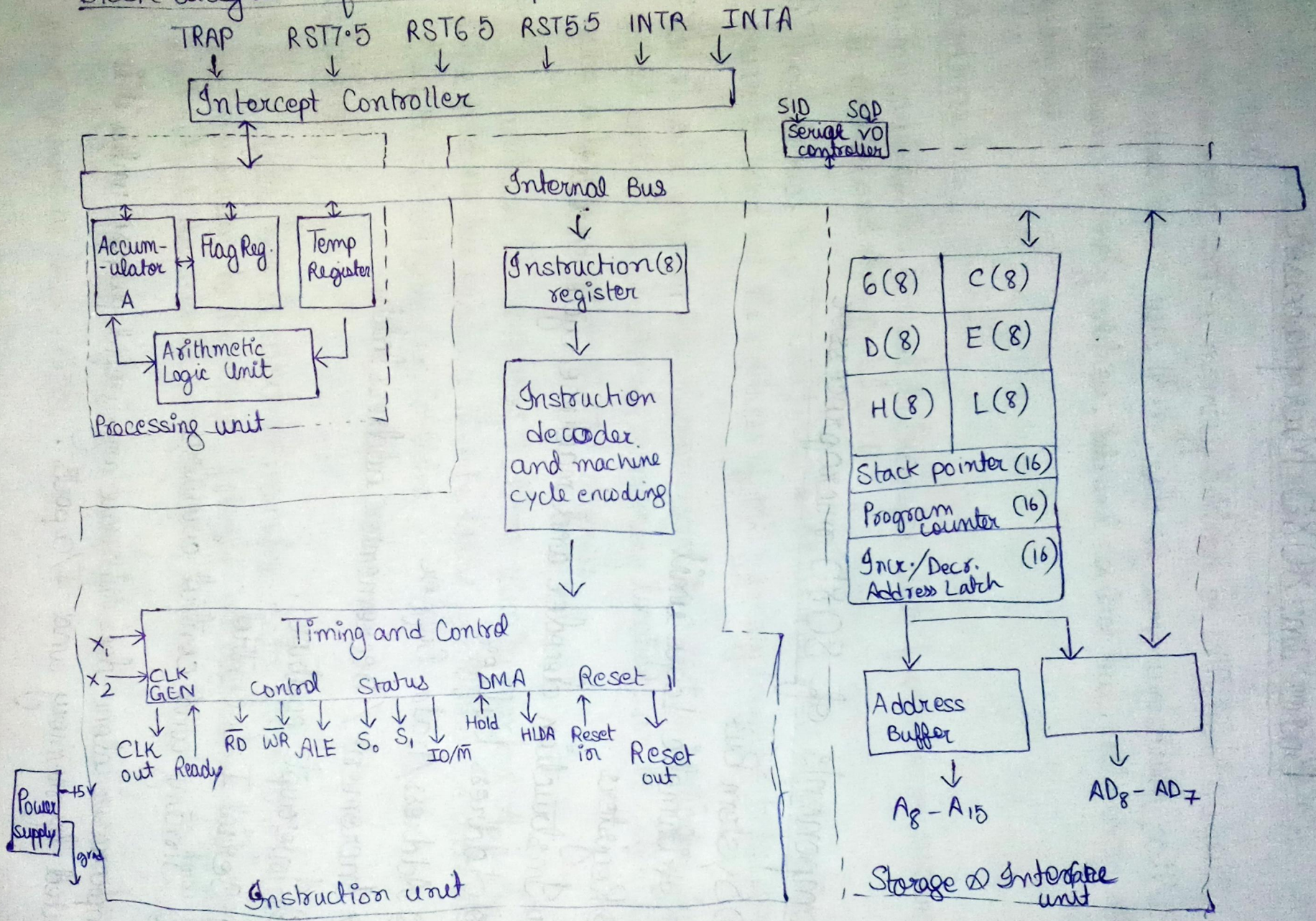
⑦ 16 address lines, hence 2^{16} = 64 KB of memory

⑧ 8 bit multiplexed address/data bus, which reduce the no of pins.

⑨ It generates 8 bit I/O address, hence it can access 2^8 = 256 I/O ports

⑩ 5 hardware interrupts, i.e TRAP, RST 6.5, RST 5.5, RST 4.5, and INTR.

Block diagram of 8085 Microprocessor



Components of 8085 microprocessor

1. System Bus
2. Arithmetic Logic unit.
3. Registers.
4. Instruction decoder and machine cycle encoder.
5. Address Buffer.
6. Address/Data Buffer.
7. Increment / Decrementer address latch.
8. Interrupt control.
9. Serial I/O control.
10. Timing and control circuitry.

Microprocessor alone does not serve any useful purpose unless it is supported by memory and I/O ports.

System Bus or Bus in Microprocessor

Why needed?

To communicate with a memory address or with input/output, the microprocessor uses three sets of communication paths called buses namely address, data and control bus, collectively called system bus.

Address bus:

(a) The address bus is used to transfer data from the microprocessor to memory and other peripherals

(b) The address bus is unidirectional and is used by the microprocessor to send out the address of the memory location to be accessed.

(c) It is also used by the microprocessor to select a particular input or output port. Each peripherals or memory location can be identified using a binary number called address

(d) The address bus consist of 16 lines usually marked A_0 to A_{15}. The address bus carries a 16-bit address and thus can address upto $2^{16} = 65536 (= 64K)$ memory locations.

Data bus:

(a) The data bus is used to transfer data from one part of microprocessor to the other, between microprocessor and memory or input/output devices in both directions. i.e data bus is bidirectional.

(b) The data bus has 8 lines, namely D_0 to D_7. This number is also known as bus width.

(c) The data bus determines the word length and the register size of a microprocessor. The largest number appearing on the data bus is $(11111111)_2$.

Control bus

(a) The control bus sends out control signals to memory, I/O ports and other peripheral devices to ensure proper operation.

(b) It carries control signals such as memory read, memory write, read input port, write output port, hold, interrupt etc.

For ex- If it is desired to read the contents of a particular memory location, the CPU first sends out the address of that location on the address bus and a 'memory read' control signal on the control bus.

Multiplexing

In the Intel 8085 microprocessor, the lower byte of the address is sent over the address/data bus with pins marked as $AD_0 - AD_7$ and the higher byte of the address is sent over a dedicated 8 bit address bus with pins marked as $A_8 - A_{15}$. This type of operation, where single bus is used for two different functions, is known as multiplexing.

ARITHMETIC LOGIC UNIT (ALU)

① Arithmetic logic unit is the heart of microprocessor.

② It performs arithmetic and logical functions on eight bit variables.

③ The arithmetic unit performs bitwise fundamental arithmetic operations such as addition and subtraction.

④ The logic unit performs logical operations such as complement, AND, OR and EX-OR, as well as rotate and clear.

⑤ The ALU also looks after the branching decisions.

⑥ The results of ALU can be stored in registers or in memory, or transferred to output devices.

Registers in 8085 Microprocessor

are used for storage of small data, instructions in the microprocessor.

a) Temporary registers
b) General purpose registers
c) Special purpose registers.

A) Temporary Registers

1. Temporary data register

(a) It is called as operand register (8 bit)

Function :-

(a) It provides operand to ALU.

The ALU has two inputs. One input is supplied by accumulator and other by Temporary data registers. However, it is internally used for execution of most of the arithmetic and logical instructions.

2. W and Z Registers.

W and Z registers are temporary registers.
These registers are not available for programmer, since 8085 uses them internally
These registers are used to hold 8-bit data during execution of some instructions.

General purpose registers

B	C
D	E
H	L

There are six general purpose 8 bit registers in 8085 microprocessor.
These registers are marked B, C, D, E, H, L
For 16 bit operations, the registers are paired such as BC, DE and HL.
These are also called scratchpad registers, as user can store data in them.
The data can be loaded or transferred from the registers by using instructions through programs.

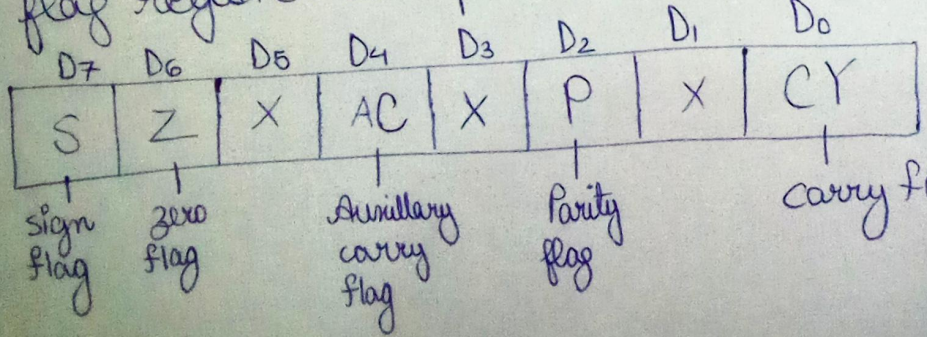
Special purpose registers

(a) Accumulator: Accumulator is an 8-bit register that is a part of ALU

This register is used to store 8-bit data and to perform arithmetic and logical operations
It is also used to store the result of an operation.
The accumulator is denoted as register A.

(b) Flag register or Status - To store the status of a result

Five flag register are possible



a) Carry flag

This flag is set whenever there has been a carry out of, or a borrow into, the higher order bit of the result (8 or 16 bit)

1 - there is a carry out from the most significant bit
0 - no carry out from msb.

b) Parity flag

This flag is set when the result has even parity or even number of 1 bits

1 - low byte has an even number of 1 bits
0 - low byte has odd parity.

c) The Auxillary carry flag (AF)

This flage is set when ~~set~~ carry is generated at D_3 bit position.

1 - Carry generated at D_3 position
0 - No auxillary carry generated.

d) The zero flag (ZF)

This flag is set, when the result of operation is zero else it is reset.

1- zero result

0- non zero result.

e) The sign flag -

This flag is set, when msb of the result is 1

1 - msb is 1 (-ve) 0- msb is 0 (+)ve

(c) Instruction Register

(i) The instruction register holds the opcode of the instruction that is decoded and executed.

(d) Program Counter

(i) It is used to hold the address of program memory.

(ii) Function of the program counter is to point to the memory address from which the next byte is to be fetched.

(c) Stack Pointer -

(i) Stack is reserved portion of memory where information can be stored or taken back under software control. This memory area is referred to as stack area.

(ii) SP is a 16 bit register used to define the stack starting address.

Memory and Stack Memory

Memory is an essential part of a Micro Processing Unit (MPU). To store binary data for the microprocessor, memory is used in a micro processing unit. In 8085 Micro Processing Unit two memory chips are there namely - R/W Memory and EPROM, both with 256 bytes.

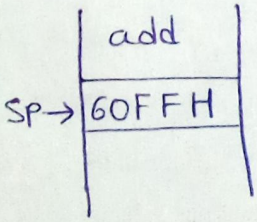
Stack or Stack Memory

- Stack is a group of memory locations.
- Used for storage of information during execution of program.
- Stack follows Last in first output principle.

Stack Instructions

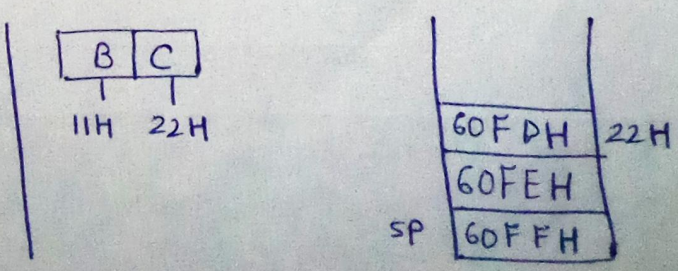
① LXI SP

- used for defining beginning address of stack.
- eg. LXI SP, 60FFH



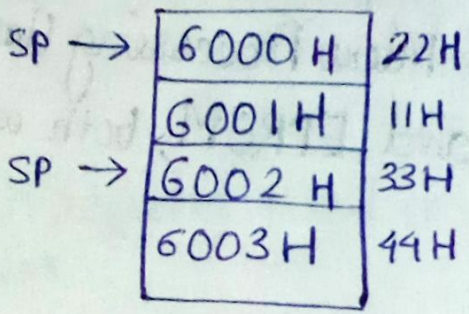
② PUSH RP

- This instruction is used to load data of register pair on the stack.
- It is predecrement instruction.
  - eg. Push B



③ POP Rp

- This instruction is used to retrieve data from stack.
- It is post increment instruction.
- e.g POPH
  POP PSW



H	L
11H	22H

A	flag
44H	33H

Timing and Control circuitry

① The control circuitry in the 8085 Microprocessor Architecture maintains the proper sequence of all the operations performed by various sections of the microprocessor and other devices in the system.

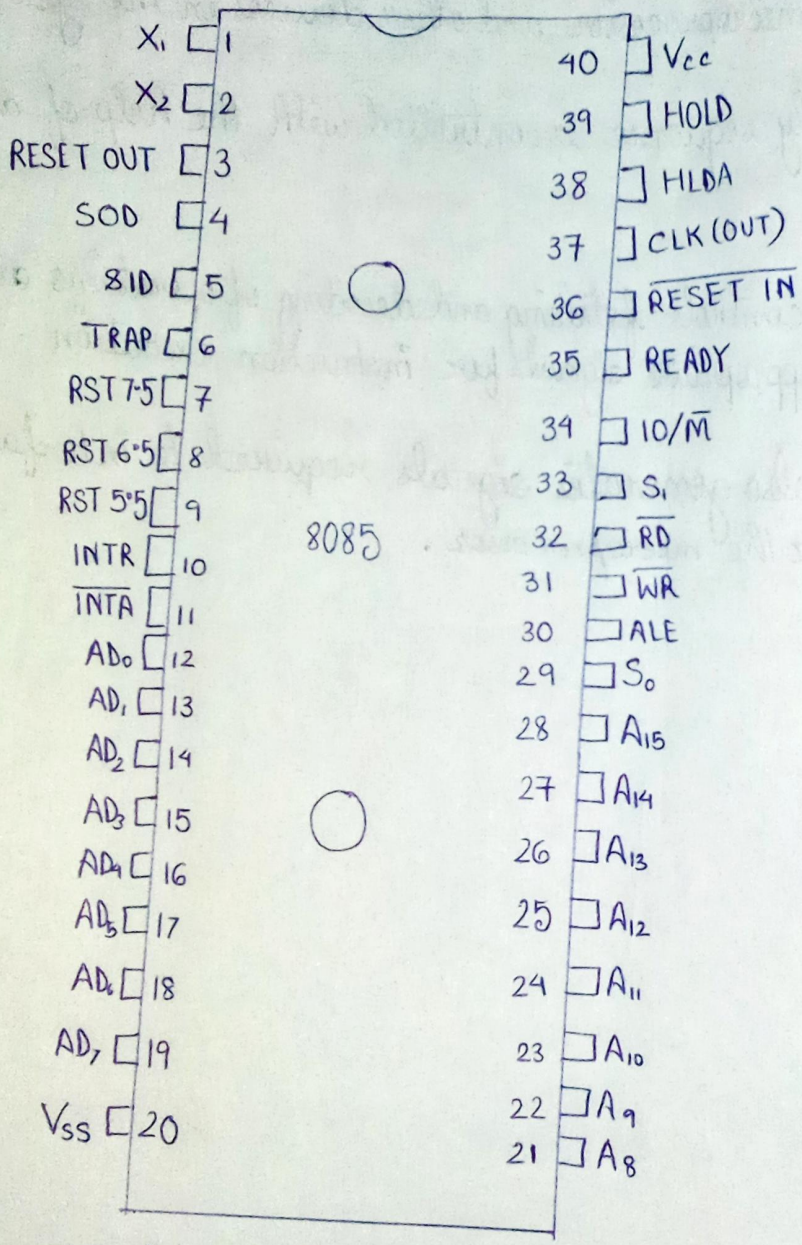
② Timing of the orderly sequence is controlled with the help of an external clock signal.

③ Control circuitry controls fetching and decoding of operations as well as generates appropriate signals for instruction execution.

④ Control circuitry also generates signals required to interface external devices to the microprocessor.

Pin Out diagram of 8085

- Total 40 signal pins are there



1	2	3	4	5	6	7
Power supply & frequency signal	Data Bus & Address Bus	Control & Status Signal	Interrupt signals	Serial I/O signals	DMA signal	Reset signals
V_{CC}, V_{SS}, X_1, X_2, CLK OUT	$AD_0 - AD_7$ $AD_8 - AD_{15}$	ALE, RD, WR, $IO/\overline{M}$, S_0, S_1, READY	RST 5.5, RST 6.5, RST 7.5, TRAP, INTA, INTR	SID SOD	HOLD HLDA	RESET IN RESET OUT

Instruction cycle

① The fetching, decoding and execution of a single instruction constitutes an instruction cycle.

Thus, Instruction cycle is defined as the time required to complete the execution of an instruction.

② The time required to complete the operation of accessing either memory or I/O is called machine cycle. In other words to move byte of data in or out of the microprocessor, a machine cycle is required.

③ One subdivision of the operation performed in one clock period is called T state.

④ To say, one Instruction cycle consist of -

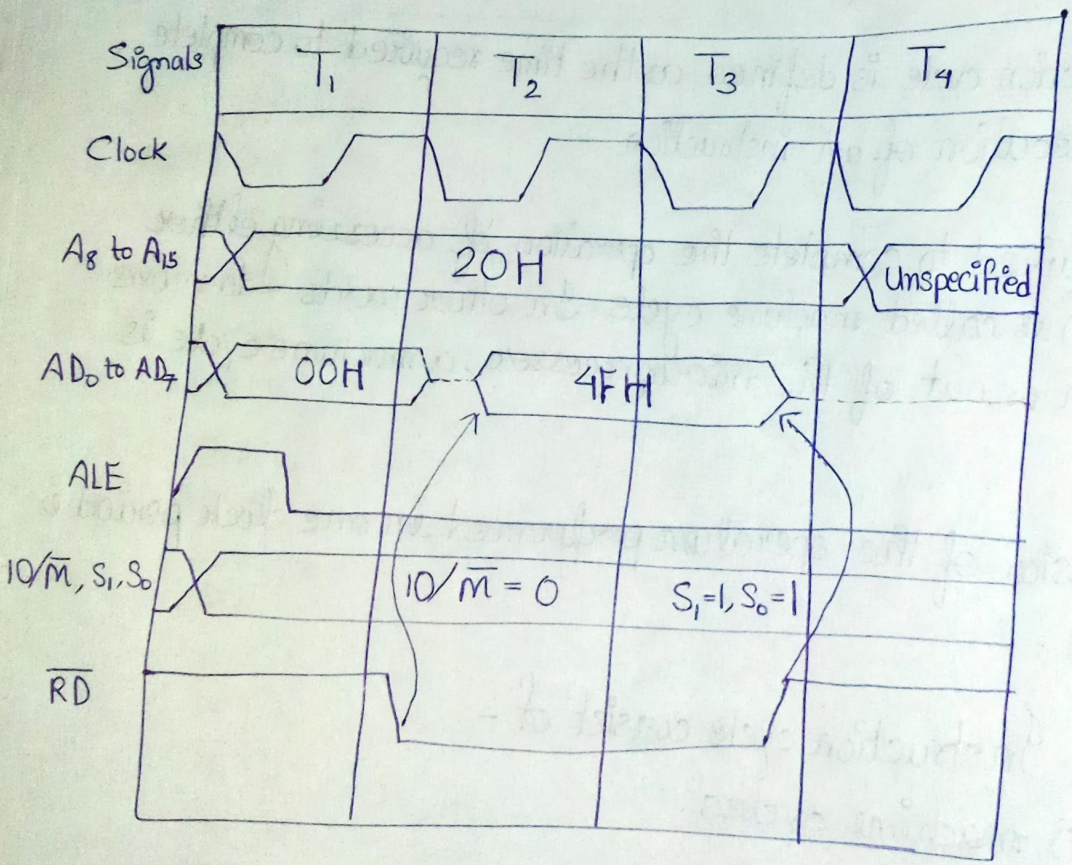
1-5 machine cycles.

3-6 T-states.

Timing diagrams for MOV reg 1, reg 2

Ex-

2000H MOV C, A 4F



Timing diagram of MVI Instruction

ex - MVI A, 32H 2000H opcode - 3EH