Unit -I

8085 Microprocessor Architecture

What is Microprocessor?

- Microprocessor is the CPU designed on a single chip (IC).
- The word "Micro" indicates that it is small in size.
- It is developed by Intel company.

What is 8085 Microprocessor?

- The 8085 Microprocessor is also a CPU designed on a single LSI i.e. Large Scale Integation (IC consisting of less then 100 components) or VLSI i.e. Very Large Scale Integration)IC consisting of thousands of components).
- It is an 8-bit Microprocessor.
- It is the first general purpose Microprocessor used by the user.
- It is developed by Intel in March 1976.

Features of 8085 Microprocessor:

The features of 8085 Microprocessor are classified into two two main categories (types):

I] Hardware Features:

The hardware features of 8085 Microprocessor are as follows:

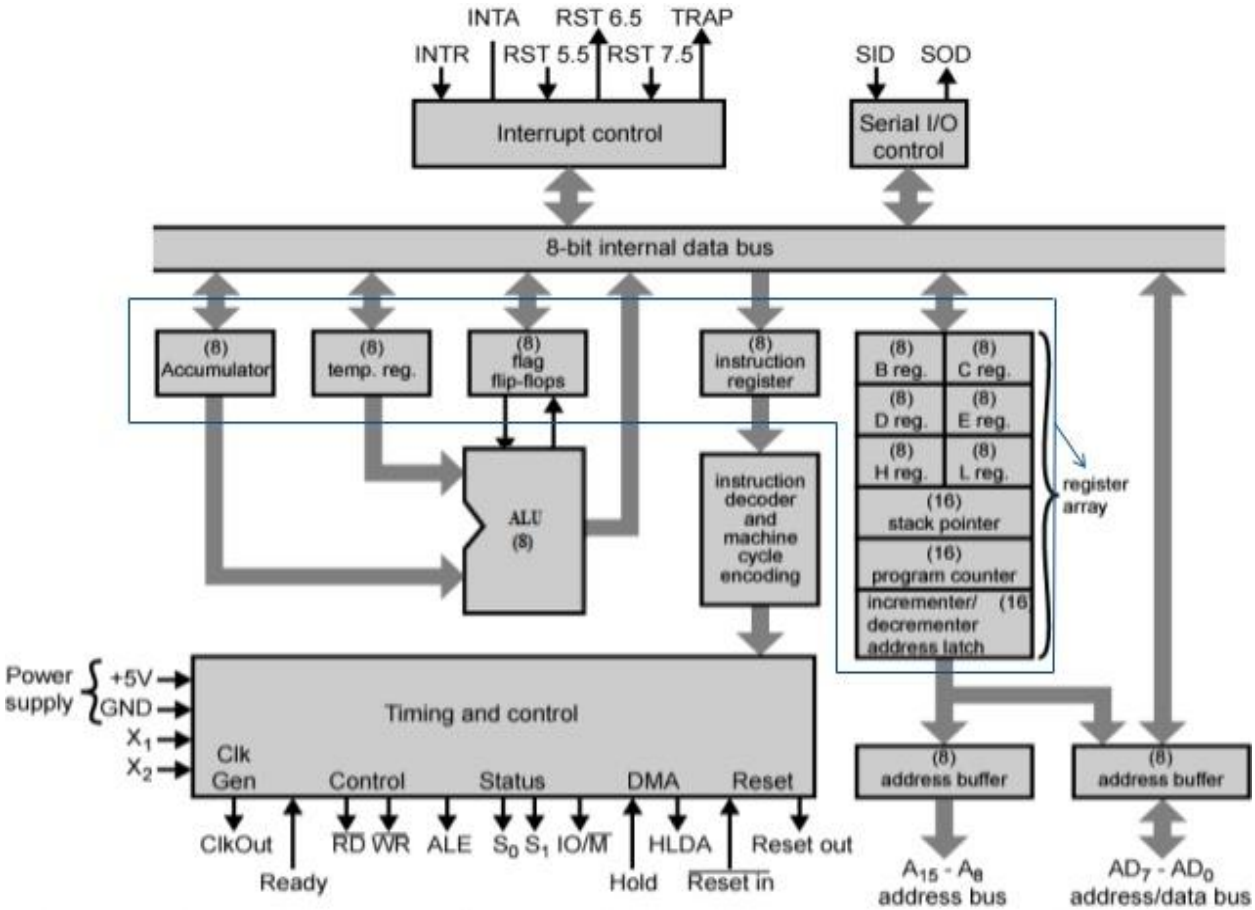
1) It is designed on a single 40 pin IC (Chip).
2) It requires (operates) on $-^{+}$5V DC supply.
3) It requires (operates) on 3 MHz clock frequency.
4) It has 8-bit Data bus from D0-D7.

5) It has 16-bit Address bus from A0-A15.
6) It has 8-bit time Multiplexed Address/Data bus from AD0-AD7.
7) It provides (gives) 8-bit I/O address.
8) It provides two serial data transmission pins SID i.e. Serial Input data pin and SOD i.e. Serial Output Data pin.
9) It provides two parallel data transmission pins called as DMA i.e. Direct Memory Access pins HOLD and HLDA.
10) It provides five hardware interrupts i.e. TRAP, RST 7.5, RST 6.5, RST 5.5 and INTR.

II] Architectural Features:

1) It provides seven 8-bit registers such as A, B, C, D, E, H and L. Separately these are used as 8-bit registers and in combination these can be used as 16-bit registers. The valid register pairs are BC, DE and HL.
2) It provides two 16-bit registers such as SP (Stack Pointer) and PC (Program Counter).
3) It can perform two types of operations such as Arithmetic and Logical operations. The Arithmetic operations are Addition, Subtraction, Increment and Decrement and Logical operations are AND, OR, NOT, Ex-OR, Rotate, Compare and Shift.
4) It provides 74 instructions.
5) It Provides 8-bit Flag register, which consists of only 5 flags i.e. Carry, Parity, Auxiliary Carry, Zero and Sign and the 3-bits of Flag register are not defined.
6) It provides Five Addressing modes i.e. Register, Immediate, Direct, Indirect and Implicit/Implied.

Block diagram (Architecture) of 8085 Microprocessor:



Internal Architecture (functional block diagram) of 8085

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Above figure shows the block diagram (Architecture) of 8085 Microprocessor:

The block diagram (Architecture) of 8085 Microprocessor is divided into five main blocks:

I) ALU:

- ALU means Arithmetic and Logic Unit.
- ALU can perform two types of operations such as Arithmetic and Logical operations. The Arithmetic operations are Addition, Subtraction, Increment and Decrement and Logical operations are AND, OR, NOT, Ex-OR, Rotate, Compare and Shift.
- The inputs to the ALU are from Accumulator and Temporary Register.
- ALU consists of 3 main parts such as Accumulator, Temporary Register and Flag Register.

  The function of each part (block) of ALU is as follows-

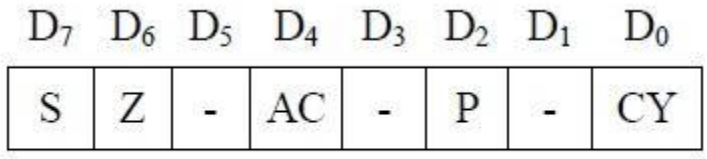
1) Accumulator:

In short Accumulator is called as Register 'A'. It is 8-bit general purpose register used by user. Compulsory the first number (operand) is stored in Accumulator, required for Arithmetic or Logical operation. Also the result of ALU is stored back into the accumulator. The 8085 microprocessor is called as "Accumulator Based Microprocessor" because all the operations of 8085 Microprocessor are carried out through the Accumulator.

2) Temporary Register:

The second input to the ALU is given by the Temporary Register. As its name suggest that the data is stored temporary in this register. There are two types of Temporary Register i.e. W and Z. These registers are not used by user but these are internally used by the 8085 Microprocessor.

3) Flag Register:



Flag register of 8085

Above figure shows the diagram of Flag Register.

Flag means Flip-Flop, which gets either set or reset according to the result of ALU. The Flag register is an 8-bit register, which consists of only 5 flags i.e. Carry, Parity, Auxiliary Carry, Zero and Sign and the 3-bits of Flag register are not defined. The function of each Flag is as follows:

1) Carry Flag:

The Carry Flag is set i.e. 1 , if there is carry in the result of ALU. Otherwise the Carry Flag gets reset i.e. 0, if there is no carry in the result of ALU.

2) Parity Flag:

The Parity Flag is set i.e. 1, if the result of ALU contains even number of 1's . Otherwise the Parity Flag is reset i.e. 0, if the result of ALU contains odd number odd 1's.

3) Auxiliary Carry Flag:

The Auxiliary Carry Flag is set i.e. 1 , if there is carry from D3-bit to D4-bit in the result of ALU. Otherwise the Auxiliary Carry Flag gets reset i.e. 0, if there is no carry from D3-bit to D4-bit in the result of ALU.

4) Zero Flag:

The Zero Flag is set i.e. 1 , if there the result of ALU is zero. Otherwise the Zero Flag gets reset i.e. 0, if the result of ALU is not zero.

5) Sign Flag:

The Sign Flag is set i.e. 1 , if there the result of ALU is negative. Otherwise the Sign Flag gets reset i.e. 0, if the result of ALU is positive.

II) Registers:

Every Microprocessor has a number of registers for the temporary storage of data, which requires frequently. Data remain in these registers till the data is sent to the memory or the I/O devices. Registers are used by the microprocessors because accessing the data from register is always faster than accessing the data from the memory. The 8085 Microprocessor has 4 types of registers is as follows-

1) General Purpose Registers:

The 8085 Microprocessor has seven 8-bit registers such as A, B, C, D, E, H and L. Separately these are used as 8-bit registers to store 8- bit data and in combination these can be used as 16-bit registers to store 16-bit data. The valid register pairs are BC, DE and HL. The user cannot use their own choice

register pairs. The HL register pair is called as "Memory Pointer" because HL always stores the address of memory. All these registers are accessible by the user.

2) Temporary Register:

The second input to the ALU is given by the Temporary Register. As its name suggest that the data is stored temporary in this register. There are two types of Temporary Register i.e. W and Z. These registers are not used by user but these are internally used by the 8085 Microprocessor.

3) Special Purpose Registers:

8085 Microprocessor has two types of Special Purpose Registers and these are as follows-

i) PC:

PC means Program Counter. It is 16-bit register used by both the user and the microprocessor. The PC holds the address of next instruction to be executed (run). PC contents gets automatically incremented or decremented by one. On reset the PC contents become zero i.e. 0000H.

ii) SP:

SC means Stack Pointer. It is 16-bit register used by both the user and the microprocessor. The SP holds the starting address of stack called "Stack Top" . The Stack means the reserved area in the RAM. The contents of SP gets automatically incremented or decremented by one. On reset the SP contents become zero i.e. 0000H

4) Increment/Decrement Address Latch:

It is an 16-bit register, which is used to either increment/ Decrement the contents of PC or SP.

III) Instruction Register, Decoder, Timing and Control Unit:

i) Instruction Register:

The CPU access the code of instruction from the memory and stores the code of instruction in Instruction Register called IR. Than IR will transfer this code of the instruction to the Decoder.

ii) Decoder:

Than the Decoder will accept the code of instruction from the IR and than the decoder will decode the code. Finally the decoder will transfer the decoded information to the Timing and Control Unit.

iii) Timing and Control Unit:

The Timing and Control Unit will accept the decoded information from the Decoder and then will generate the timing and control signals, which are required for the execution of the instructions and also to control the operation of Microprocessor and the I/O devices.

IV) Interrupt Control Unit (Group):

Interrupt is the process to stop the current operation of the microprocessor, so as to give the service to the I/O devices. Then after giving the service to the I/O devices, microprocessor comes back to its normal working condition. The 8085 microprocessor has five hardware interrupts i.e. TRAP, RST 7.5, RST 6.5, RST 5.5 and INTR. Where the TRAP has the highest

priority and INTR has the lowest priority. On receiving the INTR interrupt microprocessor gives **INTA** signal i.e. interrupt acknowledgement. By using INTR interrupt we can add 64 interrupts, using 8259A IC called " Interrupt Controller".

V) Serial I/O Control Unit (Group):

This Unit is used to transfer the data by two methods:

i) Parallel:

For the parallel transmission of the data the 8085 microprocessor uses 8-bit data bus from D0-D7.But the parallel data transmission method is costly as compared to the serial data transmission.

ii) Serial:

As the serial data transmission method is less costly as compared to the parallel data transmission method, the 8085 microprocessor uses the serial data transmission method. For this serial transmission 8085 microprocessor has two pins SID and SOD. SID i.e. Serial Input data pin, which is used to input the data i.e. write the data or enter the data into the microprocessor and SOD i.e. Serial Output Data pin, which is used to output the data i.e. read or access the data from the memory or I/O devices.

Pin Diagram (Configuration) of 8085 Microprocessor:

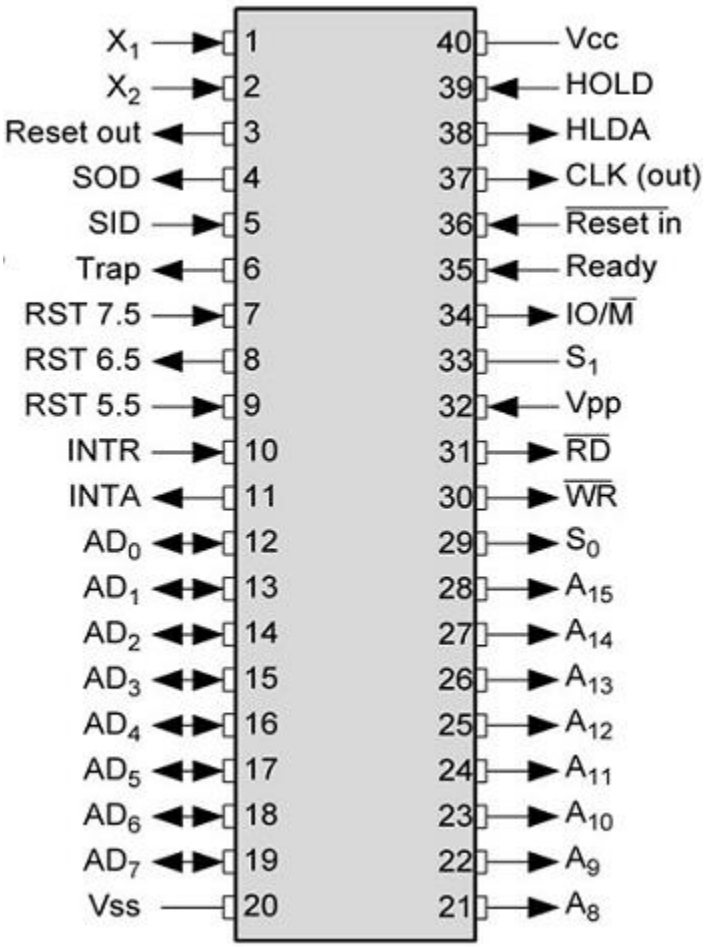


Figure shows the pin diagram (configuration) of 8085 Microprocessor:

The 8085 microprocessor is designed on a single 40 pin IC . The function of each pin is as follows:

1] X1 and X2:

X1 and X2 are the active high input pins.These are used to give the clock input to the microprocessorby placing a

crystal of 6MHz. Here the clock frequency is divided by 2, the microprocessor gets clock of 3MHz.

2] Resetout:

It is active high output pin , used to reset the I/O devices.

3] SID and SOD:

For this serial transmission 8085 microprocessor has two pins SID and SOD. SID i.e. Serial Input data pin, which is used to input the data i.e. write the data or enter the data into the microprocessor and SOD i.e. Serial Output Data pin, which is used to output the data i.e. read or access the data from the I/O devices.

4] Interrupts:

Interrupt is the process to stop the current operation of microprocessor, so as to give the service to the I/O devices. Then after giving the service to the I/O devices, microprocessor comes back to its normal working condition. The 8085 microprocessor has five hardware interrupts i.e. TRAP, RST 7.5, RST 6.5, RST 5.5 and INTR. Where the TRAP has the highest priority and INTR has the lowest priority. On receiving the INTR interrupt processor gives **INTA** signal i.e. interrupt ack.

5] AD0-AD7:

It is time multiplexed Address/Data bus. It is used to carry low order address from A0-A7 and then it will carry the data from D0-D7.

6] Power Supply pins:

There are two power supply pins Vcc and Vss. Vcc is positive supply pin +5V and Vss is negative supply pin

-5V.

7] A8-A15:

It is high order address bus used to carry high order address of memory.

8] S1 and S0:

These are status pins used to indicate the status of 8085 Microprocessor.

Status pins S1 and S0	Status of 8085 Microprocessor
00	Halt (stop)
01	Write
10	Read
11	Fetch(Access)

9] ALE:

ALE means Address Latch Enable, which is used to latch (lock) the low order address i.e. A0-A7 From AD0-AD7 to make the Address/Data bus free to carry the data from D0-D7.

10] WR/RD:

These are active low output pins, which are used to control the Write/Read operation. When WR becomes low than data is written into the selected memory or I/O devices. And when RD becomes low then data is read from the selected memory or I/O devices.

11] IO/M:

This pin is used to indicate whether the address on the address bus is for I/O or memory. When this pin this becomes low then the address is for memory and when

this pin becomes high then address is for I/O devices.

12] Ready:

It is active high input pin, which is used to indicate that the I/O device is ready for data transmission.

13] Reset In:

It is active low input pin, which is used to reset the microprocessor by the I/O devices.

14] Clock out:

It is active high output pin, which is used to give the clock to the I/O devices by the microprocessor of 3MHz.

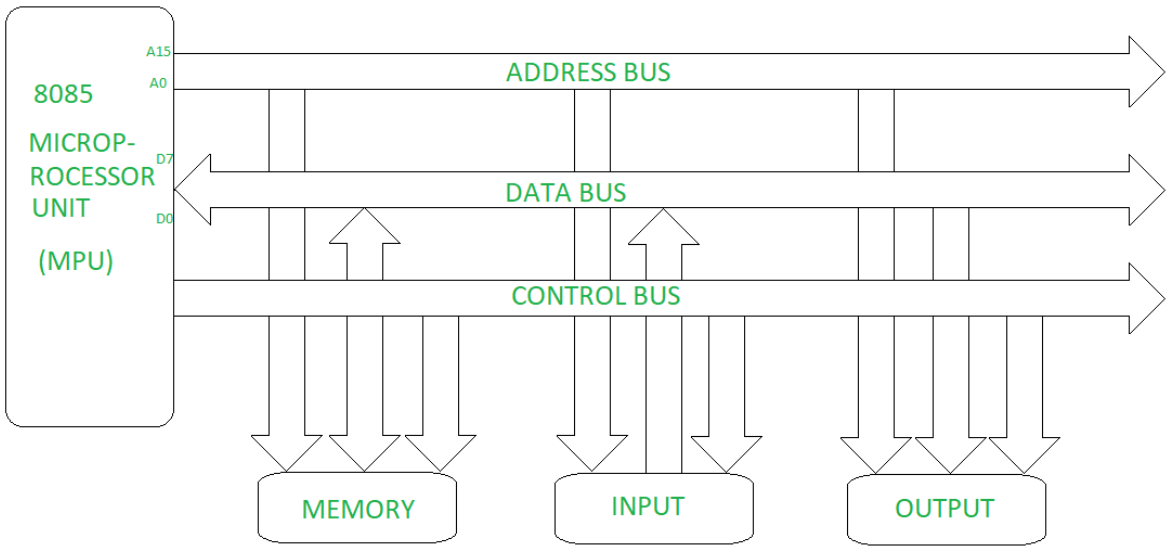
15] HLDA and HOLD:

These are DMA pins (Direct Access Memory). HOLD pin is used to make the request for the use of address/Data made by the I/O devices to the microprocessor.

On receiving HOLD request processor gives HLDA i.e. hold acknowledgement.

Address/Data Bus of 8085 Microprocessor:

Figure shows the Address/Data Bus of 8085 Microprocessor.



Bus organization system of 8085 Microprocessor

BUS:

It is group of lines or wires or the conductors. It is used to carry the information between the Microprocessor and the Memory or I/O devices. It is also used to connect the different parts of computer such as memory and I/O devices with the CPU. The 8085 Microprocessor has three types of buses and the function of each bus is as follows-

1] Address Bus:

The 8085 microprocessor has 16-bit address bus A0-A15. This bus is divided into two parts i.e. A0-A7 and A8-A15. Where A0-A7 is called low order address bus and A8-A15 is called high order address bus. This bus is unidirectional because it carries the address in only one direction i.e. from CPU (processor) to memory or I/O devices.

2] Data Bus:

The 8085 microprocessor has 8-bit address bus D0-D7. This bus is bidirectional because it carries the data in both direction i.e from CPU (processor) to memory or I/O devices and again back from memory or I/O devices to CPU.

3] Control Bus:

This bus is unidirectional because it carries the address in only one direction i.e. from CPU (processor) to memory or I/O devices. This bus is used to carry the control signals used to control the operation of CPU, memory and I/O devices. Example are WR and RD signals:

These are active low output pins, which are used to control the Write/Read operation. When WR becomes low than data is written into the selected memory or I/O devices. And when RD becomes low then data is read from the selected memory or I/O devices.

Opcode and Operand:

Every instruction has two parts i.e. Opcode and Operand.

1] Opcode:

Opcode is the first part of the instruction. Opcode means operational cod, which defines the operation performed by the computer i.e. CPU.

2] Operand:

Operand is the second part of the instruction. Where operand means the data on which operation is performed.

There are different methods to define the data:

i) 8-bit or 16-bit data is given in the instruction:

ex. 1. MVI A,05H

In this instruction 05H is the 8-bit data given in instruction.

ex. 2. LXI H,2000H

In this instruction 2000H is the 16-bit data given in the instruction.

ii) One or two registers are given in the instruction:

ex. 1. INR B

In this instruction only one register B is given in the instruction.

ex. 2. MOV A,B

In this instruction two registers A and B are given in the instruction.

iii) No data is given in the instruction:

ex. CMA

In this instruction no data is given in

the instruction, so processor will perform operation on directly on the contents of Accumulator by default.

iv) 16-bit address of memory or 8-bit address of I/O is given in the instruction:

ex. 1. STA 5000H

In this instruction 5000H is the 16-bit address of memory is given in the instruction.

ex. 2. IN 01H

In this instruction 01H is the 8-bit address of I/O is given in the instruction.

Instruction Format:

Instruction:

An instruction is the command given to the computer to perform some operation or job or task. Every instruction has different instruction formats because there are number of methods to define the data.

The 8085 Microprocessor has 3 types of instruction formats:

1] One-Byte instruction format:

One-Byte means 8-bits. This format consists of only one field called opcode. Opcode means operational cod, which defines the operation performed by the computer i.e. CPU.

The first 2-bits of opcode defines the operation, next 3-bits are for destination and the last 3-bits are for the source.

opcode

1	2	3	4	5	6	7	8
operation			**Destination**			**Source**	

ex.MOV A , B

01 111 000= 78H

2] Two-Byte instruction format:

Two-Byte means 16-bits. This format consists of two fields called opcode and operand. The first byte is Opcode means operational code, which defines the operation performed

by the computer i.e. CPU. The second byte is operand. Operand can be 8-bit data or 8-bit address of memory or the I/O devices.

ex. 1. MVI A,05H

The opcode is 06H and 05H is the 8-bit data i.e. operand given in instruction.

ex. 2. IN 01H

The opcode is DB and 01H is the 8-bit address of I/O is given in the instruction.

opcode	**operand**

3] Three-Byte instruction format:

Three-Byte means 24-bits. This format consists of three fields called opcode and operand 1 and operand 2. The first byte is Opcode means operational code, which defines operation performed by the computer i.e. CPU. The second byte is operand 1 which can be low order 8-bit data or 8-bit address of memory or the I/O devices. The third byte is operand 2 which can be high order 8-bit data or 8-bit address of memory or the I/O devices.

ex. 1. LXI H,2000H

In this instruction, 21 is opcode, 00H is the 8-bit low order data and 20H is high order data given in the instruction.

ex. 2. STA 5000H

In this instruction, 32h is the opcode, 00H is the low order 8-bit address of memory is and 50H is high order address of memory

given in the instruction.

opcode	**Operand 1**	**Operand 2**