Microprocessor Architecture

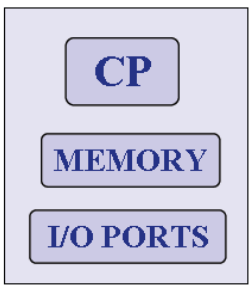
1.1 Lecture objectives: at the end of this lecture the student will able to:

- **Define the microprocessor and microcontroller and find differences between them.**
- **Define the microprocessor in general.**
- **Determine the application of microprocessor.**
- **Understand the architecture of microprocessor.**
- **Explain the applications of 8085 µP**

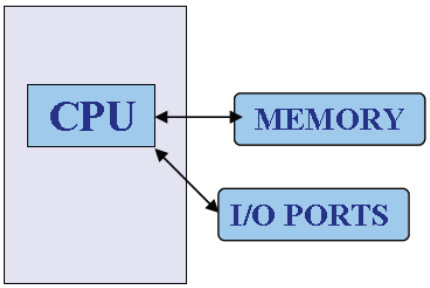
1.2 **A microprocessor (**µP) is a group of electronic circuits fabricated on a semiconductor chip using either **L**arge **S**cale **I**ntegrated circuit (**LSI)** or **V**ery **L**arge **S**cale **I**ntegrated circuit (**VLSI)** techniques that can read binary instructions written in a memory and process binary data according to those instructions. One or more microprocessors typically serve as a central processing unit (CPU) in a computer system or handheld device. Three basic characteristics differentiate microprocessors are instruction set, Bandwidth and Clock speed.

1.3 **A microcontroller**: A highly integrated chip that contains all the components comprising a controller. Typically this includes a CPU, RAM, some form of ROM, I/O ports, and timers. Unlike a general-purpose computer, which also includes all of these components, a microcontroller is designed for a very specific task - to control a particular system. A microcontroller is meant to be more self-contained and independent, and functions as a tiny, dedicated computer. The great advantage of microcontrollers, as opposed to using larger microprocessors, is that the parts-count and design costs of the item being controlled can be kept to a minimum.

Fig. (1.1) below simply show the difference between microprocessor and microcontroller. As shown in Fig. (1.1a), the microcontroller chip include memory block and I/P ports in additive to CPU, while the microprocessor chip include CPU only as shown in Fig(1.1b).



(a) microcontroller



(b) microprocessor

Figure (1.1): The difference between microprocessor and microcomputer.

1.4 8085 Microprocessor features

The salient features of 8085 µp are:

- It is a 8 bit microprocessor.
- It is manufactured with N-MOS technology.
- It has 16-bit address bus and hence can address up to 2^{16} = 65536 bytes (64KB) memory locations through A^0-A^{15}.
- The first 8 lines of address bus and 8 lines of data bus are multiplexed $AD^0 – AD^7$.
- Data bus is a group of 8 lines $D^0 – D^7$.
- It supports external interrupt request.
- A 16 bit program counter (PC).
- A 16 bit stack pointer (SP).
- Six 8-bit general purpose register arranged in pairs: BC, DE, HL.
- It requires a signal +5V power supply and operates at 3.2 MHZ single phase clock.
- It is enclosed with 40 pins DIP (Dual in line package).

1.5 8085 Microprocessor architecture :

In general, the microprocessor system contains from two basic parts are hardware and software. The hardware of 8085 µp included three parts are registers group, ALU and control unit, see Fig. (1.2).

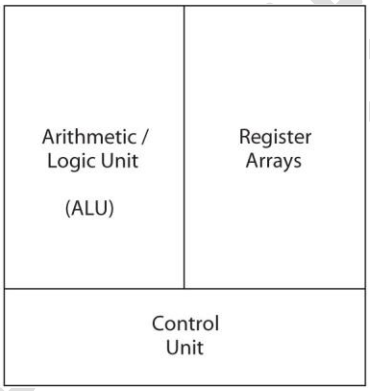


Figure 1.2: 8085 µp hardware parts.

1.5.1 Group of Register:

there are two types of registers in 8085 microprocessor as shown below:

a- **General Purpose Register**: GPRs are six (8-bit) registers used to store data temporarily during execution of programs, these registers are (B, C, D, E, H, and L) .

a.1 8-bit B and 8-bit C registers can be used as one 16-bit BC register pair. When used as a pair the C register contains low-order byte. Some instructions may use BC register as a data pointer.

a.2 8-bit D and 8-bit E registers can be used as one 16-bit DE register pair. When used as pair the E register contains low-order byte. Some instructions may use DE register as a data pointer.

b- **Special Purpose Register**: SPRs are used to achieve special task as shown below:

b.1 Accumulator(A): Accumulator is an 8-bit register which used as part of the Arithmetic/Logic unit (ALU) to perform arithmetic and logic operations and the results of these operation stored in accumulator. Some times the accumulator used as general purpose register to temporarily storage.

b.2 Flag Register(F): Flag register is an 8-bit register used to indicate the status of five flags after execute the arithmetic or logic operation. The distribution of flags on flag register is shown in fig.2 below:

F7	F6	F5	F4	F3	F2	F1	F0
S	**Z**	**X**	**AC**	**X**	**P**	**X**	**CY**

Figure2: flags position on flag register

a) CY: carry flag where is one if found carry from MSB and zero if no carry from MSB of the arithmetic or logic operation.

b) P: parity flag where is one if the parity of result of arithmetic and logic operation is even and zero if parity of arithmetic and logic operation is odd.

c) AC: auxiliary carry flag where is one if carry found from fourth bit **F3** and zero if no carry from **F3** of the arithmetic or logic operation.

d) Z: zero flag where is one if the result of arithmetic and logic operation is zero and zero if any result found.

e) S: sign flag where is one if the seventh bit (**F7**) of arithmetic and logic operation is one and zero if the seventh bit (**F7**) of arithmetic and logic operation is zero.

b.3 Stack Pointer (SP): the stack pointer is 16-bit register used to point to the memory locations called **stack**. Some times this register used as general purpose register. The stack memory is part of overall R/W memory used with subroutine and push instruction and addressed by stack pointer.

b.4 Program counter (PC): PC is 16-bit register used to addressing the memory locations which loaded with codes of program, on the other hand used to sequence the execution of instructions.

b.5 Instruction Register/Decoder : Temporary store for the current instruction of a program. Latest instruction sent here from memory prior to execution. Decoder then takes instruction and „decodes" or interprets the instruction. Decoded instruction then passed to next stage.

1.5.2 Arithmetic/Logic Unit (ALU): this unit is part of microprocessor contain from digital circuits which used to execute the arithmetic and logic operation of data that stored in general purpose register or directly data. The result of most arithmetic and logic operation are saved in accumulator.

1.5.3 Control Unit: this part of microprocessor is responsible of provides the necessary timing and control signals which organize flow of data between the microprocessor and memory or peripherals devices. Several signals are provide by this unit as shown below:

a) Reset out: to reset all units coupled to microprocessor.
b) Reset In: to reset all parts of microprocessor.
c) Hold and HLDA: to arrange transfer of data in case of DMA mode.

d) IO/$\overline{M}$: to determine if the communicate operation is between microprocessor and memory or IO devices.

e) ALE : to activate the (AD0 AD7)pins as address lines .

f) $\overline{WR}$: to write data on memory or IO devices.

g) $\overline{RD}$: to read data from memory or IO devices.

h) Ready: indicate that the microprocessor is available to transfer data or not.

i) Clock Out: to synchronize all units coupled to microprocessor.

Fig. 1.3 show the details of 8085 microprocessor hardware parts.

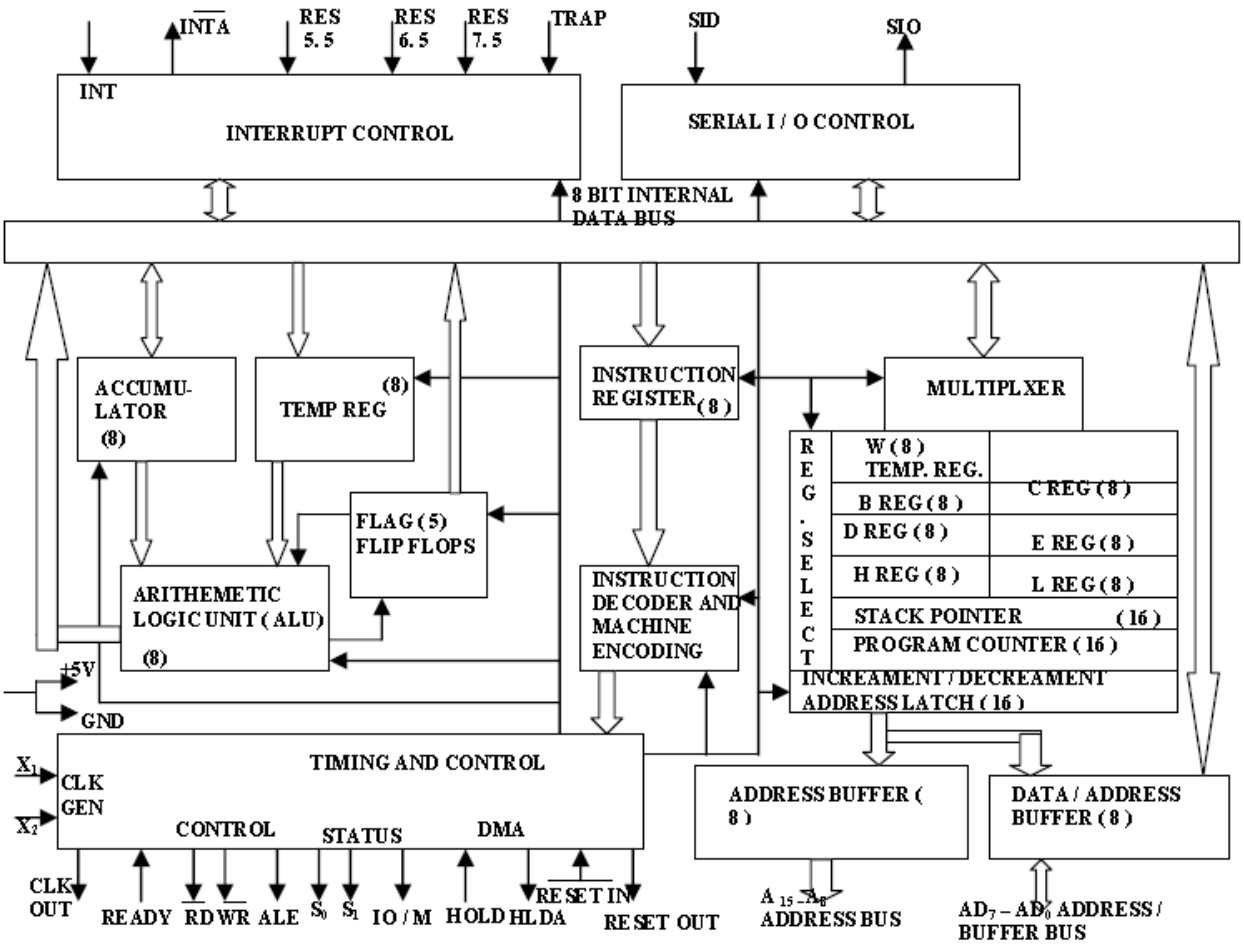


Figure 1.3: The block diagram of 8085 microprocessor hardware details.

1.6 Application of Microprocessor

Microprocessor has applications in several fields as shown below:

1-Home
2-Automotive
3-Communication/ Telecom
4-Medical
5-Office

6-Transport
7-Railways
8-Retail
9-Energy / Power
10-Industrial
11-Defence, Space, Aerospace

Home work:

Q1/ Give at least one example to each one of application of microprocessor.

Q2/ Write the contents of flag register after execute the following operation $(AC)_{16} + (3B)_{16}$.