Microprocessor Architecture and its Operation

Computer system consist primary of:-

1- Microprocessor.

2- Memory.

3- Input.

4- Output.

The internal logic design of the microprocessor called its "architecture", determine how and what various operations are performed by "µp".

*****Microprocessor architecture and its operations:-

The microprocessor is programmable logic device designed with register, flip-flop and timing elements.

All function performed by microprocessor can be classified in three general categories:-

1- Microprocessor initiated operations.

2- Internal data operations.

3- Peripheral (or externally) initiated operations.

To performed these operations, microprocessor needs [logic circuit and control signals].

1- µp Initiated Operations:-

Primarily microprocessor performs **four** operations:-

a) Memory read (Reads data from memory).

b) Memory writes (Write data into memory).

c) I/O read (Accept data from input device).

d) I/O writes (Sends data to output device).

***** These operation are part of communication process.

The microprocessor needs to perform the following steps:-

1- Identify the peripheral (memory location).

2- Transfer data.

3- Provide timing or synchronization signals.

Microprocessor performed these functions using sets of buses **[Data bus, Address bus, Control bus].**

The 8085 represents the first generation of microprocessor chips. It is an 8 bit micro with 8 bit data bus, 16 bit address bus and a 6 bit control bus. As shown in Figure 3

1- Data bus: - is used for the transfer of information between the microchip and the rest of the system. It is a group of 8 lines used for data flow, these lines are bidirectional from (00 – FF) $=2^8$ =256 numbers.

*****The largest number = 1111 1111 = FF, thus 8085 µp is called 8 bit µp.

2- Address bus: - is used for addressing the required place of memory. It is a group of 16 lines, identified as *A*0 - *A*15. This bus is unidirectional (bit flow in one direction) from µp to peripheral.

*****Each memory location or peripheral identified with binary number called address. Since the address bus is a 16 bit, then the maximum size of memory is $(2)^{16}$=64K byte of memory.

3- Control bus: - **the control is comprised of various single lines that carry synchronization signals.** It is composed of six signals to control the (Read/Write) of memory and (I/O) selection.

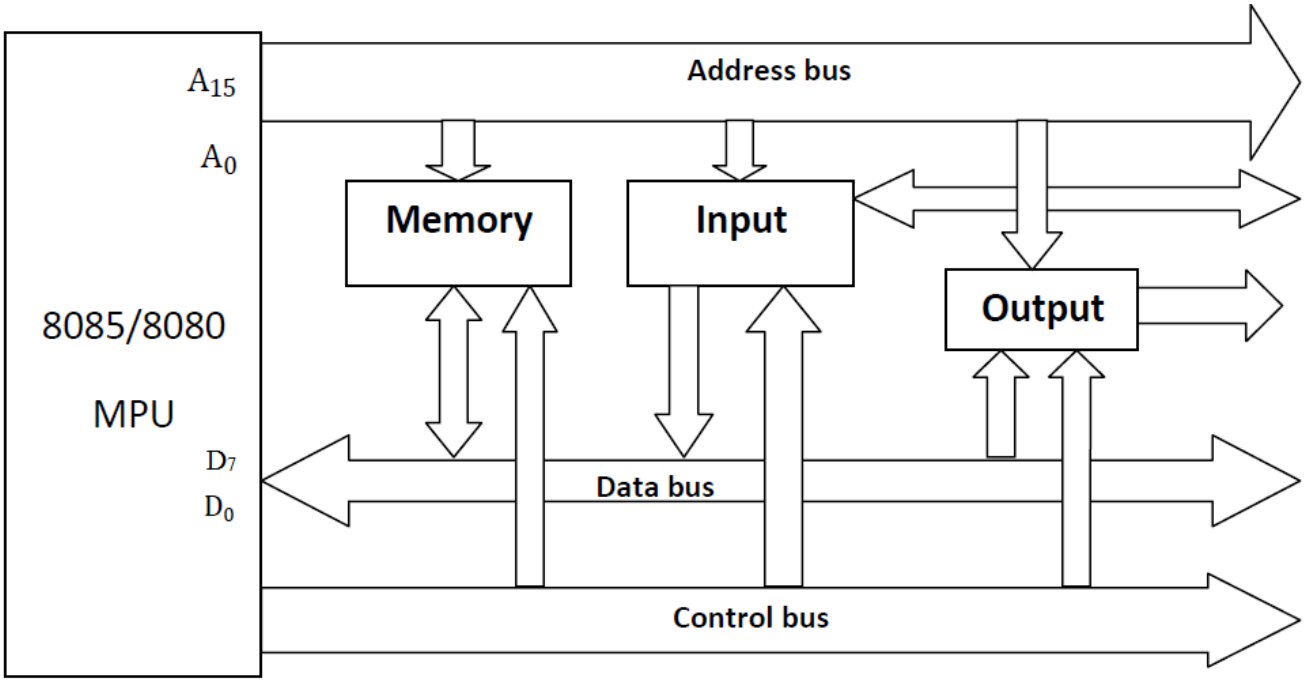

Figure (3): The 8085 Bus Structure

To communicate with a memory, for example to read instruction from memory location:-

1- µp placed 16-bit address on address bus.

2- The address on the bus is decoded by an external logic circuit.

3- The memory location is identified.

4- The µp sends a pulse called memory read as control signal.

5- The pulse activates the memory chip.

6- The contents of the memory location (8-bit data) are placed on the data bus as shown in figure. (4).

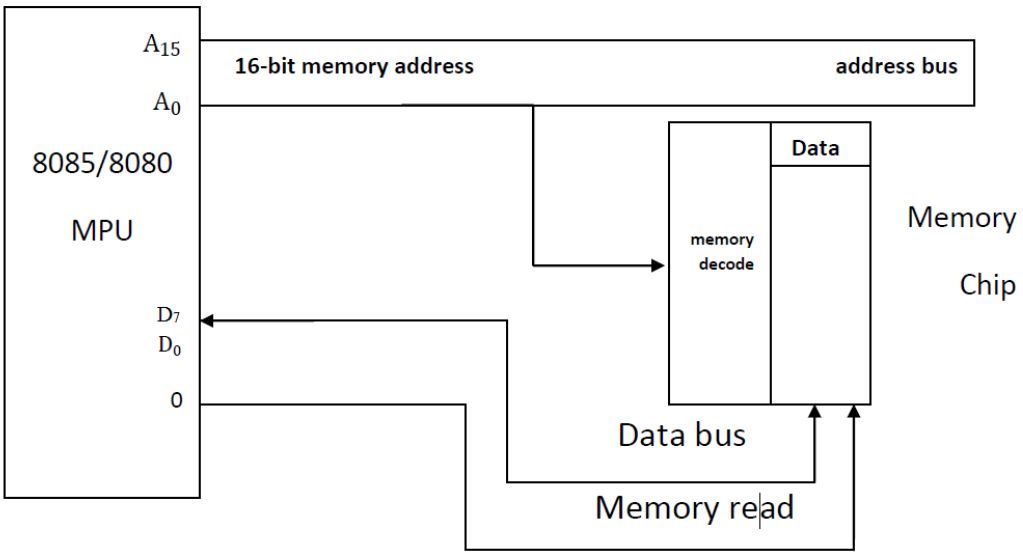

Figure (4): Memory Read Operation

Internal Data Operations:-

The internal architecture of the 8085/8080A microprocessor determines how and what operation can be performed with the data.

These operations are:-

1- Store 8-bit data.

2- Performed arithmetic and logical operations.

3- Test for conditions.

4- Sequence the execution of instructions.

5- Store data temporarily during execution in the defined R/W memory locations called the **stack**.

***To perform these operations the µp requires:-**

a) Registers.

b) An arithmetic and logic unit (ALU) & control logic.

c) Internal buses (paths for information flow).

Internally the 8085 chip contain:- (as shown in Figure 5)

A) Registers:-

The 8085 has 6 general purpose registers to perform its operation (store 8-bit data during program execution) these are: - **(B, C, D, E, H & L)**

General purpose registers can be combined as register pairs – BC, DE, and HL – to perform some 16-bit operations. For register pair BC, register C can be determined as the low register and register B as the high. So that registers (D and E) and registers (H and L).

B) Accumulator:-

8-bit register, used as part of all arithmetic and logic operations performed by the microprocessor. The result of most operations is stored in the accumulator.

C) Flag Register:-

The flag is an 8 bit register, but utilizing only five of the bits namely: zero, sign, carry, parity, and auxiliary carry.

The Processor Status Word (PSW), is another 16 bit register which comprises the accumulator and the flag register (PSW: high byte=A, Low byte=Flag register).

D) Program Counters (PC):-

This 16-bit register used in sequencing the execution of instructions, this register is memory pointer. The µp uses this register to sequence the execution of the instruction. The function of the program counter is to point to the memory address for which the next byte is to be fetched.

E) Stack Pointer (SP):-

This 16-bit register used as memory pointer, it point to memory location in R/W memory **called** (the stack), the beginning of the stack is defined by loading 16-bit address in stack pointer (register).

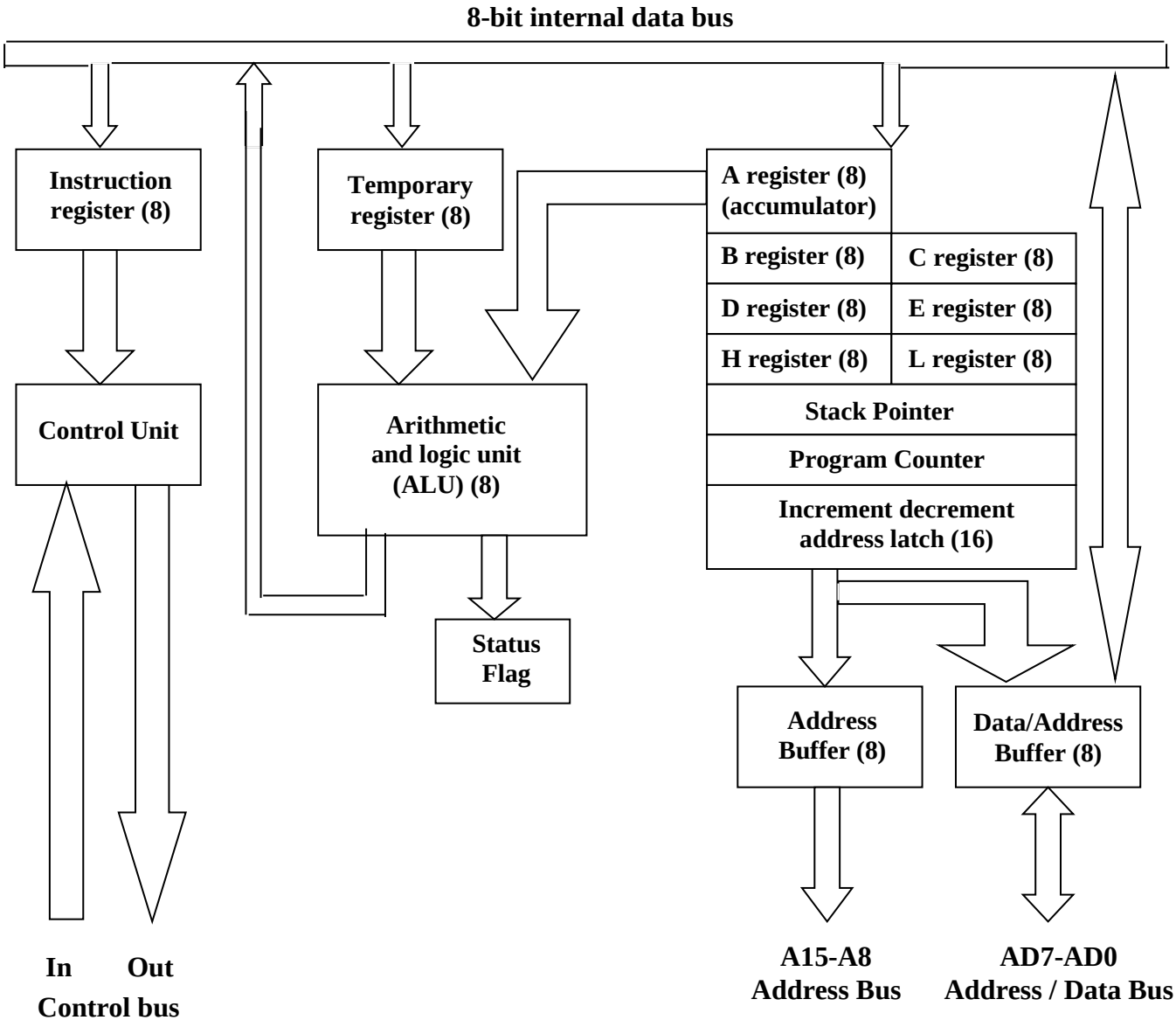

Figure (5): The Intel 8085 Microprocessor

The flag register is affected by the result of arithmetic and logical operations only. The **structure of flag register** is as follow:

S (Sign flag):

This bit is set (logic 1) if the most significant bit of the result of an operation is "1" otherwise it is reset (logic 0).

Z (Zero flag):

This bit is set if the content of the accumulator after an operation is zero, otherwise it is reset.

CY (Carry flag):

This bit is set if an operation causes carry or borrow out of the most significant bit of the accumulator.

AC (Auxiliary Carry):

This bit is set if there is a carry between the fourth and fifth bits of the accumulator.

P (Parity flag):

This bit is set if the number of ones in the accumulator is even, otherwise it is reset.

S	Z	X	AC	X	P	X	CY

Bit 7 **Bit 0**

X : Don't care

Flag register diagram

Peripheral or Externally Initiated Operations:-

External devices (or signals) can initiate the following operation for which individual pins on µp chip are assigned: **Reset, Interrupt, Ready, Hold.**

A) Reset: when reset is activated all internal operations are suspended and the program counter is cleared.

B) Interrupt: the µp can be interrupted from normal execution and asked to execute other instructions called **"service routine"** (emergency), µp resumes its operation after that.

C) Ready: 8085 has pin called ready, if the signal is low µp enters into wait state, this signal used to synchronized slower peripherals with µp.

D) Hold: when hold pin activated by external signal µp relinquishes control buses and allows the external peripheral to use them. For example: Hold signal is used in direct memory access data transfer