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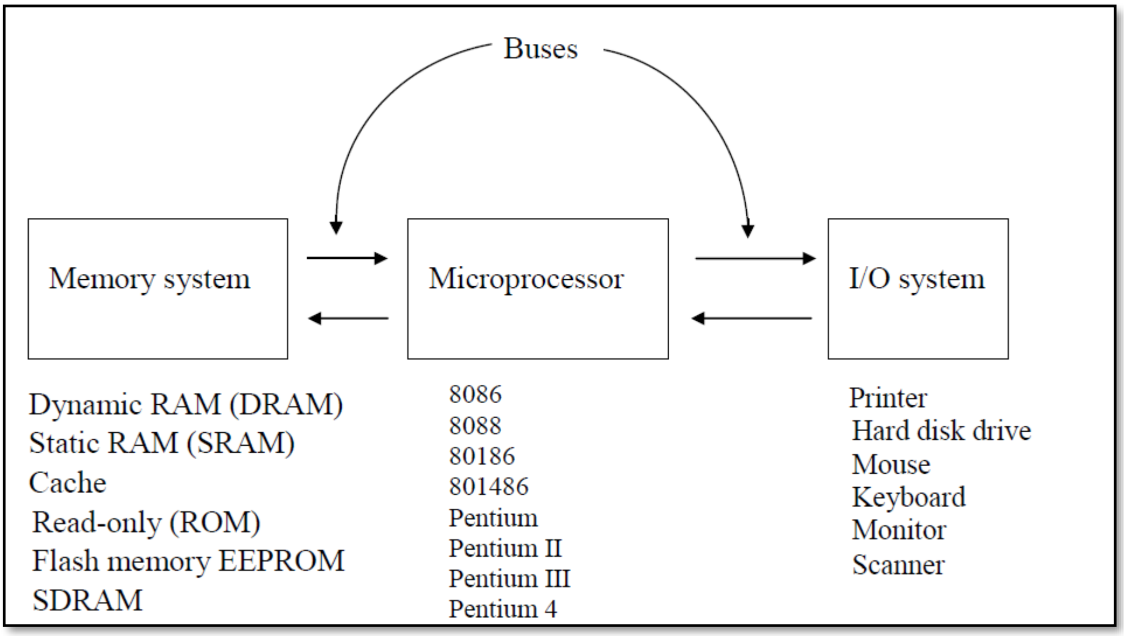
❖ The Microprocessor-based Personal Computer System

Figure below shows the block diagram of the personal computer. The block diagram is composed of four parts:



The Block Diagram of a Microprocessor-based Personal Computer System

✓ What is a Microprocessor?

• The word comes from the combination of micro and processor.

• Processor means a device that processes whatever. In this context processor means a device that processes numbers, specifically binary numbers, 0's and 1's.

• To process means to manipulate. It is a general term that describes all manipulation. It means to perform certain operations on the numbers that depend on the microprocessor's design. ***It is a programmable device that takes in numbers, performs on them arithmetic or logical operations according to the program stored in memory and then produces other numbers***.

✓ *As a Programmable device:*

The microprocessor can perform different sets of operations on the data it receives depending on the sequence of instructions supplied in the given program.

❖ Basic Concepts of Microprocessors

Differences between: Microcomputer, Microprocessor and Microcontroller.

– ***Microcomputer*** is a *computer* with a microprocessor as its CPU (microprocessor-based systems). In addition, it includes memory, I/O, etc.

– ***Microprocessor*** is a *silicon chip* which includes ALU, register circuits & control circuits.

– ***Microcontroller*** is a *silicon chip* which includes microprocessor, memory & I/O in a single package. This is a complete microprocessor-based control system built onto a single chip.

❖ MPU and CPU:

A **CPU** is a Central Processing Unit. This is the central 'brain' of a computer and can be (usually is) ***made from one or more microprocessors (Microprocessor Unit)***. The IBM design for the 'Blue Gene' supercomputer includes a million processors.
A CPU is a type of processor tasked with a variety of roles. A microprocessor is generally tasked with one specific task and does that one task exceedingly well. A CPU issues commands to microprocessors and in return the microprocessors send data to the CPU or other component as specified by the CPU. Microprocessors are tasked with executing specific and repeatable actions whereas a CPU is tasked with executing a wide and diverse range of tasks.

✓ The microprocessor performs three main tasks:

1- Data transfer between itself and the memory or I/O system.
2- Simple arithmetic and logic operations.
3- Program flow via simple decisions.

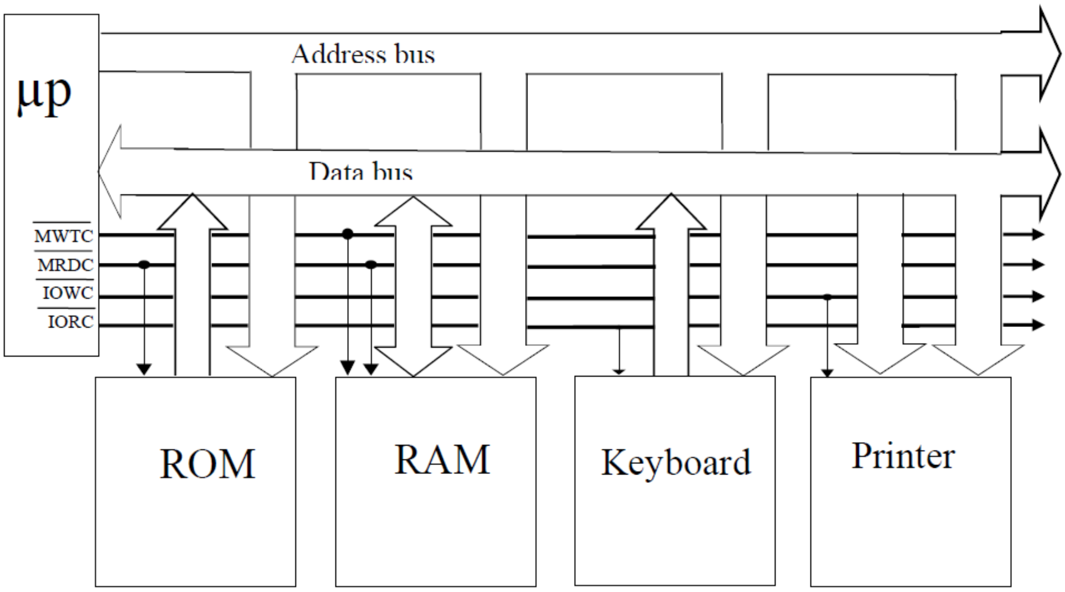
❖ <u>Buses:</u>

A bus is a number of wires organized to provide a means of communication among different elements in a microcomputer system. The figure below shows the buses of 8086 microprocessor, these buses are:

• **Address bus:** It is a group of wires or lines that are used to transfer the addresses of Memory or I/O devices. The address bus is **<u>unidirectional.</u>**

• **Data bus:** Data Bus is used to transfer data within Microprocessor and Memory/Input or Output devices. It is **<u>bidirectional</u>** as Microprocessor requires to send or receive data.

• **Control bus:** It contains lines that select the memory or I/O and cause them to perform a read or write operation.



The Bus Structure of 8086 Microprocessor

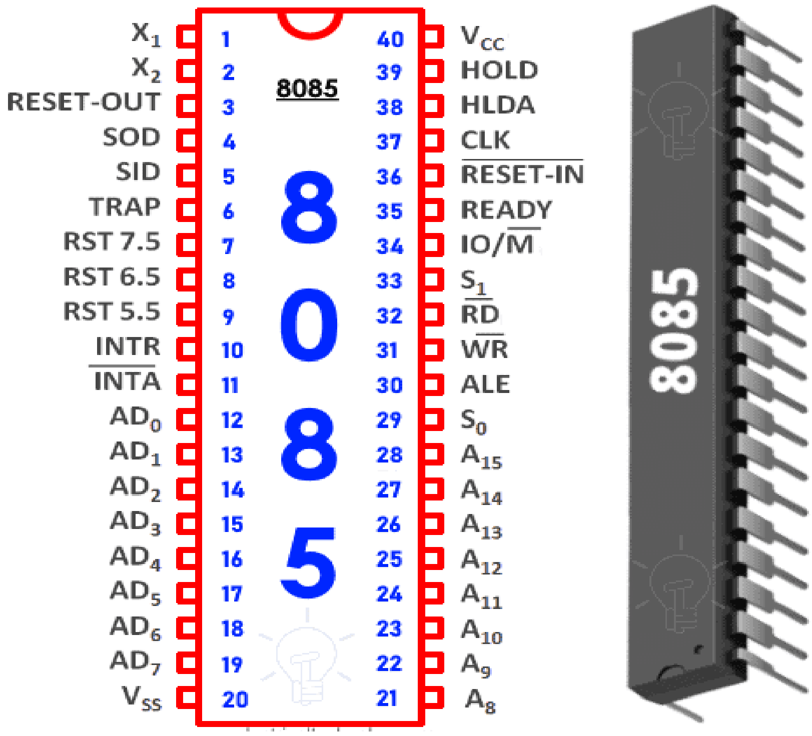
❖ 8085 Microprocessor Architecture

It is an 8-bit microprocessor produced by Intel and introduced in 1976 using NMOS (Negative-channel Metal-Oxide Semiconductor) technology, enclosed with 40 pins DIP (Dual In line Package). NMOS is a type of semiconductor that is negatively charges so that transistors are turned on or off by the movement of electrons.

❖ The main features of 8085 µp are:

1. It is a 8-bit microprocessor. Data bus is a group of 8 lines D0-D7.
2. It has 16-bit address bus and hence can address up to $\mathbf{2^{16}}$= 65536 bytes (64KB) memory actions through A0-A15.
3. The first 8 lines of address bus and 8 lines of data bus are multiplexed AD0-AD7.
4. It supports external interrupt request.
5. It has 16-bit program counter (PC) and 16-bit stack pointer (SP).
6. It has six 8-bit general purpose register arranged in pairs: B, C, D, E, H, L.

7. It requires a signal +5V power supply and operates at 3.2 MHZ single phase clock.



Intel 8085 Microprocessor Pin Configuration

❖ **The main functional components of 8085 microprocessor are as given below:**

1) Registers.
2) Arithmetic logic unit.
3) Address buffer.
4) Incrementer/Decrementer address latch.
5) Interrupt control.
6) Serial I/O control.
7) Timing and control circuitry.
8) Instructions decoder and machine cycle.

➢ Registers

S. No.	Name of the Register	Quantity	Capacity
1.	Accumulator (or) Register A	1	8-bit
2.	Temporary register	1	8-bit
3.	General purpose registers (B, C, D, E, H and L)	6	8-bit each
4.	Stack pointer (SP)	1	16-bit
5.	Program counter (PC)	1	16-bit
6.	Instruction register	1	8-bit
7.	Incrementer/Decrementer address latch	1	16-bit
8.	Status flags register	1	8-bit

1. Accumulator register

This 8-bit register is the most important one amongst all the registers of 8085. Any data input/output to/from the microprocessor takes place via the accumulator. It is generally used for temporary storage of data and for the placement of final result of arithmetic/logical operations. Accumulator (ACC or A) register is extensively used for arithmetic, logical, store and rotate operations.

2. Temporary data

Is an 8-bit temporary data register, which is not available to the programmer, but is used internally for execution of most of the arithmetic and logical operations.

3. General purpose registers

The general purpose registers of 8085 are: B, C, D, E, H and L. They are all 8-bit registers but can also be used as 16-bit register pairs BC, DE and HL.

4. Stack pointer (SP)

Is a 16-bit register which points to the stack (It is used as a memory pointer). The stack is a memory location in read/write memory.

5. Program counter (PC)

Is a 16-bit register which contains the address of the instruction to be executed just next. PC acts as an address pointer to the next instruction. As the processor executes instructions one after another, the PC is incremented. The number by which the PC increments depends on the nature of the instruction. For example, for a 1-byte instruction, PC is incremented by one, while for a 3-byte instruction, the processor increments PC by three address locations.

6. Instruction register (IR)

Program written by the programmer resides in the R/W memory. When an instruction is being executed by the system, the opcode of the instruction is fetched from the memory and stored in the instruction register (8-bit IR).

7. Incrementer/Decrementer address latch register

This 16-bit register increments/decrements the contents of PC or SP when instructions related to them are executed.

8. The (Status) flag register

It is an 8-bit register in which five-bit positions contain the status of five condition flags which are: *Zero (Z), Sign (S), Carry (CY), Parity (P) and Auxiliary carry (AC)*. Each of these five flags is 1-bit.

D7	D6	D5	D4	D3	D2	D1	D0
S	Z	X	AC	X	P	X	CY

HW: **Give the Flags for** $(7E)_{16} + (49)_{16}$

- **Arithmetic logic unit (ALU)**

The ALU functions as a part which includes arithmetic logic group of circuits. This includes accumulator, flags and temporary register blocks.

- **Address buffer:**

An 8-bit unidirectional buffer is used to buffer the higher order address bus (A8-A15). A bidirectional buffer can be used to drive the bidirectional data bus (D0-D7) after its demultiplexing. The contents of the stack pointer and program counter are loaded into the address buffer and address-data buffer.

- **Interrupt control:**

Sometimes it is necessary to interrupt the execution of the main program. For this, an interrupt request is sent from the I/O devices. After receiving the interrupt request, processor temporarily stops what it was doing and attends to the I/O device. After the work of the I/O device is complete, it returns to what it was doing earlier.

- **Serial I/O control:**

It allows 8085 to communicate serially with external devices

- **Timing and control circuitry:**

It is very important unit as it synchronizes the registers and flow of data through various registers and other units. It generates timing and control signals for execution of instructions. This section includes Clock signals, Control signals, Status signals, Direct Memory Access (DMA) signals, and the reset signals.

- **Instructions decoder and machine cycle encoder:**

It decodes the information's present in the Instruction Register for further processing.

❖ 8085 Memory Addressing and Data Transfer

There are several different types of memory. ***One is Program memory (ROM)***, this is where the program is located. ***Another is Data memory (RAM)***, this is where data (that might be used by the program) is located. Two terms used when talking about memory, ***Reading*** is getting a value from memory and ***Writing*** is putting a value into memory.

Busses associated with the memory subsystem, these busses transport data and addresses every where. In the 8085 microprocessor, **the address bus is 16-bits wide**. It acts to select one of the unique **2^{16} (64KB)** memory locations. The control bus determines whether this will be a read or a write.

The steps to communicate with memory can be summarized as follows:

1. The MPU places an 16-bit memory address on address bus.
2. The MPU sends a control signal (Read or Write) to load or store data.
3. Data are placed on the data bus for transfer.

The Program Counter is what holds the address when the microprocessor is executing instructions. Because of the automated program counter incrementation that occurs after fetching the current instruction, the instructions are read sequentially.

❖ 8085 I/O addressing and data transfer

8085 microprocessor uses two instructions (IN & OUT) for data transfer. MPU uses 8-address lines to send the address of I/O device (can identify 256 input devices / 256 output devices).

The steps in communicating with an I/O can be summarized as follows:

1. The MPU places an 8-bit device address on address bus.

2. The MPU sends a control signal (I/O Read or I/O Write) to enable the I/O device.

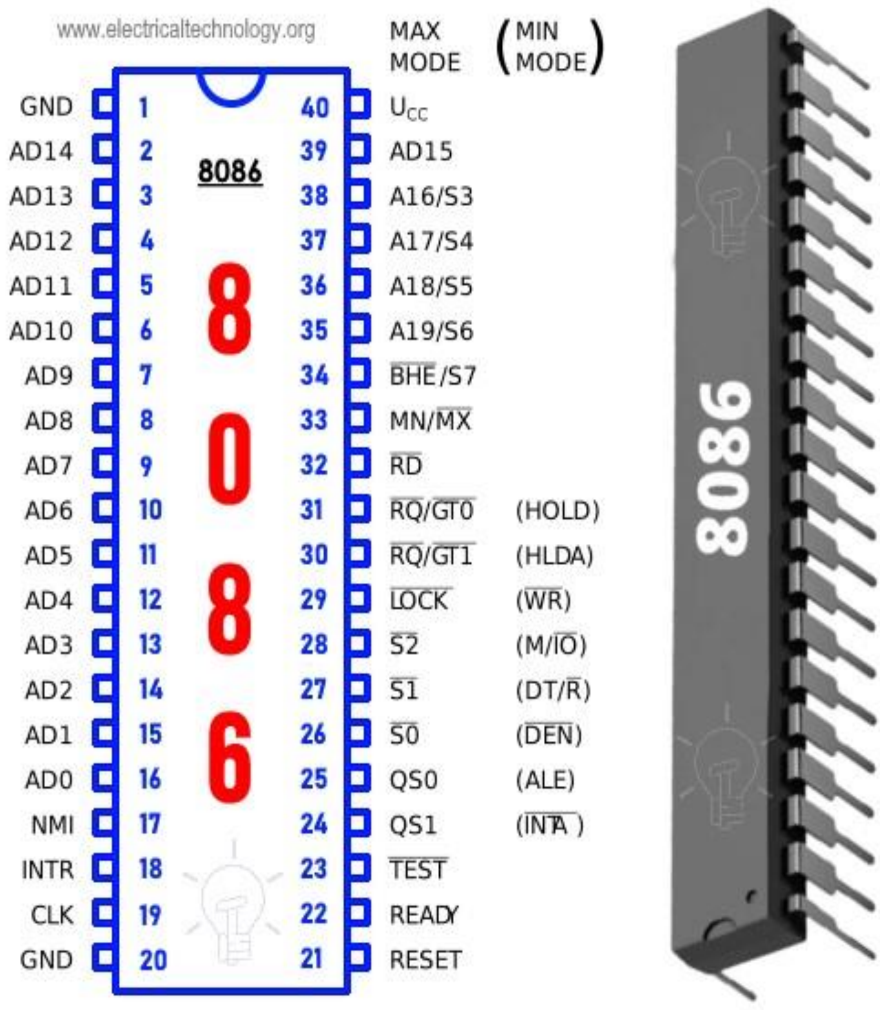
3. Data are placed on the data bus for transfer.

❖ 8086 Microprocessor Architecture

It is a 16-bit microprocessor produced by Intel using HMOS (High Performance Metal-Oxide Semiconductor) technology, It has approximately 29,000 transistors and housed in a 40-pin DIP package. It supports two modes of operation, ***Maximum mode and Minimum mode***.

Maximum mode is suitable for system having multiple processors and ***Minimum mode*** is suitable for system having a single processor. The main features of 8086 µp are:

1. It is a 16-bit microprocessor. Data bus is a group of 16 lines D0-D15.
2. 8086 µP has a 20-bit address bus can access up to 2^{20} memory locations (1 MB).
3. It has multiplexed address and data bus AD0-AD15.
4. It can support up to 64K I/O ports.
5. It provides 14 registers.
6. 8086 is designed to operate in two modes, Minimum and Maximum.
7. It can prefetches up to 6 instruction bytes from memory and queues them in order to speed up instruction execution.

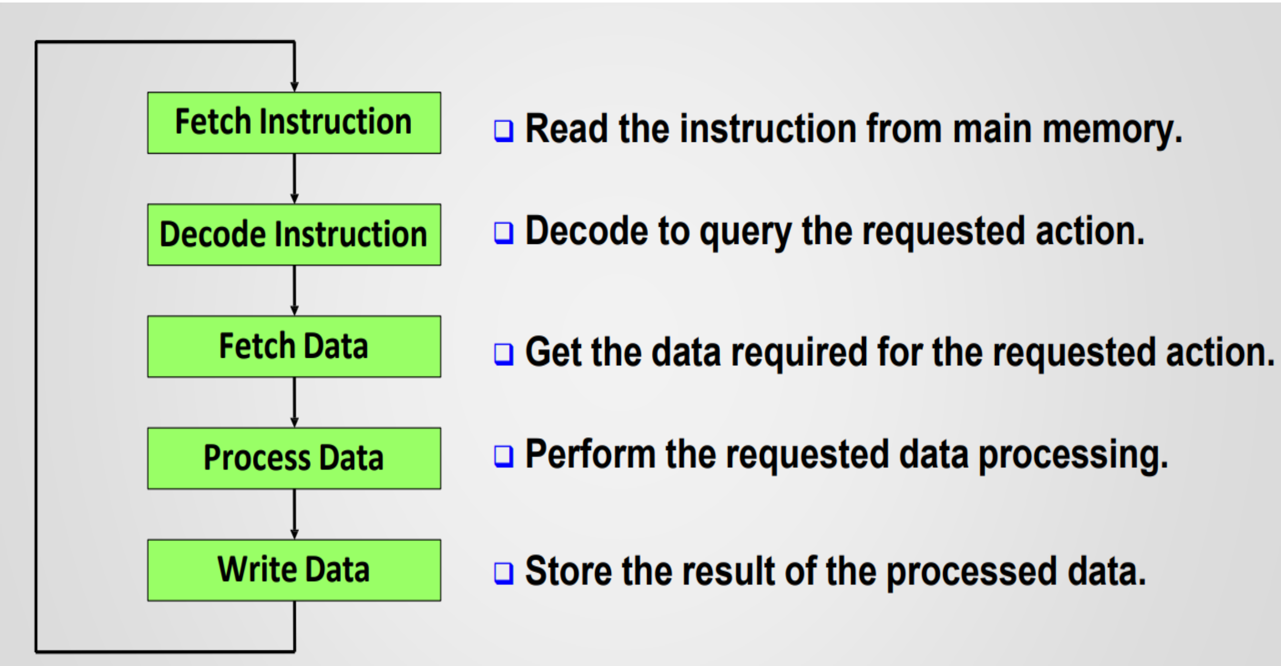


Intel 8086 Microprocessor Pin Configuration

❖ Comparison between 8085 and 8086 Microprocessor Architecture

8085 Microprocessor Architecture	8086 Microprocessor Architecture
1. 8085 is made of material (Negative-channel Metal-Oxide Semiconductor).	1. 8086 is made of material (High Performance Metal-Oxide Semiconductor).
2. It is a 8 bit microprocessor.	2. It is a 16 bit microprocessor.
3. Data bus is a group of 8 lines D0-D7.	3. Data bus is a group of 16 lines D0-D15.
4. It has 16-bit address bus and hence can address up to 2^{16} = 65536 bytes (64 KB) memory actions through A0-A15.	4. It has 20-bit address bus and hence can address up to 2^{20}= 1 MB memory locations through A0-A19.
5. It can support up to 256 I/O ports.	5. It can support up to 64K I/O ports.
6. It provides 8 registers.	6. It provides 14 registers.
7. 8085 is not designed to operate in two modes.	7. 8086 is designed to operate in two modes, Minimum and Maximum.

❖ Simple Instruction Cycle



❖ ***The execution of one instruction requires the following three steps to be performed by the CPU:***

1. Fetch the contents of the memory location pointed at by the PC. The content of this location are interpreted as an instruction to be executed.

Therefore, they are stored in the Instruction Register (IR). Symbolically, this can be written as:

IR ⟵ [[PC]]

2. Increment the contents PC by 1.

PC ⟵ [PC] + 1

3. Carry out the actions specified by the instruction stored in the IR.

Note: in cases where an instruction occupies more than one word, ***steps 1 and 2*** can be repeated as many times as necessary to fetch the complete instruction. These two steps are usually referred to as the ***fetch phase***, while ***step 3*** constitutes the execution phase.