What is a Microprocessor?

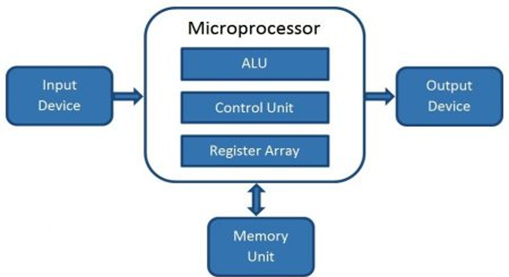
Computer's Central Processing Unit (CPU) built on a **single Integrated Circuit (IC)** is called a **microprocessor**.

A digital computer with one microprocessor which acts as a CPU is called microcomputer.

It is a programmable, multipurpose, clock -driven, register-based electronic device that reads binary instructions from a storage device called memory, accepts binary data as input and processes data according to those instructions and provides results as output.

The microprocessor contains millions of tiny components like transistors, registers, and diodes that work together.

Block Diagram of a Microcomputer



A microprocessor consists of an ALU, control unit and register array. Where **ALU** performs arithmetic and logical operations on the data received from an input device or memory. Control unit controls the instructions and flow of data within the computer. And, **register array** consists of registers identified by letters like B, C, D, E, H, L, and accumulator.

Evolution of Microprocessors

We can categorize the microprocessor according to the generations or according to the size of the microprocessor:

First Generation (4 - bit Microprocessors)

The first generation microprocessors were introduced in the year 1971-1972 by Intel Corporation. It was named **Intel 4004** since it was a 4-bit processor.

It was a processor on a single chip. It could perform simple arithmetic and logical operations such as addition, subtraction, Boolean OR and Boolean AND.

I had a control unit capable of performing control functions like fetching an instruction from storage memory, decoding it, and then generating control pulses to execute it.

Second Generation (8 - bit Microprocessor)

The second generation microprocessors were introduced in 1973 again by Intel. It was a first 8 - bit microprocessor which could perform arithmetic and logic operations on 8-bit words. It was Intel 8008, and another improved version was Intel 8088.

Third Generation (16 - bit Microprocessor)

The third generation microprocessors, introduced in 1978 were represented by **Intel's 8086, Zilog Z800 and 80286**, which were 16 - bit processors with a performance like minicomputers.

Fourth Generation (32 - bit Microprocessors)

Several different companies introduced the 32-bit microprocessors, but the most popular one is the **Intel 80386**.

Fifth Generation (64 - bit Microprocessors)

From 1995 to now we are in the fifth generation. After 80856, Intel came out with a new processor namely Pentium processor followed by **Pentium Pro CPU**, which allows multiple CPUs in a single system to achieve multiprocessing.

Other improved 64-bit processors are **Celeron, Dual, Quad, Octa Core processors**.

Table: Important Intel Microprocessors

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Microprocessor** | **Year of Invention** | **Word Length** | **Memory addressing Capacity** | **Pins** | **Clock** | **Remarks** |
| 4004 | 1971 | 4-bit | 1 KB | 16 | 750 KHz | First Microprocessor |
| 8085 | 1976 | 8-bit | 64 KB | 40 | 3-6 MHz | Popular 8-bit Microprocessor |
| 8086 | 1978 | 16-bit | 1MB | 40 | 5-8 MHz | Widely used in PC/XT |
| 80286 | 1982 | 16-bit | 16MB real, 4 GB virtual | 68 | 6-12.5 MHz | Widely used in PC/AT |
| 80386 | 1985 | 32-bit | 4GB real, 64TB virtual | 132 14X14 PGA | 20-33 MHz | Contains MMU on chip |
| 80486 | 1989 | 32-bit | 4GB real, 64TB virtual | 168 17X17 PGA | 25-100 MHz | Contains MMU, cache and FPU, 1.2 million transistors |
| Pentium | 1993 | 32-bit | 4GB real,32-bit address,64-bit data bus | 237 PGA | 60-200 | Contains 2 ALUs,2 Caches, FPU, 3.3 Million transistors, 3.3 V, 7.5 million transistors |
| Pentium Pro | 1995 | 32-bit | 64GB real, 36-bit address bus | 387 PGA | 150-200 MHz | It is a data flow processor. It contains second level cache also,3.3 V |
| Pentium II | 1997 | 32-bit | - | - | 233-400 MHz | All features Pentium pro plus MMX technology,3.3 V, 7.5 million transistors |
| Pentium III | 1999 | 32-bit | 64GB | 370 PGA | 600-1.3 MHz | Improved version of Pentium II; 70 new SIMD instructions |
| Pentium 4 | 2000 | 32-bit | 64GB | 423 PGA | 600-1.3 GHz | Improved version of Pentium III |
| Itanium | 2001 | 64-bit | 64 address lines | 423 PGA | 733 MHz-1.3 GHz | 64-bit EPIC Processor |

**Where,**

* **PGA** - Pin Grid Array
* **MMX** - MultiMedia eXtensions
* **EPIC** - Explicitly Parallel Instruction Computing
* **SIMD** - Single Instruction Multiple Data
* **ALU** - Arithmetic and Logic Unit
* **MMU** - Memory Management Unit
* **FPU** - Floating Point Unit

Basic Terms used in Microprocessor

Here is a list of some basic terms used in microprocessor:

**Instruction Set** - The group of commands that the microprocessor can understand is called Instruction set. It is an interface between hardware and software.

**Bus** - Set of conductors intended to transmit data, address or control information to different elements in a microprocessor. A microprocessor will have three types of buses, i.e., data bus, address bus, and control bus.

**IPC (Instructions Per Cycle)** - It is a measure of how many instructions a CPU is capable of executing in a single clock.

**Clock Speed** - It is the number of operations per second the processor can perform. It can be expressed in megahertz (MHz) or gigahertz (GHz). It is also called the Clock Rate.

**Bandwidth** - The number of bits processed in a single instruction is called Bandwidth.

**Word Length** - The number of bits the processor can process at a time is called the word length of the processor. 8-bit Microprocessor may process 8 -bit data at a time. The range of word length is from 4 bits to 64 bits depending upon the type of the microcomputer.

**Data Types** - The microprocessor supports multiple data type formats like binary, ASCII, signed and unsigned numbers.

Working of Microprocessor

The microprocessor follows a sequence to execute the instruction: Fetch, Decode, and then Execute.

Initially, the instructions are stored in the storage memory of the computer in sequential order. The microprocessor fetches those instructions from the stored area (memory), then decodes it and executes those instructions till STOP instruction is met. Then, it sends the result in binary form to the output port. Between these processes, the register stores the temporary data and ALU (Arithmetic and Logic Unit) performs the computing functions.

Features of Microprocessor

* **Low Cost** - Due to integrated circuit technology microprocessors are available at very low cost. It will reduce the cost of a computer system.
* **High Speed** - Due to the technology involved in it, the microprocessor can work at very high speed. It can execute millions of instructions per second.
* **Small Size** - A microprocessor is fabricated in a very less footprint due to very large scale and ultra large scale integration technology. Because of this, the size of the computer system is reduced.
* **Versatile** - The same chip can be used for several applications, therefore, microprocessors are versatile.
* **Low Power Consumption** - Microprocessors are using metal oxide semiconductor technology, which consumes less power.
* **Less Heat Generation** - Microprocessors uses semiconductor technology which will not emit much heat as compared to vacuum tube devices.
* **Reliable** - Since microprocessors use semiconductor technology, therefore, the failure rate is very less. Hence it is very reliable.
* **Portable** - Due to the small size and low power consumption microprocessors are portable.