



ZERO TO HERO [ACF & CP, DSA]

BY Biswajit Sahoo.



[CODEWISDOM ACADEMY]

CHAPTER 1

THE COMPUTER

A **computer** is an *electronic machine* that takes input from the user, processes the given input and generates output in the form of useful information. A computer accepts input in different forms such as *data*, *programs* and *user reply*.

- *Data* refer to the raw details that need to be processed to generate some useful information.
- *Programs* refer to the set of instructions that can be executed by the computer in sequential or non-sequential manner.
- *User reply* is the input provided by the user in response to a question asked by the computer.

The main task of a computer system is to process the given input of any type in an efficient manner. Therefore, computer is also known by various other names such as data processing unit, data processor and data processing system.

A computer includes various devices that function as an integrated system to perform several tasks described above. These devices are:

Central Processing Unit (CPU): It is the processor of the computer that is responsible for controlling and executing instructions in the computer. It is considered as the most significant component of the computer. It is the “brain” of the computer.

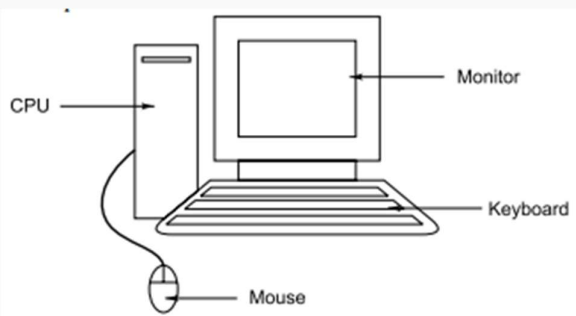


Fig. 1.1 The components of computer

Monitor: It is a screen, which displays information in visual form, after receiving the video signals from the computer.

Keyboard and Mouse: These are the devices, which are used by the computer, for receiving input from the user.

The characteristics and capabilities of a modern digital computer:

The unique capabilities and characteristics of a computer have made it very popular among its various users, including engineers, managers, accountants, teachers, students, etc. The characteristics and capabilities of a modern digital computer includes –

Speed: A computer is a fast electronic device that can solve large and complex problems in few seconds. The speed of a computer generally depends upon its hardware configuration.

Storage capacity: A computer can store huge amount of data in its different storage components in many different formats. The storage area of a computer system is generally divided into two categories, main memory and secondary storage.

Accuracy: A computer carries out calculations with great accuracy. The accuracy achieved by a computer depends upon its hardware configuration and the instructions.

Reliability: A computer produces results with no error. Most of the errors generated in the computer are human errors that are created by the user itself. Therefore, they are very trustworthy machines.

Versatility: Computers are versatile machines. They can perform many different tasks and can be used for many different purposes.

Diligence: Computers can perform repetitive calculations any number of times with the same accuracy. Computers do not suffer from human traits, such as tiredness, fatigue, lack of concentration, etc.

Although computers are highly reliable and versatile machines, they do possess certain limitations. Since computers are capable of doing only what they are instructed to do, any wrong instruction (or faulty logic) or any wrong

data may result in erroneous output. This is popularly known as “**Garbage-In, Garbage-Out**” (GIGO).

Computer is a dumb machine and therefore lacks “**common sense**”. Anything it does is a result of human instructions. It carries out instructions as long as it can understand them, no matter whether they are right or wrong.

Although computers can be instructed to make certain decisions based on mathematical or logical equations, they cannot make decisions in situations where qualitative considerations are involved (**No I.Q. & No Feelings**).

Evolution of Computers:

- Blaise Pascal invented the first *mechanical adding machine* in 1642
 - Baron Gottfried Wilhelm von Leibniz invented the first *calculator for multiplication* in 1671
 - *Keyboard machines* originated in the United States around 1880
 - Around 1880, Herman Hollerith came up with the concept of *punched cards* that were extensively used as input media until late 1970s
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- *Charles Babbage* is considered to be the father of modern digital computers
 - He designed “Difference Engine” in 1822
 - He designed a *fully automatic analytical engine* in 1842 for performing basic arithmetic functions
 - His efforts established a number of principles that are fundamental to the design of any digital computer

Some Well Known Early Computers:

- The Mark I Computer (1937-44)
- The Atanasoff-Berry Computer (1939-42)
- The Electronic Numerical Integrator And Calculator (ENIAC) (1943-46)
- The Electronic Discrete Variable Automatic Computer (EDVAC) (1946-52)
- The Electronic Delay Storage Automatic Calculator (EDSAC) (1947-49)
- Manchester Mark I (1948)
- The Universal Automatic Computer (UNIVAC) I (1951)
- IBM 701 (1952)
- IBM 650 (1953)

Generations of Computers:

Generation:

"**Generation**" refers to distinct phases of improvement in computing devices, leading to the development of smaller, cost-effective, faster, reliable, and productive computers over time.

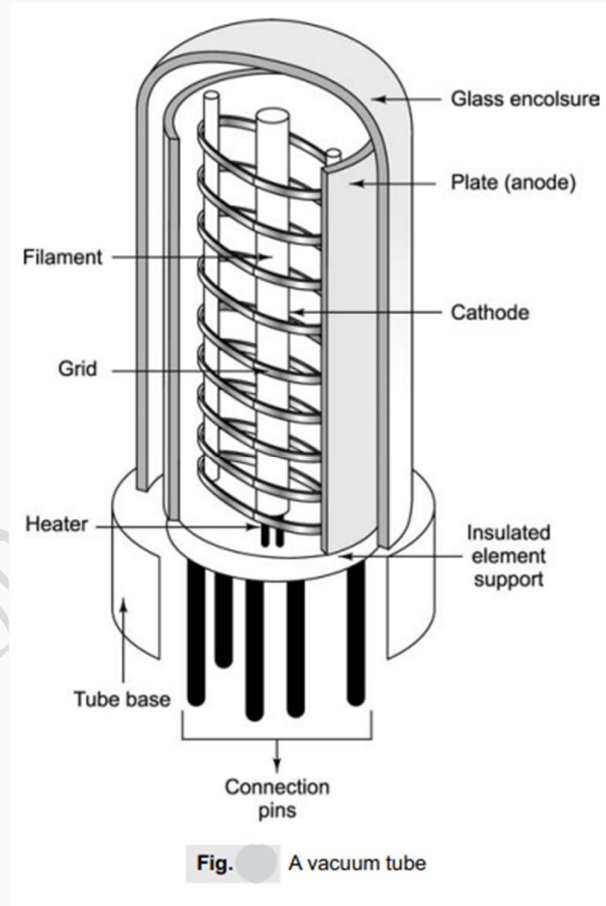
Over time, a progression of computing devices has emerged, each marking a distinct generation of technological advancement. These generations signify the evolving phases of improvement in both hardware and software technologies. The result has been the development of small, affordable, fast, reliable, and highly productive computers. The history of computers is often categorized into several key generations, each representing a significant leap forward in computational capabilities:

1. First generation computers
2. Second generation computers

3. Third generation computers
4. Fourth generation computers
5. Five generation computers

First Generation Computers:

The first generation computers were employed during the period 1940–1956. These computers used the *vacuum tubes* technology for calculation as well as for storage and control purposes. Therefore, these computers were also known as vacuum tubes or thermionic valves based machines. A vacuum tube is made up of glass and contains filaments inside it. The filaments when heated generate electrons, which eventually help in the amplification and de-amplification of electronic signals. The input and output medium for first generation computers was the punched card and printout respectively. Some examples of first generation computers are ENIAC, EDVAC, EDSAC and UNIVAC.



Major advantages of First generation computer systems:

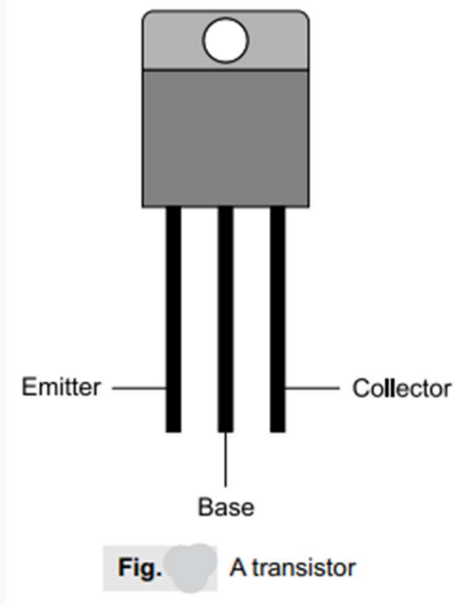
- These computers were the fastest computing devices of their time.
- These computers were able to execute complex mathematical problems in an efficient manner

Some of the disadvantages of First generation computers:

- The functioning of these computers depended on the machine language. A machine language is a language in which all the values are represented in the form of 0s and 1s. Therefore, these computers were not very easy to program.
- They were generally designed as special-purpose computers. Therefore, they were not very flexible in running different types of applications.
- The use of vacuum tube technology made these computers very large and bulky. Due to their large size, it was not an easy task to install them properly.
- They were not easily transferable from one place to another due to their huge size and also required to be placed in cool places.
- They were single tasking because they could execute only one program at a time and hence, were not very productive.
- They generated huge amount of heat and hence were prone to hardware faults. Hence, they were not considered as reliable and required proper maintenance at regular intervals.

Second Generation Computers:

The second generation computers were employed during the period 1956–1963. The main characteristic of these computers was the use of *transistors* in place of vacuum tubes in building the basic logic circuits. The transistor was invented by *Shockley, Brattain and Bardeen* in 1947 for which they won the *Nobel Prize*. A transistor is a *semiconductor* device that is used to increase the power of the incoming signals by preserving the shape of the original signal. It has three connections, which are emitter (E), base (B) and collector (C). The base of transistor is the gate through which the signal, needed to be amplified, is sent.



The signal sent through the base of the transistor is generally a small flow of electrons. Therefore, the base terminal also acts as the input gate for the transistor. The collector of the transistor is used to collect the amplified signal. The emitter of the transistor acts as the output gate for emitting the amplified signal to the external environment. The use of transistor technology helped in improving the performance of computers to a large extent. Transistor was a superior technology over vacuum tubes. Transistors used in second generation computers were smaller, faster, cheaper and generated less heat than that of vacuum tubes used in first generation computers. Transistors were also light weight electronic devices that required very less power during their operation. These characteristic features of transistors made the second generation computers smaller, faster, cheaper, more efficient, more productive and more reliable, as compared to the first generation computers. Printers, secondary storage and operating system technology were also invented during this era. However, these computers still relied on punched card and printout for carrying out their input/output operations. Another major technological development made to these computers was the replacement of the machine language with the assembly language. **Assembly language** is a low-level language that allows the programmer to use simple English words—called **mnemonics**—to represent different instructions in a program. Some examples of second generation computers are PDP-8, IBM 1401 and IBM 7090.

Major advantages of Second generation computer systems:

- They were the fastest computing devices of their time.
- They were easy to program because of the use of assembly language.
- They could be transferred from one place to other very easily because they were small and light weight computing devices.
- They required very less power in carrying out their operations.
- They were more reliable as compared to first generation computers and hence, did not require maintenance at regular intervals of time.

Some of the disadvantages of Second generation computers:

- The input and output media for these computers were not improved to a considerable extent.
- They were required to be placed in air-conditioned places.

- The cost of these computers was very high and they were beyond the reach of home users.
- They were special-purpose computers and could execute only specific applications.

Third Generation Computers:

The third generation computers were employed during the period 1964–1975. The major characteristic feature of third generation computer systems was the use of Integrated Circuits (ICs). The IC technology was also known as microelectronics technology. ICs are the circuits that combine various electronic components, such as

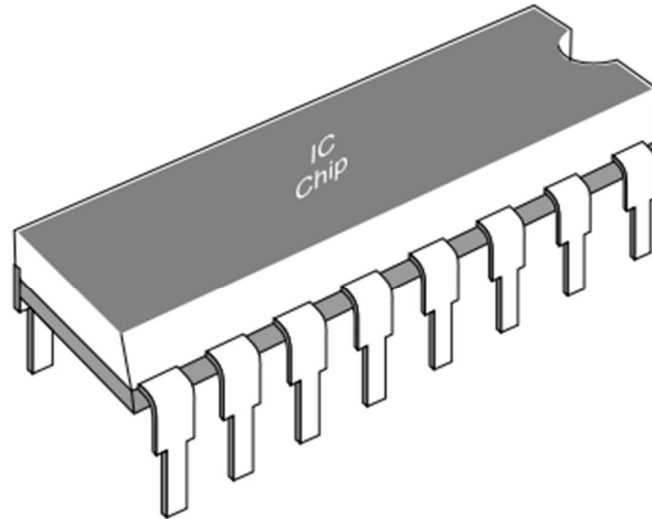


Fig. An integrated circuit

transistors, resistors, capacitors, etc. onto a single small silicon chip. The first IC was developed by Jack Kilby and Robert Noyce in the year 1958. ICs were superior to vacuum tubes and transistors in terms of cost and performance. The cost of ICs was very low and the performance was very high because all the electronic components were arranged very close to each other. They also required very low power for performing their operations. Therefore, the use of ICs in third generation computers made them smaller, faster, more efficient and more reliable than the first and second generation of computers. Some examples of third generation computers are NCR 395, B6500, IBM 370, PDP 11 and CDC 7600.

Major advantages of Third generation computer systems:

- They were the fastest computing devices as compared with first and second generation of computers. The computational time for these

computers was also reduced to great extent. The computational time for these computers was usually measured in nanoseconds.

- They were very productive because of their small computational time.
- They were easily transportable from one place to another because of their small size.
- They used high-level languages. A high-level language is a computer programming language that is independent of the machine details. Hence, the programmer finds it very easy to use them and the programs written in these languages on one computer can be easily executed on some other computer.
- They could be installed very easily and required less space for their installation.
- They were able to execute any type of application, such as business and scientific applications. Hence, the third generation computers were also considered as general-purpose computers.
- They were more reliable and required less frequent maintenance schedules.

Some of the disadvantages of Third generation computers:

- The storage capacity of these computers was still very small.
- The performance of these computers degraded while executing large applications, involving complex computations because of the small storage capacity.
- The cost of these computers was very high.
- They were still required to be placed in air-conditioned places.

Fourth Generation Computers:

The fourth generation computers were employed during 1975–1989. The invention of Large Scale Integration (LSI) technology and Very Large Scale Integration (VLSI) technology led to the development of fourth generation computers. However, these computers still used the IC technology to build the basic circuits. The LSI technology allowed thousands of transistors to be fitted onto one small silicon chip. On the other hand, the VLSI technology allowed hundreds of thousands of transistors to be fitted onto a single chip. As a result, the manufacturers were able to reduce the size of the computers and made

them cheaper as compared to the other generation of computers. The progress in LSI and VLSI technologies led to the development of microprocessor, which became the major characteristic feature of the fourth generation computers. A microprocessor incorporates various components of a computer—such as CPU, memory and Input/Output (I/O) controls—onto a single chip. The computers in this generation were designed to have a microprocessor,

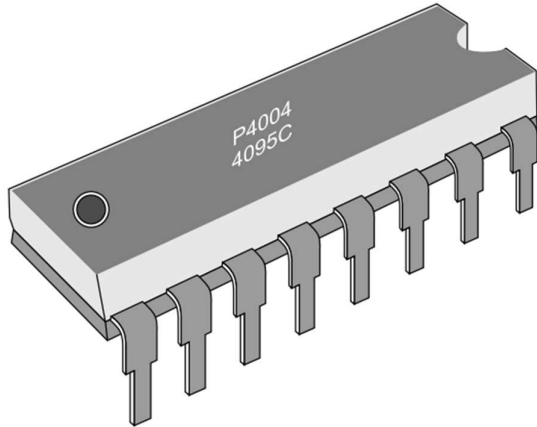


Fig. The Intel P4004 microprocessor chip

some additional storage chips and support circuitry. Figure shows the Intel P4004 microprocessor chip developed in 1971. Some popular later microprocessors include Intel 386, Intel 486 and Pentium. The term Personal Computer (PC) became known to the people during this era. The term PC refers to a computer that is designed to be used by an individual. Since the size and cost of the computer was decreased to a considerable extent in this period, people started using these computers for their personal work too. The storage technologies used in the fourth generation computers were also improved and they started using static and dynamic Random Access Memory (RAM). The advantage of using this type of memory was that it allowed the computers to access the stored information at a rapid pace and hence helped in increasing the productivity and performance of the computers. Some of the examples of fourth generation computers are IBM PC, IBM PC/AT, Apple and CRAY-1.

The use of LSI and VLSI technologies made the fourth generation computers small, cheap, compact and powerful. Apart from these technologies, the fourth generation also include the following developments:

- Development of Graphical User Interfaces (GUIs)
- Development of new operating systems
- Invention of various secondary storage and I/O devices
- Development of Local Area Network (LAN)

Major advantages of Fourth generation computer systems:

- The use of LSI, VLSI and semiconductor technologies made these computers very powerful in terms of their processing speed and access time.
- The storage capacity of these computers was very large and faster and hence they were very productive and highly optimised.
- They were highly reliable and required very less maintenance.
- They provided a user-friendly environment while working because of the development of GUIs and interactive I/O devices.
- The programs written on these computers were highly portable because of the use of high-level languages.
- They were very versatile and suitable for every type of applications.
- They required very less power to operate.

Some of the disadvantages of Fourth generation computers:

- The soldering of LSI and VLSI chips on the wiring board was not an easy task and required complicated technologies to bind these chips on the wiring board.
- The working of these computers is still dependent on the instructions given by the programmer.

Fifth Generation Computers:

The different types of modern digital computers come under the categories of fifth generation computers. The fifth generation computers are based on the Ultra Large Scale Integration (ULSI) technology that allows almost ten million electronic components to be fabricated on one small chip. The ULSI technology helps in increasing the power and speed of the microprocessor chips and the capacity of primary and secondary storage devices to a great extent. As a result, the fifth generation computers are faster, cheaper and more efficient, as compared to the fourth generation computers. Some of the improvements or developments made during this generation of computers are as follows:

- Development of various portable computers such as laptop, pocket computer, Personal Digital Assistant (PDA), etc.
- Development of Parallel Processors.

- Development of centralised computers called servers.
- Invention of optical disk technology.
- Invention of the Internet and its different services

Some of the advantages of Fifth generation computers are as follows:

- They are the fastest and powerful computers till date.
- They are able to execute a large number of applications at the same time and that too at a very high speed.
- The use of ULSI technology helps in decreasing the size of these computers to a large extent. Some of the fifth generation computers are so small in size that they can be used while traveling.
- The users of these computers find it very comfortable to use them because of the several additional multimedia features.
- They are versatile for communications and resource sharing.

The fifth generation computers are really enjoyed by their users because of the several advantages offered by them. However, the major disadvantage of the fifth generation computers is that they are not provided with an intelligent program that could guide them in performing different operations. Nowadays, scientists are making some serious efforts in this field and artificial intelligence and expert system applications are the results of these efforts.