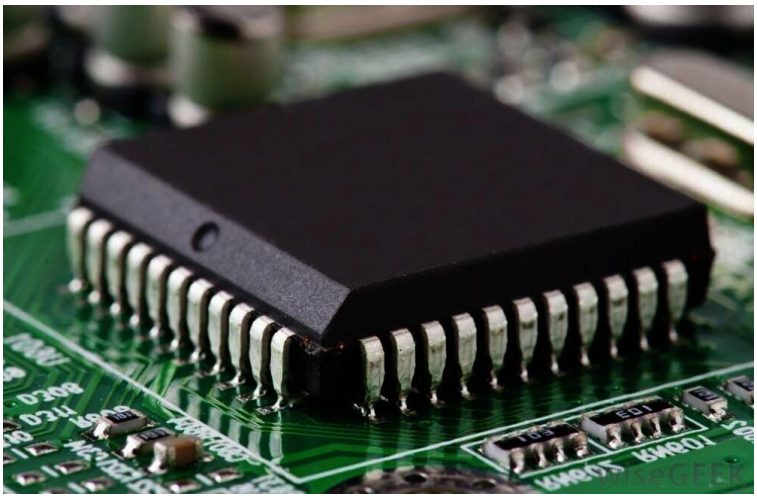
Integrated circuits

An **integrated circuit** *is one in which circuit components such as transistors, diodes, resistors, capacitors etc. are automatically part of a small semiconductor chip.*



- **In an *IC*, the various components are automatically part of a small semi-conductor chip and the individual components cannot be removed or replaced.**
- **The size of an *IC* is extremely small.**
- **No components of an *IC* are seen to project above the surface of the chip.**

Active components-- Active components are parts of a circuit that rely on an external power source to control or modify electrical signals,

- **Active components deliver power or energy to the circuit.**
- **Examples- Transistor, Diode, rectifier etc.**
- **Active components can control the flow of current.**
- **They are capable of providing power gain.**

<u>Passive components--</u> Passive components do not require any external source for the operations and utilize power or energy from the circuit.

- **Examples- Resistor, Capacitor, Inductor etc**
- **Passive components cannot control the flow of the current**
- **They are capable of providing power gain.**

What is Discrete Circuit?

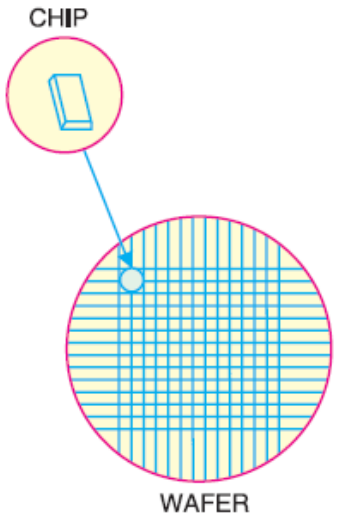
Refers to the type of circuit construction in which the components are manufactured separately. The component are connected using a conducting wires, breadboard or a printed circuit board (PCB). These components can be resistor, diodes, transistors and inductors.

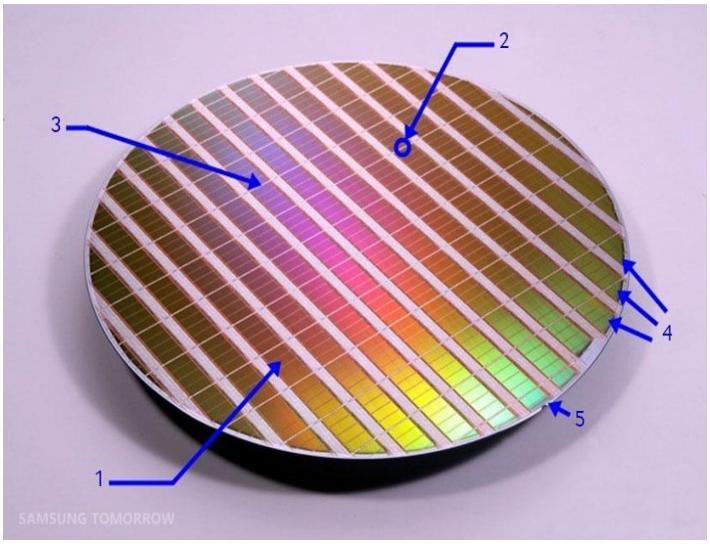
Disadvantages—

- **Assembling and Wiring**
- **Designing the Circuitry**
- **Replacement of failed components**
- **Less Reliability**

Wafer--

- **A wafer is a substrate or a thin slice of semiconductor material that's used in fabricating integrated circuits.**
- **Since wafers function as the base on which integrated circuits are embedded, they're considered the heart of electronic devices.**
- **Moreover, various substances are diffused and deposited into the wafers to construct microcircuits.**





Chips---

- **In practice, the wafer is divided into a large number of areas. Each of these areas will be a separate chip. The manufacturer produces hundreds of alike *ICs* on the wafer over each area.**
- **To separate the individual *ICs*, the wafer is divided into small chips by a process similar to glass cutting.**

Advantages of ICs

- **Increased reliability due to lesser number of connections.**
- **Extremely small size due to the fabrication of various circuit elements in a single chip of semi-conductor material.**
- **Lesser weight and space requirement due to miniaturized circuit.**
- **Low power requirements.**
- **Greater ability to operate at extreme values of temperature**
- **Low cost because of simultaneous production of hundreds of alike circuits on a small semiconductor wafer.**

Disadvantages

- **If any component in an *IC* goes out of order, the whole *IC* has to be replaced by the new one.**
- **In an *IC*, it is neither convenient nor economical to fabricate capacitances exceeding 30 *pF*. Therefore, for high values of capacitance, discrete components exterior to *IC* chip are connected.**
- **It is not possible to fabricate inductors and transformers on the surface of semi-conductor chip. Therefore, these components are connected exterior to the semi-conductor chip.**
- **It is not possible to produce high power *ICs* (greater than 10 W).**

Scale of integration

An *IC* chip may contain as large as 100,000 semiconductor devices or other components. The relative number of these components within the chip is given by referring to its scale of integration.

Scale of integration	Abbreviation	Number of components
Small	*SSI	1 to 20
Medium	MSI	20 to 100
Large	LSI	100 to 1000
Very large	VLSI	1000 to 10,000
Super large	SLSI	10,000 to 100,000

Classification of ICs

Analog IC----

Analog ICs work by processing continuous signals i.e. analog signal.

Examples- OP-AMP (Operational Amplifier), NE 555 Timers and Sensors.

These types of ICs are used for amplification, filtering, modulation, demodulation etc

Digital ICs

These types of ICs work on the basic digital system i.e. two defined level which is 0's and 1's (in other words, Low and High or ON and OFF respectively).

Examples--- Microprocessor and Micro controller is the example of Digital ICs which contains of million of flip flops and logic gates

Classification of ICs depending upon fabrication process

Thin and Thick ICs:

- **In thin or thick film ICs, passive components such as resistors, capacitors are integrated but the diodes and transistors are connected as separate components to form a single and a complete circuit.**
- **Thick and thin ICs have similar characteristics, similar appearance except the method of film deposition. Method of deposition of films distinguished Thin ICs from Thick ICs.**
- **Thin film ICs are made by depositing films of a conducting material on a glass surface or on a ceramic base. By varying the thickness of the films deposited on the materials having different resistivity, Passive electronic components like resistors and capacitors can be manufactured.**

Monolithic IC—

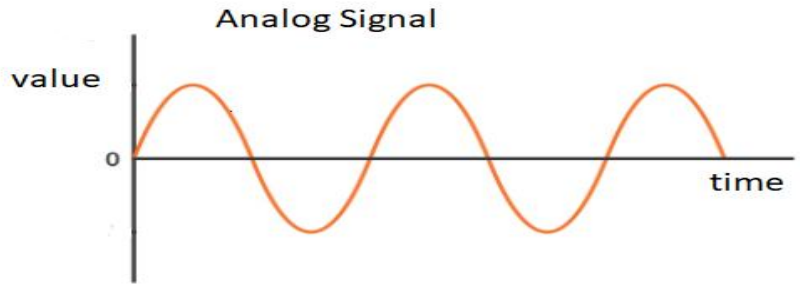
- **The word monolithic is actually derived from two Greek words "mono" meaning one or single and Lithos meaning stone. Thus monolithic circuit is a circuit that is built into a single crystal.**
- **In monolithic ICs, the discrete components, the active and the passive and also the interconnections between then are formed on a silicon chip.**
- **Monolithic ICs are the most common types ICs in use today. Its cost of production is cheap and is reliable.**
- **Example—OPAMP (IC741)**

Hybrid multi chips IC—

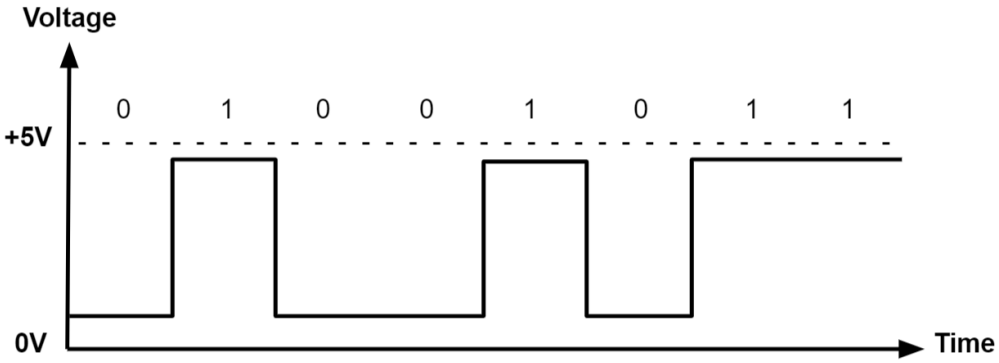
- **As the name implies, "Multi", more than one individual chips are interconnected.**
- **Hybrid ICs are widely used for high power-amplifier applications from 5W to more than 50W. Its performance is better than that of monolithic ICs.**

Digital circuits

- **A continuously varying signal (voltage or current) is called an *analog signal*.**
- **Example-Sine wave**



- **A signal (voltage or current) which can have only two discrete values is called a *digital signal*.**
- **Example-Square wave**



- **An electronic circuit that handles only a digital signal is called a digital circuit.**
- **The branch of electronics which deals with digital circuits is called *digital electronics.***
- **The output voltage of a digital circuit is either low or high and no other value. In other words, digital operation is a two-state operation. These states are expressed as (*High* or *Low*) or (*ON* or *OFF*) or (1 or 0). Therefore, a digital circuit is one that expresses the values in digits 1's or 0's. Hence the name digital.**
- **The numbering concept that uses only the two digits 1 and 0 is the *binary numbering system.***

Factors	Analog	Digital
Waves	Denoted by Sine waves	Denoted by Square waves
Signal	Continuous signal representing physical measurements	Discrete signal representing discrete time signals generated by digital modulation
Data Transmission	Subject to deterioration by noise	Noise-immune without deterioration
Bandwidth	Consumes less bandwidth	Consumes more bandwidth
Memory	Stored in the form of wave signal	Stored in the form of binary bit
Power	Draws large power	Draws negligible power
Impedance	Low impedance	High order of 100 megaohm
Errors	Analog instruments have considerable observational errors	Digital instruments are free from observational errors