

Introduction

- WHAT IS INTEGRATED CIRCUITS ?
- A complex set of electronic components and their interconnections that are imprinted onto a tiny slice of semiconducting material.
- Integrated Circuits are usually called ICs or chips.



Integrated circuits were made possible by experimental discoveries which showed that semiconductor devices could perform the functions of vacuum tubes and by mid-20th-century technology advancements in semiconductor device fabrication.



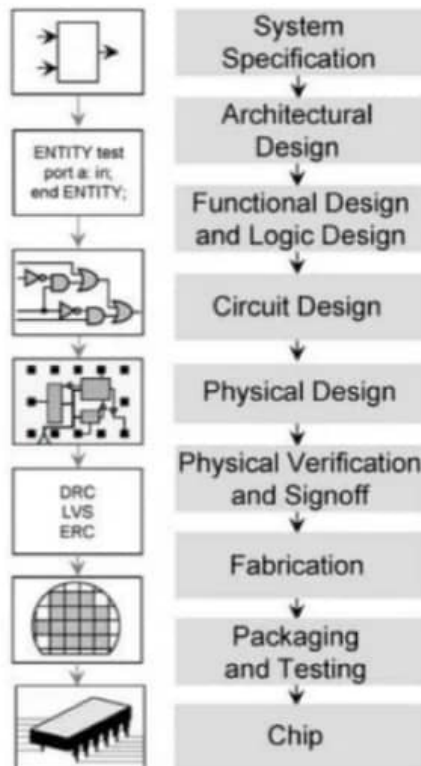
- The integration of large numbers of tiny transistors into a small chip was an enormous improvement over the manual assembly of circuits using electronic components.
- The integrated circuit's mass production capability, reliability, and building-block approach to circuit design ensured the rapid adoption of standardized ICs in place of designs using discrete transistors.



History of ic

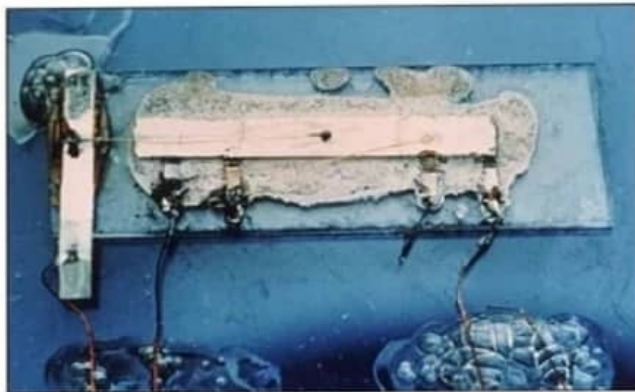
- ✓ An IC also referred as chip or micro chip is a set of electronic circuits on one small chip of semiconductor material, normally silicon.
- ✓ This can be made much smaller than a discrete circuit made from independent electronic components.
IC's can be made very compact having up to several billion transistors and other electronic components in an area the size of a fingernail.
- ✓ The width of each conducting line in a circuit can be made smaller and smaller as a technology advances; in 2008 it dropped below 100 nanometers and has now been reduced to tens of nanometers.

Structure of IC



1958 - Integrated circuit invented

- September 12th 1958 Jack Kilby at Texas instrument had built a simple oscillator IC with five integrated components (resistors, capacitors, distributed capacitors and transistors)
- In 2000 the importance of the IC was recognized when Kilby shared the Nobel prize in physics with two others. Kilby was sited by the Nobel committee *"for his part in the invention of the integrated circuit"*



IC Types

- In the early days of integrated circuits, only a few transistors could be placed on a chip, as the scale used was large because of the contemporary technology, and manufacturing yields were low as compared with today's standards.
- As the degree of integration was small, the design was done easily.
- Over time, millions, and today billions, of transistors could be placed on one chip, and to make a good design became a task to be planned thoroughly. This gave rise to new design methods.

Integrated circuits are often classified by the number of transistors and other electronic components they contain:

- **SSI (small-scale integration):** Up to 100 electronic components per chip
- **MSI (medium-scale integration):** From 100 to 3,000 electronic components per chip
- **LSI (large-scale integration):** From 3,000 to 100,000 electronic components per chip
- **VLSI (very large-scale integration):** From 100,000 to 1,000,000 electronic components per chip
- **ULSI (ultra large-scale integration):** More than 1 million electronic components per chip

Classification

ON BASIS OF APPLICATIONS

✦ *LINEAR or ANALOG INTEGRATED CIRCUITS*

✦ *DIGITAL INTEGRATED CIRCUITS*

✦ *MIXED SIGNAL INTEGRATED CIRCUITS*

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DIGITAL INTEGRATED CIRCUITS

- Digital integrated circuits can contain anything from **one to millions** of logic gates, flip-flops, multiplexers, and other circuits in a few square millimeters.
- The small size of these circuits allows high speed, low power dissipation, and reduced manufacturing cost compared with board-level integration.
- These digital ICs, typically microprocessors, DSPs, and micro controllers, work using binary mathematics to process **"one"** and **"zero"** signals.

ANALOG INTEGRATED CIRCUITS

- Analog ICs, such as sensors, power management circuits, and operational amplifiers, work by **processing continuous signals**.
- They perform functions like amplification, active filtering, demodulation, and mixing.
- Analog ICs ease the burden on circuit designers by having expertly **designed analog circuits** available instead of designing a difficult analog circuit from **conventional components**.

MIXED SIGNAL

ICs can also combine analog and digital circuits on a single chip to create functions such as **A/D converters** and **D/A converters**. Such circuits offer smaller size and lower cost, but must carefully account for **signal interference**.



Merits or Advantages of IC

The integrated circuits offer a number of advantages over those made by interconnecting discrete components. These are summarized as follows:

1. Extremely small size—thousands times smaller than discrete circuit. It is because of fabrication of various circuit elements in a single chip of semi-conductor material.
 2. Very small weight owing to miniaturized circuit.
 3. Very low cost because of simultaneous production of hundreds of similar circuits on a small semiconductor wafer. Owing to mass production an **IC** costs as much as an individual transistor.
 4. More reliable because of elimination of soldered joints and need for fewer inter-connections.
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5. Low power consumption because of their smaller size.
 6. Easy replacement as it is more economical to replace them than to repair them.
 7. Increased operating speeds because of absence of parasitic capacitance effect.
 8. Improved functional performance as more complex circuits can be fabricated for achieving better characteristics.
 9. No component project above the chip surface in an IC as all the components are formed within the chip.

Demerits or Disadvantages of IC

The integrated circuits have few limitations also, as listed below :

1. In an IC the various components are part of a small semi-conductor chip and the individual component or components cannot be removed or replaced, therefore, if any component in an IC fails, the whole IC has to be replaced by the new one.
 2. Limited power rating as it is not possible to manufacture high power (say greater than 10 Watt) ICs.
 3. Need of connecting inductors and transformers exterior to the semi-conductor chip as it is not possible to fabricate inductors and transformers on the semi-conductor chip surface.
 4. Operations at low voltage as ICs function at fairly low voltage.
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5. Quite delicate in handling as these cannot withstand rough handling or excessive heat.
 6. Need of connecting capacitor exterior to the semi-conductor chip as it is neither convenient nor economical to fabricate capacitances exceeding 30 pf. Therefore, for higher values of capacitance, discrete components exterior to IC chip are connected.
 7. Low temperature coefficient is difficult to be achieved.
 8. Difficult to fabricate an IC with low noise.
 9. Voltage dependence of resistors and capacitors.
 10. The diffusion processes and other related procedures used in the fabrication process are not good enough to permit a precise control of the parameter values for the circuit elements. However, control of the ratios is at a sufficiently acceptable level.