

INTEGRATED CIRCUITS : MERITS AND DEMERITS

The concept of IC was first introduced in the year 1958. Since then this concept has reached great technological heights than any other concepts and has helped in the miniaturization of a lot of components like mobiles, computers, laptops, and many more devices in the digital world.

The digital era started with the invention of vacuum tubes. Vacuum based computers were rare and expensive. This was then replaced by transistors, which were faster in use and smaller in size, cost effective, less power consuming and reliable. Then came the invention of integrated circuits which just revolutionized the use of computers. Due to its small dimension, low cost, and very high reliability even the common man is familiar with its applications like smart phones and laptops.

The IC's also found its way in military applications, state of the art communication systems, and industrial applications due to its high reliability and compact size. Nowadays, an IC that has the size of a fingernail consists of more than a million transistors and other discrete components embedded into it. Thus an integrated circuit can also be called a microchip and is basically a collection of some discrete circuits on a small chip that is made of a semiconductor material like silicon.

The use of discrete circuits was replaced by IC's due to two factors. One is space consumption. A discrete circuitry consists of transistors, resistors, diodes, capacitors, and many other discrete devices. Each of them is soldered on to printed circuit boards (PCB) according to the need of circuitry. In the end PCB will occupy a large space. Another drawback is that the soldered components will show less reliability due to the use of many components. Both these factors urged engineers to invent microcircuits that have more reliability and consume less space.

The idea of an integrated circuit was first proposed by Geoffrey W. A. Dummer in the year 1952. But the attempt to build it led to failure. Another idea was proposed by Jack Kilby. He came up with an idea to create small ceramic wafers where each wafer carried a small miniature discrete component. All these wafers could then be wired to form a compact circuit. But this concept, though developed for the U.S army failed to find momentum and was discarded. Shortly soon, the very same Jack Kilby came up with the original idea of making an IC while he was working for Texas Instruments. He started building his first IC and finally completed it on 12th September 1958. He made his IC using germanium as the semiconductor chip. This invention won him the Nobel prize for physics in the year 2000. Soon Robert Noyce developed his own prototype of an IC, using silicon as a semiconductor material. This invention helped in resolving many practical problems that Jack Kilby's IC had.

All IC's consist of both active and passive components and the connections between them are so small that it may be impossible to see them even though a microscope. All the components (active and passive) are interconnected through fabrication process.

In a circuit diagram, there is no common symbol for representing an IC. They are mostly available as dual in-line packages, metal cans and also ceramic flat packs. They may be 8-pin, 10-pin, or 14-pin depending on the specification of the manufacturer.

Merits and Demerits

Advantages of Integrated Circuits

1. Miniature in size. As fabrication process is used for the integration of active and passive components on to a silicon chip, the IC becomes a lot smaller. When compared to a discrete circuit, it may be at least a thousand times smaller.
2. Due to small size, the weight of the IC also reduces, when compared to the discrete circuit.
3. To produce hundreds of discrete circuits on a PCB for the same logic takes more time and increase the cost factor. But for the production of hundreds of IC's the cost of production will be very low and less time consuming.
4. The PCB consisting soldered joints will be less reliable. This problem is omitted in IC's because of no soldered joints, with fewer interconnections, and thus highly reliable.
5. The small size of IC's causes lesser power consumption and lesser power loss.
6. In a discrete circuitry, if a single transistor becomes faulty, the whole circuit may fail to work. This transistor has to be desoldered and replaced. It is difficult to find out which component has failed. This problem can be omitted in an IC by replacing an entire IC as it is low in cost.
7. Increased operating speed because of absence of parasitic capacitance effect.
8. As the IC's are produced in bulk the temperature coefficients and other parameters will be closely matching.
9. Improved functional performance as more complex circuits can be fabricated for achieving better characteristics.
10. All IC's are tested for operating ranges in very low and very high temperatures.
11. As all the components are fabricated very close to each other in an IC, they are highly suitable for small signal operation, as there won't be any stray electrical pickup.
12. As all the components are fabricated inside the chip, there will not be any external projections.

Disadvantages of Integrated Circuits

1. Some complex IC's maybe costly. If such integrated circuits are used roughly and become faulty, they have to be replaced by a new one. They cannot be repaired as the individual components inside the IC are too small.
2. The power rating for most of the IC's does not exceed more than 10 watts. Thus it is not possible to manufacture high power IC's.

3. Some components like transformers and inductors cannot be integrated into an IC. They have to be connected externally to the semiconductor pins.
4. High grade P-N-P assembly is not possible.
5. The IC will not work properly if wrongly handled or exposed to excessive heat.
6. It is difficult to achieve low temperature coefficient.
7. It is difficult to fabricate an IC with low noise.
8. It is not possible to fabricate capacitors that exceed a value of 30pF. Thus, high value capacitors are to be connected externally to the IC.
9. There is a large value of saturation resistance of transistors.

Source : <http://www.circuitstoday.com/integrated-circuits#ic-classification>