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MICROELECTRONICS –BASICS

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ABSTRACT

The earliest electronic circuits were fairly simple. They were composed of a few tubes, transformers, resistors, capacitors, and wiring. As more was learned by designers, they began to increase both the size and complexity of circuits. Component limitations were soon identified as this technology developed.

The initial idea about electronics began about a century ago and is established in the radio and radar communications. Initially electronics use "vacuum tubes, "which are amplifying devices. These are operated with the flow of electrons between plates in a vacuum chamber. The finite lifetime and the large size of vacuum tubes is the motivation to invent an electronic device with better properties. The first transistor which was invented in the 1940s replaced vacuum tubes. It exhibited a very long (in principle, infinite) lifetime and occupied a much smaller volume (e.g., less than 1cm 3 in packaged form) than vacuum tubes did. During 1960s, the field of microelectronics, which is the science of integrating many transistors on one chip, began. Subfield of electronics is Microelectronics. This is connected to micro fabrication of very tiny electronic designs and components ,which means that manufacturing of electronics on micrometre-scale.

These are prepared from semiconductor materials. General electronics components like transistors, capacitors, inductors, resistors, diodes ,insulators and conductors are available in a microelectronic equivalent. The wiring technique that is used in microelectronic fabrication is wire bonding. Due to small size of the components, leads and pads wire bonding is used. This process needs specialized equipment which is very expensive.

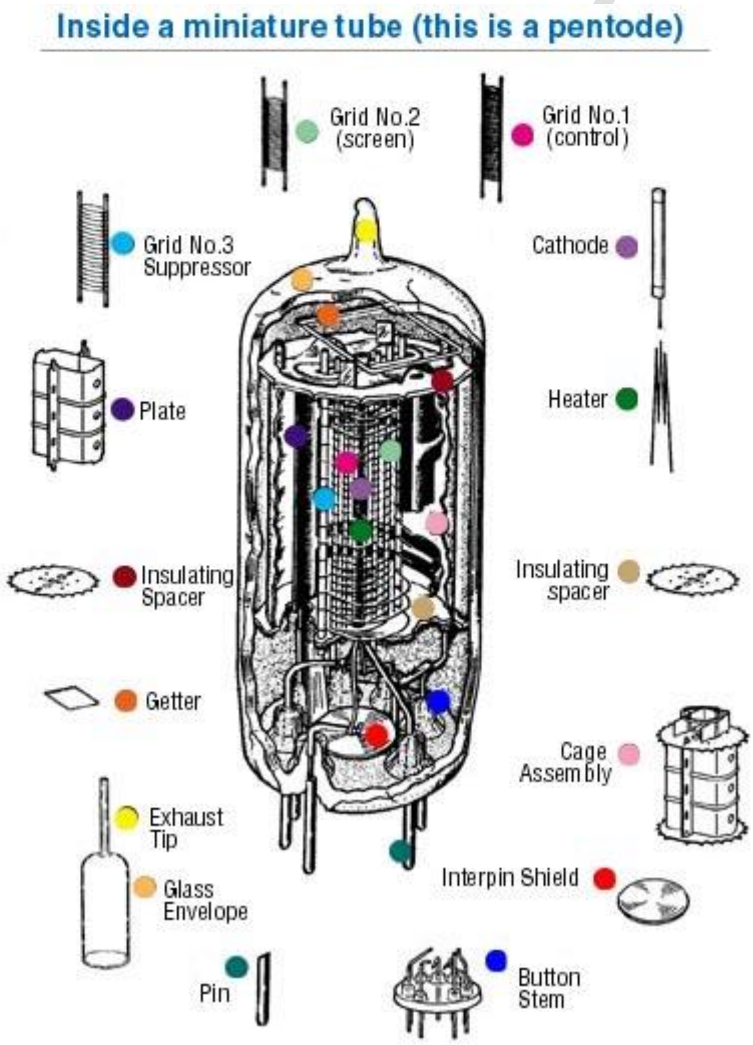
Key words: Solid state device, Fabrication, Component arrangement, Point to point wiring.

INTRODUCTION

The advancement in the technology minimizes the scale of microelectronic components. As the scale is minimum mainly interconnections will play vital role and this kind of effects due to interconnections is called parasitic effects. Microelectronics design includes compensation of these effects or to minimize these effects, hence smaller, faster, and cheaper devices can be fabricated. Microelectronics has great impact on world economy due to its technology driving capacity for Computers, software, Telecommunications, media Commerce, logistics , transportation, Natural science , medicine , Power generation, power distribution , Finance and administration industry. Since 1960,microelectronics has revolutionized our lives. While beyond the realm of possibility a few decades ago, cell phones, digital cameras, laptop computers, and many other electronic products have now become key part of our regular works.

VACUUM-TUBE EQUIPMENT

Vacuum tubes were found to have several built-in problems. Although the tubes were lightweight, associated components and chassis were quite heavy. It was not uncommon for such chassis to weigh 40 to 50 pounds. In addition, the tubes generated a lot of heat, required a warm-up time from 1 to 2 minutes, and required hefty power supply voltages of 300 volts dc and more. No two tubes of the same type were exactly alike in output characteristics. Therefore, designers were required to produce circuits that could work with any tube of a particular type. This meant that additional components were often required to tune the circuit to the output characteristics required for the tube used.



A circuit could be designed either as a complete system or as a functional part of a larger system. In complex systems, such as radar, many separate circuits were needed to accomplish the desired tasks. Multiple-function tubes, such as dual diodes, dual triodes, tetrodes, and others helped considerably to reduce the size of circuits. However, weight, heat, and power consumption continued to be problems that plagued designers. Another major problem with vacuum-tube circuits was the method of wiring components referred to as POINT-TO-POINT WIRING.

1.This wiring look like a rat's nest

2.It often caused unwanted interactions between components. For example, it was not at all unusual to have inductive or capacitive effects between wires.

3.Point-topoint wiring posed a safety hazard when troubleshooting was performed on energized circuits because of exposed wiring and test points.

4.Point-to-point wiring was usually repaired with general purpose test equipment and common hand tools.

5.Vacuum-tube circuits proved to be reliable under many conditions. Still, the drawbacks of large size, heavy weight, and significant power consumption made them undesirable in most situations. For example, computer systems using tubes were extremely large and difficult to maintain. ENIAC, a completely electronic computer built in 1945, contained 18,000 tubes. It often required a full day just to locate and replace faulty tubes.

Instead of building a system on one large chassis, it was built of MODULES or blocks. Each module performed a necessary function of the system. Modules could easily be removed and replaced during troubleshooting and repair. Vacuum tubes were the basis for electronic technology for many years and some are still with us.

SOLID-STATE DEVICES

Although printed circuit boards represent a major improvement over tube technology, they are not without fault. For example, the number of components on each board is limited by the sizes and shapes of components. Also, while vacuum tubes are easily removed for testing or replacement, pcb components are soldered into place and are not as easily removed. Normally, each pcb contains a single circuit or a subassembly of a system. All printed circuit boards within the system are routinely interconnected through CABLING HARNESSES (groups of wiring or ribbons of wiring). You may be confronted with problems in faulty harness connections that affect system reliability. Such problems are often caused by wiring errors, because of the large numbers of wires in a harness, and by damage to those wires and connectors. transition from vacuum tubes to solid-state devices took place rapidly. As new types of transistors and diodes were created, they were adapted to circuits. The reductions in size, weight, and power use were impressive. Circuits that earlier weighed as much as 50 pounds were reduced in weight to just a few ounces by replacing bulky components with the much lighter solid-state devices. The earliest solid-state circuits still relied on point-to-point wiring which caused many of the disadvantages mentioned earlier. A metal chassis, similar to the type used with tubes, was required to provide physical support for the components. The solid-state chassis was still considerably smaller and lighter than the older, tube chassis. Still greater improvements in component mounting methods were yet to come. The pcb is usually an epoxy board on which the circuit leads have been added by the PHOTOETCHING process. This process is similar to photography in that copper-clad boards are exposed to controlled light in the desired circuit pattern and then etched to remove the unwanted copper. This process leaves copper strips (LANDS) that are used to connect the components. In general, printed circuit boards eliminate both the heavy, metal chassis and the point-to-point wiring.

Another mounting form that has been used to increase the number of components in a given space is the CORDWOOD MODULE. The components are placed perpendicular to the end plates. The components are packed very closely together, appearing to be stacked like cordwood for a fireplace. The end plates are usually small printed circuit boards, but may be insulators and solid wire, as shown in the figure. Cordwood modules may or may not be

ENCAPSULATED (totally imbedded in solid material) but in either case they are difficult to repair.

INTEGRATED CIRCUITS

Many advertisements for electronic equipment refer to integrated circuits or solid-state technology. Integrated circuit is that it consists of elements inseparably associated and formed on or within a single SUBSTRATE (mounting surface). In other words, the circuit components and all interconnections are formed as a unit.

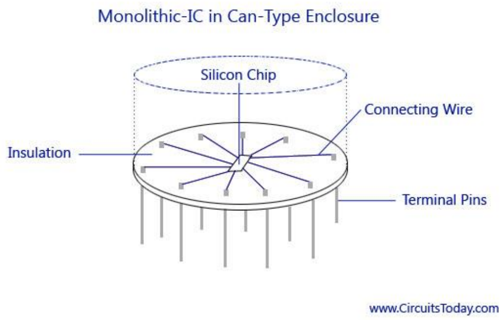
There are three types of integrated circuits:

1.MONOLITHIC

2.FILM

3.HYBRID

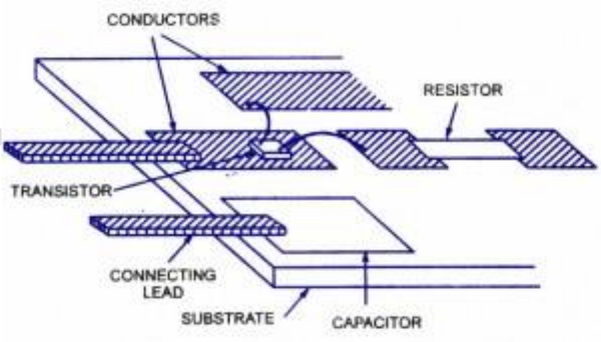
MONOLITHIC INTEGRATED CIRCUITS are those that are formed completely within a semiconductor substrate. These integrated circuits are commonly referred to as SILICON CHIPS.



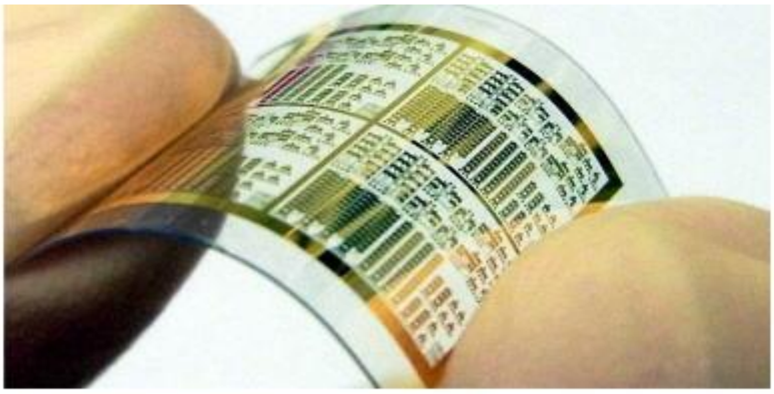
FILM INTEGRATED CIRCUITS are broken down into two categories.

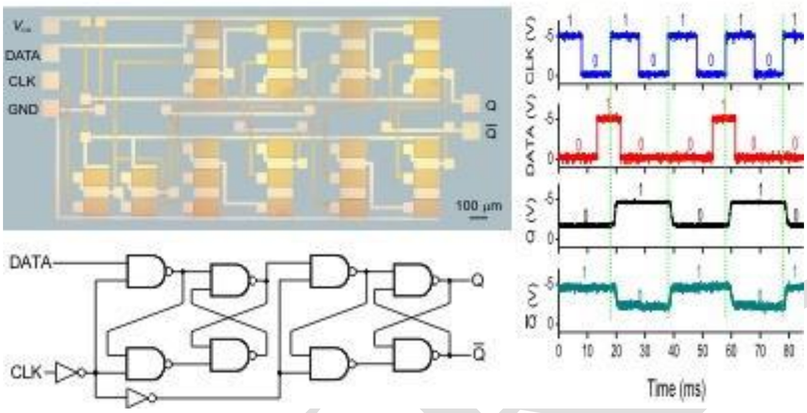
THIN FILM and THICK FILM.

Film components are made of either conductive or nonconductive material that is deposited in desired patterns on a ceramic or glass substrate. Film can only be used as passive circuit components, such as resistors and capacitors. Transistors and/or diodes are added to the substrate to complete the circuit.



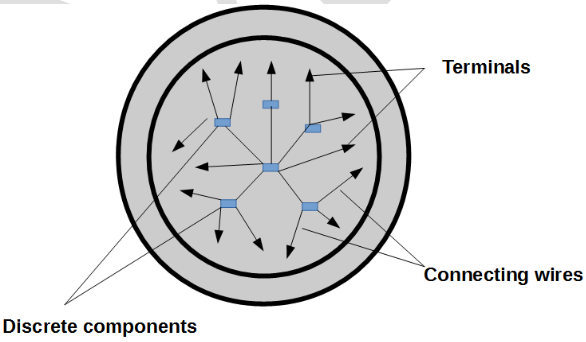
Enlarged Portion of Thick-Film IC





Enlarged portion of Thin film IC

HYBRID INTEGRATED CIRCUITS combine two or more integrated circuit types or combine one or more integrated circuit types and DISCRETE (separate) components



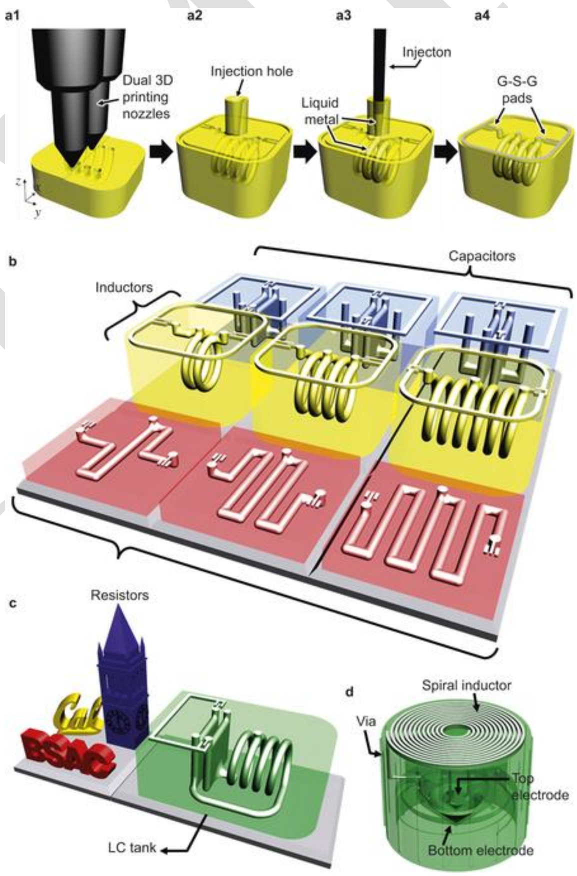
HYBRID CHIP

Microelectronic technology today includes thin film, thick film, hybrid, and integrated circuits and combinations of these. Such circuits are applied in DIGITAL, SWITCHING, and LINEAR (analog) circuits. Because of the current trend of producing a number of circuits on a single chip, you may look for further increases in the packaging density of electronic circuits. At the same time you may expect a reduction in the size, weight, and number of connections in individual systems. Improvements in reliability and system capability are also to be expected. Thus, even as existing capabilities are being improved, new areas of microelectronic use are being explored. To predict where all this use of technology will lead is impossible. However, as the demand for increasingly effective electronic systems continues, improvements will continue to be made in state-of the-art microelectronics to meet the demands. LARGE-SCALE INTEGRATION (lsi) and VERY LARGE-SCALE

INTEGRATION (vlsi) are the results of improvements in microelectronics production technology. In lsi and vlsi, a variety of circuits can be implanted on a wafer resulting in further size and weight reduction. ICs in modern computers, such as home computers, may contain the entire memory and processing circuits on a single substrate.

FABRICATION OF MICROELECTRONIC DEVICES

The purpose of this section is to give you a simplified overview of the manufacture of microelectronic devices. The process is far more complex than will be described here. Still, you will be able to see that microelectronics is not magic, but a highly developed technology. Development of a microelectronic device begins with a demand from industry or as the result of research. A device that is needed by industry may be a simple diode network or a complex circuit consisting of thousands of components. No matter how complex the device, the basic steps of production are similar.



Each type of device requires

1.circuit design

2.component arrangement

3. preparation of a substrate

4.the depositing of proper materials on the substrate.

The first consideration in the development of a new device is to determine what the device is to accomplish. Once this has been decided, engineers can design the device. During the design phase, the engineers will determine the numbers and types of components and the interconnections, needed to complete the planned circuit.

COMPONENT ARRANGEMENT

Planning the component arrangement for a microelectronic device is a very critical phase of production. Care must be taken to ensure the most efficient use of space available.

With simple devices, this can be accomplished by hand. In other words, the engineers can prepare drawings of component placement. However, a computer is used to prepare the layout for complex devices. The computer is able to store the characteristics of thousands of components and can provide a printout of the most efficient component placement. Component placement is then transferred to extremely large drawings. During this step, care is taken to maintain the patterns as they will appear on the substrate. IC MASK PATTERN. If this pattern were being prepared for production, it would be drawn several hundred times the size shown and then photographed. The photo would then be reduced in size until it was the actual desired size. At that time, the pattern would be used to produce several hundred patterns that would be used on one substrate.

CONCLUSION:

This topic has presented information on the development and manufacture of microelectronic devices. The information that follows summarizes the important points of this topic.

1.VACUUM-TUBE CIRCUITS in most modern military equipment are unacceptable because of size, weight, and power use.
2.Discovery of the transistor in 1948 marked the beginning of MICROELECTRONICS.
3.The PRINTED CIRCUIT BOARD(pcb)reduces weight and eliminates point-to-point wiring.
4.The INTEGRATED CIRCUITS (IC) consist of elements inseparably associated and formed on or within a single SUBSTRATE
5.FILM COMPONENTS are passive elements, either resistors or capacitors.
HYBRID ICs are combinations of monolithic and film or of film and discrete components, or any combination thereof. They allow flexibility in circuits. Rapid development has resulted in increased reliability and availability, reduced cost, and higher
element density.
6.LARGE-SCALE (lsi) and VERY LARGE-SCALE INTEGRATION (vlsi) allow thousands of elements in a single chip.
7.MONOLITHIC ICs are produced by the diffusion or epitaxial methods.
8.DIFFUSED elements penetrate the substrate, EPITAXIAL do not.
9.ISOLATION is a production method to prevent unwanted interaction between elements within achip.
10.THIN-FILM ELEMENTS are produced through EVAPORATION or CATHODE

SPUTTERING techniques.
11.THICK-FILM ELEMENTS are screened onto the substrate.
12.The most common types of packages for ICs are TO, FLAT PACK, and DUAL INLINE
13.Large DIPs are being used to package lsi and vlsi. They can be produced with up to 64 pins and are designed to fulfill a specific need.
14.Viewed from the tops, DIPS and FLAT-PACK LEADS are numbered counterclockwise from the reference mark.Viewed from the bottom, TO-5 LEADS are numbered clockwise from the tab.
Numbers and letters on schematics and ICs identify the TYPE OF IC.Knowledge of TERMINOLOGY used in microelectronics and of packaging concepts will aid you in becoming an effective technician.STANDARD
15.TERMINOLOGY has been adopted by the Navy to ease communication.
16.MICROELECTRONICS is that area of technology associated with electronic systems designed with extremely small parts or elements.
17.A MICROCIRCUIT is a small circuit which is considered as a single part composed of elements on or MICROCIRCUIT MODULE is an assembly of microcircuits or a combination of microcircuits and discrete components packaged as a replaceable unitithin a single substrate
18.A MICROCIRCUIT MODULE is an assembly of microcircuits or a combination of microcircuits
and discrete components packaged as a replaceable unit.
19.MINIATURE ELECTRONICS are card assemblies and modules composed exclusively of discrete electronic components.
20.SYSTEM PACKAGING refers to the design of a system, taking into account environmental and electronic characteristics, access, and maintainability.

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