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Dr. Tapanendu Kamilya
Assistant Professor, Department of Physics, Narajole Raj College

Topic:

Integrated Circuits: Active & Passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs. Examples of Linear and Digital ICs.

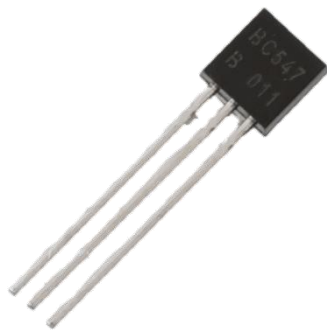
Integrated Circuits:

Active and Passive Components:

Active components:

The active **components** of a circuit are the components which inject the power into the circuit as well as are proficient of electrically monitoring and amplifying the flow of electrical current within the circuit.

The active components which require an external power source in order to control current and/or voltage in the circuit might transmit the energy or else drive an input signal. The transistors, triode valves, and tunnel diodes such are the examples of active components.



Active Component: Transistor

Passive components:

Passive components are the components which are incapable to introduce the net energy into the circuit. The passive two-terminal components either consume or store energy as well as influence the flow of power in the circuit, however do not require an external power source for the functioning of their. Such as the resistors, capacitors, inductors, and transformers are the examples of passive components.



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Passive component: Resistance

Discrete components:

We can construct an elementary electronic device in the system of a single unit. Earlier, the advent and advancement of integrated circuits (IC/chips), the transistors, resistors, capacitors as well as diodes are typically termed as discrete components which are manufactured separately.

Later on, these discrete components are connected together by using conducted wires on a circuit board or a printed circuit board for the construction of different circuits.

In single sentence, discrete components are the electronic component having just one circuit element, either active or passive component other than the integrated circuit.

Integrated Circuit (IC):

Integrated circuit (IC) which is also typically termed as microelectronic circuit, microchip, or chip, fabricated in single unit as well as build up with the interconnections of different electronic active and passive components to perform several operations.

A large number of integrated circuits (IC) are prepared at the same time on a single thin silicon wafer as well as finally it are cut apart into individual IC chips. The industrial manufacturing processes are performed in dust free room with controlled environment to avoid the contamination from the air borne foreign particles.

Silicon is used for the fabrication of integrated circuits because it can be used as either an insulator which does not permit electricity to flow or a semiconductor for the flow of small amount electricity. This is important condition for making integrated circuits. The resulting circuit becomes small monolithic "chip," are generally microscopic in size.



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Presently, the integration of large number of MOS transistors into a small microsize chip results the formation of integrated circuits which are smaller in magnitude, faster in performance as well as less expensive than those constructed with active and passive discrete electronic components for such specific operation.

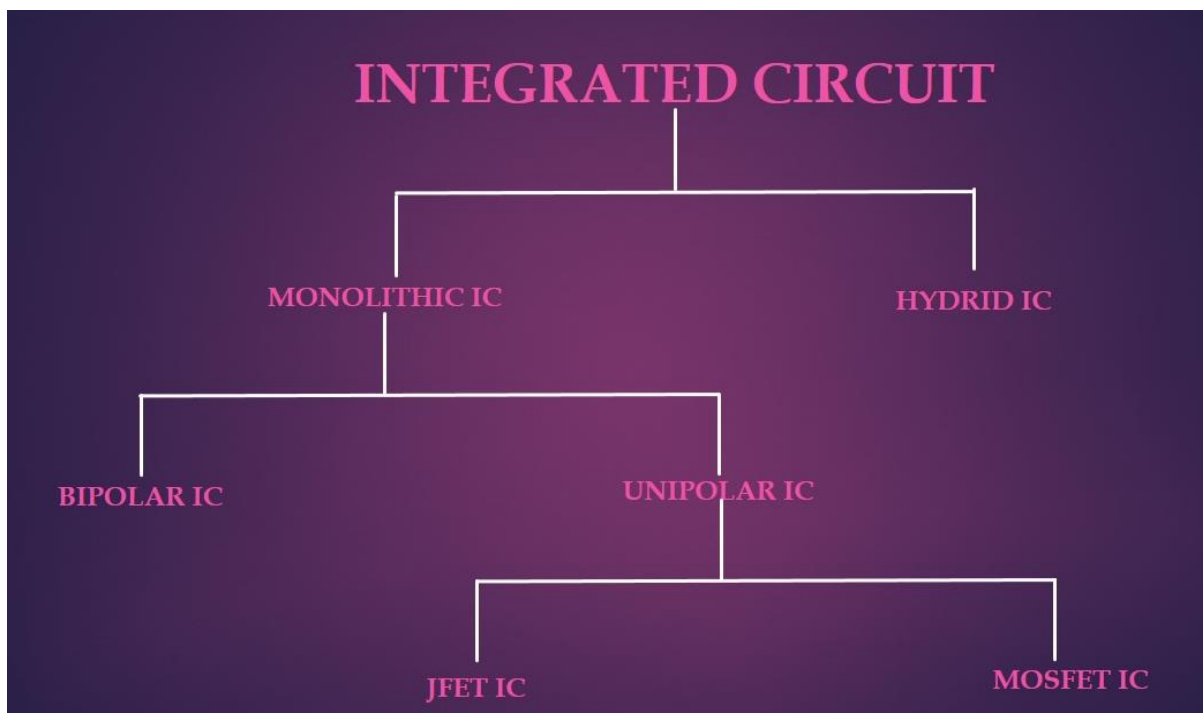
Example: IC 741 for differentiation, integration, comparison, solving differential equation, inverting and non-inverting addition as well as amplification.

IC555 for timer circuits.



IC 741: Operational Amplifier (OPAMP)

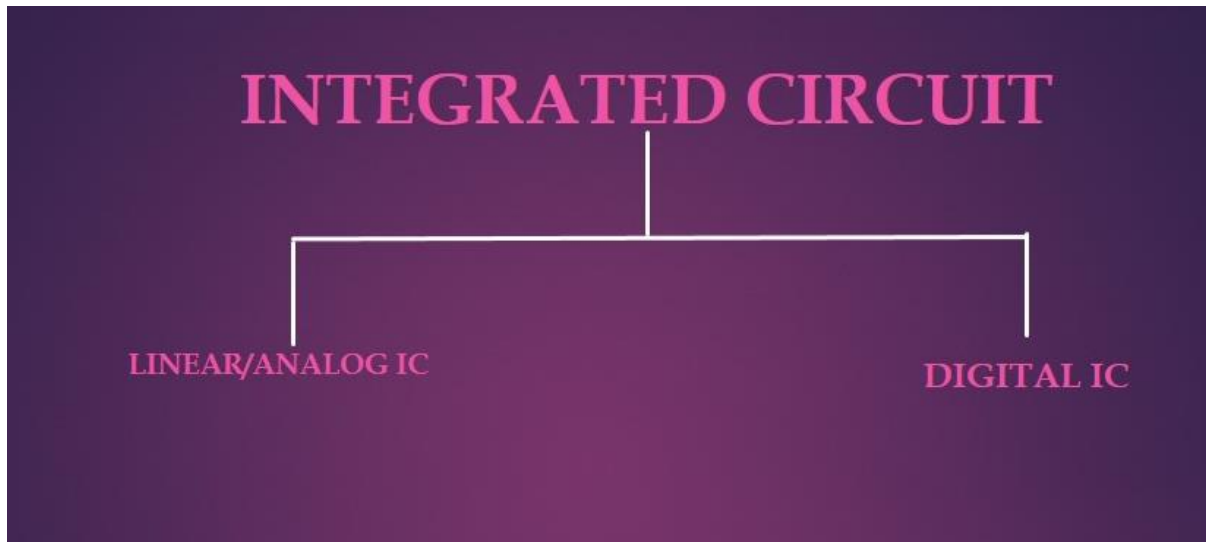
Classification of Integrated Circuit (IC):





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Based on circuits Functions the Integrated circuits (IC) can be classified into two ways These are (1) Analog/Linear ICs and (2) Digital ICs.



Analog/Linear IC:

The integrated circuits which performs work by continuous analog signals are typically termed as linear/analog IC. The operational amplifier (OPAMP/IC741), IC 555 Timer ICs are such examples of analog/linear ICs. These types of ICs are used for integration, differentiation, amplification, etc.

Digital IC:

The integrated circuits which performs work by discrete digital two defined level which are low/Off/ 0' state and high/On/1' state are typically termed as digital ICs. Microprocessor, Flip-Flop ICs are such examples of digital ICs .

Mixed IC:

However, an analog-to-digital converter (ADC) receives the continuously varying analog input voltage and transform it into binary digital numbers. Also, a digital-to-analog converter (DAC) receives binary digital numbers in place of input data and transform these binary digital input data into continuously varying analog output voltage. ADC 0808 IC and DAC 0800 are examples of Mixed ICs for such performances.

Advantage and Disadvantage of IC:



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Advantages of ICs:

- i) ICs have very small size and low weight.
- ii) The production costs of ICs are low.
- iii) On a single silicon chip, the components and the interconnections are made.
- iv) Strong reliability because there is no soldered joints between the components.
- v) ICs consumes small amount of energy.
- vi) ICs can be replaced very easily.
- vii) ICs can perform at high temperature.

Disadvantages of ICs:

- i) ICs have limited power rating.
- ii) ICs are very sophisticated they can be handled with very care.
- iii) ICs operates at low voltage.
- iv) ICs may produce noise during operating mode.
- v) The capacitors and resistors component of ICs are voltage dependent.

SSI, MSI, LSI, VLSI:

The number of components built-in into a standard size IC typically termed as its integration scale. It also be termed as density of components. The term "**integrated circuit**" is come from the "**integration**". A high **integration density** referred as a large number of transistors/components are circuited in very small area of chip.

SSI- Small Scale Integration. In these types of ICs there are less than 100 components/transistors or 10 logic Gates. Example- AND, OR ICs

MSI- Medium Scale Integration. In these types of ICs there are less than 500 components/transistors or have more than 10 however less than 100 logic gates. Example- MUX, DEMUX ICs

LSI- Large Scale Integration. In these types of ICs there are 500-300000 components/transistors or have more than 100 logic gates. Example-Small Memory Chip

VLSI- Very Large Scale Integration. In these types of ICs there are more than 300000 components in a chip. Example-Computer Microchip, Complex programmable memory device, large memory chip.

VVLSI- Very Very Large Scale Integration. In these types of ICs there are more than 1500000 components in a chip. Example- Pentium 4 Processor



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Frequently Asked Questions:

1. What do you mean by active and passive components of a digital circuit? Give examples?
2. What are the difference between active and passive components?
3. What do you mean by discrete components?
4. What do you mean by integrated Circuit (IC)?
5. What are different types of ICs?
6. What are linear and digital ICs? Give examples?
7. State the classifications of ICs?
8. What is mixed IC?
9. What are the advantage and disadvantage of ICs?
10. Define SSI, MSI, LSI, and VLSI.

References:

- (i) *Device Electronics for Integrated Circuits, 3rd Ed: R.S. Muller, T. I. Kamins, M. Chan, Published by WILEY (3rd Ed.).*
- (ii) *Linear Integrated Circuits, Author- R. Anand, Published by Khanna Book Publishing (2018 Ed.).*
- (iii) *Digital Integrated Circuits A Design Perspective- Author- J. M. Rabaey, A. Chandrakasan, B. Nicolic, Published by PEARSON. (2nd Ed.).*
- (iv) <https://www.electricaltechnology.org/2015/04/types-of-ics-classification-of-integrated-circuits-and-their-limitation.html>
- (v) <https://www.allaboutcircuits.com/video-tutorials/common-analog-digital-and-mixed-signal-ics/>
- (vi) <https://www.daenotes.com/electronics/devices-circuits/integrated-circuits-ic>

Link to Audio visual Lectures (e-Lectures) and NPTEL lectures on this topic given by Distinguish Professors of Indian & Foreign Universities:

- (1) <https://www.youtube.com/watch?v=2aRwFWWhLk0o>
- (2) <https://www.digimat.in/nptel/courses/video/108108111/L01.html>
- (3) <https://nptel.ac.in/courses/108/106/108106068/>