Logic Families

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# What is logic families? And why should you care

Most electronic systems which are responsible for modern advances are based on digital technology. All digital systems, computers and microprocessors are assembled from simple circuits called logic circuits. The basic building blocks of logic circuits are **logic gates**. And logic gates themselves are simple electronic circuits comprising of **diodes**, **transistors** and **resistors**.

As to why you should care? When we talk about digital systems actually the digital ICs are the ones which make up the whole system. And if all the ICs are of same logic family then they are compatible to each other and the intended logic functions are performed and the goal is achieved.
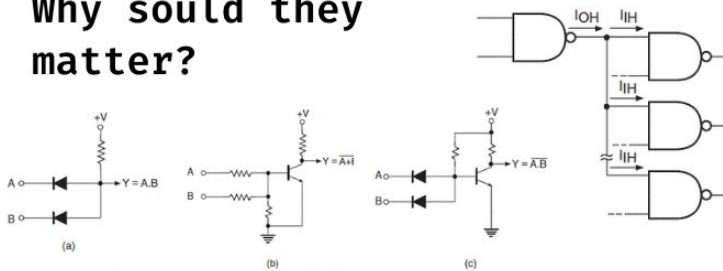
(a) Diode logic (b) resistor transistor logic and (c) diode transistor logic.
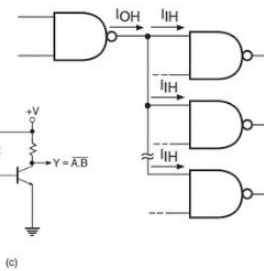
Digital Integrated circuits

Digital Integrated circuits are produced using several different circuit configurations and production technologies. Each such approach is called a specific logic family. A logic family is a collection of different integrated circuit chips that have similar input, output, and internal circuit characteristics, but they perform different logic gate functions such as AND, OR, NOT, etc. The idea is that different logic gate functions, when fabricated in the form of an integrated circuit with the same approach, or which belongs to the same logic family, will have identical electrical characteristics (electrically compatible with each other). These families may vary by speed, power consumption, cost, voltage and current levels.

In case of integrated circuits belonging to different logic families, digital system should ensure compatibility interfacing techniques. And that is the reason why we must be clear about different logic families and use the best combination of integrated circuits during the design of a digital system.

The characteristics which are bound to be identical and used to compare performance are:

1. Supply voltage range
2. Speed of response
3. Dissipation of power
4. Input and output logic levels
5. Current sinking capability
6. Current sourcing capability
7. Flexibility
8. Noise immunity
9. Fan-out

Integrated circuit and logic technology

Many **logic families** were produced as individual components, each containing one or a few related basic logical functions, which could be used as "**building-blocks**" to create systems or as so-called "**glue**" to interconnect more complex integrated circuits. A logic family may also refer to a set of techniques used to implement logic within very large scale integrated circuits such as central processors, memories, or other complex functions. Some such logic families use static techniques to minimize design complexity. Other logic families, such as **domino logic**, use clocked dynamic techniques to minimize size, power consumption and delay.

Before the widespread use of integrated circuits, various **solid-state** and **vacuum tube** logic systems were used for logic circuitry operations. But these were not standardized and interactive as the integrated circuit devices. The most common logic family in modern semiconductor devices is **Metal Oxide Semiconductor (MOS) logic**, due to lower power consumption, small sized transistor, and high transistor density.

What is logic gates

The electric circuits which perform logical operations are called **Electric Gate**. A **Logic Gate** is an electronic circuit that has two or more inputs but only one output. Logic follows well defined rules, producing predictable digital output from certain input.

Main Logic gates are **AND, OR, NOT, NAND, NOR and XOR**. Digital logic gates NAND and NOR are called universal logic gate because we can construct all other logic gates using NAND gate or NOR gate alone.

In digital electronics, a gate is defined as an electronic circuit having only one output but two or more input. These electronic circuits consist of p-n junction diodes, transistors and resistors. Gates work with only two voltage levels at their input and output terminals with respect to ground or common, ie., the input and output voltages can have only two values.

Types of logic family

The digital integrated circuits are designed using bipolar devices or Metal Oxide Semiconductor (MOS) or a combination of both. There are two kinds of semiconductor devices. The logic family which falls under the first kind Bipolar logic family and the other is Unipolar logic family.

Bipolar Logic Family:

There are two kinds of operations in bipolar integrated circuits: Saturated Bipolar Logic family and Non-saturated Bipolar Logic family.

> **Saturated Bipolar Logic Family**: In this family the transistors used in ICs are driven into saturation.

> **Unsaturated bipolar logic Family**: In this family the transistors used in IC is not driven into saturation.

Unipolar Logic Families:

It mainly uses Unipolar devices like MOSFETs in addition to passive elements like resistors and capacitors. These logic families have the advantages of high speed and lower power consumption than Bipolar families

Bipolar

Saturated Bipolar

1. Transistor-Transistor Logic (TTL)
2. Resistor-Transistor Logic (RTL)
3. Direct Coupled Transistor Logic (DCTL)
4. Diode Transistor Logic (DTL)
5. High Threshold Logic(HTL)
6. Integrated Injection Logic (IIL or I 2 L)

UnSaturated Bipolar

1. Schottky TTL
2. Emitter Coupled Logic(ECL)

Unipolar

1. PMOS or P-Channel MOS Logic Family
2. NMOS or N-Channel MOS Logic Family
3. CMOS Logic Family

Features of logic families

1. TTL – Transistor-Transistor Logic: Standard logic family; used for the longest time.
2. ECL – Emitter Coupled Logic: Suitable for systems requiring high-speed operations.
3. MOS – Metal Oxide Semiconductor Logic: Suitable for systems with high component density.
4. CMOS – Complementary Metal Oxide Semiconductor Logic: Suitable for systems with low power consumption (VLSI circuits). Gradually becomes the dominant logic family.
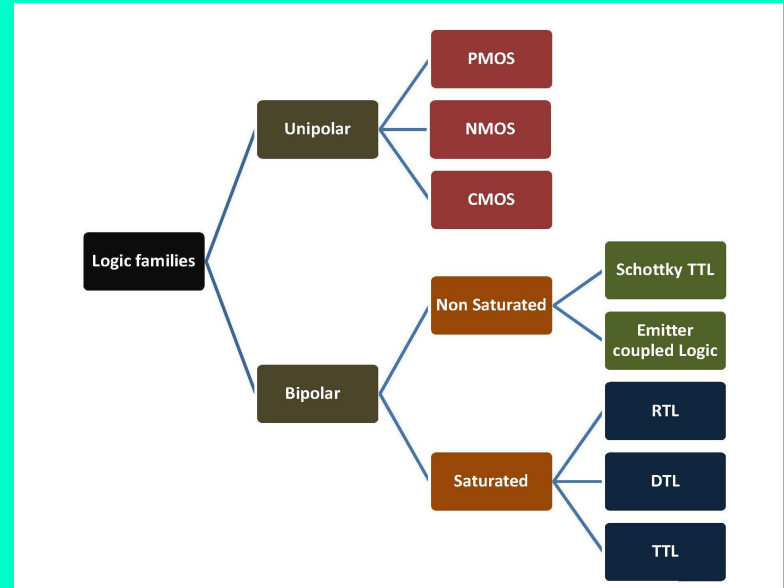
Thank You

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