**LOGIC FAMILIES**

**ASSIGNMENT**

**Roll no: 11720068**

**Section : IT -3**

**1. Introduction :**

***The first logic circuit was developed using discrete circuit components. Using advance techniques, these complex circuits can be miniaturized and produced on a small piece of semiconductor material like silicon. Such a circuit is called integrated circuit (IC). Now-a-days, all the digital circuits are available in IC form. While producing digital ICs, different circuit configurations and manufacturing technologies are used. This results into a specific logic family. Each logic family designed in this way has identical electrical characteristics such as supply voltage range, speed of operation, power dissipation, noise margin etc.***

***A logic family of monolithic digital integrated circuit devices is a group of electronic logic gates constructed using one of several different designs, usually with compatible logic levels and power supply characteristics within a family.***

**2. Significance of Logic families ;**

***Almost all electronic gadgets make use of different digital systems for their operation. All the digital systems use some kind of digital ICs. For the sake of simplicity in design and compatibility in constructing any complex digital system, all digital circuits (ICs) used in the design process should be from same logic family.***

**3.Types of logic families:**

***As explained in previous section, logic families are the logic circuits having identical electrical parameters. It is a group of compatible ICs with the same logic levels and supply voltages for performing various logic functions. They are fabricated using a specific circuit configuration which is referred to as a Logic family. The circuit design of the basic gate of each logic family is the same.***

**4.Bipolar Logic Families:**

***The main elements of a bipolar IC are resistors, diodes (which are also capacitors) and transis-tors.***

***Basically, there are two types of operations in bipolar ICs:***

***1.Saturated***

***2.Non-saturated.***

***In saturated logic, the transistors in the IC are driven to saturation, whereas in the case of non-saturated logic, the transistors are not driven into saturation.***

***The saturated bipolar logic families are:***

***1.Resistor–transistor logic (RTL)***

***2.Direct–coupled transistor logic (DCTL)***

***3.Integrated–injection logic (IL)***

***4.Diode–transistor logic (DTL)***

***5.High–threshold logic (HTL)***

***6.Transistor-transistor logic (TTL).***

**5.The non-saturated bipolar logic families are:**

***1.Schottky TTL***

***2.Emitter-coupled logic (ECL)***

**6.Unipolar Logic Families:**

***MOS devices are unipolar devices and only MOSFETs are employed in MOS logic circuits.***

***The MOS logic families are:***

***1. PMOS***

***2.NMOS***

***3.CMOS***

***Out of the logic families mentioned above, DL, RTL and DTL are not very useful due to some inherent disadvantages while TTL, ECL and CMOS are widely used in many digital circuit design applications. Each logic family is further classified based on the significant variation in the key parameters. This helps in improving the performance of that logic family. For example, TTL logic family has subfamilies such as low power TTL, Schottky TTL etc.***

**7.Characteristics of Logic Families:**

***The various characteristics of digital ICs used to compare their performances are:***

***1. Speed of operation***

***2. Power dissipation***

***3. Figure of merit***

***4. Fan-out***

***5. Current and voltage parameters***

***6. Noise immunity***

***7. Operating temperature range***

***8. Power supply requirements***

***9.Flexibilities available.***

***1) Speed of operation :***

***The speed of a digital circuit is specified in terms of the propagation delay time. If the propagation delay time is lower, the speed of the IC is higher.***

***2) Power of dissipation:***

***This is the amount of power dissipated in an IC. It is determined by the current, ICC, that it draws from the VCC supply, and is given by VCC \* ICC.***

***ICC is the average value of ICC(0) and ICC(1). This power is specified in milliwatts.***

***3) Figure of merit:***

***The figure of merit of a digital IC is defined as the product of speed and power. The speed is specified in terms of propagation delay time expressed in nanoseconds.***

***Figure of merit = propagation delay time (ns) \* power (mW)***

***It is specified in pico joules (ns \* mW = pJ).***

***A low value of speed-power product is desirable. In a digital circuit, if it is desired to have a high speed, low propagation delay time, then there is a corresponding increase in the power dissipation and vice-versa.***

***4) Fan Out:***

***Fan out is the number if similar gates which can be driven by a gate. High fan-out is advantages because it reduces the need for additional drivers to drive more gates.***

***5) Current and voltage parameters:***

* ***High level input voltage (VlH): This is the minimum input voltage which is recognized by the gate as logic 1.***
* ***Low level input voltage (VlL): This is the maximum input voltage which is recognized by the gate as logic 0.***

***6) Noise immunity:***

***The input and output voltage levels are defined above are shown in figure. Stray electric and magnetic fields may induce unwanted voltages, known as noise, on the connecting wires between logic circuits. This may cause the voltage at the input to a logic circuit to drop below VlH or rise above VlL and may produce undesired operation.***

***The circuit's ability to tolerate noise signals is referred to as the noise immunity, a quantitative measure of which is called Noise Margin.***

***7) Operating temperature range:***

***The temperature range by which a IC functions properly must be known. The accepted temperature ranges are: 0 to 70 degree Celsius for consumer and industrial applications and -55 degree Celsius to 125 degree Celsius.***

***8) Power supply requirements:***

***The supply voltage and the amount of power required by an IC are important characteristics required to choose the proper power supply.***

***9) Flexibility available:***

***Various flexibilities are available in different IC logic families and these must be considered while selecting a logic family for a particular job.Some of the flexibilities are:***

* ***The breadth of the series***
* ***Popularity of the series***
* ***Wired logic capability***
* ***Availability of complement outputs***
* ***Type of output.***

**8. Transistor-transistor logic (TTL):**

***• based on bipolar transistors.***

***• One of the most widely used families for small- and medium-scale devices –***

***rarely used for VLSI.***

***• Typically operated from 5V supply.***

***• Typical noise immunity about 1 –1.6 V***

***• Many forms, some optimised for speed, power, etc.***

***• High speed versions comparable to CMOS (~ 1.5 ns)***

***•low-power versions down to about 1 mW/gate.***

**9.Types of TTL:**

***•Standard TTL***

***–typical gate propagation delay of 10ns***

***–and a power dissipation of 10 mW per gate,***

***–for a power***

***–delay product (PDP) or switching energy of about 100 pJ***

***•Low-power TTL (L)***

***–slow switching speed (33ns)***

***–reduction in power consumption (1 mW)***

***–(now essentially replaced by CMOSlogic)***

***•High-speed TTL (H)***

***–faster switching than standard TTL (6ns)***

***–but significantly higher power dissipation (22 mW)***

***•Schottky TTL (S)***

***–used Schottky diode clamps at gate inputs to prevent charge storage and improve switching time.***

***–A Schottky diode has a very low forward-voltage drop of 0.15–0.45V approx (silicon diode has a voltage drop of 0.6–1.7V). This lower voltage drop can provide higher switching speed.***

***–Faster speed of (3ns)***

***–but had higher power dissipation (19 mW)***

***•Low-power Schottky TTL (LS)***

***–used the higher resistance values of low-power TTL and the Schottky diodes***

***–to provide a good combination of speed (9.5ns)***

***–and reduced power consumption (2 mW), and PDP of about 20 pJ.***

**10.Emitter-coupled logic (ECL):**

***– based on bipolar transistors, but removes problems of storage time by preventing the transistors from saturating.***

***– Very fast operation - propagation delays of 1ns or less***

***– High power consumption, perhaps 60 mW/gate***

***– Low noise immunity of about 0.2-0.25 V***

***– used in some high speed specialist applications, but now largely replaced by high speed CMOS.***

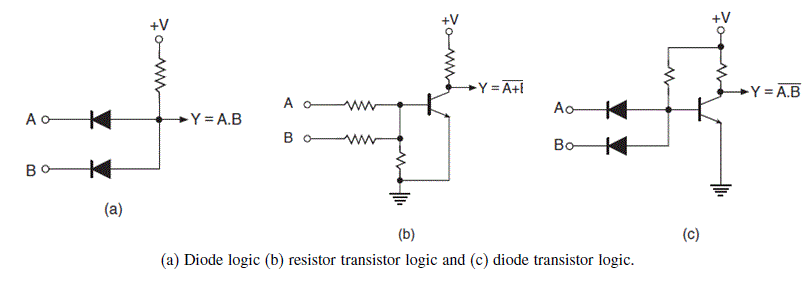
***ECL features:***

***• Faster speed (2 ns propagation delay)ofoperation than TTL (10 ns),***

***74STTL (3 ns)***

***• More power dissipation (50 mW/gate) than TTL (10 mW), 74S (19mW)***

***• Noise Margin at ‘1’or ‘0’output and input = 0.4V (– 1.7V and – 1.4V).***

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