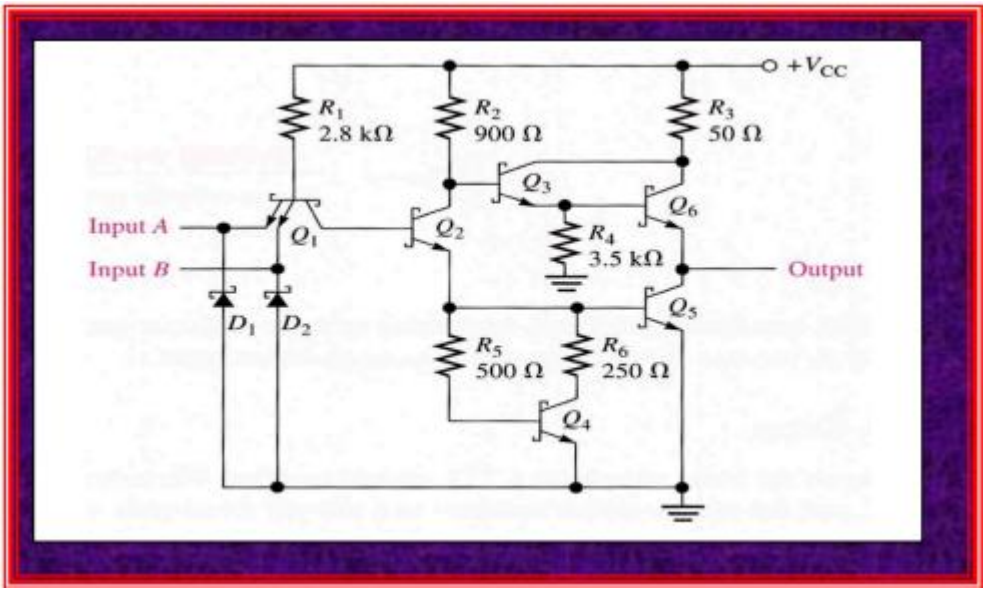
Al-Mustaqbal University
Department of Medical Instrumentation Techniques Engineering
Class: four
Subject: Advanced logic design
Lecturer: Dr. Zahraa hashim kareem
Second term / Lec.- 4: TTL and CMOS Family

TTL and CMOS Family



The growing popularity of digital circuits is due in part to the availability of inexpensive integrated circuits (ICs). Manufacturers have developed many families of digital ICs—groups that can be used together in building a digital system. The ICs in a family are said to be compatible, and they can be easily connected.

Digital ICs can be categorized as either **bipolar or unipolar**. Bipolar digital ICs are fabricated from parts comparable to discrete bipolar transistors, diodes, and resistors. The TTL (transistortransistor logic) family is the most popular of the ICs using the bipolar technology. Unipolar digital ICs are fabricated from parts comparable to insulated-gate field-effect transistors (IGFETs).

The CMOS (complementary-metal-oxide semiconductor) family is a widely used group of ICs based on the metal-oxide semiconductor (MOS) technology.

TTL INTEGRATED CIRCUITS

The famous 7400 series of TTL logic circuits was introduced by Texas Instruments in 1964. The

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TTL family of ICs is still one of the more widely used for constructing logic circuits. TTL ICs are manufactured in a wide variety of SSI and MSI integrated circuits. Over the years, improvements in TTL logic circuits have been made, which has led to subfamilies of transistor-transistor logic ICs. The TTL family has a number of subfamilies including:

standard TTL, low-power TTL, high-power TTL, low-power Schottky TTL, Schottky TTL, advanced low-power Schottky TTL, advanced Schottky TTL and fast TTL. The ICs belonging to the TTL family are designated as 74 or 54 (for standard TTL).

1- 74L or 54L (for low-power TTL)

2- 74H or 54H (for high-power TTL)

3- 74LS or 54LS (for low-power Schottky TTL)

4- 74S or 54S (for Schottky TTL)

5- 74ALS or 54ALS (for advanced low-power Schottky TTL)

6- 74AS or 54AS (for advanced Schottky TTL)

7- 74F or 54F (for fast TTL).

The code letters L, LS, S, ALS, and AS are used in the middle of the 7400 series number to designate the subfamily. This can be observed above where typical IC markings for the various TTL subfamilies are listed. Notice that no special code letter is used in the middle of a standard TTL logic IC. The subfamilies with the code letter S contain a Schottky barrier diode to increase switching speed. Several companies also use the code letter F (as in 74F04) for a fast advanced Schottky TTL IC.

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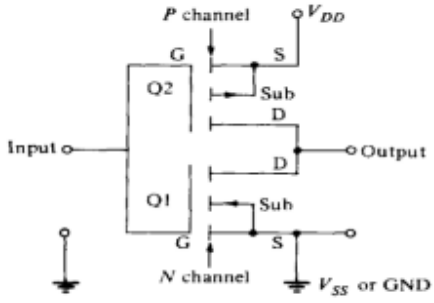
CMOS INTEGRATED CIRCUITS

The popular CMOS subfamilies include the 4000A, 4000B, 4000UB, 54/74C, 54/74HC, 54/74HCT, 54/74AC and 54/74ACT families. The 4000A CMOS family has been replaced by its high-voltage versions in the 4000B and 4000UB CMOS families, with the former having buffered and the latter having unbuffered outputs.

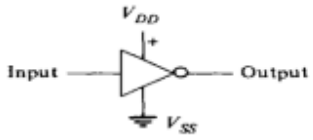
54/74C, 54/74HC, 54/74HCT, 54/74AC and 54/74ACT are CMOS logic families with pin-compatible 54/74 TTL series logic functions. The first complementary metal-oxide semiconductor (CMOS) family of ICs was introduced in 1968 by RCA. Since then, it has become very popular.

CMOS ICs are growing in popularity because of their extremely low power consumption, high noise immunity, and their ability to operate from an inexpensive non regulated power supply.

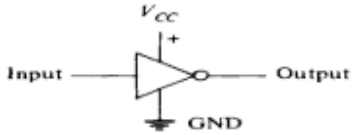
Other advantages of CMOS ICs over TTLs are low noise generation and a great variety of available functions. Some analog functions available in CMOS ICs have no equivalents in TTLs. The schematic diagram of a CMOS inverter is shown in Fig. 4a. It is fabricated by using both N-channel and P-channel MOSFETS (metaloxide semiconductor field-effect transistors). The bottom transistor (Ql) in Fig. 4a is the N-channel enhancement-mode MOSFET. The top transistor (Q2) is the P-channel enhancement-mode MOSFET. Note that the gate (G), source (S), and drain (D) connections of each FET are labeled.



(a) Schematic diagram of a CMOS inverter



(b) Power connections on 4000 series CMOS ICs



(c) Power connections on 74C00 and 74HC00 CMOS ICs

FIG.(4) CMOS INVERTOR.

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Comparison between TTL and CMOS

TTL (Transistor-Transistor Logic) and CMOS (Complementary Metal-Oxide-Semiconductor) are both types of digital logic families used in electronic circuits. Here's a comparison between the two:

1. Power Consumption:

- TTL: Higher power consumption due to the direct coupling of transistors.

- CMOS: Lower power consumption since CMOS devices consume power only when they switch.

2. Speed:

- TTL: Generally faster than CMOS due to direct transistor coupling.

- CMOS: Slower compared to TTL but has improved with advancements in technology.

3. Noise Immunity:

- TTL: Less immune to noise due to direct coupling, making it more susceptible to noise interference.

- CMOS: More immune to noise due to the differential nature of its input stages.

4. Voltage Levels:

- TTL: Operates at higher voltage levels (typically 5V).

- CMOS: Operates at lower voltage levels (typically 3.3V or lower), which reduces power consumption and allows for compatibility with newer technologies.

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5. Fan-Out:

- TTL: Limited fan-out due to higher power consumption and limited driving capability.

- CMOS: Higher fan-out due to lower power consumption and improved driving capability.

6. Temperature Sensitivity:

- TTL: More sensitive to temperature variations, which can affect its performance.

- CMOS: Less sensitive to temperature variations, providing more stable performance over a range of temperatures.

7. Cost:

- TTL: Historically cheaper to manufacture, but this can vary depending on specific implementations.

- CMOS: Initially more expensive to manufacture but has become more cost-effective with advancements in technology and increased demand.

In summary, TTL and CMOS each have their advantages and disadvantages, and the choice between them depends on factors such as power consumption, speed, noise immunity, voltage levels, and cost, as well as specific requirements of the application.

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TTL Applications:

1. Computers and Microprocessors: TTL logic gates were widely used in early computers and microprocessors for tasks such as arithmetic operations, data storage, and control logic.

2. Digital Signal Processing: TTL logic circuits are used in digital signal processing applications such as filtering, modulation, and demodulation.

3. Industrial Control Systems: TTL logic is utilized in industrial control systems for tasks like process monitoring, automation, and feedback control.

4. Test and Measurement Equipment: TTL logic is employed in test and measurement instruments for signal generation, data acquisition, and signal analysis.

5. Telecommunications: TTL logic finds applications in telecommunications equipment for tasks like signal routing, switching, and encoding/decoding.

CMOS Applications:

1. Microcontrollers and Embedded Systems: CMOS technology is extensively used in microcontrollers and embedded systems due to its low power consumption and compatibility with battery-operated devices.

2. Digital Cameras and Imaging Devices: CMOS sensors are commonly used in digital cameras and imaging devices for capturing images and video due to their low power requirements and high integration capabilities.

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3. Consumer Electronics: CMOS technology is prevalent in various consumer electronics devices such as smartphones, tablets, and wearable gadgets for processing data, managing power, and controlling peripherals.

4. Wireless Communication: CMOS circuits are used in wireless communication systems for functions like signal processing, modulation/demodulation, and frequency synthesis.

5. Medical Devices: CMOS technology is employed in medical devices for tasks such as patient monitoring, diagnostic imaging, and data processing due to its low power consumption and integration flexibility.

These are just a few examples of the diverse applications of TTL and CMOS technology in various fields. Both technologies continue to evolve, enabling the development of advanced electronic systems with improved performance and efficiency.