Exp.No.1 TTL GATE CHARACTERISTICS

Aim:

1. To study the characteristics of TTL (NAND) gate
2. Find out $V_{IL}$, $V_{IH}$, $V_{OL}$, $V_{OH}$, Fan-out, Noise margin

Components Required:

1. IC 7400
2. Potentiometer
3. Voltmeter, Ammeter, Digital Multimeter

Standard TTL Gate

Principle:

A two input TTL NAND gate is shown in fig. If either of the inputs A or B is low it will forward bias the emitter junction of the multi-emitter transistor (Q1). This turns Q2 off. Q2 acts as a phase-splitter giving complimentary inputs to Q3 and Q4. Therefore Q3 is on and Q4 off. So output quickly rises to $V_{cc} - I_c R_2 - V_{BE3} - V_0 = 3.8V$ (output high). The output voltage is till 0.4V input.

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When the input voltage reaches 0.4V, Q2 has cut in voltage at emitter-base junction and it goes to active region, with unity gain. Hence the output voltage starts to fall. When input reaches 1.3V, output becomes $V_{CESat}$ of Q4 (0.2V) i.e. Output low.

Fan-out specifies the standard number of the load gates that the output of the gate can drive without affecting its normal operation. This is calculated for both condition of the output (i.e. output low & output high). The smaller one is chosen as fan-out.

**Circuit Diagram**

1. **Transfer characteristics of TTL Gate**

![Transfer characteristics of TTL Gate](image)

2. **To Find Low-level Input Current**

![To Find Low-level Input Current](image)
3. To Find Sinking Current

![Sinking Current Diagram]

4. To Find the Sourcing Current

![Sourcing Current Diagram]

**Procedure**

The circuits are assembled according to the circuit diagrams. To plot the transfer characteristics, vary the input and measure the output. These values are plotted and parameters $V_{IL}, V_{IH}, V_{OL}, V_{OH}$ are measured.

- Low level noise margin = $V_{IL} - V_{OL}$
- High level noise margin = $V_{OH} - V_{IL}$
- Transmission bandwidth = $V_{IH} - V_{IL}$
- Logic output swing = $V_{OH} - V_{OL}$
Using the second circuit $I_{OL}$ is found out for voltmeter reading of $V_{OH}$. Using the third circuit calculate $I_{OL}$ for which the voltmeter reading is $V_{OL}$.

$$\text{Fan-out} = \frac{I_{OL}}{I_{IL}}$$

**Viva Questions**

1. What are the merits and demerits of the TTL family?

2. When does a TTL circuit act as a current source? As a current sink?

3. Explain the working of open collector configuration of TTL gates. Why are open collector outputs generally slower than totem-pole outputs?

4. What is totem–pole output and explain its significance?

5. Explain what is Fan out, Fan in, Propagation delay, and figure of merit of a gate and what are its values for TTL logic families?

**Result:**