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Voltage and Current Measurement of TTL Gates using Kl- 22001 Basic Electrical/Electronic Circuit Lab and Kl- 26001 Combinational Logic Circuit Experiment Module

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ABSTRACT

The experiment carried out on voltage and current measurement on TTL logic gates, by the students of electrical and information engineering in the final year of their studies, in the department's laboratory, which help to understand the voltage and current characteristics of TTL gates and how also how to measure the voltage and current values of TTL gates. This experiment basically shows how voltage and current of TTL gate can be measured. KL-22001 Basic Electrical/Electronic Circuit lab and KL-26001 Combinational Logic Circuit experiment module are the major equipment used to perform the experiment .These were used because it is much more self-explanatory and easier to work with compared other models. It was discovered that Due to its higher resistance value the LS series, TTL gates have lower input current than the standard series TTL gates. Their output currents are about equal.

Introduction

Logic gates are electronic circuits that can be used to implement most elementary logic expressions also known as Boolean expression. The logic gate is the most basic building block of combinational logic. There are three basic logic gates, namely the OR gates, AND gates and NOT gates. The Exclusive OR gate, Exclusive NOR gates, NAND gates, NOR gates are al derived from the basic gates, i.e. combinations of two or more basic logic gates.

Basic logic functions like AND, OR, XOR can be realized in many ways. In the first electronic devices relays and vacuum tubes were used for these purposes. In 1947 the transistor was invented at Bell Laboratories. This resulted in solid state switching, that is much faster and more reliable than relays. Therefore enabled the creation of complex logic functions in small chips. In 1958 the first integrated circuits were invented. One of the simplest integrated ICs is the basic logic circuits.

Logic family integrated circuits are fabricated using bipolar device,metaloxide,semi-conductor(MOS)device, or combination of both.

The logic families that fall under bipolar fabrication family include:

- Diode Logic (DL)
- Diode Transistor Logic (DTL)
- Resistor Transistor Logic (RTL)
- Transistor Transistor Logic (TTL)
- Emitter Coupled Logic (ECL)

And the logic families that falls under the MOS fabrication family are:

- CMOS. etc.

For the purpose of this experimental paper, the TTL will only be discussed

The TTL circuit family

TTL (transistor-transistor logic) uses bipolar transistors to form its integrated circuits. The first TTL family of integrated circuits was produced by Texas Instruments in 1964, which was the SN54 and SN74 series. The SN54 family has a higher temperature range, and it is intended primary for military and extended industrial use. Over the years many TTL variants and versions were developed to improve speed, reduce power consumption, or both. The SN74L series is slower than the original SN74 (typical delay of SN74L series is about 30ns, where the SN74 series has about 10ns delay), but it has a significantly lower power consumption (SN74 has about 1mW/gate power consumption where SN74 series has about 10mW). The first Schottky technology based TTL IC is introduced in 1969. The normal Schottky SN74S series has significantly lowered the delay (to about 3ns), but raised the power consumption (to about 20mW). The Low-power Schottky series SN74LS is introduced in 1971 and it has very low power consumption about 2mW/gate, and a fair delay (about 10ns). Among the last TTL families in 1980s the TTL-F (Fast), TTL-AL (Advanced Schottky) TTL-ALS (Advanced Low-power Schottky) series were also introduced with improved speed and/or with reduced power consumption.

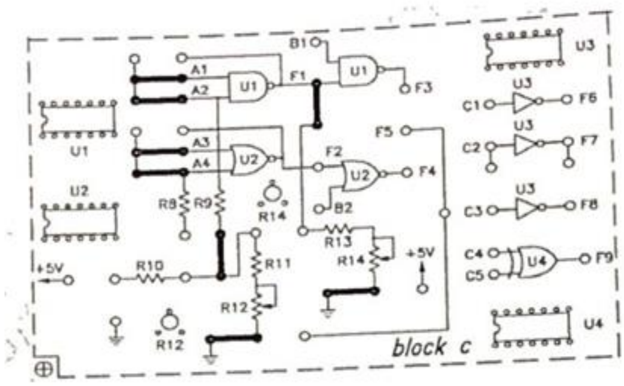

Figure 1

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The experiment was carried out in the following: Procedures, results, references and conclusion.

Procedures

KL- 26001 Module was placed on the KL-22001 Basic Electrical/Electronic Circuit Lab; comparing the connections by referring to figure 1 in the circuit below

External +5VDC from a fixed power was applied on KL-22001 Lab to KL- 26001 module. The input voltage of U1 was measured and R12 adjusted so that V_{IL}= 0.8 V. The voltage across R9 was measures and recorded, V1. I_{IL} was calculated by Vi/10. R14 was also adjusted to find the maximum and minimum of respectively. R14 was then adjusted so as to set V_{OH}= 2.4 V. And ammeter was used instead of the bridging plug between R14 and ground. I_{OH} was measured and recorded. Bridging plugs from R9- R11 and F1-R13 to R8-R11 and F2-R13 were all removed so as to measure the characteristics of U2 (LS series) voltage and current. The input voltage U2 was measured. R12 was adjusted so that V_{IL}= 0.8V. The voltage across R8 was measured and recorded, V. Then I_{IL} was calculated by V_I/100. Also the output voltage of U2 was measured. R14 was adjusted to find the maximum and minimum of $V_{OH.}$ R14 was adjusted so that V_{OH}= 2.4V, an ammeter was used instead of the bridging plug between R14 and ground so as to measure I_{OH}

The previous connections were disconnected and another one was made. The connections were completed by referring Figure 2

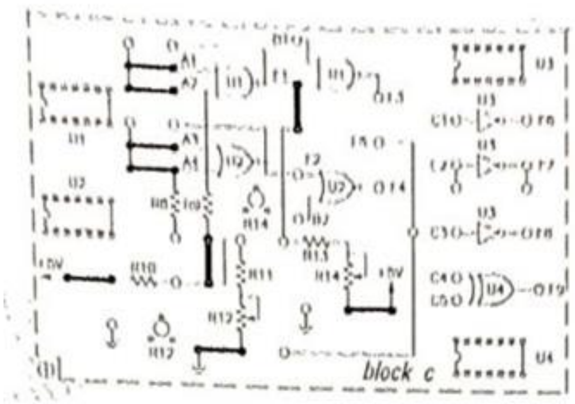

Figure 2

Adjust to set the voltage V_{IH} was adjusted to 2V. Voltage across R9 was measured and recorded. Then I_{IH} was calculated = V_I/100.

The output voltage of U1 was measured and R14 was adjusted to find the maximum and minimum $V_{OL.}$ R14 was set to V_{OL}= 0.4. Ammeter was used instead of the bridging plug between R14 and +5V to measure $I_{OL.}$. The bridging plugs from R9-R10 and F1-R13 to R8-R10 and F2-R13 were removed respectively. Then R12 was set to V_{IH} to 2V. Voltage across R8, V1 was measured and recorded, and I_{IH} was calculated by VI/100. Output voltage of U2 and R14 were adjusted to find the maximum and minimum V_{OL}. R14 was set to V_{OL}= 0.4V, ammeter was used instead of the bridging plug between R14 and +5V to get I_{OL}.

Result

The voltage across R9, V1 as measured b y a voltmeter was 0.03 V. Using equation (1) below, the IIL was calculated.

$$I_{IL}= \frac{V1}{100} \qquad (1)$$

So $I_{IL} = \frac{0.3}{100}$ = 0.3 mA

The maximum and minimum VOH measured were 3.35 V and 1.64 V respectively.

The current flowing across R14, I_{OH} recorded was 21.48 mA.

The voltage across R8, V1 was also measured, and it was found to be 0.1 V. Using equation (1) above, the I_{IL} was also calculated as 1 mA.

At the output voltage of U2, the maximum and minimum V_{OH} were found to be 3.09 V and 0.32 V respectively.

When the new connections was made;

Current across R14 was found to be 13.48 mA.

The voltage across R8, V1 was also measured, 0.1 V. Then also using equation (1) to calculate I_{IL}, 1 mA.

Then at the output voltage of U2, the maximum and minimum V_{OL} were gotten to be 3.09 V and 0.32 V respectively.

The current across R14, I_{OL} when measured was 9.25 mA

Conclusion

Due to its higher resistance value the LS series, TTL gates have lower input current than the standard series TTL gates. Their output currents are about equal

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