[[1]](#footnote-1)

CmpE 124 Lab 1: NOT Gate Characteristics

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*Abstract*— This lab was to recognize the voltage and current characterizes of a 74LS04 Hex Inverter. With 4 different input and output set ups which utilized the potentiometer the goal was to compare the data collected to the manufacture specification sheet of the NOT gate.

# INTRODUCTION

During the lab many measurements were taken across either input or the output of the 74LS04. To measure current the multimeter was to be connected in series, this would ensure precise measurements and safety of the equipment. For voltage the multimeter was connected in parallel. A potentiometer was used as voltage division circuit that would affect the measurements as the resistance was changed. By graphing the collected data for each set up, the output, input, high, low characteristics for voltage and current were compared to the manufactures results. The 74LS04 worked close to its ideal state but some values such as voltage and current output low were not ideal showing that the gates performs well but is not as per specification. This is caused by other factors such as prolonged usage, additive interferences and internal resistances from the wiring and equipment.

# Design methodology

## Parts List

* 1 x 74LS04
* 2 x Multimeter
* 1x Potentiometer

## Truth Tables

Truth Table for 74LS04 Hex Inverter

|  |  |
| --- | --- |
| A | Y |
| 0 | 1 |
| 1 | 0 |

Voltage Table for 74LS04 Hex Inverter

|  |  |
| --- | --- |
| A | Y |
| L-- | H++ |
| H++ | L-- |

## Karnaugh Maps

N/A

## Original and Derived Equations

74LS04 Boolean Equation

## Schematics

Figure 1: 74LS04 Plotting Iin vs Vin [1]

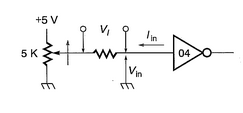


Figure 2: 74LS04 Plotting Vout vs Vin [1]

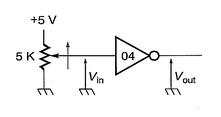


Figure 3: 74LS04 Plotting Vol vs Lol [1]

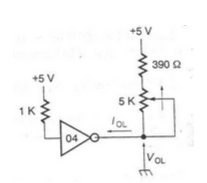
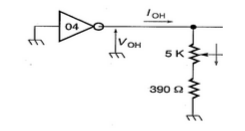


Figure 4: 74LS04 Plotting Voh vs Ioh [1]



# testing procedures

Testing Procedure:

1. Construct circuit schematics labeled as Figure 1, 2, 3, and 4.
2. Figure one vary Vin from 0V to 5V and measure Iin
3. Figure two vary Vin from 0V to 5V and measure Vout
4. Figure three vary Lol from 0mA to 10mA and measure Vol
5. Figure four vary Voh from 0mA to 2mA and measure Voh
6. Collect ­­data using the multimeter in voltage mode and current mode. For voltage measurement attach in parallel, for current attach in series.
7. Plot the data and compare with manufacture specification sheet

# testing results

Table 1: Data for Figure 1

|  |  |
| --- | --- |
| Project 1.1 | |
| Iin vs Vin | |
| Vin (V) | Iin (mA) |
| 5 | 0 |
| 4.5 | 0 |
| 4 | 0 |
| 3.5 | 0 |
| 3 | 0 |
| 2.5 | 0 |
| 2 | 0 |
| 1.5 | 0 |
| 1 | -0.12 |
| 0.5 | -0.18 |
| 0 | -0.24 |

Graph 1: Graph for Table 1

By using a 1kΩ for the center resistor the data from table one plotted show the input current and voltage. While the input voltage is above 1V the current is 0mA but once the voltage drops below 1V a reading is acquired. The reason the current is shown 0mA is due to the fact the multimeter cannot acquire such precise measurements. The specification sheet confirm this by listing the input current high as 40µA and input current low as -1.6mA [2].

Table 2: Data for Figure 2

|  |  |
| --- | --- |
| Project 1.2 | |
| Vout vs Vin | |
| Vin (V) | Vout (V) |
| 0 | 4.33 |
| 0.5 | 4.07 |
| 1 | 0.92 |
| 1.5 | 0.135 |
| 2 | 0.135 |
| 2.5 | 0.135 |
| 3 | 0.14 |
| 3.5 | 0.136 |
| 4 | 0.136 |
| 4.5 | 0.136 |
| 5 | 0.13 |

Graph 2: Graph for Table 2

Analyzing the data from table two and graph two it shows that once the voltage input is above 3V the output voltage is a stable .136V. This is confirmed as the specification sheet states that if the input voltage is higher than 2V the output voltage will be low with a typical of .2V to a max of .4V [2]. For low input voltage of max .8V the output will be high with a typical of 3.4V to a min of 2.4V [2].

Table 3: Data for Figure 3

|  |  |
| --- | --- |
| Project 1.3 | |
| Vol vs Iol | |
| Vol(V) | Iol(mA) |
| 0.132 | 0 |
| 0.168 | 0.5 |
| 0.189 | 1 |
| 0.206 | 1.5 |
| 0.221 | 2 |
| 0.236 | 2.5 |
| 0.25 | 3 |
| 0.262 | 3.5 |
| 0.277 | 4 |
| 0.287 | 4.5 |
| 0.299 | 5 |
| 0.32 | 6 |
| 0.346 | 7 |
| 0.369 | 8 |
| 0.39 | 9 |
| 0.412 | 10 |

Graph 3: Graph for Table 3

During the increased variation of the output current the output voltage increased as well. At the last data point 10mA the voltage was recorded .412V meaning the current was a low output and the voltage was a low output in relation. Even though the specifications says that the output current low max is 16mA, while at the max the output voltage will be low but at a max .4V [2]. Since the data collected hit the max voltage before max current it means the data is verified but the gate was no operating in an ideal state.

Table 4: Data for Figure 4

|  |  |
| --- | --- |
| Project 1.4 | |
| Voh vs Ioh | |
| Voh(V) | Ioh(mA) |
| 4.95 | 0 |
| 3.54 | 0.3 |
| 3.48 | 0.6 |
| 3.46 | 0.9 |
| 3.36 | 1.3 |
| 3.41 | 1.6 |
| 3.4 | 1.9 |
| 3.39 | 2 |

Graph 4: Graph for Table 4

From the final graph and table the voltage and current output highs were measured. As the output high current was increased the output high voltage remained stable around 3.4V. This is confirmed as the specification sheet shows a typical output voltage high of 3.4V with a minimum of 2.4V for a maximum output current high of -.4mA [2]. This means as long at the output current is of any value at or below the maximum the output voltage will be close to 3.4V.

# Conclusion

This lab showed the basic characteristics and reinforced the fundamentals for one of the most important logic gates, 74LS04 known as the NOT gate or Hex Inverter. Proving that the manufactures tests under ideal environment are true for all non-defective gates was done with standard measuring equipment and simple circuit construction. Since most of the collected data matched the expected it shows the gate can be used optimally for logic design.

# appendices and references

[1] Özemek, Haluk. (2014, Aug 14). 124\_Labs [Online], Available:https://sjsu.instructure.com/courses/1142847/files

[2] Texas Instruments. (1998) TTL Logic Data Book, Texas Instruments. Dallas, TX. [Online]. Available: http://www.ti.com/sc/docs/psheets/databook.htm

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