

Lab 2: Functionality Verification of Gates

ECE218-L01

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Introduction

Purpose

To become familiar with basic digital circuits and confirm the functionality of gates.

Scope

Measure the voltage across LEDs and resistors for the AND gate and measuring digital data using Analog Discovery device.

Theory

Theoretical Basis

All digital systems perform computations using Boolean algebra. Because of this dependence it is important for understanding the working of the gates to ensure success.

Preliminary Work

1. Write the truth tables for the NOT and OR gates

NOT Gate	
Input	Output
0	1
1	0

OR Gate		
Input 1	Input 2	Output
0	0	0
0	1	1
1	0	1
1	1	1

- 2. What is the maximum low level input voltage for the NOT gate in the chip SN74LS04?
➤ 0.8 V
3. What is the minimum high level input voltage for the OR gate in the chip SN74LS32?
➤ 2 V
4. What is the allowed range of the supply voltage for the AND, OR and NOT gates from Texas Instrument (SN74LS08, SN74LS32, SN74LS04)?
➤ AND: 4.75 V ~ 5.25 V
➤ OR: 4.75 V ~ 5.25 V
➤ NOT: 4.75 V ~ 5.25 V
5. What is the minimum and nominal output high voltage for all the three gates mentioned in preceding question (V_{OH} for $V_{cc} = \text{Min}$, $I_{OH} = -0.8 \text{ mA}$ and $V_{IH} = 2V$; Refer the datasheet of all three gates)?

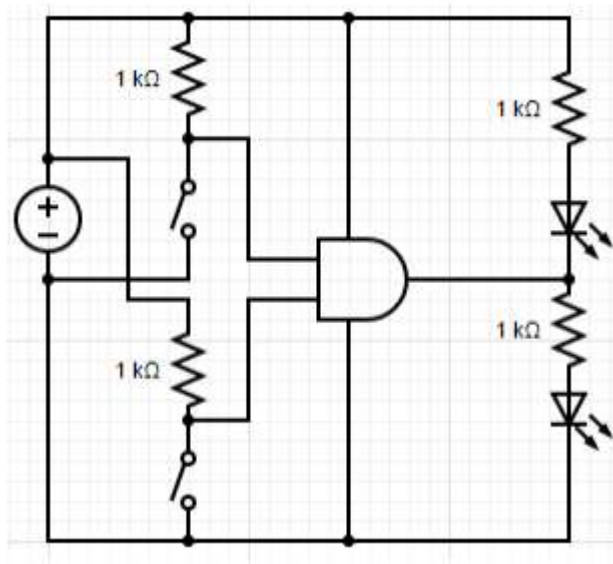
Chip	Min. V	Max. V
SN74LS08 (AND)	2.4V	3.4V
SN74LS32 (OR)	2.4V	3.4V
SN74LS04 (NOT)	2.4V	3.4V

- 6. What is the maximum frequency of a square wave that can be provided to the NOT gate (see T_{plh} and T_{phl} values given in datasheet)?

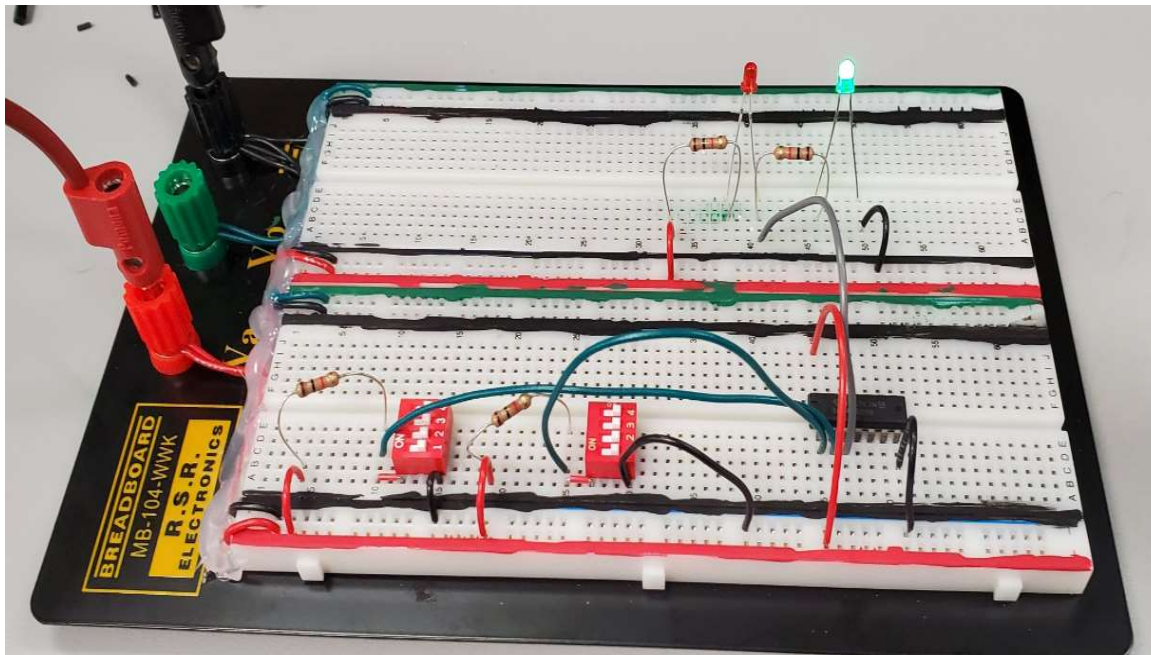
➤ $\frac{1}{15ns} = 0.0667ns^{-1}$

Experimental Procedure

Schematics (Circuit Diagram)



Breadboard



Equipment:

- copper wire

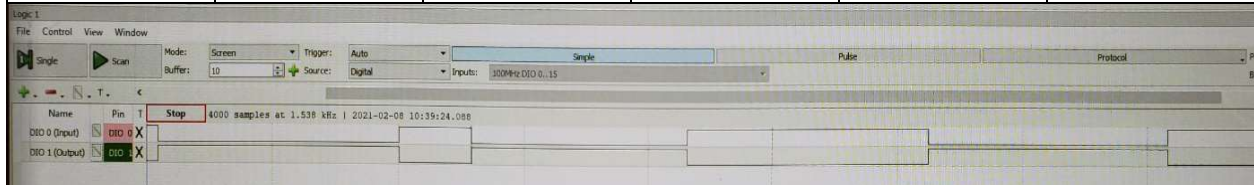
- 4 1k Ω resistors
- 2 DIP SPST switch
- red LED
- green LED
- SN74LS08N AND gate
- SN74LS04N NOT gate

Procedure

1. Set up circuit depicted in circuit diagram on breadboard
2. Connect breadboard to desktop voltage source and set to 5V
3. With both switches closed record voltage across resistors and LED and record which LED is lit
4. Repeat step 3 for all combinations of switch states
5. Set up NOT gate circuit with input from the waveform generator attached to both the NOT gate and Analog Discovery device and the output of the NOT gate attached to the Analog Discovery device
6. Connect Analog Discovery device to computer and, using the Waveform Digilent software, screenshot what the software displays

Results

Voltage (V)					
Input	LED (Red)	LED (Green)	Resistor 1	Resistor 2	LED lit
00	1.89	0.18	2.93	0	Red
01	1.89	0.18	2.93	0	Red
10	1.89	0.18	2.93	0	Red
11	1.54	2.36	0	1.10	Green



No calculations performed.

Interpretation

The results were as expected with the green LED lit when both switches were open while all other configurations had the red LED lit. The green LED signified that the AND gate was outputting a true signal while the other configurations were an output of false. While analyzing the NOT gate

the Waveform software displayed that the output of the gate was inverse to the input from the waveform generator. Resistance in wires could have led to incorrect voltage measurements.

Conclusion

We can conclude that it is possible to create circuits using AND and NOT gates and view their output using LEDs and digital software. We can also confirm that both gates perform as expected.