**Lab– XOR Logic Gates and Comparators**

**Investigation 1**

**Objectives:**

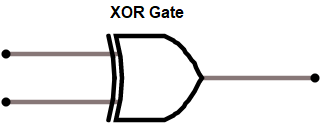
-To compare the input and output digital waveform signal of an XOR Logic gate.

-To draw the timing diagram of operation for an XOR gate

-To look at an application that uses XOR gates

**Pre-Lab:**

-Determine the truth table for an XOR gate

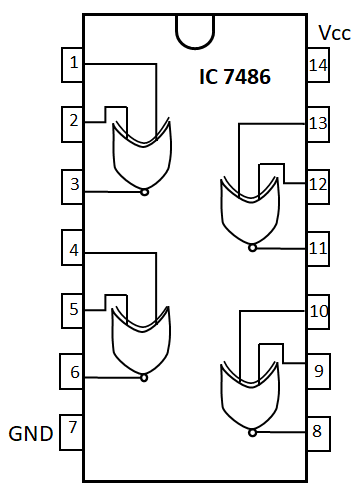
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**Figure 1-** XOR Gate[[1]](#endnote-1)

**Equipment:**

One 7486 XOR gate; One 330 Ohm resistor; 1 kOhm resistor; One 4 position DIP switch.; One LED

IC Pin Diagrams

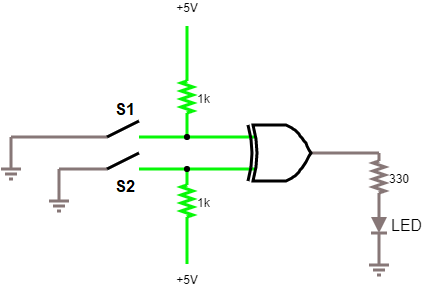


**Figure 2-** Pin diagram for 7486 Quad 2-input XOR gate

**Investigation 1- Activity 1**

**Procedure**

1.Use the pin diagram and wire up the circuit below. Note that the circuit uses just one XOR gate. The IC 7486 chip has 4 logic gates since in many cases you will need to use more than one logic gate to build more complex circuits.

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**Figure 3-** Circuit for determining the truth table of an XOR gate

2.Make sure that you know which pins of the IC are the inputs and which are the outputs. Refer to the pin diagram above and lab the pins on the circuit in figure 1. Also, be sure you are applying power (Vcc) and ground to the correct pins otherwise your circuit will not function. The value of Vcc should be 5 Volts.

3. It is important to note that when the switches are open the inputs are set to 5.0 V which is a ‘high’ or ‘1’ and when the switches are closed they are connect to ground or ‘Low”. Also, when output of the XOR gate is a high, the LED will turn on.

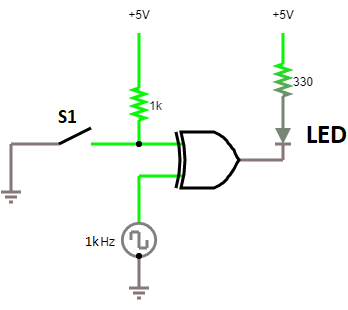
Complete the following truth table for the XOR Gate

|  |  |  |  |
| --- | --- | --- | --- |
| Input A | Input B | Output  Logic  State | Output Voltage (V) |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

**Investigation 1- Activity 2**

**Procedure**

1.Use the pin diagram and wire up the circuit below. Note that the circuit uses just one XOR gate. The IC 7486 chip has 4 logic gates since in many cases you will need to use more than one logic gate to build more complex circuits.

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**Figure 4-** Circuit that uses XOR gate

2.Make sure that you know which pins of the IC are the inputs and which are the outputs. Also, be sure you are applying power (Vcc) and ground to the correct pins otherwise your circuit will not function. The value of Vcc should be 5 Volts.

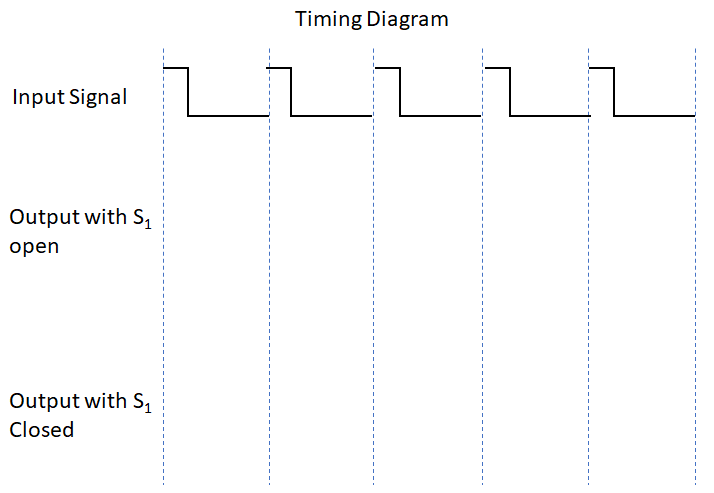
3. The input on pin 2 of the XOR gate should be a pulsed signal from the frequency generator. Use a 5V square wave and set its frequency to 1000 Hz

4. With switch S1 open, observe the input and output signals simultaneously on the oscilloscope and draw what you see in your notebook (see below for an example of how to sketch it).

6. Now close switch S1 and draw the timing diagram in your notebook.

**Data and Observations**

Examine the input and output waveforms of the circuit above. Draw the timing diagram in your notebook in the same format as shown below.

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**Questions**

1. What effect does opening and closing S1 have on the original digital signal?
2. In the previous lab, you constructed an inverter and a follower using a combination of NAND or NOR gates. Under what conditions does the circuit above behave like an inverter?

**Investigation 2- Comparators**

**Objectives:**

-To build a comparator circuit and use it to compare two binary numbers

-To understand the concept of MSB and LSB

**Pre-Lab:**

1.Determine the Most Significant Bit (MSB) and Least Significant Bit(LSB) of the following numbers:

1001

101

011110

2. Which of the following 4 bit numbers is greater? Circle the answer.

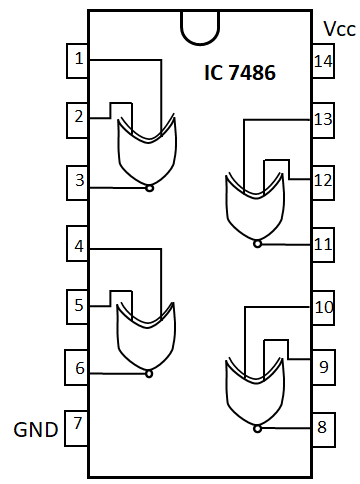
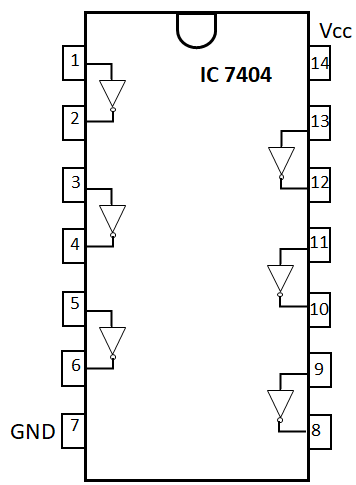
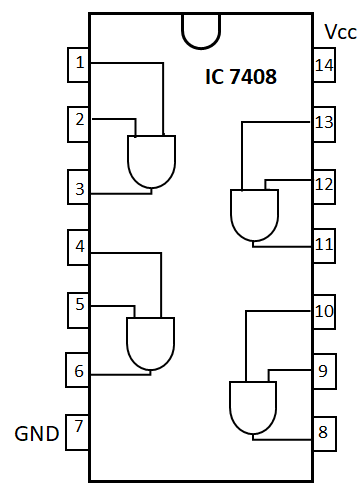
a. 1011 or 1101?

b. 0110 or 0111?

c. 1010 or 0100?

**Equipment:**

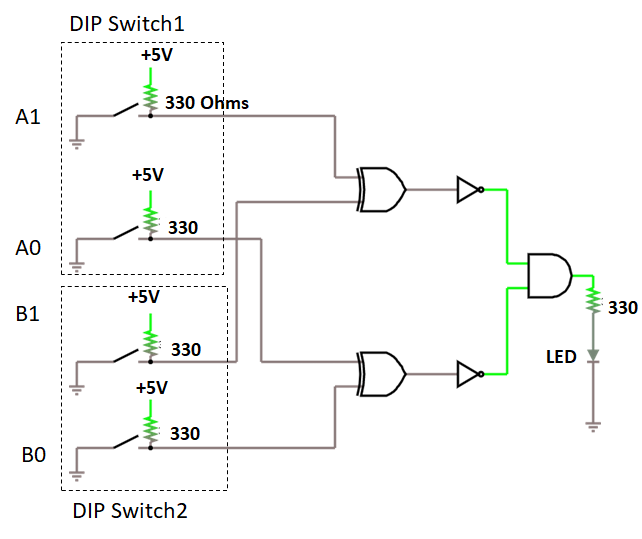
One Quad 7486 XOR gate; One 7404 Hex Inverter; One 7408 Quad AND gate; One 7485 4 bit comparator; Five 330 Ohm resistor; Two 4 position DIP switch.; One LED

IC Pin Diagrams

**Figure 5-** Pin layout diagrams for IC 7486 XOR gate, IC 7404 Hex Inverter, and IC 7408 AND gates

**Activity 1 – Build a Comparator circuit**

1.Use the pin diagrams above and wire up the circuit below. You will be comparing two binary numbers A and B with A1 and B1 being the most significant bit (MSB) of each number and A0 and B0 being the least significant bit (LSB).



**Figure 6-** Comparator circuit

2.Make sure that you know which pins of the IC are the inputs and which are the outputs. Also, be sure you are applying power (Vcc) and ground to the correct pins of each IC otherwise your circuit will not function. The value of Vcc should be 5 Volts.

3. You will use the two DIP switches to set the input values. The table below gives you a list of 2 bit numbers that you will use as inputs to the logic gates. **Note:** The circuit has been designed so that the LED only lights up when the output of the AND gate is a high.

**Data and Observations**

Examine the inputs and outputs of the circuit above. Determine the truth table for this circuit.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| A1 | A0 | B1 | B0 | Output |
| 0 | 0 | 0 | 0 |  |
| 1 | 0 | 0 | 1 |  |
| 0 | 0 | 1 | 1 |  |
| 0 | 1 | 0 | 1 |  |
| 1 | 0 | 1 | 0 |  |
| 0 | 1 | 1 | 0 |  |
| 0 | 1 | 1 | 1 |  |
| 1 | 1 | 0 | 1 |  |
| 1 | 1 | 1 | 1 |  |

**Questions**

1. From the data in the table, in which cases is the output of the AND gate high? In other words, how do the binary numbers A and B compare when the LED goes on?

1. All schematic diagrams were created with Falstad circuit simulator (https://falstad.com/circuit/) [↑](#endnote-ref-1)