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BS – Multimedia Gamming

Digital Logic Design Lab

Lab # 02: NAND, NOR, XOR, and XNOR Gate

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Lab Learning Objectives:

Upon successful completion of this experiment, the student will be able:

- To explore the function of various different logic gates
- To create circuits with varying logic gates in theory and in practice

Lab Hardware and Software Required:

Platform: NI ELVIS III	✓ View User Manual: http://www.ni.com/en-us/support/model.ni-elvis-iii.html ✓ View Tutorials: https://www.youtube.com/playlist?list=PLvcPIuVaUMIWm8ziaSxv0gwtshBA2dh_M
Hardware: Digilent Digital Electronics Board for NI ELVIS III	✓ View NI DSDB Board Manual: http://www.ni.com/pdf/manuals/376627b.pdf
Software: NI Multisim 14.0.1 Education Version or newer	✓ Install Multisim: http://www.ni.com/gate/gb/GB_ACADEMICEVALMULTISIM/US ✓ View Help: http://www.ni.com/multisim/technical-resources/
Software: NI LabVIEW FPGA Vivado 2014.4	✓ Install: http://www.ni.com/download/labview-fpga-module-2015-sp1/5920/en/ **Note:** Digilent Driver (The installer above automatically downloads the installer below onto your computer) ✓ Navigate to: C:\NIFPGA\programs\Vivado2014_4\data\xicom\cable_drivers\nt64\digilent ✓ Install: install_digilent.exe

Background Theory:

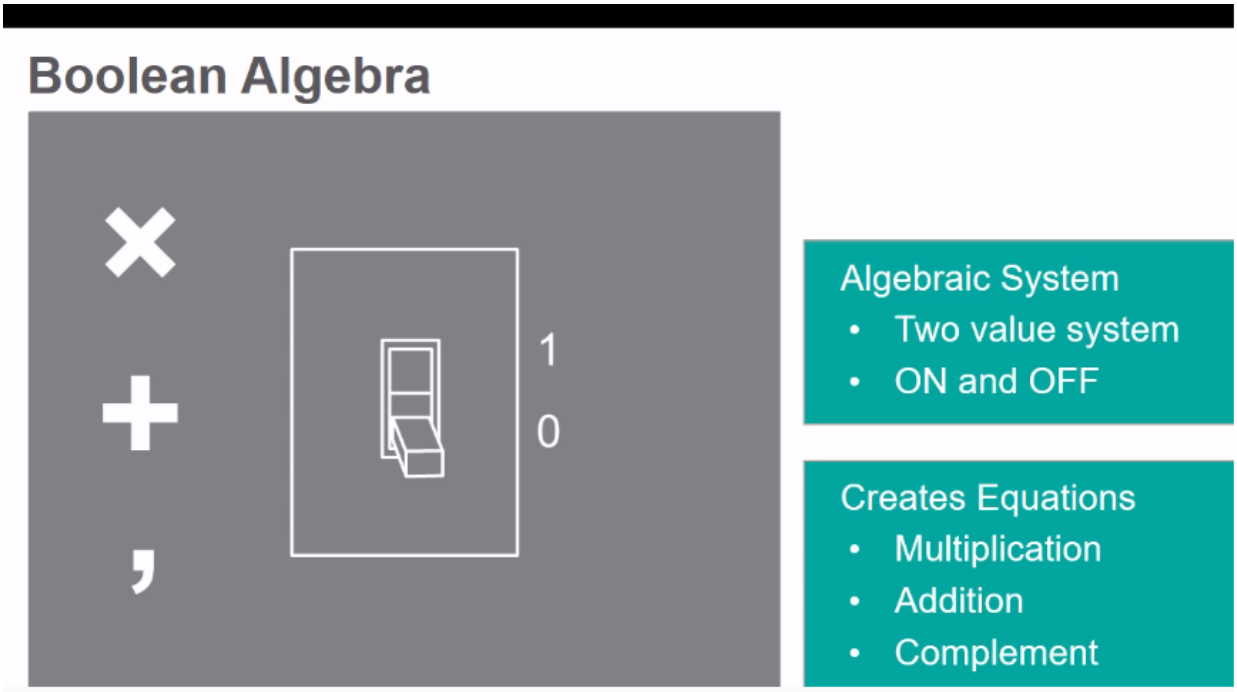


Figure 1-1 Video. View the video here: https://youtu.be/1wnztS6et0w

Video Summary

- NAND, NOR, XOR, and XNOR gates have at least two inputs, one output, and a unique truth table
- NOT gate output is the inverse of the input

Inverters

- Inverters are also known as *NOT* gates.
- They have only one input and one output.
- The truth table for an inverter is simple. The output is always the *opposite* of the input.
- For example, if the input is 1, the output will be 0 and vice versa. Visually this is depicted by a circle at the input and/or output ends of the logic gates.
- In this situation, the circle is at the output, which means that the output is inverted. If it was at the input, then it is the input that would be inverted.
- Circuits with more than one input can use NAND or NOR logic gates which we will explore next.

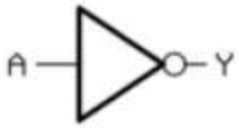


Figure 1-2 Inverter

NAND Logic Gates

- *NAND* gates invert the output of the AND gate.
- The inputs do not change from those of the AND truth table, but the output is the opposite.
- As a rule, if any of the inputs are 0, the output will always be 1.
- See below for the truth table and the symbol.

A	B	O
0	0	1
0	1	1
1	0	1
1	1	0

Figure 1-3 NAND gate truth table and symbol

NOR Logic Gates

- The *NOR* logic gate inverts the output of the OR gate.
- The inputs of the truth table for the OR gate do not change, but the output is the opposite.
- As a rule, if any of the inputs are 1, the output will always be 0.
- See below for the truth table and symbol.

A	B	O
0	0	1
0	1	0
1	0	0
1	1	0

Figure 1-4 NOR gate truth table and symbol

XOR Logic Gates

- An *XOR* gate is also known as an exclusive OR gate.
- The output will be 1 if only one of the inputs is 1. The output will be 0 if both inputs are 0 or both are 1.
- See below for the truth table and symbol.

A	B	O
0	0	0
0	1	1
1	0	1
1	1	0

Figure 1-5 XOR gate truth table and symbol

XNOR Logic Gates

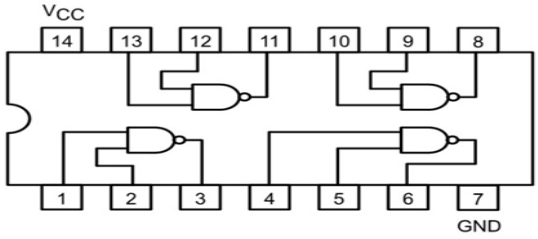
- The *XNOR* gate does the opposite of the XOR gate.
- The output will be 1 if the inputs are the same and the output will be 0 if the inputs are not the same.
- See below for the truth table.

A	B	O
0	0	1
0	1	0
1	0	0
1	1	1

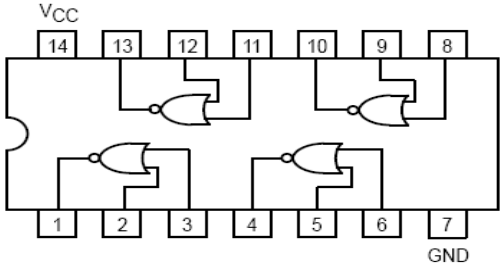
Figure 1-6 XNOR gate truth table

Exercise 1: Implementation of following ICs' on NI Elvis kit using Digital Reader and Digital Writer

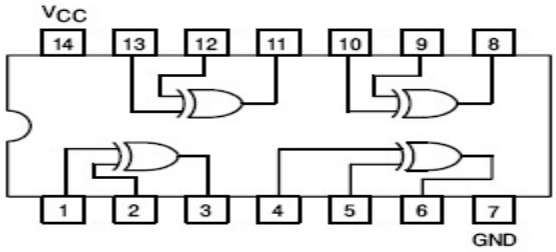
74LS00 2-input NAND gate IC:



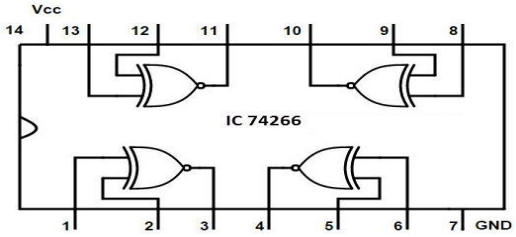
74LS02 2-Input NOR Gate IC:



74LS86 2-Input XOR Gate IC:



74LS266 2-Input XNOR Gate IC:



Exercise 2: Building an XOR Logic Gate in Multisim

XOR Gate Circuit

Build the following circuit using an XOR gate:

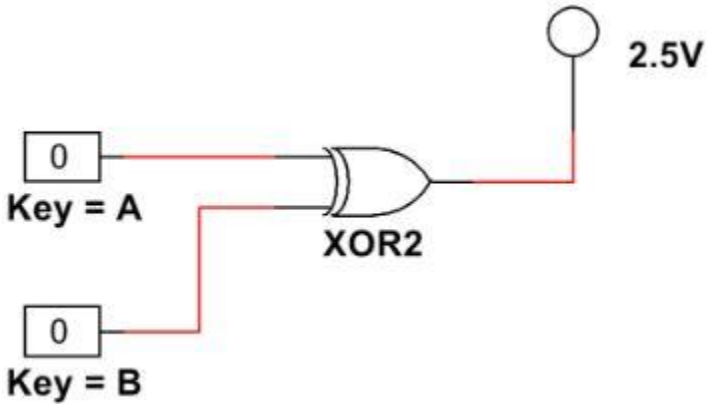


Figure 1-18 XOR gate circuit

Configure the Digital Constants:

- Double-click the top **Digital Constant**.
- In the window that appears, select '**A**' from the Key for toggle dropdown.
- Change the second constant to toggle with the '**B**' key.
- Click the **Run** to begin simulating the circuit.

Figure 1-19 Run button

- Press the '**A**' key on the keyboard to change the value of that input to **1**.

1-9 Does the probe turn on?

A. Yes
B. No

- Press the '**A**' key again to change the top input back to **0**.
- Press the '**B**' key to change the second input to **1**.

1-10 Does the probe turn on?

A. Yes
B. No

- Press the '**A**' key, so that both inputs are equal to **1**.

1-11 Does the probe turn on?

A. Yes
B. No

1-12 How would you describe the behavior of this gate?

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- When you're done, stop the simulation by clicking the **Stop** button.

Figure 1-20 Stop button

Exercise 3: Building a NOR Logic Gate on the Digital Electronics Board

Using the switches, LEDs, and logic gates, create the following circuit:

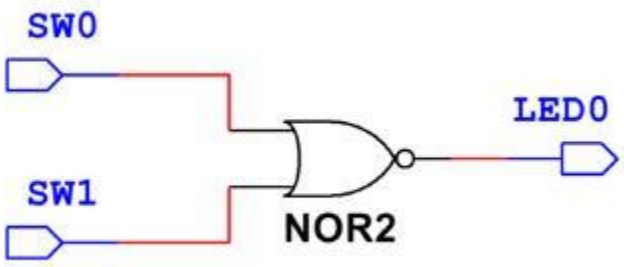

Figure 1-21 PLD design

Configure the Digital Constants:

- Double-click the top **Digital Constant**.
- In the window that appears, select '**A**' from the Key for toggle dropdown.
- Change the second constant to toggle with the '**B**' key.
- Click the **Run** to begin simulating the circuit.

Figure 1-21 Run button

- Press the '**A**' key on the keyboard to change the value of that input to **1**.

1-9 Does the probe turn on?

C. Yes
D. No

- Press the '**A**' key again to change the top input back to **0**.

- Press the '**B**' key to change the second input to **1**.

1-10 Does the probe turn on?

C. Yes
D. No

- Press the '**A**' key, so that both inputs are equal to **1**.

1-11 Does the probe turn on?

C. Yes
D. No

1-12 How would you describe the behavior of this gate?

_____

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- When you're done, stop the simulation by clicking the **Stop** button.

Figure 1-22 Stop button