Lab Experiment 5

Combination of Logic Circuit

COMPONENTS

- 74LS08 Quad AND gate
- 74LS32 Quad OR gate
- Jumper Wires
- Protoboard
- Digital Board

INTRODUCTION

The theoretical operation of a combination logic circuit can be predicted by analyzing the circuit's output for every possible input combination. The circuit analysis for each input combination is performed by determining the resultant output of each gate, working from the input side of the circuit to the output.

Logic circuits may be functionally equivalent. They may perform the same function (their logic truth tables are identical) but be constructed from different logic gates or interconnected in an entirely different manner.

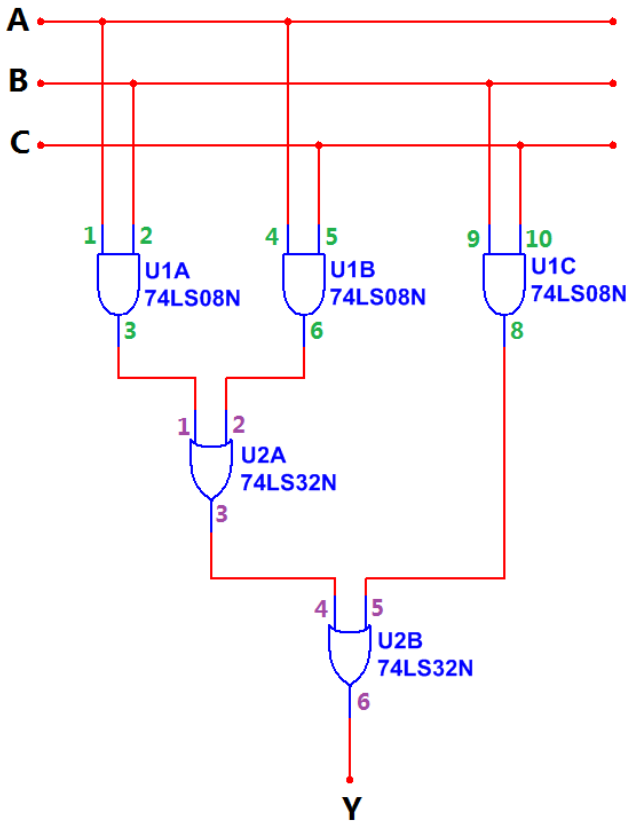
The process of combinational circuit design start from obtaining a Sum-Of-Product, SOP, equation, which is the most commonly used format for writing logic expressions. SOP expressions can be quickly written from a truth table and they are easily implemented using a tow-level (not counting inverters that may be needed) gate network. Conversely, these standard circuits that are used to implement SOP functions can be quickly analyzed just by inspection. A SOP expression consists of two or more products (AND operation) terms that are sum (OR operation) together. The SOP expression is obtained from a truth table by writing down all of the product terms (called midterms) whose outputs are high fro the desired function and then add them together. The resultant and simplified SOP expression can be directly implemented with either AND/OR or NAND/NOR circuit designs. (Moss, 2004)[1]

[1] Moss, G. L. (2004). *Lab Manual: a design approach to accompany digital systems: "Combination of Circuit Desing" page 21-22.* New Jersey: Pearson Prentice Hills.

Part 5.1 – 3 input sensors design

Circuit Description: In a chemical plant three tanks are used to store three different liquid chemicals used in a manufacturing process. A level sensor in each tank produces a HIGH voltage when the liquid level in the tank drops below a specific point. Design a circuit that monitors the levels and produces a HIGH when the level of any two tanks drops below the specified level.

Here is the logic circuit design:



Circuit 5.1 – Three input Logic Circuit Design

LAB EXPERIMENT PROCEDURE

The first step of this lab is to find the Sum of Product Equation (SOP) of the given Circuit 5.1.

For this, you are going to use the logic inputs A, B, and C from Circuit 5.1, and write the output Y according to the flow of the inputs through the circuit.

The SOP equation of Y is: _____

Once the SOP equation of Y is found, the next step is to build the physical Circuit 5.1 in a protoboard and test and record the output Y in Table 5.1. Before building the physical circuit, remember to assign a switch and LED from your digital board to each input. One way to assign them could be as:

- Switch 8 will be the A input.
- Switch 7 will be the B input.
- Switch 6 will be the C input
- LED 1 will show the state of the C input.
- LED 2 will show the state of the B input.
- LED 3 will show the state of the A input.
- LED 5 will show the state of the output.

Now, build the circuit according to the connection in Circuit 5.1.

With the circuit built, manage the inputs according to Table 5.1, and observe and record the output Y (LED 5). Use "1" when the LED is ON and "0" when the LED is OFF.

Inputs			**Output Y**
Tank C	**Tank B**	**Tank A**	**Confirmed by experiment**
0	**0**	**0**	
0	**0**	**1**	
0	**1**	**0**	
0	**1**	**1**	
1	**0**	**0**	
1	**0**	**1**	
1	**1**	**0**	
1	**1**	**1**	

Table 5.1 - Truth Table for 3-inputs Sensors Circuit Figure 1

Once Table 5.1 is completed, call the lab instructor to check the result.

Using the output from Table 5.1, write the SOP equation for all output that are "1"

The SOP equation from Table 5.1 is: _____

Compare your data in Table 5.1 with the SOP equation of Y, are they related? Discuss this experimental part in your lab report.

Sketch below the logic circuit schematic of the SOP equation from Table 5.1

Logic Circuit Schematic

Ask the lab instructor to check your sketch. Once the lab instructor approved your circuit schematic, open multisim, save the file as *Lab5_LastName*, and construct the logic circuit schematic. After the circuit is built, run the simulation and check if it is working as its truth table, Table 5.1. If it is working as Table 5.1, insert a title block with the following information (if you forgot how to insert a title block, use lab 3 as reference)

Title: Combination of Logic Circuit and SOP equation
Description: Simulation of a three input sensors

Designed by: Student Name (type your name)
Date: Insert the data

Have a screenshot of complete logic circuit, the workspace with the title block, and save the image for your lab report.

QUESTIONS

1. In your own words, describe what is a SOP equation and what does it represent in digital circuit?
2. Find the SOP of the following truth table

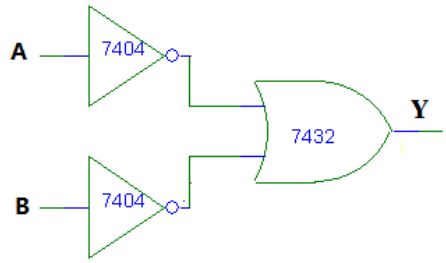
Truth Table		
Inputs		Output
B	A	Y
0	0	1
0	1	0
1	0	1
1	1	0

SOP _____

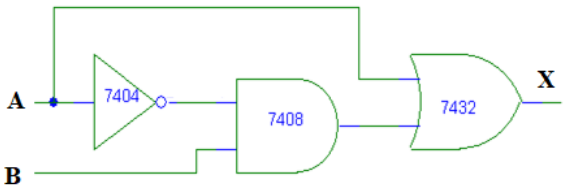
Truth Table		
Inputs		Output
LED 1	LED 2	LED 3
0	0	0
0	1	1
1	0	1
1	1	1

SOP _____

3. Find the SOP of the following logic circuits:



SOP of Y = _____



SOP of X = _____

4. Sketch the logic circuit of the following SOP equations:
   a. $A + \bar{A}B + A\bar{B}$
   b. $ABC + \bar{A}\bar{B}C$

Student's name:_____ Lab instructor's signature_____

---------- **LAB EXPERIMENT 5 ENDS HERE** ----------