Project 2: Combinational Circuit Design

Objectives

Design a combinational logic circuit from a functional specification. Minimize a logic function using a Karnaugh map. Develop a NAND-NAND implementation of a logic function.

Specific Instructions

A 2-bit "comparator" circuit receives two 2-bit numbers $P = P_1P_0$ and $Q = Q_1Q_0$. Design a minimal sum-of-products circuit that produces an output GT = 1 iff P > Q.

1. Fill in the truth table to determine the input/output relationship of the circuit.
2. Obtain a minimized sum-of-products logic expression using a Karnaugh map.
3. Draw a NAND-NAND circuit diagram implementing the minimized function.
4. Implement the circuit in hardware, using the Xilinx design tools and the Spartan3E FPGA on the BASYS Board.
   a. Draw the schematic using standard gates from the symbol library.
   b. Constrain the design with the following pin assignments:

I/O Name	Location	BASYS	BASYS 2
P_1	SW3	P24	B4
P_0	SW2	P29	K3
Q_1	SW1	P36	L3
Q_0	SW0	P38	P11
GT	LD0	P15	M5

   c. Generate a programming file (.bit) for the FPGA.
   d. Download the design onto the BASYS Board.
5. Test the circuit on the BASYS Board using the input switches and output LED.
6. Demonstrate the correct operation of your circuit to your professor and obtain his initials on your cover sheet.
7. Write a project report containing the following:
   a. Cover sheet with project name/number, date, and authors names.
   b. Objective section describing what was to be accomplished.
   c. Discussion section showing your truth table, Karnaugh map, and NAND-NAND circuit schematic.
   d. Results and Conclusions.

Truth Table

mt	P Q	P_1 P_0 Q_1 Q_0	GT (P > Q)
0	0 0	0 0 0 0	
1	0 1	0 0 0 1	
2	0 2	0 0 1 0	
3	0 3	0 0 1 1	
4	1 0	0 1 0 0	
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