Project 2.2.4 Combinational Logic Circuit Design: Displays

Introduction

As you have seen in your activities this unit, logic gates can be used to create displays in a variety of ways using seven segment displays. In this project, you will work as a team to create a message display on a group of seven segment displays to simulate a LED display board.

Procedure

1. Define the Problem:
   a. Brainstorm ideas for messages or designs to display under the following constraints.
      i. There must be 2 inputs utilized for a total of 4 states shown on a given display.
      ii. Each person must create outputs for at least 2 displays - one common anode, one common cathode.
      iii. Any 1 display may not be dark for more than 2 states.
   b. Create a design brief that summarizes your design problem and constraints.
   c. Select one member to create a folder titled P224_LastNames under their Unit 2.2 folder. List the last names of team members in alphabetical order with _ between. Share this folder with all remaining team members so that they "Can edit". All remaining team members should move this file into their DE folder from the "Shared with me" location.
   d. Elect one person to create a copy of the ProjectLog Spreadsheet for your team & move it into this folder. Title the **spreadsheet as P224_LastNames**. The first tab of your spreadsheet should be your norms and then rename the other sheets for the project log of each person in your team.
   e. Elect one person on your team to create a Google **Document titled P224_LastNames**. Type all team members' last names in alpha order.
   f. Create a title page as the first page and then table of contents on the second page. Begin your design brief on the third page.
2. Circuit Design:
   Each person should complete Parts 1-5 for their 2 displays - please be sure to note who completes which displays in the documentation and what type of display (CK or CA) it is.
   a. Part 1: Create a truth table for ***each*** display being used in your circuit like the one shown below. ***Be sure to note when the inversion for common anode is done - TT or LE.***

Inputs		Seven-Segment Display Segments							Display
X	Y	a	b	c	d	e	f	g	
0	0								
0	1								
1	0								
1	1								

   b. Part 2: Write the un-simplified logic expression for each segment output. Then simplify each expression if possible.

3. Implement & Test:
    a. Part 3: Now, create the AOI circuit needed to implement each display. Evaluate the efficiency of IC usage needed to implement your circuit. (Efficiency is defined as the % of gates used on each IC needed. For example, using only 1 of the 4 gates on an IC would be 25% efficient.)
    b. Part 4: Use NAND and/or NOR substitution on the circuit to see if you can increase the efficiency of ICs used. Show the necessary circuits/work to prove that you've reached the highest efficiency for your part of the design. Annotate your logic clearly so that implementation and equality is easily understood. Use the same 2+ inputs wired to each of the 2+ displays. Save your file as P224_LastFirst_Sim. Upload your file to your P224 shared folder.
    c. Part 5: Each team member will now build their circuit using the needed logic gates. On your protoboard, additionally wire 2 LEDs to your input switches so that the current state can be seen with the correct letter display. Verify it is working correctly by checking it against your truth table.
    d. **Part 6: Simulation Integration -** Now, elect one member to download all other Multisim files and collect all team members' simulations into 1 circuit. Move the displays into the correct locations so that your simulation displays your message correctly and clearly. Wire all displays to the same 2 inputs and use highlighting on your simulation file to clearly define sections and logic. Save this final file as **P224_LastNamesinAlphaOrder_FinalSim**.
    e. **Part 7: Breadboard Integration -** Connect all breadboards together through a panel of SSDs on one board. You may decide to do this in a number of ways, but you must be able to demonstrate the section that EACH person worked on.
    f. Optional - You may implement a 2-bit counter to toggle through your binary states if desired.
4. Document & Present:
    a. Part 8: Calculate the overall efficiency of your team's circuit. Be sure to enumerate the ICs used and express your efficiency in terms of IC-types and total ICs in the circuit.
    b. Part 9: Complete your document with the following sections.
        i. Title Page - team members names, date, period, project name
        ii. Table of Contents - corresponding sections and page numbers
        iii. Design Brief - all design brief sections fit to one page
        iv. Display Definitions & Truth Tables - display configuration and definitions, truth tables, paragraph explanation of output requirements
        v. Output Logic Expression & Simplification - algebraic expression and simplification shown neatly
        vi. Solution - Simulation & Breadboard - images of simulation and breadboard shown clearly, multiple views as necessary, labels and descriptions of final design, join/show images of the states to show the fully message clearly, tables with efficiency summary of full circuit
    c. Part 10: In-Class Presentation - Be sure to include the following during your presentation.
        i. Introduce your team members and project
        ii. Describe your circuit design - purpose, use, input definitions, output requirements
        iii. Demonstrate the functionality of your full simulation and how the system was divided - show all states perform as intended
        iv. Demonstrate the functionality of each breadboarded portion - show all states to prove your output requirements have been met
        v. Give us some insight into your design process - address any challenges, discuss strategies that you took in creating your design, anything especially interesting or unique about your design

File Submission Due on Tuesday 02/06/2024 - Submit the link to your ENTIRE folder containing all project files to the Inbox (documentation, spreadsheet, Multisim files, photos, etc). **In-class presentations will be on 02/05**.