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Digital Logic Design, Winter Semester 2023
Final Project - Milestone 1
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Milestone Overview

In this milestone, you will be challenged to apply the knowledge and skills you've acquired throughout the course to design, construct, and test a 4-bit binary adder/subtractor circuit. Using key components from your curriculum such as multiplexers, decoders, and adders, you will create a practical and interactive solution to a real-world computational task.

Project's Description

Your primary objective is to design a 4-bit binary adder/subtractor circuit in Logisim that incorporates the following elements. Please follow the sequence of steps mentioned below:

Input and Output Preparation: Begin by setting up eight binary inputs (4 bits each for the two numbers you're adding/subtracting), a control input (1 bit to select the operation: 0 for addition, 1 for subtraction), and an output to display the 5-bit result. Assign different colored LEDs for each type of output (Check the below section for the LEDs).

Full Adders: Construct your adder/subtractor using full adders. Each full adder should take three inputs (two bits of the numbers being added/subtracted and a carry bit from the previous full adder) and produce two outputs (a sum and a carry). Stack four full adders to create a 4-bit adder.

2-to-1 Multiplexer: Incorporate a 2-to-1 multiplexer to select between addition and subtraction operations. The multiplexer should be controlled by the single-bit control input you set up in step 1. In other words, Insert a 2-1 MUX with a single select line where the output is connected to C0 of the 4-bit adder/subtractor. Hence, the select line would be used to change the circuit from being an adder to being a subtractor.

Remember, the core project sets the base for your team-specific variations and bonus tasks. So, ensure the base design is robust and functional.

LED Displays

- **Input bits**: Green LEDs. They light up to represent the binary value of each input bit.
- **Multiplexer output** (operation selection): Red LEDs. They light up to signify whether the operation selected is addition (1) or subtraction (0).

Bonus Task

Extend the functionality of your adder/subtractor circuit to include a decimal display output. Implement a 7-segment display to show the 4-bit binary output of the adder/subtractor as a decimal digit. This requires each segment of the display to be controlled by a different bit of the output.

To accomplish this, you will need to incorporate a binary to 7-segment decoder into your circuit. This decoder will translate the 4-bit binary output from your adder/subtractor into 7 output bits. Each of these bits controls a different segment of the 7-segment display, allowing the display to show the decimal equivalent of your binary output. You can see in the blow diagram how the circuit final output (A,B,C,D going in from the left) are input to the Seven Segment Decoder. The outputs of the decoder are then connected to the Seven Segment Display.

To receive the bonus points, your circuit must successfully display the correct decimal digit on the 7-segment display for all possible input combinations.

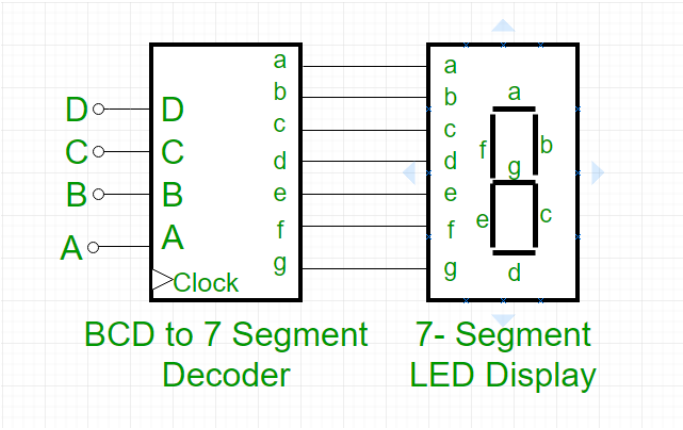

Figure 1: Seven Segment Decoder and Display

Useful Links

- Logisim Beginngers Tutorial
- 4-bit Full Adder
- Multiplixer
- Seven Segment Display