ALU

COMP 273 Assignment 6

Due: November 20, 2022, on myCourses

Submission instructions

All work must be your own and must be submitted to myCourses. Include your name and student number in a comment at the top of your documents / Logisim circuits. **Submit only one file: a6.circ**. Do not use a zip archive. Check your submission by downloading it from myCourses and checking that it was correctly submitted. You will not receive marks for work that is incorrectly submitted.

Purpose

- Learning about the basic circuitry in the ALU
- To get used to 2's complement
- To get used to using flags

Helpful

- A5 should be completed before you start this assignment
- The lecture recordings on ALU.

Implementation

Using Logisim Evolution create the circuit for the following problem:

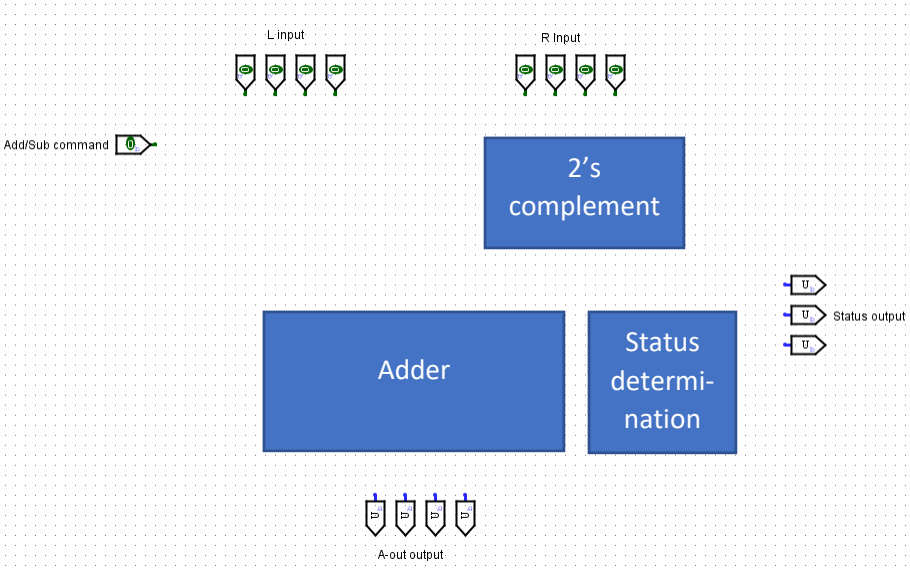

Figure 1: High-level view of ALU

- Task: Build the circuit (blue boxes) of figure 1.
- Inputs: L and R (nibble sized, 4 pins each), Add/Subtract command pin.
- Outputs: A-out (nibble sized, 4 pins) and Status (3 pins)
- Circuits: 2's complement circuit, adder circuit, and status output circuits. Plus, a CLOCK.

NOTE: Your final circuit does not need to look exactly like figure 1. However, the input and output pins must look like figure 1.

NOTE 2: Your final circuit must use designs we covered during class. You cannot use any outside (other sourced) circuit designs.

NOTE 3: You must build the circuit from the following components ONLY: wires, D-flip-flop, clock, AND, OR, NOT, pins, and XOR. You **CANNOT** use: any prebuilt adder circuits, or any other prebuild items from Logisim. Optionally you **can** use: tunneling and "adding a circuit" from the project menu.

Steps

- Begin by placing the input and output pins onto the circuit. These pins will be used to enter and see values.
- **Do not use registers for**: L, R, A-out, Status, and the command pin.
- The Adder circuit assumes two 2's compliment inputs in L and R. The L input goes directly into the Adder without modification. The R input goes through the 2's complement circuit and may modify R's value (for example, R may be 5, but the 2's complement circuit changes it to -5). The solution to the addition is outputted to the A-out pins.
- The 2's complement circuit is controlled by the command pin and will negate the 2's complement R input value when commanded to do so during subtraction. Otherwise, during

addition it simply lets the R value pass through without change. When the command pin is 0 the ALU is performing an addition. When the command pin is 1 the ALU is performing a subtraction.

- The Status register's flag bits are updated by the result stored in A-out. Bit 0 = negative, Bit 1 is zero, and bit 3 is overflow.
- Add a clock to control the execution of this circuit.

Execution

Your ALU circuit must be able to do the following:

1. 0 – 0
2. 1 – 1
3. 1 – (-1)
4. 2 – 1
5. 1 – 2
6. Overflow
7. And the other numbers that fit within the 2's compliment nibble.

Note: The TA will input the numbers into the L and R pins in 2's complement form by hand.

Marking

- Maximum 20 points
  - +7 Adder circuit
  - +7 2's complement circuit
  - +6 Status determination circuits
- -20% per day late with max 2 late days
- -3 points for not following instructions
- -5 points for not using the clock
- Assignment must execute to be graded