

Assignment 3
Due Monday, October 3

Building a Small Register File

In this assignment, using Logisim you will build a small register file that contains 4 registers, where each register has 4 bits. To build the register file, you'll first need to build a 2-input/4-output decoder and an 4-input/1-output multiplexor.

Step 1. A 2-input/4-output decoder

From AND, OR, and NOT gates, build a decoder that has 2 inputs and 4 outputs. Name this subcircuit "2-bit decoder". The order of the inputs, from top to bottom, should be: input0, input1. The order of the outputs, from top to bottom, should be: output0, ..., output 3.

Step 2. A 4-input/1-output multiplexor

From AND, OR, and NOT gates, build a multiplexor that has 4 input lines, 2 select lines, and 1 output line (each line is one bit). From top to bottom, the inputs to the multiplexor should be:

select line0
select line1
input line0
input line1
...
input line 3

Name this subcircuit "4-bit multiplexor".

Step 3. Experiment with the Logisim built-in register

In Logisim, click on "Project>Load Library>Load Built-in Library" and then choose "Memory". You will see, on the left hand side of the window, a new folder of devices called "Memory". Expand the folder by clicking on "+" next to it. You'll see a bunch of memory devices, one of which is called "Register". When you click on Register, you'll see a table open up at the bottom left, with options for configuring the register. The field you'll have to change is "Bit Width", which you should set to 4.

Once you place a register in the canvas section of Logisim (the big portion where you create portions of circuits) you'll see that it has three inputs: "D" (the 4-bit data input), the clock/write-enable bottom (it looks like a "^") and a "clr" (which you should ignore). The only output is Q (4 bits).

Connect a 4-bit input pin (click on the input-pin icon on the top menu, and then change the “bit width” in the table at the bottom-left to “4”) to the “D” input of the register. Then, connect a 1-bit input pin to the write-enable line of the register. Finally, connect the “Q” output of the register to a 4-bit output pin (click on the output-pin icon on the top menu, then select a bit width of 4). Now, experiment by changing the value of the 4-bit input and the value of the write-enable line to see how the output changes.

Note that, unlike the description in the textbook, the Logisim memory devices change state on the rising edge of the clock (i.e. when the clock/write-enable line goes up). This does not affect your circuit design at all.

Step 4. Building the register file

You are now ready to build the 4-register register file (name the subcircuit “register file”). Build it using multiple copies of your decoder and multiplexor, and any other gates you’ll need. One more logisim “gate” (it’s really not a gate) that you’ll probably need is a splitter, which splits a multi-bit wire into multiple one-bit wires, to take a 4-bit output from a register and send one bit to each of four of your multiplexors. Open the “Base” folder, click on “Splitter”, and then choose the “Fan Out” and “Bit Width In” to be 4.

The inputs to your register file should be as follows:

read-select line0, bit 0
read-select line0, bit 1
read-select line1, bit 0
read-select line1, bit 1
write-select line, bit 0
write-select line, bit 1
write-data line: 4 bits (use a 4-bit input-pin, as described above).
write enable line

and the following outputs (again, from top to bottom of the right hand side of your circuit):

read-data0, bit 0
...
read-data0, bit 3
read-data1, bit 0
...
read-data1, bit 3

Step 5: Turning it in

By October 3, email your file as an attachment to Joseph Sofaer at jss322@nyu.edu .