

CSCB58 Lab 3: Multiplexer & Demultiplexer Devices

1 Introduction

This week, we will practice with two of the logical devices that we learned from last week's lecture – multiplexers and demultiplexers. You will first implement a simple 2-to-1 multiplexer, and a 1-to-2 demultiplexer. Then, using these sub-circuits you will make a 6-to-1 multiplexer and a 1-to-6 demultiplexer.

PRELAB REPORT: This lab requires the submission of a prelab report to **Quercus by the start of your lab section**. The deadline shown on Quercus may not apply to you. Your TA will access your prelab submission during the lab and ask you about it.

2 The Basic 2-to-1 Multiplexer

Multiplexers (muxes) are devices which select between data inputs. A mux with an n -bit *select* input can select from up to 2^n data inputs, and the selected data input is connected to the output of the mux. The data inputs are treated like an array, and the *select* input contains the index of the data input that should be forwarded to the output.

Below is the design of a simple 2-to-1 mux, in which a 1-bit *select* input can select between the two data inputs x and y .

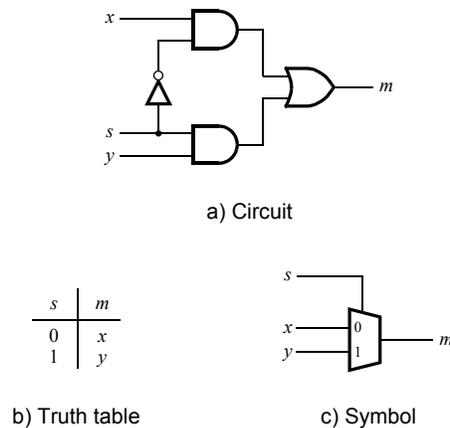


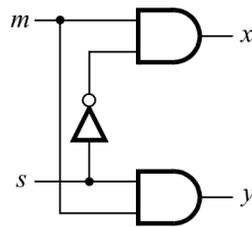
Figure 1: Design of a 2-to-1 mux

Create a new Logisim-Evolution project, rename the default `main` circuit to “mux2to1” or something similar (`Circuit Name` in properties) and implement the above 2-to-1 mux. Test the circuit to verify that your implementation is working correctly. Make sure that your inputs and outputs are **named Pin** components, and not something like an LED or Button, as this will affect using the circuit as a symbol.

3 The Basic 1-to-2 Demultiplexer

Demultiplexers (demuxes) are devices which route a data input to one of multiple data outputs. A demux with an n -bit *select* input can select up to 2^n data outputs, and the data input is connected to the selected output. The remaining outputs are often set to 0, but this is not the same for all demultiplexers.

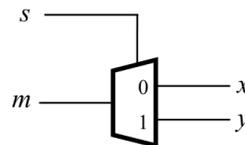
Below is the design of a simple 1-to-2 demux, in which a 1-bit *select* input chooses what output (x and y) is connected to the input m .



a) Circuit

s	x	y
0	m	0
1	0	m

b) Truth table



c) Symbol

Figure 2: Design of a 1-to-2 demux

In the same Logisim-Evolution project, create a new circuit for the above 1-to-2 demux. Name it “demux1to2” or something similar. **This is a separate “circuit” component in Logisim! See the Logisim-Evolution reference document Section 2.5 if you need help.** Test

the circuit to verify that your implementation is working correctly. Once again, make sure your inputs and outputs are **named** Pin components.

4 Your Job: Design and Implement a 6-to-1 Mux & 1-to-6 Demux

Using the above circuits, you will design a 6-to-1 mux, and a 1-to-6 demux, **using only 2-to-1 muxes and 1-to-2 demuxes as building blocks**. Before the lab, design the circuit diagram of these circuits and complete the following prelab report.

PRELAB REPORT: Write up a prelab report that includes the following information:

- Your name and student number.
- The circuit diagram of your 6-to-1 mux and your 1-to-6 demux. It is OK to include a picture of a hand drawn diagram in your PDF, but make sure everything is clearly and neatly presented.

Submit the prelab report to Quercus as a PDF file. The prelab report must be completed individually.

Note: For the 6-to-1 mux, the inputs `Input0`, `Input1`, `Input2`, `Input3`, `Input4`, `Input5` must be selected by selection bits 000, 001, 010, 011, 100, 101, respectively.

For the 1-to-6 demux, the outputs `Output0`, `Output1`, `Output2`, `Output3`, `Output4`, `Output5` must be selected by selection bits 000, 001, 010, . . . , 101, respectively.

Hint: Think about how many muxes and demuxes you would need for each higher-level circuit.

In the same Logisim-Evolution project, create a third and fourth circuit for the 6-to-1 mux and the 1-to-6 demux, using **only** the 2-to-1 mux symbol for the mux, and the 1-to-2 demux symbol for the demux that you created earlier in the lab. Test your circuit to verify that it works as you expect.

To use the circuits you created previously as a symbol, you simply place it just like you place any other component in the components list: click on it, and then click somewhere in the canvas. See the Logisim-Evolution reference document Section 2.5 if you need help.

5 Summary of TODOs

Below is a short summary of the steps to be completed for this lab:

1. Before the lab, read through the lab handout, understand the design of the 2-to-1 mux and 1-to-2 demux, and design the circuit diagram of a 6-to-1 mux and the 1-to-6 demux. Write up the prelab report and submit it on Quercus.
2. In the lab, implement the 2-to-1 mux and 1-to-2 demux as separate circuits, and demonstrate your working circuits to the TA.
3. Use your own 2-to-1 mux and 1-to-2 demux symbols to build the 6-to-1 mux and 1-to-6 demux, and demonstrate your working circuits to the TA.

Evaluation (5 marks in total):

- 2 mark for prelab report.
- 1.5 mark for 6-to-1 mux in Logisim-Evolution.
- 1.5 mark for 1-to-6 demux in Logisim-Evolution.