

CSC258H Lab 3: Multiplexer & Demultiplexer Devices

1 Introduction

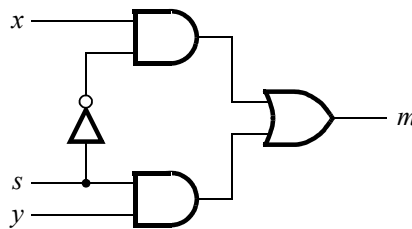
This week, we will practice with two of the logical devices that we learned from last week's lecture – multiplexers and demultiplexers. You will first implement a simple 2-to-1 multiplexer, and a 1-to-2 demultiplexer. Then, using these sub-circuits you will make a 6-to-1 multiplexer and a 1-to-6 demultiplexer.

Required Submissions: This lab requires the submission of a circuit file (“lab3.circ”) and a lab report (“lab3report.pdf”) to MarkUs by **Tuesday, February 2, 10:00 PM**. Please read the syllabus regarding the late policy. All submitted work must be completed **individually**.

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.

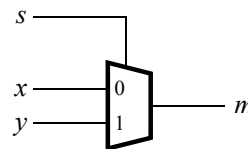
Below is the design of a simple 2-to-1 mux, in which a 1-bit *select* input can select between the two data inputs x and y .



a) Circuit

s	m
0	x
1	y

b) Truth table



c) Symbol

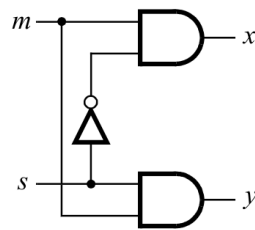
Figure 1: Design of a 2-to-1 mux

Create a new Logisim-Evolution project named “lab3”, 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.

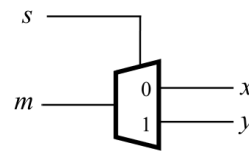
Below is the design of a simple 1-to-2 demux, in which a 1-bit *select* input chooses what output (x and y) is connected to the input m .



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.

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 (named lab3), 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.

Note: When you save the `lab3` project, the file `lab3.circ` should contain all the circuits that you created in this lab, including the 2-to-1 mux, the 1-to-2 demux, the 6-to-1 mux, and the 1-to-6 demux.

5 Lab Report

Include the following in your lab report named “`lab3report.pdf`”.

- Your name and student number.
- The circuit diagrams of your 6-to-1 mux and 1-to-6 demux. The circuit must be built using **only** symbols of the 2-to-1 mux and the 1-to-2 demux.
- Two screenshots showing that your 6-to-1 mux is working correctly when the select input is 011.
- Two screenshots showing that your 1-to-6 demux is working correctly when the select input is 101.

6 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.
2. In the lab, implement the 2-to-1 mux and 1-to-2 demux as separate circuits, and test that they are working correctly.
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.
4. Complete the lab report.
5. Submit `lab3.circ` and `lab3report.pdf` to MarkUs before the deadline.

Evaluation (2 marks in total):

- 1 mark for the correctness of the 6-to-1 mux and its report
- 1 mark for the correctness of the 1-to-6 demux and its report