Terna Engineering College

Department of Information Technology

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Subject: Microprocessor Programming Lab

Practical No.: 4

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Aim: To verify the truth table/functionality of

1. 4:1 Multiplexer,
2. 1:4 Demultiplexer using simulator.

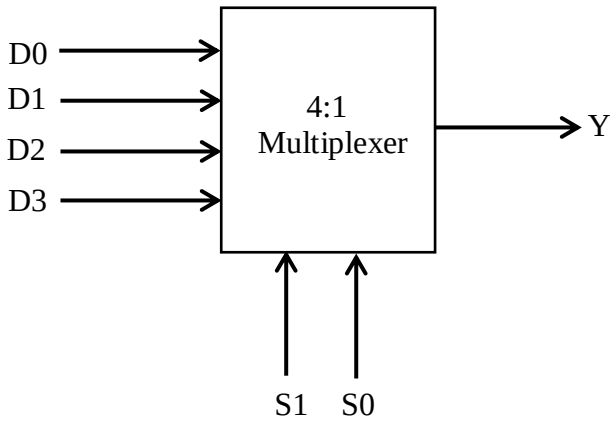
Resources required: Logisim Tool

Theory:

Multiplexer is a combinational circuit that has maximum of 2^n data inputs, 'n' selection lines and single output line. One of these data inputs will be connected to the output based on the values of selection lines. Since there are 'n' selection lines, there will be 2^n possible combinations of zeros and ones. So, each combination will select only one data input. Multiplexer is also called as Mux. It is also known as data selector circuit since it accepts more than one inputs and connects only one of them at a time to the output.

4:1 Multiplexer

4:1 Multiplexer has four data inputs D0, D1, D2 and D3, two selection lines S1 & S0 and one output Y. The block diagram of 4:1 Multiplexer is shown in the following figure.



One of these 4 inputs will be connected to the output based on the combination of inputs present at these two selection lines.

The truth table of a 4:1 multiplexer is shown below in which four input combinations 00, 10, 01 and 11 on the select lines respectively switches the inputs D0, D2, D1 and D3 to the output. That means when S1=0 and S0 =0, the output at Y is D0, similarly Y is D1 if the select inputs S1=0 and S0= 1 and so on.

Truth Table for 4:1 Multiplexer

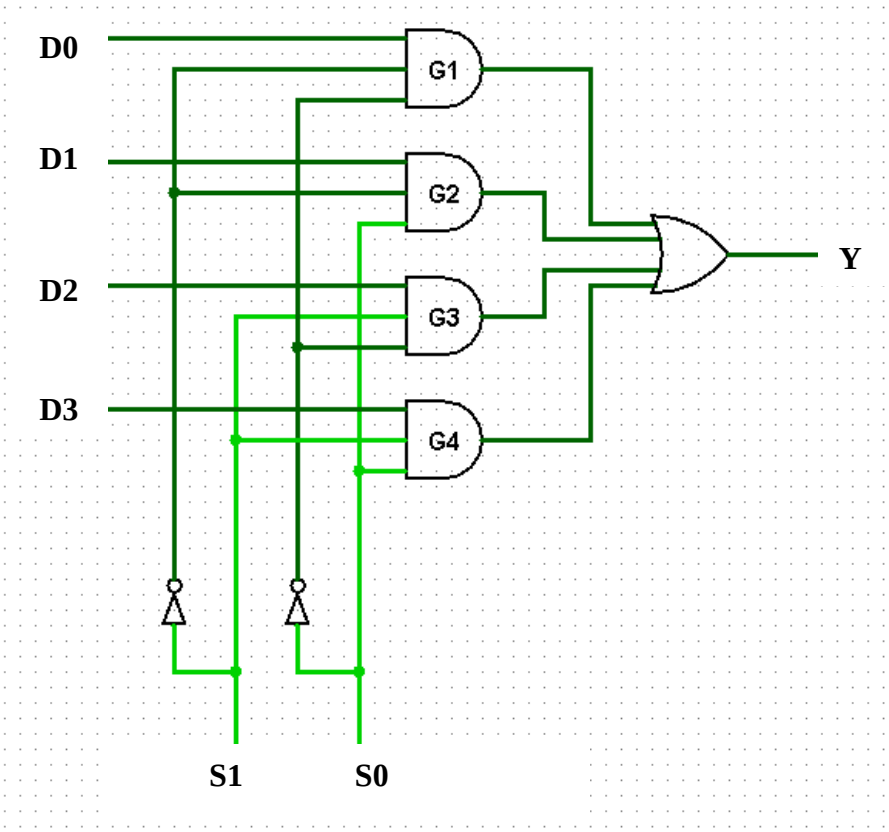
Selection Lines		Output
S1	S0	Y
0	0	D0
0	1	D1
1	0	D2
1	1	D3

From Truth table, we can directly write the Boolean equation for output, Y as

$Y = D0\ S1'\ S0' + D1\ S1'\ S0 + D2\ S1\ S0' + D3\ S1\ S0$

From the above expression of the output, a 4-to-1 multiplexer can be implemented by using basic logic gates. The below figure shows the logic circuit of 4:1 MUX which is implemented by four 3-inputs AND gates, two 1-input NOT gates, and one 4-inputs OR gate.

In this circuit, each data input line is connected as input to an AND gate and two select lines are connected as other two inputs to it. The AND gate output is connected to with inputs of OR gate so as to produce the output Y.

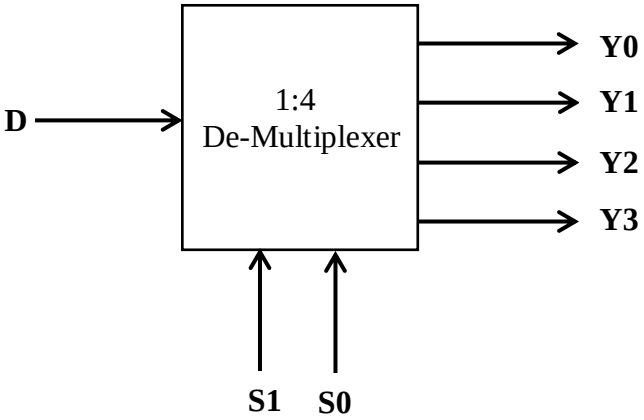


De-Multiplexer

De-Multiplexer is a combinational circuit that performs the reverse operation of Multiplexer. It has single input, 'n' selection lines and maximum of 2^n outputs. The input will be connected to one of these outputs based on the values of selection lines. Since there are 'n' selection lines, there will be 2^n possible combinations of zeros and ones. So, each combination can select only one output. De-Multiplexer is also called as De-Mux.

1:4 De-Multiplexer

1:4 De-Multiplexer has one input D, two selection lines, S1 and S0 and four outputs Y0, Y1, Y2 and Y3. The block diagram of 1:4 De-Multiplexer is shown in the following figure.



The single input 'D' will be connected to one of the four outputs, Y0, Y1, Y2 and Y3 based on the values of selection lines S1 and S0.

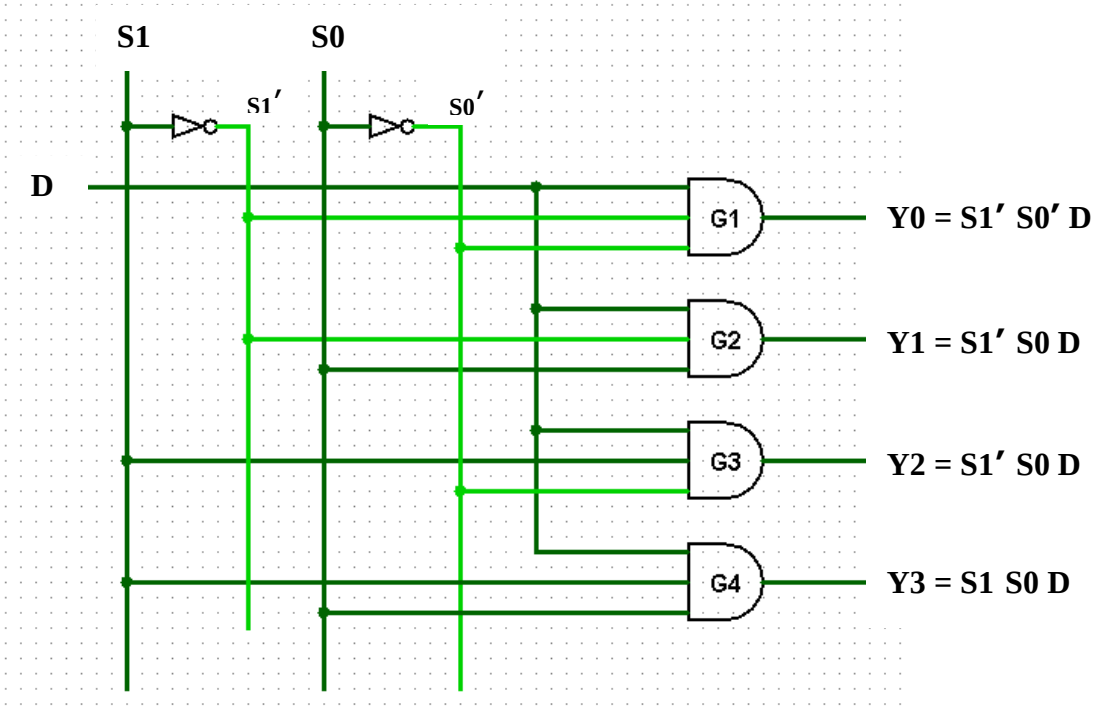
The truth table of this type of demultiplexer is given below. From the truth table it is clear that, when S1=0 and S0= 0, the data input is connected to output Y0 and when S1= 0 and s0=1, then the data input is connected to output Y1.
Similarly, other outputs are connected to the input for other two combinations of select lines.

Truth Table for 1:4 De-Multiplexer

Control Lines		Output			
S1	S0	Y0	Y1	Y2	Y3
0	0	**D**	0	0	0
0	1	0	**D**	0	0
1	0	0	0	**D**	0
1	1	0	0	0	**D**

From the table, the output logic can be expressed as min terms and are given below
$Y0 = S1' S0' D$
$Y1 = S1' S0 D$
$Y2 = S1 S0' D$
$Y3 = S1 S0 D$

From the above Boolean expressions, a 1:4 demultiplexer can be implemented by using four 3-input AND gates and two NOT gates as shown in figure below. The two selection lines enable the particular gate at a time. So depends on the combination of select inputs, input data is passed through the selected gate to the associated output.

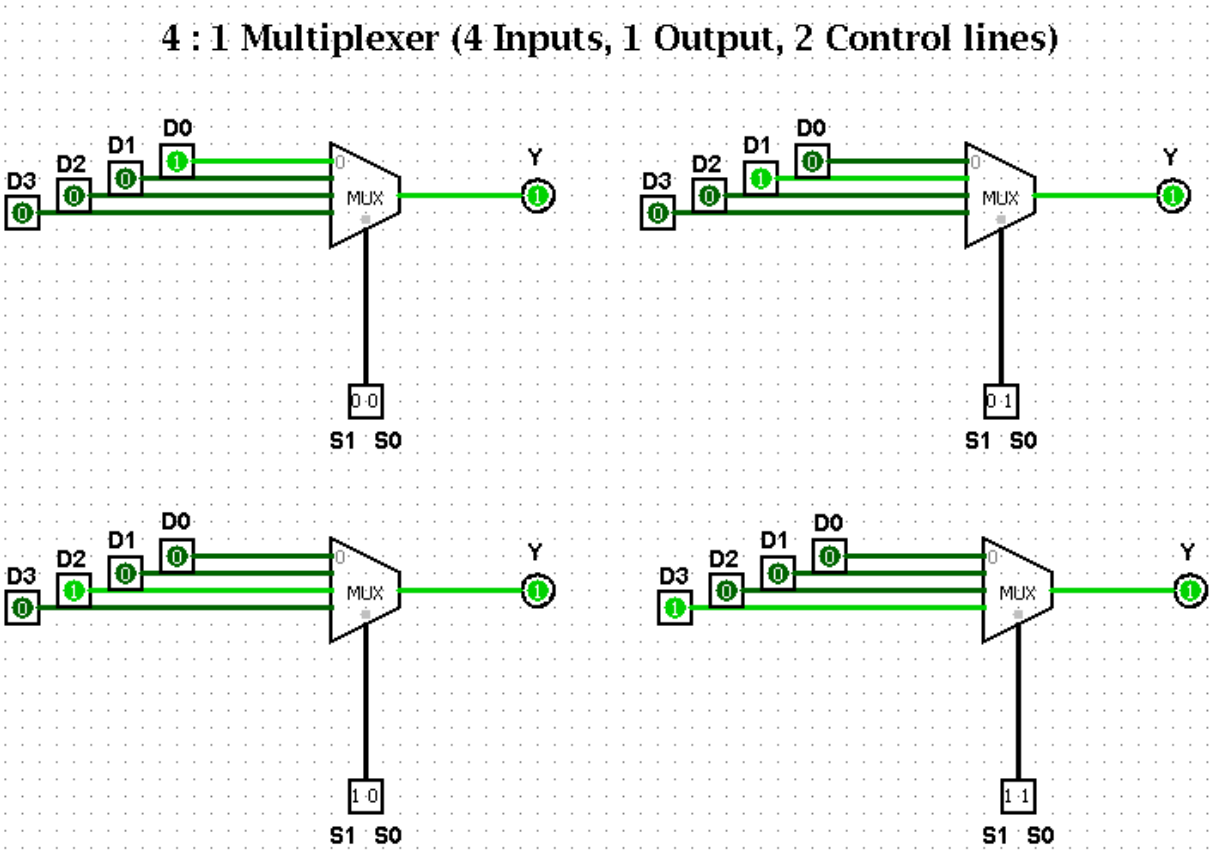


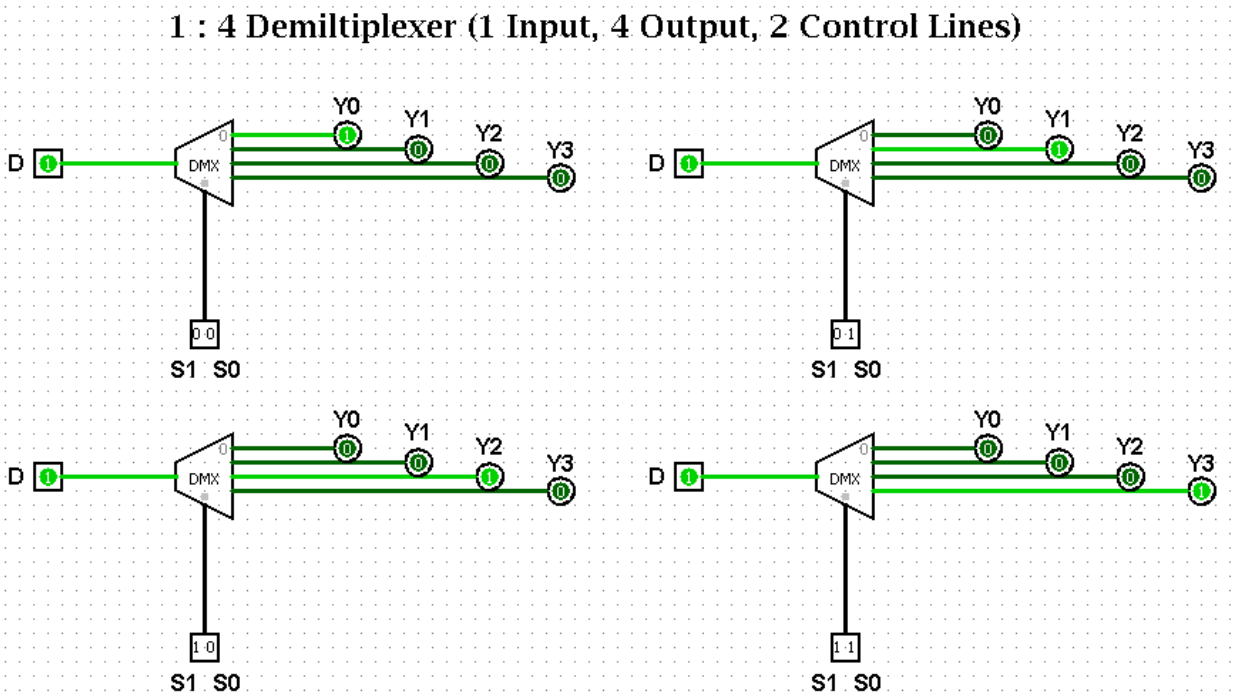
Procedure:

1. Open Logisim tool.
2. Select the component which you want to add i.e. multiplexer and demultiplexer in our case, from the library present in the left hand side.
3. Select the desired plexer(either multiplexer or demultiplexer) from the options available under the ‘Plexers’ component in the library.
4. After selecting the desired plexer move the cursor towards workspace and place the selected plexer over the same as per the space available.
5. After placing the plexer in the workspace change the properties of the tool as required. In our case, for multiplexer and demultiplexer both we set ‘select bit’ as 2 and set ‘include enable’ as ‘No’.
6. Now extend the wires for input line, output line and selection lines as per the type of the multiplexer(in our case 4 input lines, 1 output line and 2 selection lines) or demultiplexer(in our case 1 input line, 4 output lines and 2 selection lines).
7. Now, select the input pin from the quick access menu bar (at the top of the application window) and place it over the workspace beside the wires for which you want to give the input i.e. for input lines and for selection lines.
8. For selection lines set the property of input pin i.e. set direction facing as North and set ‘Data Bits’ as 2 for both multiplexer and demultiplexer

9. Similarly, place the output pin from the menu bar over the workspace and extend the wire from output pin to the output terminal of the multiplexer and demultiplexer.
10. To select the input as per the truth table i.e. to change the input select ‘change values within circuit’ tool present at the leftmost corner in the menu bar.
11. Change the input values as required according the truth table, simultaneously the output will change.
12. As per the user, label can be added by selecting ‘edit text in circuit’ option from the menu bar if required.
13. Save the file using .circ extension.

Observation: Circuit simulation with results.





Conclusion: Thus, from the above practical we have verified the truth table of some combinational circuits such as multiplexer(4:1) and demultiplexer(1:4) using simulation by Logisim tool. All the practical results were corresponding to theoretical results.

Lab Outcomes: In the above practical we learned about the combinational circuits such as multiplexer, demultiplexer and their operations along with the truth table, Boolean expression and circuit diagram. Using these operations we also learned about the implementation of other multiplexers and demultiplexers.