Digital Logic Design Laboratory

Lab 4

Multiplexers

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# I. Objectives

In this laboratory, students will study:

- Understand and design a multiplexer.

- Use a multiplexer and design/implement a circuit based on a function definition.

- Design combinational circuits using MUX.

# II. Procedure

1. Design multiplexer using logic gates

a. Design 2-to-1 multiplexer using logic gates:

A 2-to-1 multiplexer has I0 and I1 are the two inputs, S is the selector input, and Y is the output. When S = 0 then Y = I0 but when S = 1 then Y = I1. The Figure 1 shows the illustration of MUX 2-1.

MUX 2- 1

I0

I1

S

Y

Figure 1. The illustration of MUX 2-1.

Built the truth table:

|  |  |  |  |
| --- | --- | --- | --- |
| Input | | | Output |
| S­ | I0 | I1 | Y |
| 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 1 |
| 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 1 |

The expressions:



|  |  |  |
| --- | --- | --- |
|  | 0 | 1 |
| 00 | 0 | 0 |
| 01 | 1 | 1 |
| 11 | 0 | 1 |
| 10 | 0 | 1 |

Implement the circuit via simulation software and paste the result in here

A diagram of a circuit

Description automatically generated

Make comment on the results

A 2-to-1 multiplexer has I0 and I1 are the two inputs, S is the selector input, and Y is the output. When S = 0 then Y = I0 but when S = 1 then Y = I1. This mux can be built as the following expression

b. Design 4-to-1 MUX using logic gates.

Build the circuit. The inputs S0, S1, I0, I1, I2, I3 are driven by 6 switches.

|  |  |  |
| --- | --- | --- |
| Input | | Output |
| S0­ | S1 | Y |
| 0 | 0 | I0 |
| 0 | 1 | I1 |
| 1 | 0 | I2 |
| 1 | 1 | I3 |

The expressions:

S0’S1’I0 + S0’S1I1 + S0S1’I2 + S0S1I3

Implement the circuit via simulation software and paste the result in here

A diagram of a circuit

Description automatically generated

Make comment on the results

The result of the 2-to-1 multiplexer is determined by the combination of S1 and S0. For instance, when S1S0 = 01 and I1 is LOW, the output Y will be LOW as well, demonstrating the direct influence of the selector inputs on the final output.

c. Design 4-to-1 MUX using 3 MUX 2-1.

Implement the circuit via simulation software and paste the result in here

A diagram of a circuit

Description automatically generated

Make comment on the results

The 4-to-1 multiplexer, made from three 2-to-1 multiplexers, uses three selector inputs 𝑆2,𝑆1,𝑆0. When 𝑆 is high, the output 𝑌 depends on 𝐷1 of the final multiplexer, specifically the second data input. When 𝑆 is low, the output 𝑌 depends on 𝐷0 of the final multiplexer, specifically the first data input.

2. Investigate IC 8-to-1 Multiplexer (74HC151)

Construct the circuit as below:

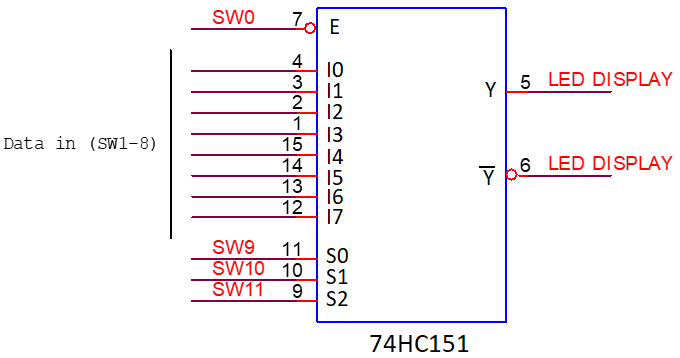


Figure 2. IC 8-to-1 Multiplexer (74HC151)

- 2 outputs are connected by using LEDs.

- The inputs are controlled by switches.

- Observe the results and fulfill the truth table

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| INPUT | | | | OUTPUT | |
| S2 | S1 | S0 | E | Y |  |
| X | X | X | 1 | 1 | 0 |
| 0 | 0 | 0 | 0 |  |  |
| 0 | 0 | 1 | 0 |  |  |
| 0 | 1 | 0 | 0 |  |  |
| 0 | 1 | 1 | 0 |  |  |
| 1 | 0 | 0 | 0 |  |  |
| 1 | 0 | 1 | 0 |  |  |
| 1 | 1 | 0 | 0 |  |  |
| 1 | 1 | 1 | 0 |  |  |

Implement the circuit via simulation software and paste the result in here

A screenshot of a computer

Description automatically generated

Briefly describe the operation of the IC

The final result Y = I(S2S1S0), for example if S2S1S0 = 010 then Y = I(2) = I2, if I2 is High then Y will be high and vice versa

3. Implement the 3-variable logic function using 74HC151

- Implement Boolean expression using IC 74HC151.

- The data inputs S0, S1, S2 are connected to switches.

- Implement the circuit and verify the truth table

a.

Implement the circuit via simulation software and paste the result in here

A circuit board with many wires

Description automatically generated

Make comment on the results

so the result Y is High when S2S1S0 = (1,3,5,6) or 001,011,101,110

b.

Implement the circuit via simulation software and paste the result in here

A computer diagram of a circuit board

Description automatically generated

Make comment on the results

so the result Y is High when S2S1S0 = (2,3,4,7) or 001,011,100,111

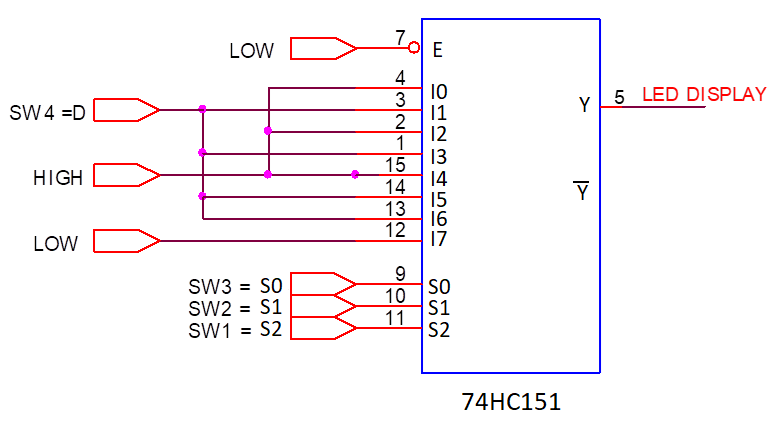
4. Implement the 4-variable logic function using 74

a. Implement the connected diagram using 74HC151.

Construct the circuit as Figure 3:

Change the logic levels of the inputs C, B, A.

Observe and make comment on the results.



Implement the circuit via simulation software and paste the result in here

A diagram of a circuit board

Description automatically generated

Write down the expression of and make comments on the results

b. Implement logic expression using 74HC151

Given the expression:

Draw the block diagram

Implement the circuit via simulation software and paste the result in here

A computer screen shot of a circuit board

Description automatically generated

Make comments on the results

, so the result Y is always high when S2S1S0 = (3,6) = 011,110 . When S2S1S0 = (1,5) = 001,101, Y depends on D ; when D is high, Y at I1 is high, Y at I5 is low, and when D is low Y at I5 is high, Y at I1 is low