Digital Logic Design Laboratory

Lab 3

MSI Combinational Logic (II)

Full name: …………………………………………….

Student number: ………………………………….

Class: ……………………………………………….......

Date: …………………………………………………....

# I. Objectives

In this laboratory, students will study:

- Understand the operation of combinational logic circuit.

- The operation of some combinational ICs such as: full adder, decoder, encoder.

# II. Procedure

1. Design the adder with two one-bit binary.

a. Design the half adder two one-bit binary.

Two inputs are A, B. Two outputs are S and C.

Build the truth table and the expressions

The simplified expressions:

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

Make comment on the results

b. Design the full adder two one-bit binary.

Three inputs are Cin, A, B. Two outputs are S and Cout.

Build the truth table and the expressions

The simplified expressions:

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

Make comment on the results

2. 8-to-3 Priority Encoder (Interrupt sorter) – IC 74HC148

a. Investigate IC – 74HC148

Construct the circuit as below:

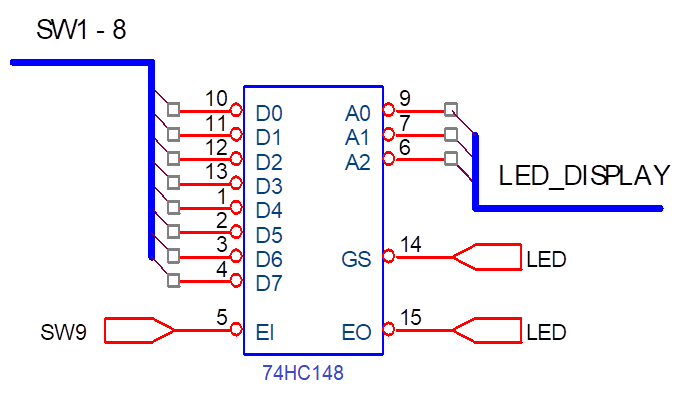


Figure 1 – Encoder 8-to-3 IC 74LS148

- The outputs are connected to LED displays to determine the logic levels.

- Choose the input data D0 - D7 by switches in the order from SW0 to SW7.

- Control EI by using switch.

- Observe the results and fulfill the truth table of 74HC148.

- What are the functions of  and ?

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Input | | | | | | | | | Output | | | | |
| EI | D0 | D1 | D2 | D3 | D4 | D5 | D6 | D7 | GS | A2 | A1 | A0 | E0 |
| 1 | X | X | X | X | X | X | X | X |  |  |  |  |  |
| 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |  |  |  |  |  |
| 0 | X | X | X | X | X | X | X | 0 |  |  |  |  |  |
| 0 | X | X | X | X | X | X | 0 | 1 |  |  |  |  |  |
| 0 | X | X | X | X | X | 0 | 1 | 1 |  |  |  |  |  |
| 0 | X | X | X | X | 0 | 1 | 1 | 1 |  |  |  |  |  |
| 0 | X | X | X | 0 | 1 | 1 | 1 | 1 |  |  |  |  |  |
| 0 | X | X | 0 | 1 | 1 | 1 | 1 | 1 |  |  |  |  |  |
| 0 | X | 0 | 1 | 1 | 1 | 1 | 1 | 1 |  |  |  |  |  |
| 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |  |  |  |  |  |

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

b. Priority encoder

Let’s EI equal to 0, fill the outputs A2, A1, A0 in the following cases

|  |  |  |  |
| --- | --- | --- | --- |
|  | A2 | A1 | A0 |
| Case 1:  I3 = I2 = I1 = 0  I7 = I6 = I5 = I4 = I0 = 1. |  |  |  |
| Case 2:  I7 = I2 = 0.  I6 = I5 = I4 = I3 = I1= I0 =1 |  |  |  |
| Case 3:  All 8 inputs are equal to 0. |  |  |  |

Case 1:

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

Make comment on results

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Case 2:

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

Make comment on results

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Case 3:

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

Make comment on results

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3. 2-to-4 Decoder - IC74HC139

Construct the circuit as below:

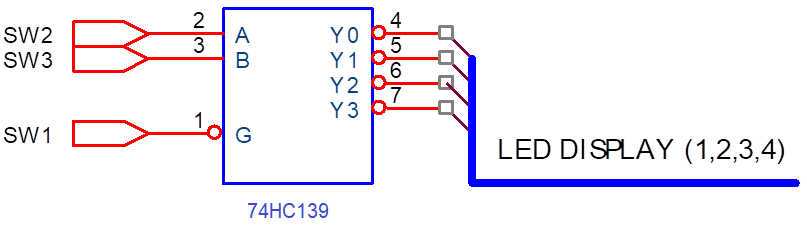


Figure 2 – Decoder 2-line-to-4-line IC 74HC139

- 4 outputs (Y0-Y3) are connected to LED display (Led 1-4).

- The data inputs (A, B) and control input (G) are connected to switches.

- Change the states of inputs to fulfill the truth table of IC 74HC139.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Inputs | | | Outputs | | | |
| Control | Data | |
| G | B | A | Y0 | Y1 | Y2 | Y3 |
| 0 | 0 | 0 |  |  |  |  |
| 0 | 0 | 1 |  |  |  |  |
| 0 | 1 | 0 |  |  |  |  |
| 0 | 1 | 1 |  |  |  |  |
| 1 | X | X |  |  |  |  |

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

Briefly describe the operation of the IC

4. 3-TO-8 Decoder– IC 74HC138

Construct the circuit as below:

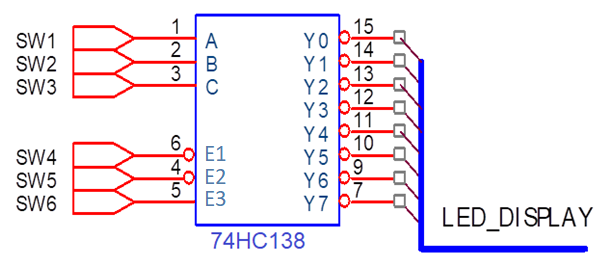


Figure 3 – 3-to-8 Decoder/demultiplexer - IC 74HC138

- 8 outputs are connected by using LEDs.

- The inputs are controlled by switches.

- Observe the results and fulfill the truth table

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| INPUT | | | | | | OUTPUT | | | | | | | |
| E3 | E2 | E1 | C | B | A | Y0 | Y1 | Y2 | Y 3 | Y4 | Y 5 | Y 6 | Y7 |
| 1 | 0 | 0 | 0 | 0 | 0 |  |  |  |  |  |  |  |  |
| 1 | 0 | 0 | 0 | 0 | 1 |  |  |  |  |  |  |  |  |
| 1 | 0 | 0 | 0 | 1 | 0 |  |  |  |  |  |  |  |  |
| 1 | 0 | 0 | 0 | 1 | 1 |  |  |  |  |  |  |  |  |
| 1 | 0 | 0 | 1 | 0 | 0 |  |  |  |  |  |  |  |  |
| 1 | 0 | 0 | 1 | 0 | 1 |  |  |  |  |  |  |  |  |
| 1 | 0 | 0 | 1 | 1 | 0 |  |  |  |  |  |  |  |  |
| 1 | 0 | 0 | 1 | 1 | 1 |  |  |  |  |  |  |  |  |
| 0 | X | X | X | X | X |  |  |  |  |  |  |  |  |
| X | 1 | X | X | X | X |  |  |  |  |  |  |  |  |
| X | X | 1 | X | X | X |  |  |  |  |  |  |  |  |

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

Briefly describe the operation of the IC

5. Design combinational circuits using decoders and OR gate

- Implement Boolean expression using IC 74HC138 & OR gate.

- The data inputs A, B, C are connected to switches.

- The control inputs are in suitable levels.

- Implement the circuit and verify the truth table

a.

Establish the truth table

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

Verify the truth table and make comment on the results

b.

Establish the truth table

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

Verify the truth table and make comment on the results