Table of Content

1.0 Objectives

The experiment is based on “Decoder” and the objective of the experiment is to know about the processings of Decoder and the outcome of this experiment is :

1. To know about the processings of Decoder Circuit.
2. To know about the modes of Decoder; Active High mode and Active Low mode.
3. To know about the Truth table of Decoders [Active High and Active Low].

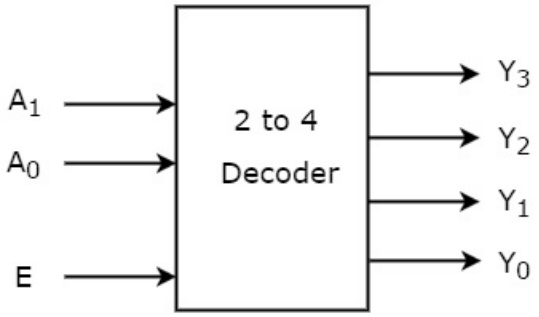
2.0 Components

1. IC 74139
2. IC 7404
3. Trainer Board

3.0 Theory

3.1 Decoder

D**ecoder** is a type of multiple-input multiple-output combinational logic circuit device.Here we are using n to 2^n decoders. It is called a decoder because it does the reverse of encoding.



En	x_2	x_1	y_4	y_3	y_2	y_1
0	x	x	0	0	0	0
1	0	0	0	0	0	1
1	0	1	0	0	1	0
1	1	0	0	1	0	0
1	1	1	1	0	0	0

Figure 3.1.1 : 2 to 4 Decoder and It’s truth table

Our language is analog and the language a system can understand is binary language. This binary language is compared to Digital signal. Encoder converts analog information into digital signal and decoder converts this digital signal into analog information and that is visible and understandable to us.

3.2 Modes of Decoder

There are two modes of a decoder.

1. Active High Mode Decoder
2. Active Low Mode Decoder

3.2.1 Active High Mode Decoder

The type of decoder that converts a binary input code into a specific output code/signal as per the input combinations, where the output of the decoder is considered active or ON when it is in the logic 1 state, it is called an active high decoder. The truth table of the 2 to 4 line active high decoder is given below −

Inputs		Outputs			
A	B	Y_0	Y_1	Y_2	Y_3
0	0	1	0	0	0
0	1	0	1	0	0
1	0	0	0	1	0
1	1	0	0	0	1

Figure 3.2.1.1 : 2 to 4 Active High Decoder and It's truth table

From the truth table, we can see that

The output Y0 is active (high) when both inputs A and B are low.
The output Y1 is active (high) when the input A is low and B is high.
The output Y2 is active (high) when the input A is high and B is low.
The output Y3 is active (high) when both inputs A and B are high.

From the truth table, we can see the output of the decoder is considered active when it is in high state or in logic 1 state. For this reason it is called an active high decoder. We can directly write the expression of each output of the active high decoder as follows −

- Y0 = **A'B'**
- Y1 = **A'B**
- Y2 = **AB'**
- Y3 = **AB**

3.2.1 **Active Low Mode Decoder**

The type of decoder that converts a binary input code into a specific output code/signal as per the input combinations, where the output of the decoder is considered active or ON when it is in the logic 0 state, it is called an active low decoder. The truth table of the active low 2 to 4 line decoder is given below −

Inputs		Outputs			
A	B	Y_0	Y_1	Y_2	Y_3
0	0	0	1	1	1
0	1	1	0	1	1
1	0	1	1	0	1
1	1	1	1	1	0

Figure 3.2.1.1 : 2 to 4 Active High Decoder and It's truth table

From the truth table, we can see that

The output Y_0 is active (Low) when both inputs A and B are low.

The output Y_1 is active (Low) when the input A is low and B is high.

The output Y_2 is active (Low) when the input A is high and B is low.

The output Y_3 is active (Low) when the input A is high and B is high.

From the truth table, we can see the output of the decoder is considered active when it is in low state, i.e. in logic 0 state. For this reason it is called an active low decoder. We can directly write the expression of each output of the active low decoder as follows −

- Y0 = **A+B**
- Y1 = **A+B'**
- Y2 = **A'+B**
- Y3 = **A'+B'**

4.0 Problem/Design Solve Procedure

4.1 Pin diagram of 74139 (with two 2-to-4 decoders inside)

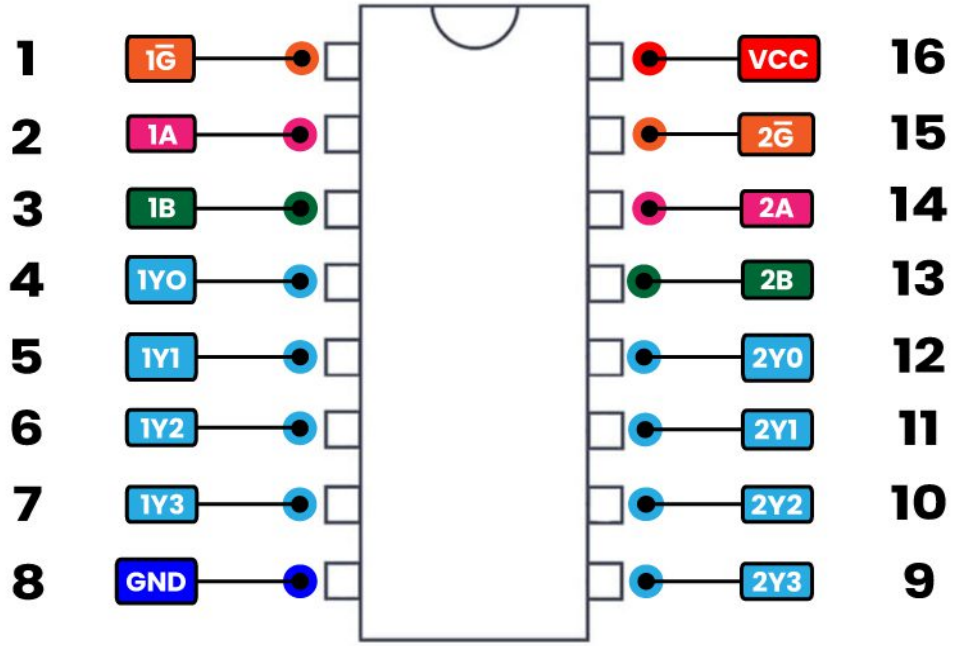


Figure 4.0.1 : Pin diagram of 74139 (with two 2-to-4 decoders inside)

Function table of 74139:

INPUTS			OUTPUTS			
ENABLE	SELECT					
$\overline{G}$	B	A	Y0	Y1	Y2	Y3
1	X	X	1	1	1	1
0	0	0	0	1	1	1
0	0	1	1	0	1	1
0	1	0	1	1	0	1
0	1	1	1	1	1	0

Here, 1= High , 0 = Low , X = Don't care

Pin no.	Symbol	Name and Function
1,15	1G', 2G'	Enable inputs (Active Low)
2,3	1A0, 1A1	Address inputs
4,5,6,7	1Y0 to 1Y3	Outputs (Active Low)
8	GND	Ground (0 V)
12,11,10,9	2Y0 to 2Y3	Outputs (Active Low)
14,13	2A0, 2A1	Address inputs
16	VCC	Positive supply voltage

4.2 Logic diagram of 3-to-8 line decoder implementation

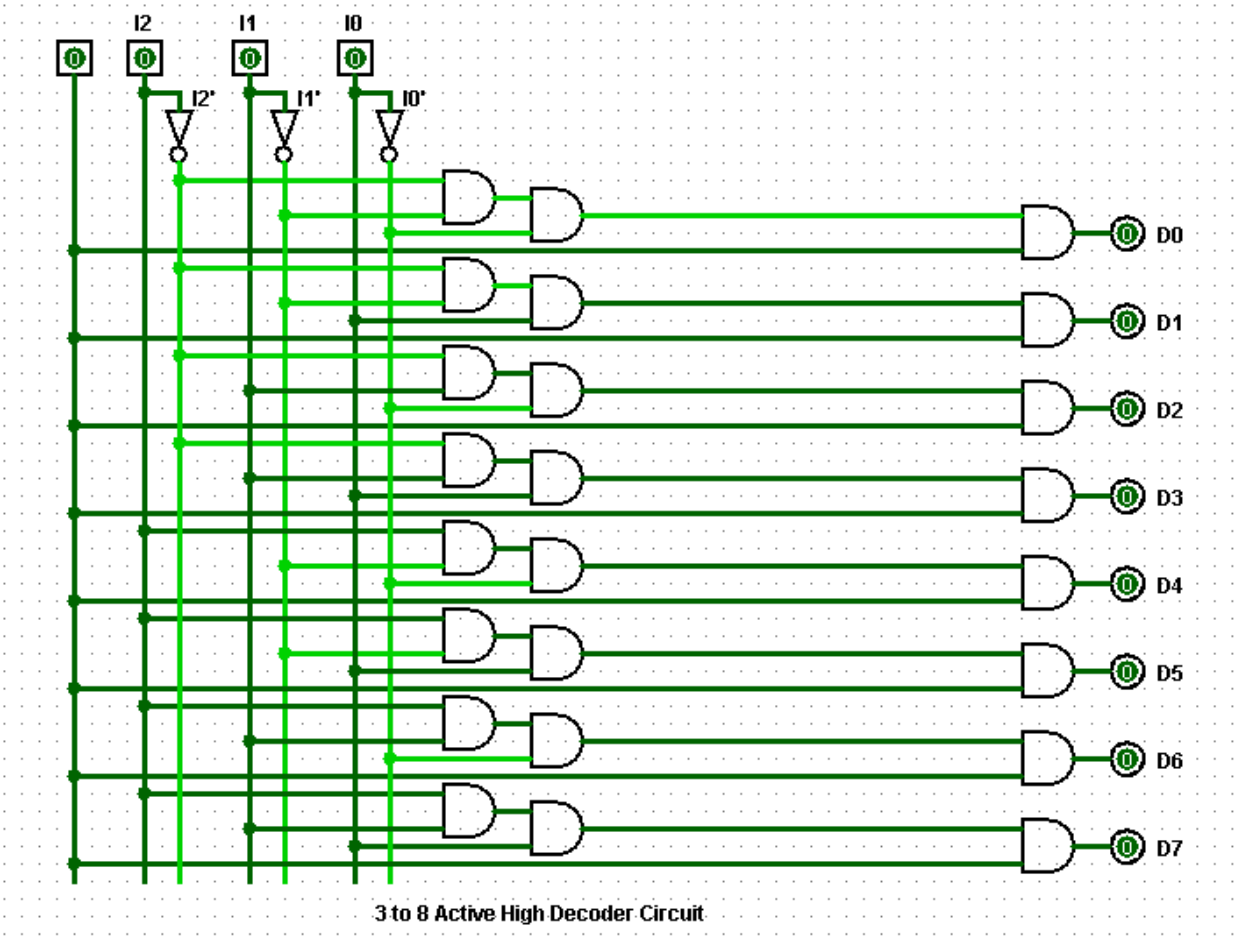


Figure 4.2.1: 3 to 8 Active High Decoder Logic Circuit

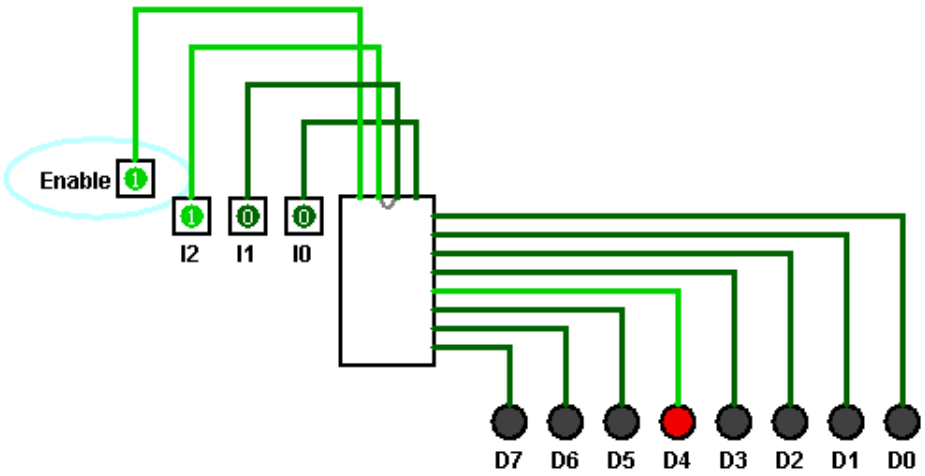


Figure 4.2.2: 3 to 8 Active High Decoder [build from logic circuit]

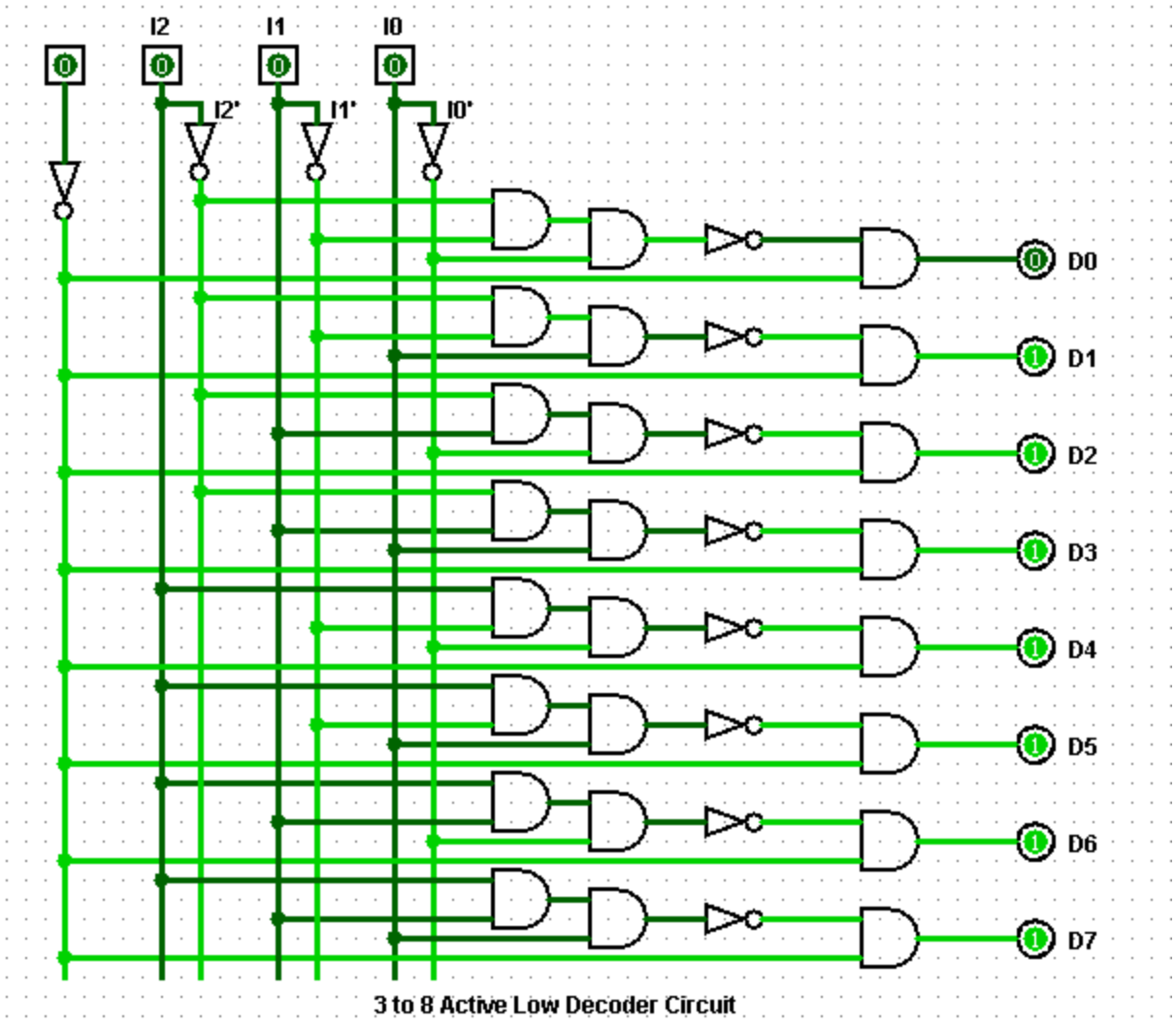


Figure 4.2.3: 3 to 8 Active Low Decoder Logic Circuit

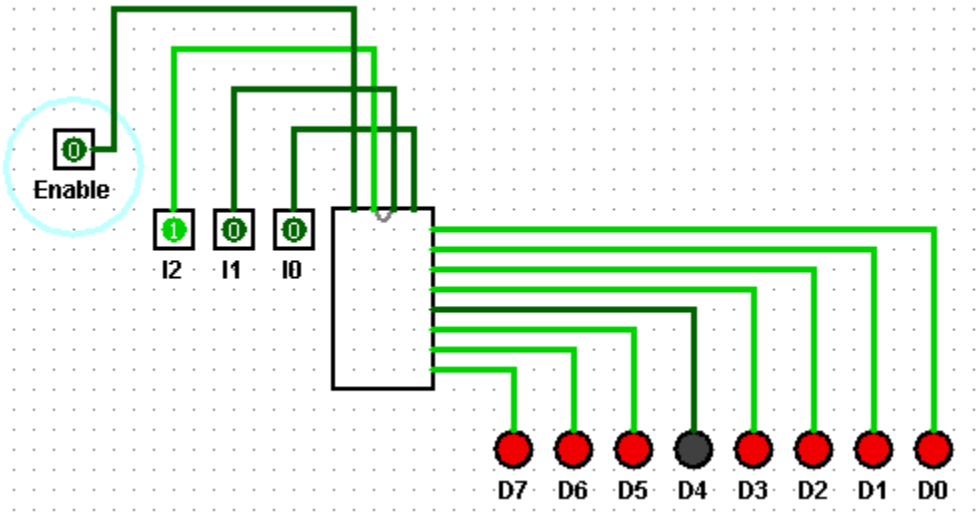


Figure 4.2.4: 3 to 8 Active Low Decoder [build from logic circuit]

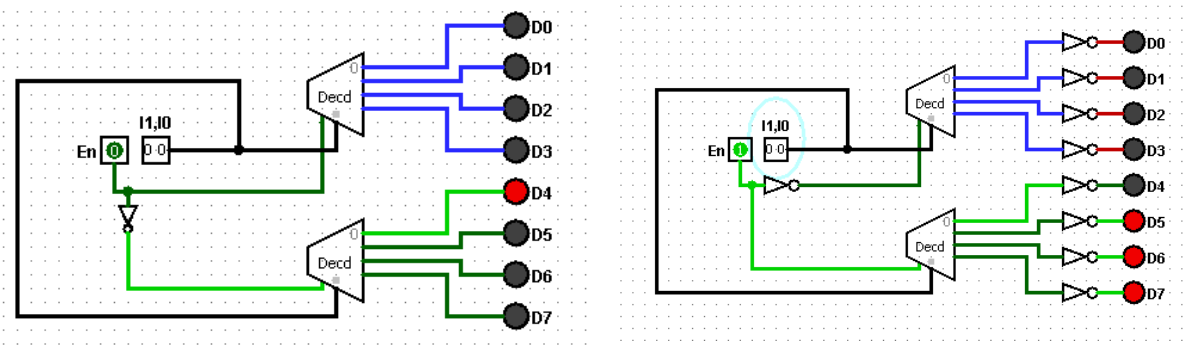


Figure 4.2.5: 3-to-8 line Active High and Low decoder (with two 2-to-4 line decoders)

4.3 Logic diagram of realizing combinational circuits

4.3.1 F = M1 . M3 . M6 . M7 using 3-to-8 line decoder

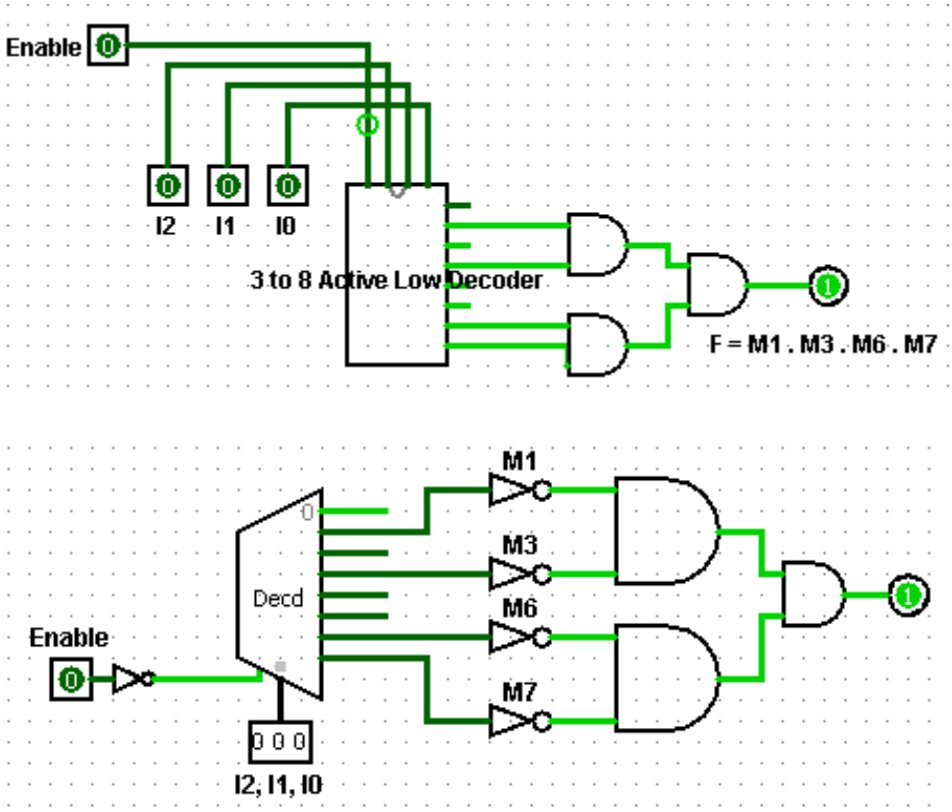


Figure 4.3.1: F = M1 . M3 . M6 . M7 using 3-to-8 line decode

4.3.2 F = m0 + m4 + m5 + m7 using 3-to-8 line decoder designed with two 2-to-4 line decoders

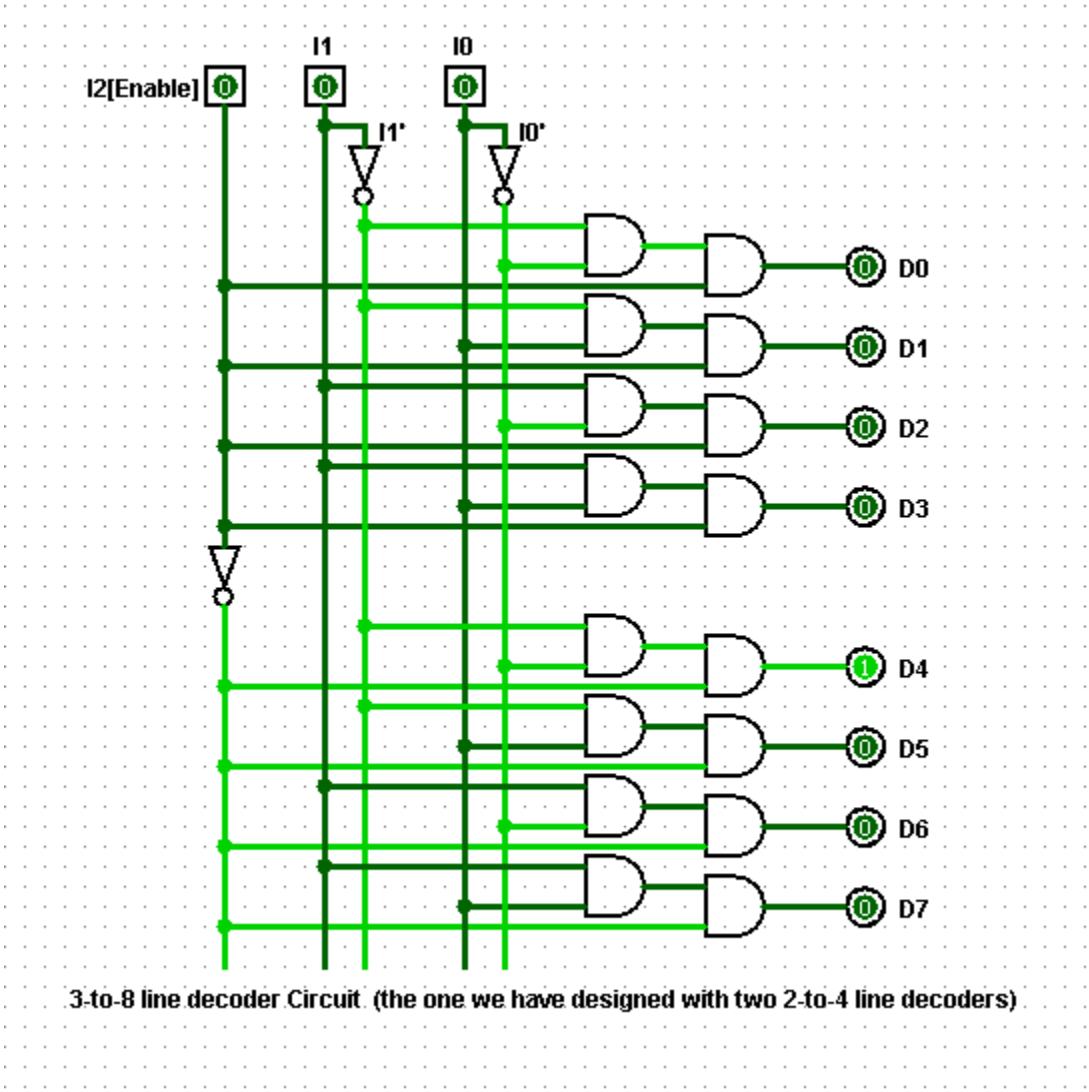
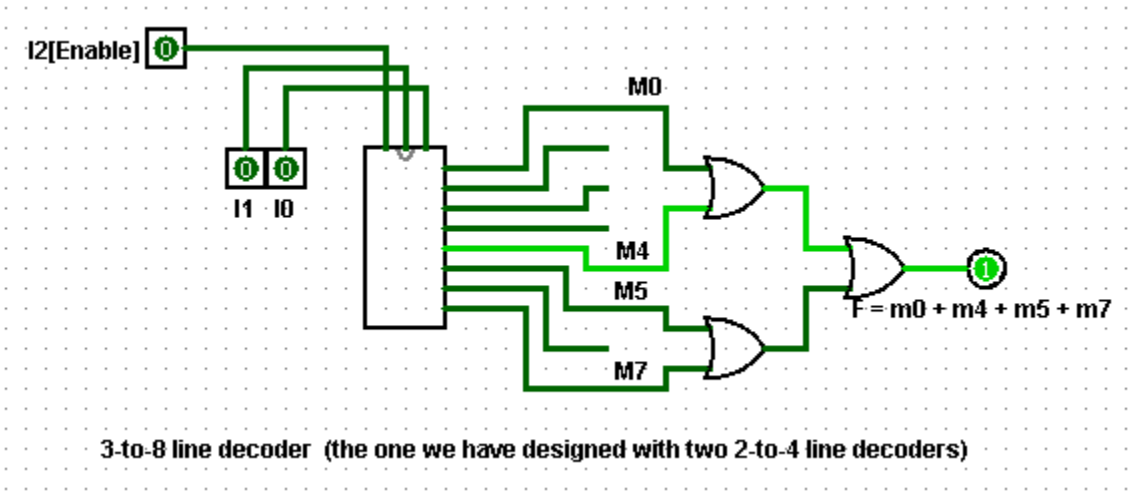


Figure 4.3.2.1: 3-to-8 line decoder Circuit (designed with two 2-to-4 line decoders)



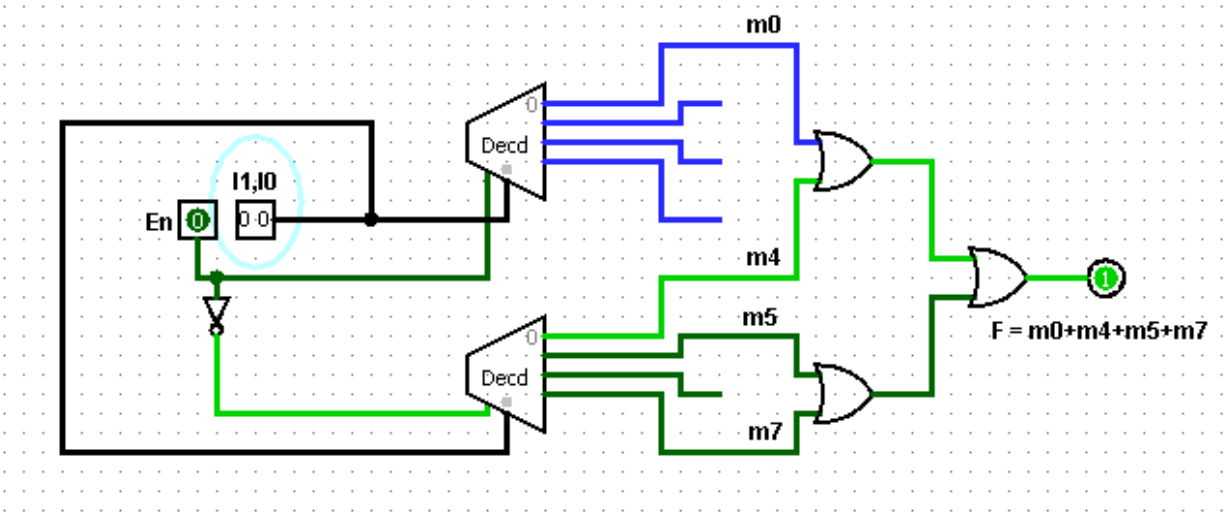


Figure 4.3.2.2: F = m0 + m4 + m5 + m7 using 3-to-8 line decoder (designed with two 2-to-4 line decoders)

5.0 Discussion

5.1 What I learnt throughout this experiment

1. Learn about the processing of Decoder Circuit.
2. Learn about Active High and Active Low Decoder and their implementation.
3. Learn about how we can apply the truth table of Decoder to build the circuit diagram.

5.2 The problems I faced while experimenting

1. To build the truth table of Decoder Circuit
2. To build the circuit in logisim specially to create difference between Active high decoder and active low decoder.
3. To build the 3 to 8 decoder circuit designed with two 2 to 4 enable decoders.

5.3 How these circuits can be used in real life

In digital electronics, a decoder can take the form of a multiple-input, multiple-output logic circuit that converts coded inputs into coded outputs, where the input and output codes are different e.g. n-to-2n , binary-coded decimal decoders. Decoding is necessary in applications such as data multiplexing, 7 segment display and memory address decoding.

The example decoder circuit would be an AND gate because the output of an AND gate is "High" (1) only when all its inputs are "High." Such output is called "active High output". If instead of an AND gate, the NAND gate is connected the output will be "Low" (0) only when all its inputs are "High". Such output is called "active low output".

Uses of Decoders :

1. Decoders are used when we need to input data to a specific output line. The most common application of this is in addressing core memory in a computer, where we have a specified memory location to store the input data.
2. They are used in code conversions like binary to decimal, like the 2 to 4 decoder.
3. It is used in data distribution as in de-multiplexing (combining multiple input streams to one)