

## Lab 6: Decoders

### Introduction

Discrete quantities are represented in digital systems with binary codes. These binary codes are comprised of  $n$  bits in which they make it possible to represent outputs. Decoders do exactly this—where  $n$ -to- $m$  lines are decoded. The purpose of decoders is to generate (or fewer) minterms of  $n$  inputs. Essentially, with use of only a few inputs, we can obtain many more outputs through decoder logic. The figure below shows a 2-4 decoder going through a few steps of the decoding process.

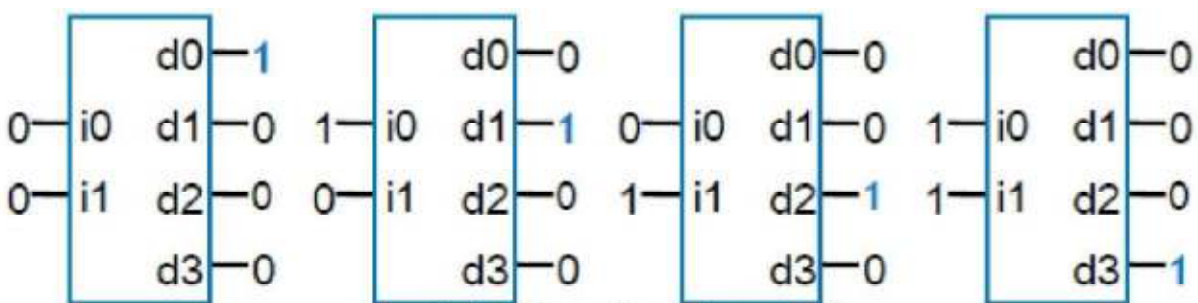


Fig. 1: 2-4 Decoder doing work!

As you can see on the far left side, when the  $i_0$  and  $i_1$  bits are 0, we get an output of 0001. When  $i_0$  is 1 and  $i_1$  is 0, we get 0010. Notice that it is in the form of  $n \rightarrow 2^n$ . For example, the binary 10 corresponds to decimal 2, which is  $n$ . If we compute  $2^n$  where  $n = 2$ , we get  $2^2$  which is 4, which corresponds to its output 1000 in binary.

However, notice this 2-to-4 decoder does not have an enable bit. The idea of an enable bit is to dictate the behavior of the circuit according to the enable bit's status. That is, for example, when the enable bit is set to "1" (active high), then a decoder would behave normally. However, behavior of the circuit by use of enable bit is up to the designer. For example, a designer could create an active low decoder where the decoder would behave normally when the enable bit is set to "0".

**Part 1: (50 points) 2-to-4 Decoder (Active High)**

Design a 2-to-4 (2 Inputs and 4 Outputs) decoder. (Enable bit will be active high. Output will be active high)

Include the following in your lab report:

- a) Truth table (there will be 3 inputs and 4 outputs).
- b) Logical expressions (there will be 4 of them).
- c) In Logisim, logic circuit.

Use 7408 (AND) and 7404 (INVERTER)

**Part 2: (50 points) 2-to-4 Decoder (Active Low)**

Design a 2-to-4 (2 Inputs and 4 Outputs) decoder. (Enable bit will be active low. Output will be active low)

Implement the circuit in breadboard.

Include the following in your lab report:

- a) Truth table (there will be 3 inputs and 4 outputs).
- b) Logical expressions (there will be 4 of them).
- c) In Logisim, logic circuit.

Use 7410 (3 Input NAND) and 7404 (INVERTER).

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