Aror University of Art, Architecture, Design & Heritage, Sukkur, Sindh

Faculty of Artificial Intelligence & Multimedia Gamming

BS – Multimedia Gamming

Digital Logic Design Lab

Lab # 07: Encoder/Decoder & Comparator

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Submission Profile

Name: Submission date (dd/mm/yy):

Marks obtained:

Comments:

Instructor

Lab Learning Objectives:

Upon successful completion of this experiment, the student will be able:

- Explain how decoders works, specifically in an SSD

Lab Hardware and Software Required:

Platform: NI ELVIS III	✔ View User Manual: http://www.ni.com/en-us/support/model.ni-elvis-iii.html ✔ View Tutorials: https://www.youtube.com/playlist?list=PLvcPIuVaUMIWm8ziaSxv0gwtshBA2dh_M
Software: NI Multisim 14.0.1 Education Version or newer	✔ Install Multisim: http://www.ni.com/gate/gb/GB_ACADEMICEVALMULTISIM/US ✔ View Help: http://www.ni.com/multisim/technical-resources/

Background Theory:

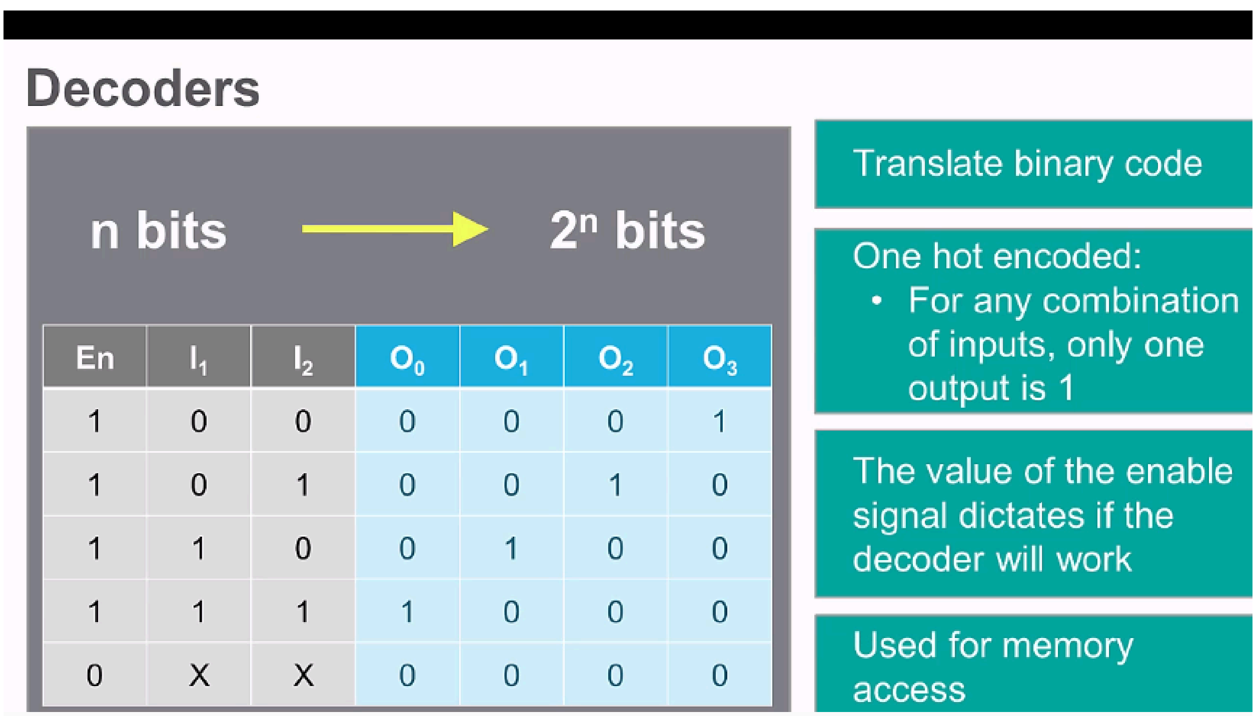


Figure 1-1 Video Screenshot. View the video here: https://youtu.be/RH2SeKV_DKg

Video Summary

- Decoders are devices that translate a binary code of n-bits of information into 2^n bits of information
- For any combination of signals there is only one output that can have a value of 1
- Encoders perform the opposite function of a decoder
- Encoders encode information from 2^n input lines into an n-bit output line

Decoders

The process of translating ambiguous information into something understood by a device receiving the data is called *decoding***.**
Therefore, the resulting device is known as a *decoder***.**

- Decoders take binary codes of n bits and generate 2^n outputs.
- The outputs of a binary decoder are said to be *one-hot encoded* because for any combination of the input signals there is only one output having the value 1.
- Decoders can include an *enable signal* for controlling the circuit operation.
- This enable signal can be active-low (meaning that the circuit will operate only when enable is 0) or active-high (the decoder is enabled when enable is 1).
- Decoders with enable inputs can be used for constructing larger decoders.
- One of the most important applications of decoders is memory access, where they are used for decoding the address of the rows in the memory blocks.

Let's take the example of a 2 to 4 decoder enabled when the *En* signal is 1:

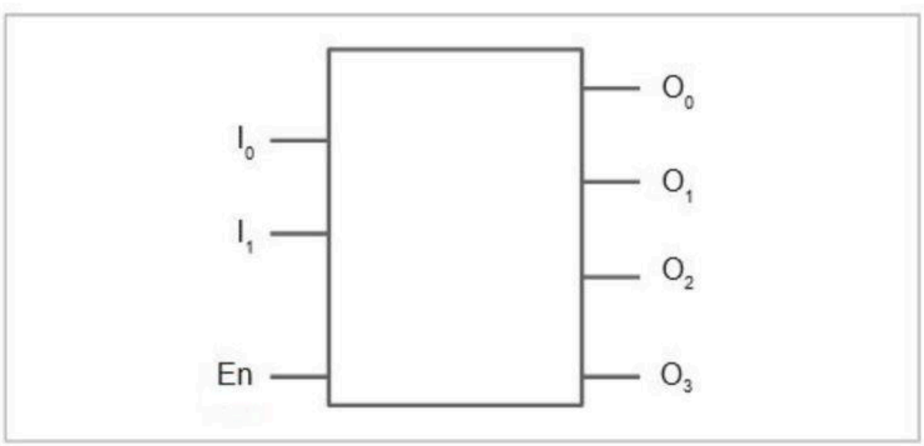


Figure 1-2 Decoder

From this, we can determine the following truth table and logic circuit:

En	I_1	I_2	O_3	O_2	O_1	O_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
0	x	x	0	0	0	0

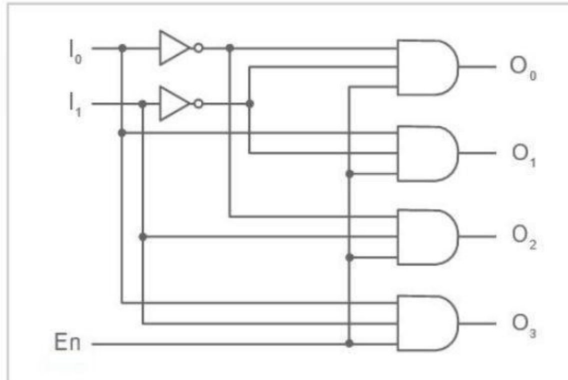
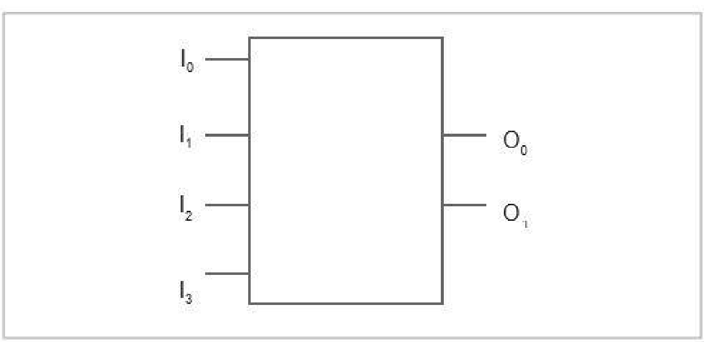


Figure 1-3 Truth table (left) and logic circuit (right)

Encoders

Encoders are logic circuits that perform the opposite function of a decoder. Binary encoders encode information from 2^n input lines, producing an n-bit code.

- At any given time, only one of the 2^n inputs can be 1.
- Encoding is used for reducing the number of bits needed to represent information. They are often used in application such as data transmission and data storing.
- The graphical symbol of the 4 to 2 binary encoder is presented below. The cases in which more than one input is 1 are not shown in the truth table because they are treated as don't care conditions.



I_3	I_2	I_1	I_0	O_1	O_0
0	0	0	1	0	0
0	0	1	0	0	1
0	1	0	0	1	0
1	0	0	0	1	1

Figure 1-4 Encoder (left) and truth table (right)

- It can be seen in the truth table that the output O_1 is 1 when either I_3 or I_2 is 1 and that the output O_0 is 1 when either I_3 or I_1 is 1.
- It can also be seen that the input I_0 can be ignored
- The encoders presented so far are considered to have *one-hot encoded* inputs.

The corresponding logic circuit is presented below:

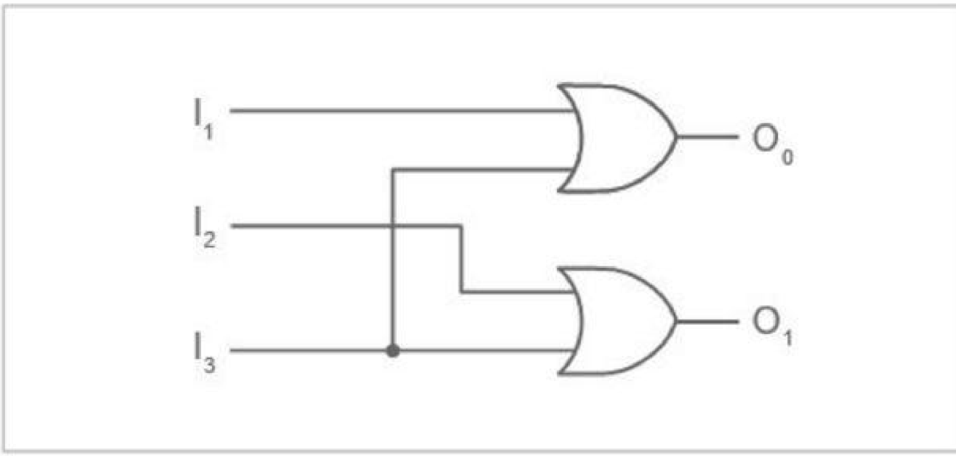


Figure 1-5 Logic circuit

Lab Activities:

1.1 Implement: Binary to Octal Decoder

A	B	C	D7	D6	D5	D4	D3	D2	D1	D0
0	0	0	0	0	0	0	0	0	0	1
0	0	1	0	0	0	0	0	0	1	0
0	1	0	0	0	0	0	0	1	0	0
0	1	1	0	0	0	0	1	0	0	0
1	0	0	0	0	0	1	0	0	0	0
1	0	1	0	0	1	0	0	0	0	0
1	1	0	0	1	0	0	0	0	0	0
1	1	1	1	0	0	0	0	0	0	0

Image of circuit

Background Theory of Comparator:

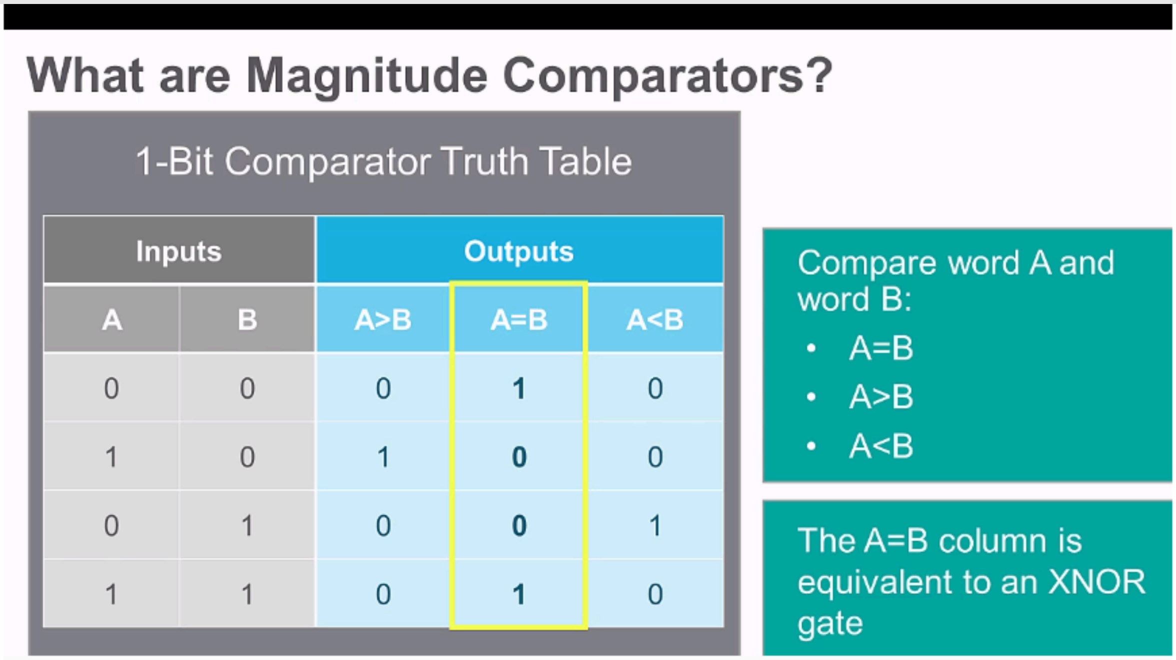


Figure 1-1 Video. View the video here: https://youtu.be/BP5G3n9dmYA

Video Summary

- The A = B column in the truth table is equivalent to an XNOR gate
- Large cascading comparators have 4-bit inputs

In its simplest terms, *comparators* are combinational logic circuits that are used to test whether word A is less than (<), equal to (=) or greater than (>) word B. Comparators that determine whether one value is less than, equal to or greater than another are called magnitude comparators. The truth table for a 1-bit digital *magnitude comparator* can be seen below:

Inputs		Outputs		
A	B	A>B	A=B	A<B
0	0	0	1	0
1	0	1	0	0
0	1	0	0	1
1	1	0	1	0

Figure 1-2 Truth table

Upon examining the table, it can be seen that the A=B output row corresponds to that of the XNOR gate. XNOR gates are used in the design of digital comparators. Below is the logic circuit for the truth table above:

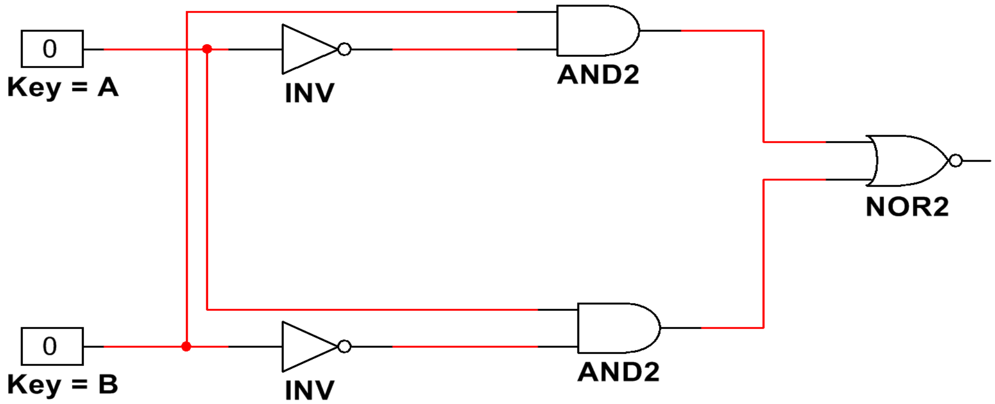


Figure 1-3 Logic circuit diagram

1-1 How do MSBs and LSBs determine the sequence of bit comparisons?

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Lab Activities:

Implement: Building a 1-bit Comparator on Multisim using gates and verify the truth table

- Take a screenshot and include it with your completed lab

Conclusion:

1-2 Comparators are combinational logic circuits.

A. True
B. False

1-3 In a one bit magnitude comparator, the output A=B corresponds to which logic gate?

A. NAND
B. NOR
C. XNOR
D. NOT

1-4 The magnitude comparator begins by comparing the:

A. Highest order bit
B. Lowest order bit
C. The bits that are equal
D. None of the above