ENCODER

- An Encoder is a combinational logic circuit.
- It performs the inverse operation of Decoder.
- The opposite process of decoding is known as Encoding.
- An Encoder converts an active input signal into a coded output signal.
- Block diagram of Encoder is shown in Fig.10. It has 'M' inputs and 'N' outputs.
- An Encoder has 'M' input lines, only one of which is activated at a given time, and produces an N-bit output code, depending on which input is activated.

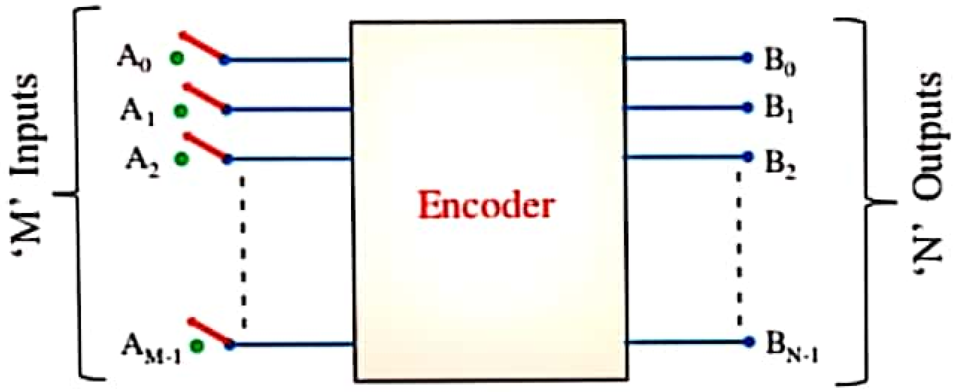

Fig. 10

Scanned with CamScanner

- Encoders are used to translate the rotary or linear motion into a digital signal.
- The difference between Decoder and Encoder is that Decoder has Binary Code as an input while Encoder has Binary Code as an output.
- Encoder is an Electronics device that converts the analog signal to digital signal such as BCD Code.
- Types of Encoders

i. Priority Encoder

ii. Decimal to BCD Encoder

iii. Octal to Binary Encoder

iv. Hexadecimal to Binary Encoder

ENCODER

M=4
$M=2^2$
$M=2^N$
'M' is the input and
'N' is the output

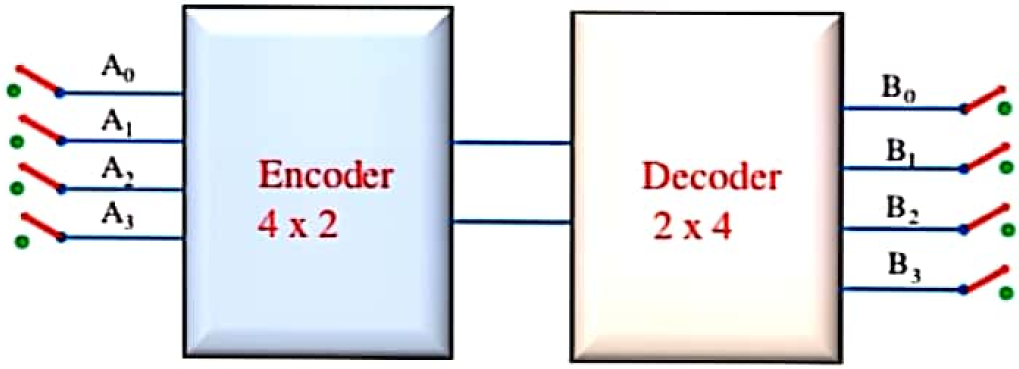

Fig. 11

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OCTAL TO BINARY ENCODER:

- Block Diagram of Octal to Binary Encoder is shown in Fig. 21
- It has eight inputs and three outputs.
- Only one input has one value at any given time.
- Each input corresponds to each octal digit and output generates corresponding Binary Code.

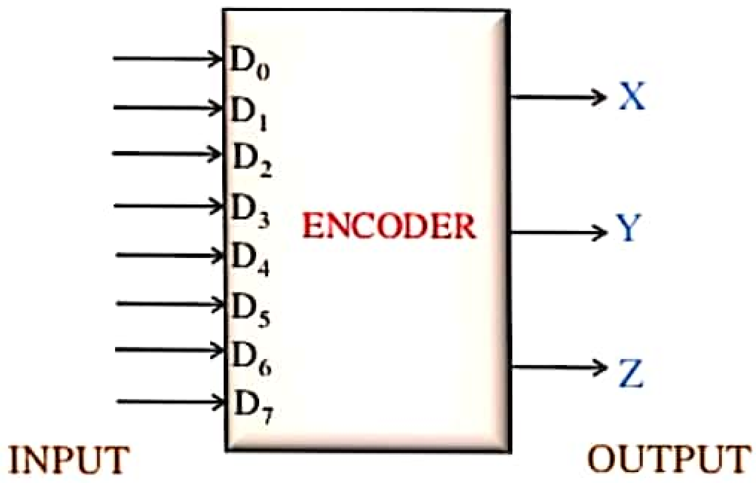


Fig. 21

TRUTH TABLE:

Fig. 22

INPUT								OUTPUT		
D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7	X	Y	Z
1	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0	1
0	0	1	0	0	0	0	0	0	1	0
0	0	0	1	0	0	0	0	0	1	1
0	0	0	0	1	0	0	0	1	0	0
0	0	0	0	0	1	0	0	1	0	1
0	0	0	0	0	0	1	0	1	1	0
0	0	0	0	0	0	0	1	1	1	1

From Truth table:

$$X = D_4 + D_5 + D_6 + D_7$$
$$Y = D_2 + D_3 + D_6 + D_7$$
$$Z = D_1 + D_3 + D_5 + D_7$$

- It is assume that only one input is HIGH at any given time. If two outputs are HIGH then undefined output will produced. For example D_3 and D_6 are HIGH, then output of Encoder will be 111. This output neither equivalent code corresponding to D_3 nor to D_6.
- To overcome this problem, priorities should be assigned to each input.
- Form the truth table it is clear that the output X becomes 1 if any of the digit D_4 or D_5 or D_6 or D_7 is 1.
- D_0 is considered as don't care because it is not shown in expression.
- If inputs are zero then output will be zero. Similarly if D_0 is one, the output will be zero.
-

$$X = D_4 + D_5 + D_6 + D_7$$
$$Y = D_2 + D_3 + D_6 + D_7$$
$$Z = D_1 + D_3 + D_5 + D_7$$

LOGIC DIAGRAM:

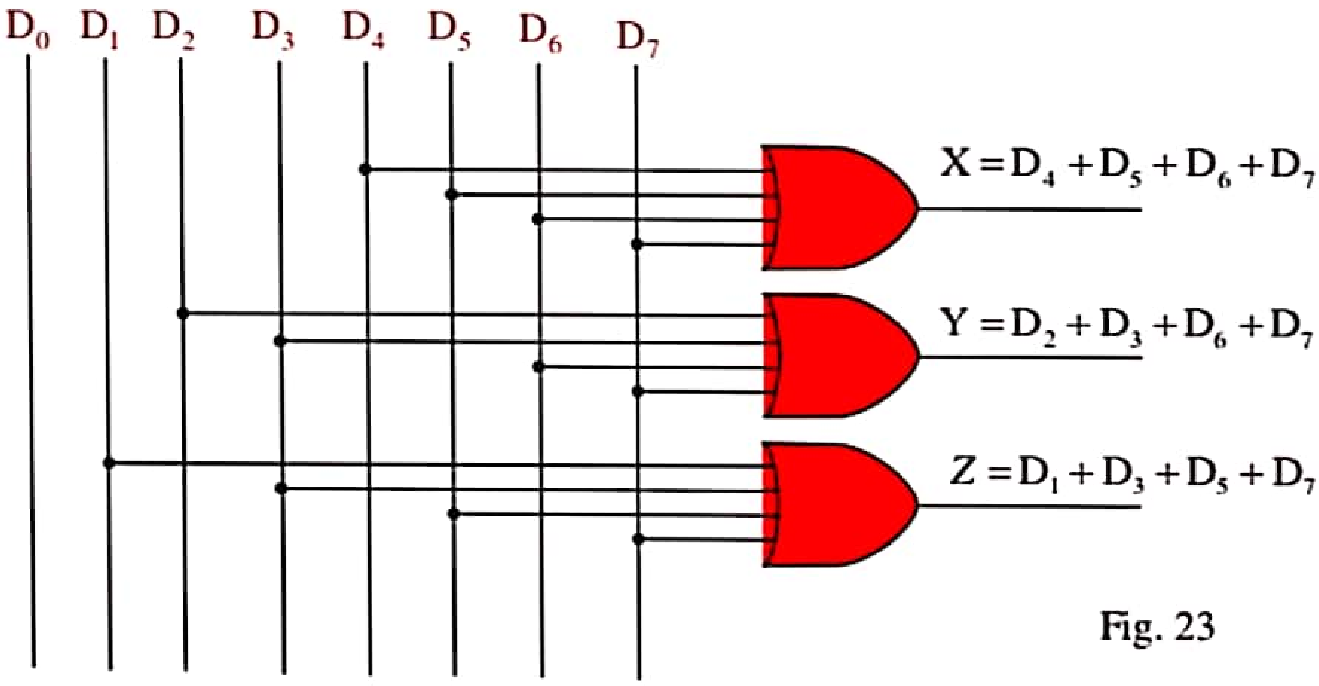
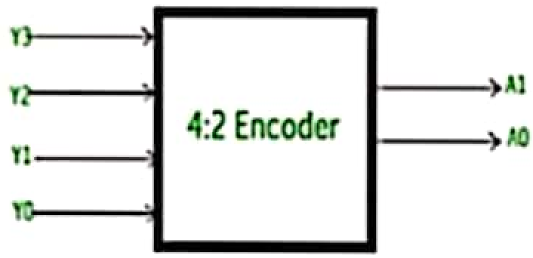


Fig. 23

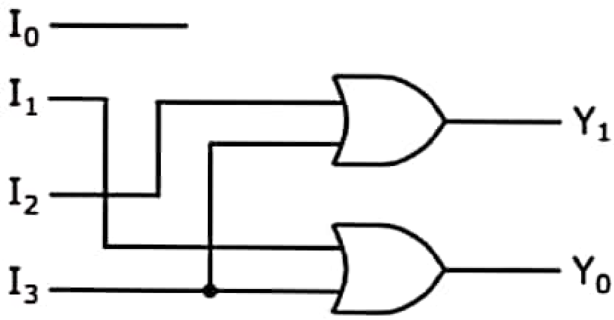
Encoder Example

- Example: 4-to-2 binary encoder

- In encoder circuit only one input may be set high (1) at a certain time.
- The output is a 2-bit number.



I_3	I_2	I_1	I_0	Y_1	Y_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

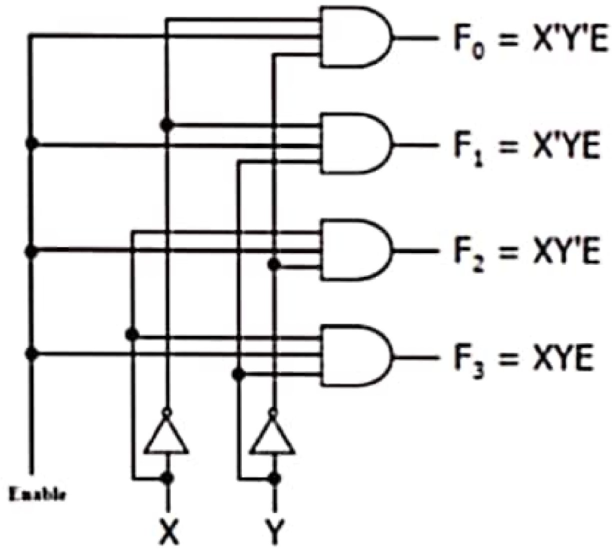


Binary Decoders

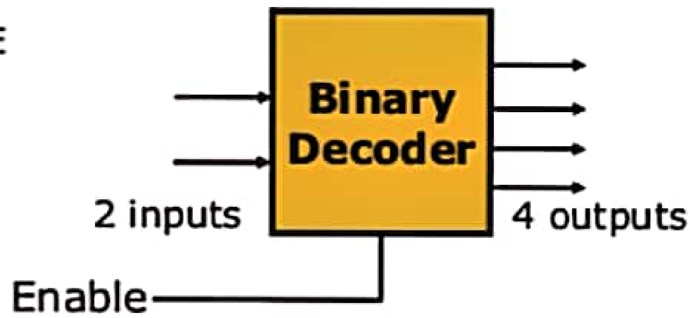
- Binary **decoders** convert an *n*-bit input to a single output. It uses its *n*-bit input to determine which of the 2^n outputs will be uniquely activated.
- Binary decoders can be developed using AND or OR Gates.
- Later on, binary decoders can be implemented in logic circuits.
- The outputs of a decoder are **minterms**. That is why decoders are sometimes called as **minterm generators.**
- We can easily use a decoder to implement any sum of minterms expression.
- **Note**: A minterm is a Boolean expression resulting in 1 only for the output of a single row (in a truth table) or a single cell (in a Karnaugh map), and 0s for all other row or cells, respectively.

2-to-4 Binary Decoder

- A circuit of 2-to-4 binary decoder is shown below.



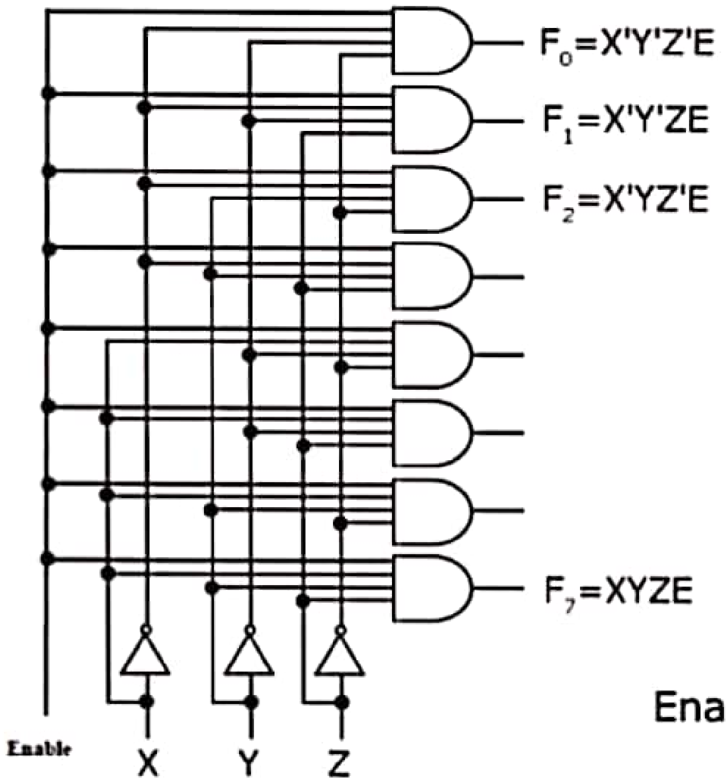
X	Y	F_0	F_1	F_2	F_3
0	0	1	0	0	0
0	1	0	1	0	0
1	0	0	0	1	0
1	1	0	0	0	1



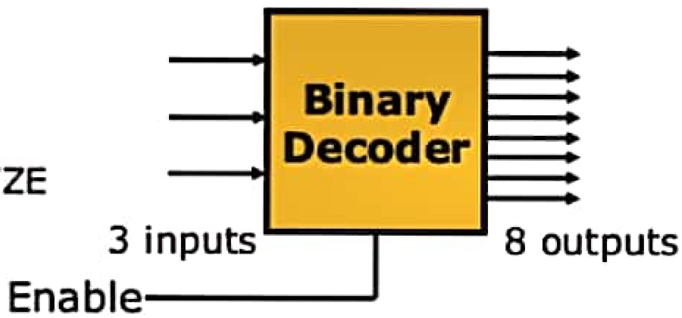
- The truth table shows that for any given input combination, exactly one output will turn to 1.
- The enable must be set to 1 to get an output.

3-to-8 Binary Decoder

- Try to understand the logic circuit of 3-to-8 binary decoder below.



X	Y	Z	F_0	F_1	F_2	F_3	F_4	F_5	F_6	F_7
0	0	0	1	0	0	0	0	0	0	0
0	0	1	0	1	0	0	0	0	0	0
0	1	0	0	0	1	0	0	0	0	0
0	1	1	0	0	0	1	0	0	0	0
1	0	0	0	0	0	0	1	0	0	0
1	0	1	0	0	0	0	0	1	0	0
1	1	0	0	0	0	0	0	0	1	0
1	1	1	0	0	0	0	0	0	0	1



Combinational Circuit Design with Decoders

Example Realize F (X,Y,Z) = Σ (1, 4, 7) with a decoder: