

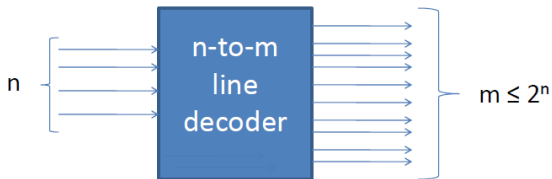
- **Decoder:**
- **Decoder is combinational circuit.**
- **Many I/P and many O/P.**
- **It is used to convert binary data into other code.**

- **Decoder: Different codes**
- **Binary to Octal (3x8).**
- **Binary to Decimal (4x10).**
- **Binary to Hexa-Decimal (4x10).**
- **BCD to seven segment .**

Decoder

- Information in digital systems represented by binary codes.
- An n -bit code = 2^n distinct elements of coded information.
- A **decoder** is a combinational circuit that converts binary information from n input lines to a maximum of 2^n unique output lines.

Decoder: specifications

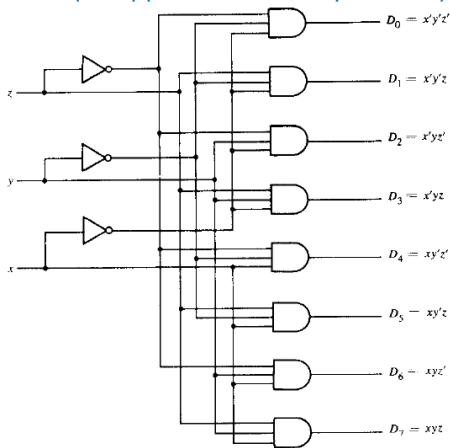


Remark:

The term decoder is also used in conjunction with other code converters, e.g., BCD-to-seven segment decoder.

3-to-8 Decoder

(An application in binary-to-octal)



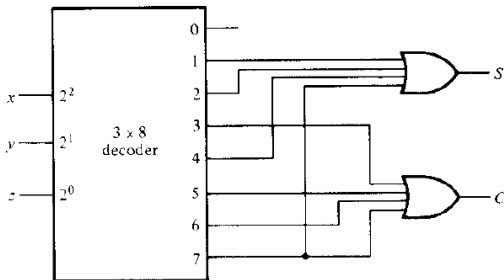
3-to-8 Decoder

Truth-table

Inputs			Outputs							
x	y	z	D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_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

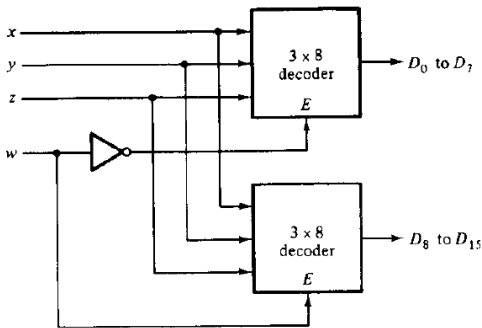
Ex.: Full-adder logic with a Decoder

- Full-adder function: $S(x, y, z) = \Sigma(1, 2, 4, 7)$
 $C(x, y, z) = \Sigma(3, 5, 6, 7)$



Example

4-to-16 line decoder using two 3-to-8 decoders



Encoder

- An encoder is a digital circuit that performs the inverse operation of a decoder.
- Encoder: 2^n (or fewer) $\rightarrow n$

Example

Octal-to-Binary encoder

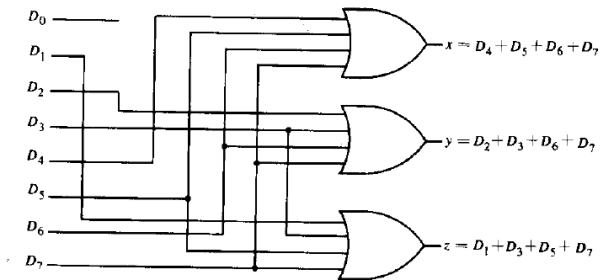
Inputs								Outputs		
D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7	x	y	z
1	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0	1
0	0	1	0	0	0	0	0	0	1	0
0	0	0	1	0	0	0	0	0	1	1
0	0	0	0	1	0	0	0	1	0	0
0	0	0	0	0	1	0	0	1	0	1
0	0	0	0	0	0	1	0	1	1	0
0	0	0	0	0	0	0	1	1	1	1

$$z = D_1 + D_3 + D_5 + D_7$$

$$y = D_2 + D_3 + D_6 + D_7$$

$$x = D_4 + D_5 + D_6 + D_7$$

Octal-to-Binary encoder



Limitations of the octal-to-binary encoder

1. Only one input can be active at a time.
i.e., if two inputs are simultaneously activated then the output may produce undefined combination.

A solution: assign priority while encoding.

2. The output is '0' when all the inputs are '0'. However, the output is also '0' when $D_0 = '1'$.

A solution: provide more output to indicate whether at least one input is '1'.

Priority Encoder

- A priority encoder is an encoder that includes the priority function.
- If two or more inputs are '1' at the same time, the input with the highest priority will take precedence.
=> leads to an understanding of the term "protocol" in CSE/IT engineering.

Example: 4-input priority encoder

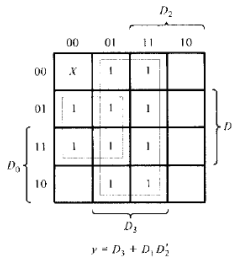
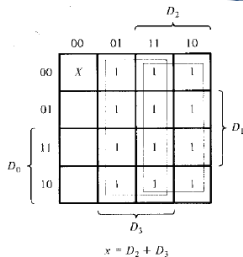
Logic: Higher the subscript number, higher the priority

Used to condensed the truth-table

Inputs				Outputs		
D_0	D_1	D_2	D_3	x	y	V
0	0	0	0	X	X	0
1	0	0	0	0	0	1
X	1	0	0	0	1	1
X	X	1	0	1	0	1
X	X	X	1	1	1	1

Valid bit

Don't care



Ex.: Priority encoder logic circuit

