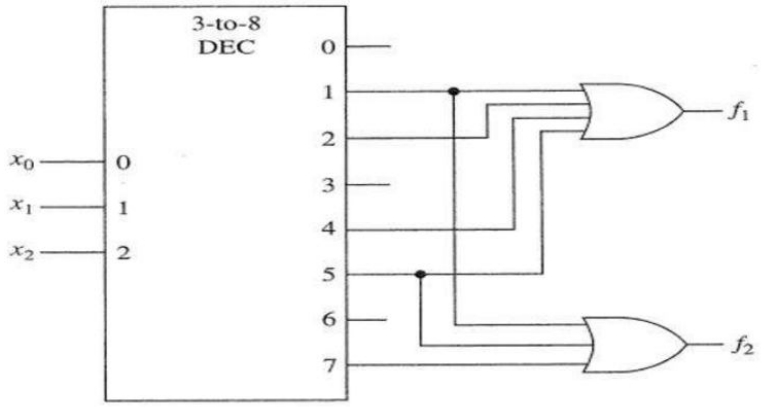
Logic Design Using Decoders

- An n-to-2^n line decoder is a minterm generator.
- By using or-gates in conjunction with an n-to-2^n line decoder, realizations of Boolean functions are possible.
- Do not correspond to minimal sum-of-products.
- Are simple to produce. Particularly convenient when several functions of the same variable have to be realized.

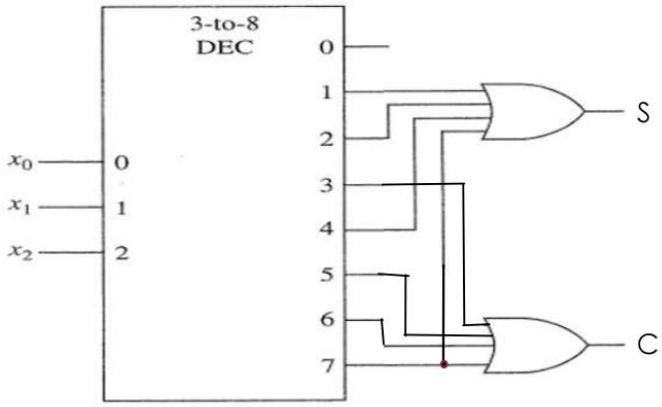
Realization of the Boolean expressions
$f_1(x_2,x_1,x_0) = \Sigma m(1,2,4,5)$ and
$f_2(x_2,x_1,x_0) = \Sigma m(1,5,7)$



Implementation of a Full Adder circuit using Decoder.

$S(x_0, x_1, x_2) = \sum(1, 2, 4, 7)$

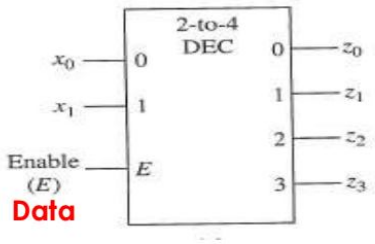
$C(x_0, x_1, x_2) = \sum(3, 5, 6, 7)$



x	y	z	C	S
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

Decoders with enable inputs

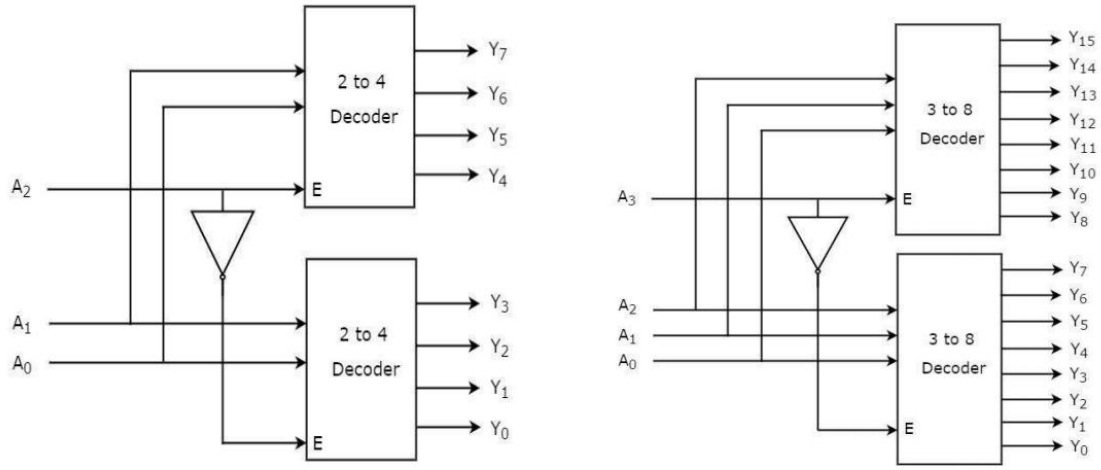
- When disabled, all outputs of the decoder can either be at logic-0 or logic-1.
- Enable input provides the decoder with additional flexibility.
- Idea: if data is applied to the enable input.
- Process is known as demultiplexing.
- Now Decoder works as Demultiplexer. $\overline{x}_0\overline{x}_1E$



If $x_0 = 0, x_1 = 0$ then data appears on line z_0.

- Enable inputs are useful when constructing larger decoders from smaller decoders.

Larger Decoders from smaller Decoder



Applications

- In digital electronic decoder play an important role. It is used to convert the data from one form to another form.
- Generally, these are frequently used in the communication systems like telecommunication, networking, and transfer the data from one end to the other end.
- In the same way it is also used in the digital domain for easy transmission of data.
- It is also used as

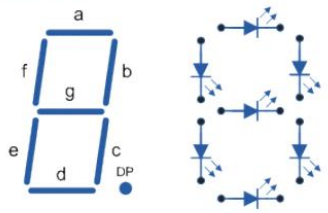
  Binary to Octal converter

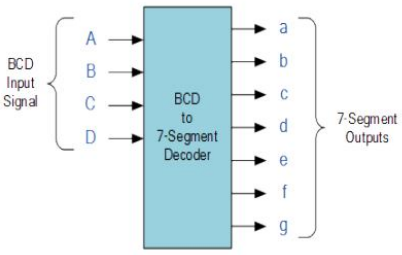
  BCD to Decimal converter

  BCD to Seven Segment Display
- Boolean functions can be implemented using decoder.

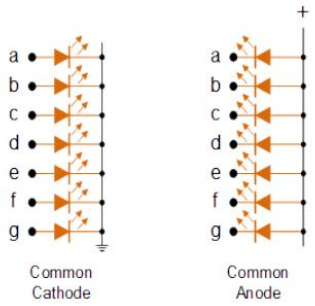
BCD to Seven segment display

- The Seven segment display is most frequently used the digital display in calculators, digital counters, digital clocks, measuring instruments, etc.
- Usually, the displays like LED's as well as LCD's are used to display the characters as well as numerical numbers.
- These displays are frequently driven by the output phases of digital integrated circuits like decade counters as well as latches.
- However, the outputs of these are in the type of 4-bit BCD (Binary Coded Decimal), so not appropriate for directly operating the seven segment display.
- For that, a display decoder can be employed for converting BCD code to seven segment code.
- Generally, it has four input lines as well as seven output lines.
- The Decoder is an essential component in BCD to seven segment display.



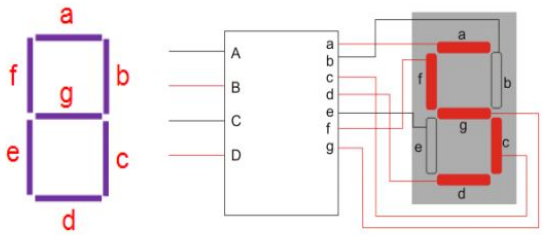


- The circuit design, as well as operation, mainly depends on the concepts of Boolean Algebra as well as logic gates.
- The common terminals are either anode or cathode. So, it may be common cathode type or common anode type.



Truth Table

Decimal Digit	Input lines				Output lines							Display pattern
	A	B	C	D	a	b	c	d	e	f	g	
0	0	0	0	0	1	1	1	1	1	1	0	0
1	0	0	0	1	0	1	1	0	0	0	0	1
2	0	0	1	0	1	1	0	1	1	0	1	2
3	0	0	1	1	1	1	1	1	0	0	1	3
4	0	1	0	0	0	1	1	0	0	1	1	4
5	0	1	0	1	1	0	1	1	0	1	1	5
6	0	1	1	0	1	0	1	1	1	1	1	6
7	0	1	1	1	1	1	1	0	0	0	0	7
8	1	0	0	0	1	1	1	1	1	1	1	8
9	1	0	0	1	1	1	1	1	0	1	1	9



a = F1 (A, B, C, D) = ∑m (0, 2, 3, 5, 6, 7, 8, 9)
b = F2 (A, B, C, D) = ∑m (0, 1, 2, 3, 4, 7, 8, 9)
c = F3 (A, B, C, D) = ∑m (0, 1, 3, 4, 5, 6, 7, 8, 9)
d = F4 (A, B, C, D) = ∑m (0, 2, 3, 5, 6, 8, 9)
e = F5 (A, B, C, D) = ∑m (0, 2, 6, 8)
f = F6 (A, B, C, D) = ∑m (0, 4, 5, 6, 8, 9)
g = F7 (A, B, C, D) = ∑m (2, 3, 4, 5, 6, 8, 9)

K-Map

a

AB \ CD	00	01	11	10
00	1	0	1	1
01	0	1	1	1
11	X	X	X	X
10	1	1	X	X

$a = A + C + BD + B\overline{D}$

b

AB \ CD	00	01	11	10
00	1	1	1	1
01	1	0	1	0
11	X	X	X	X
10	1	1	X	X

$b = \overline{B} + \overline{C}\overline{D} + CD$

c

AB \ CD	00	01	11	10
00	1	1	1	0
01	1	1	1	1
11	X	X	X	X
10	1	1	X	X

$c = B + \overline{C} + D$

g

AB \ CD	00	01	11	10
00	0	0	1	1
01	1	1	0	1
11	X	X	X	X
10	1	1	X	X

$g = A + B\overline{C} + \overline{B}C + C\overline{D}$

d

AB \ CD	00	01	11	10
00	1	0	1	1
01	0	1	0	1
11	X	X	X	X
10	1	1	X	X

$d = A + \overline{B}\overline{D} + \overline{B}C + C\overline{D} + B\overline{C}D$

e

AB \ CD	00	01	11	10
00	1	0	0	1
01	0	0	0	1
11	X	X	X	X
10	1	0	X	X

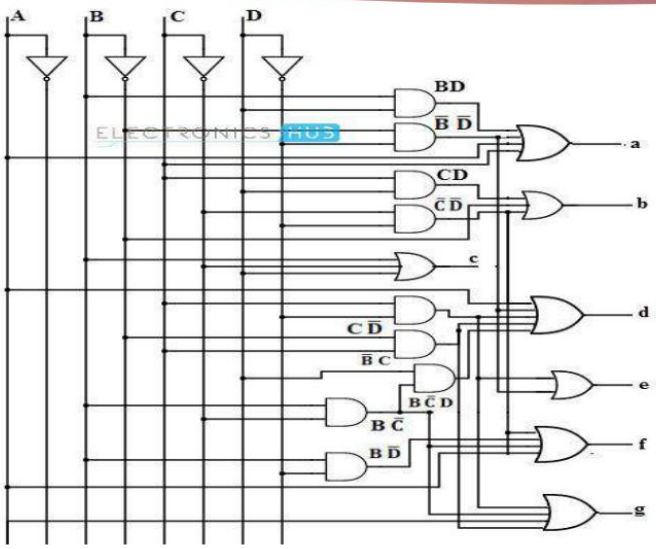
$e = \overline{B}\overline{D} + C\overline{D}$

f

AB \ CD	00	01	11	10
00	1	0	0	0
01	1	1	0	1
11	X	X	X	X
10	1	1	X	X

$f = A + B\overline{C} + B\overline{D} + \overline{C}\overline{D}$

Logic Circuit



$a = A + C + BD + \bar{B}\,\bar{D}$

$b = \bar{B} + \bar{C}\,\bar{D} + CD$

$c = B + \bar{C} + D$

$d = \bar{B}\,\bar{D} + C\,\bar{D} + B\bar{C}D + \bar{B}C + A$

$e = \bar{B}\,\bar{D} + C\,\bar{D}$

$f = A + \bar{C}\,\bar{D} + B\bar{C} + B\,\bar{D}$

$g = A + B\,\bar{C} + \bar{B}C + C\,\bar{D}$