Exp. No. 10 Encoding / Decoding and Displaying

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Encoders

- An encoder is a digital circuit that performs the inverse operation of a decoder. An encoder has 2^n (or fewer) input lines and n output lines.
- The output lines, generate the binary code corresponding to the input value. An example of an encoder is the octal-to-binary encoder whose truth table is given below:

Truth Table of an 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

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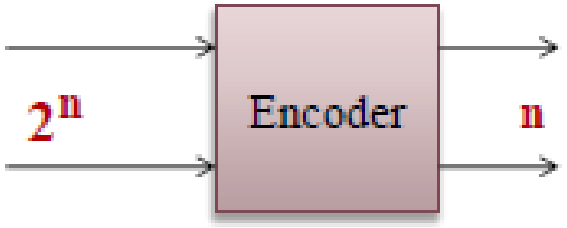
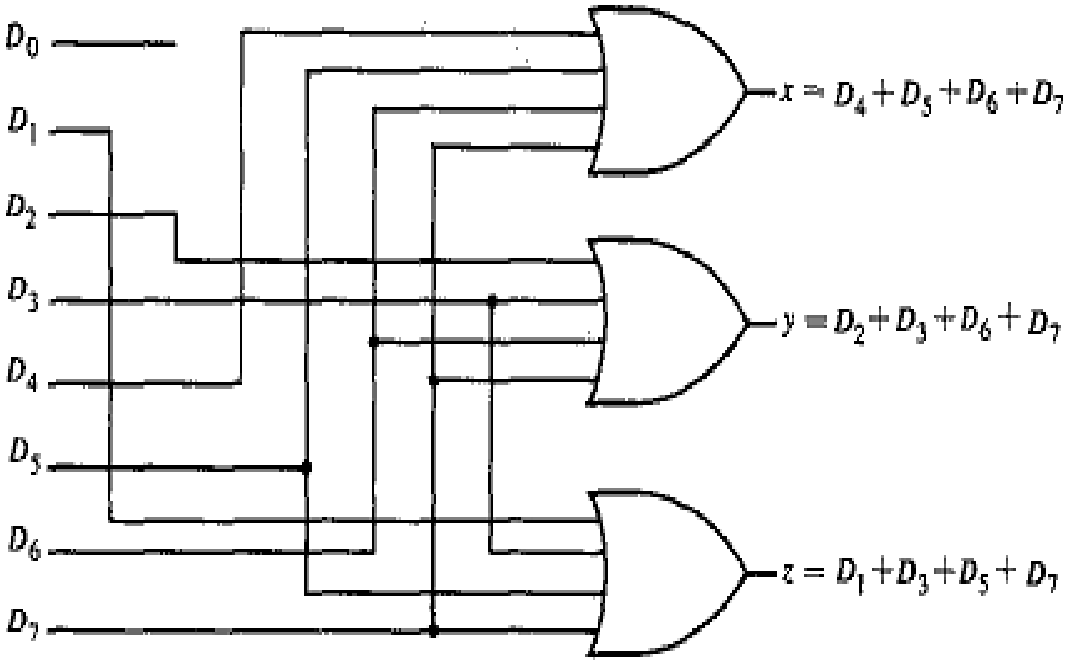
- According to the truth table, the outputs are:

$$z = D_1 + D_3 + D_5 + D_7$$
$$y = D_2 + D_3 + D_6 + D_7$$
$$x = D_4 + D_5 + D_6 + D_7$$



- The encoder can be implemented with three OR gates



8-to-3 line encoder

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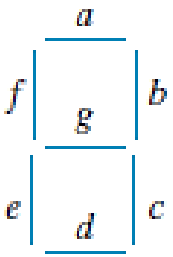
Decoder

- A *decoder* is a combinational circuit that converts binary information from n input lines to a maximum of 2^n unique output lines. If the n -bit coded information has unused combinations, the decoder may have fewer than 2^n outputs.
- **The name *decoder* is also used in conjunction with other code converters, such as a BCD-to-seven-segment decoder**.



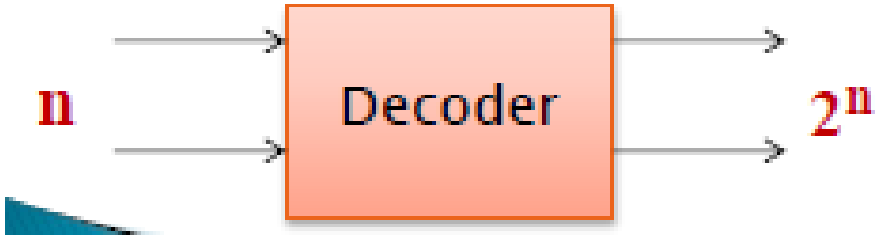
(a) Segment designation

(b) Numerical designation for display

Consider the three-to-eight-line decoder circuit of Figure below. A particular application of this decoder is binary-to-octal conversion

Truth Table of a Three-to-Eight-Line Decoder

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



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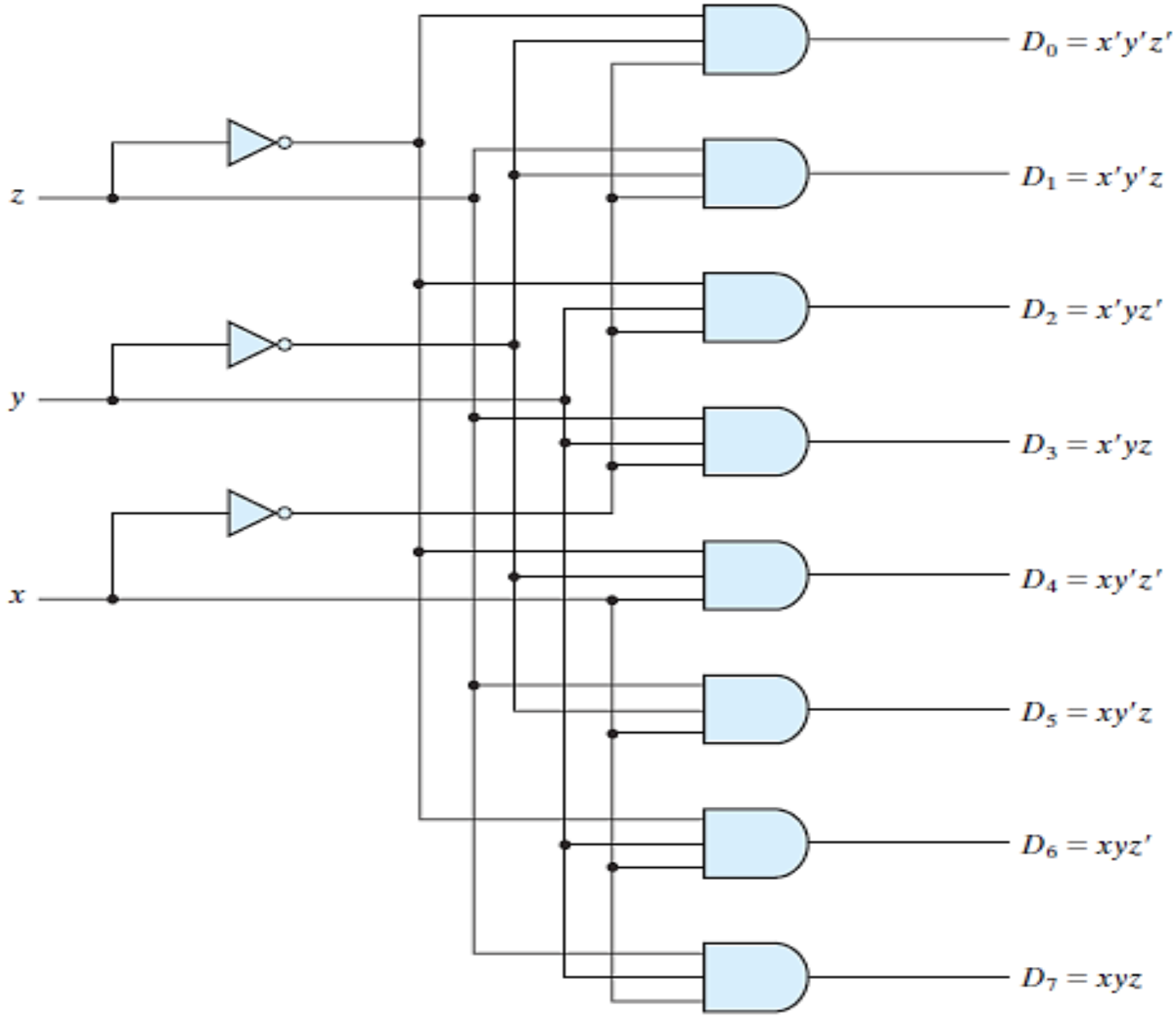
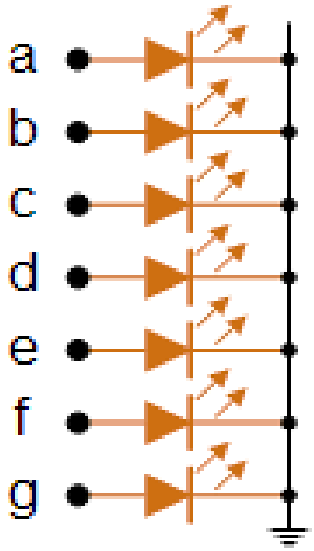

z
y
x
$D_0 = x'y'z'$
$D_1 = x'y'z$
$D_2 = x'yz'$
$D_3 = x'yz$
$D_4 = xy'z'$
$D_5 = xy'z$
$D_6 = xyz'$
$D_7 = xyz$

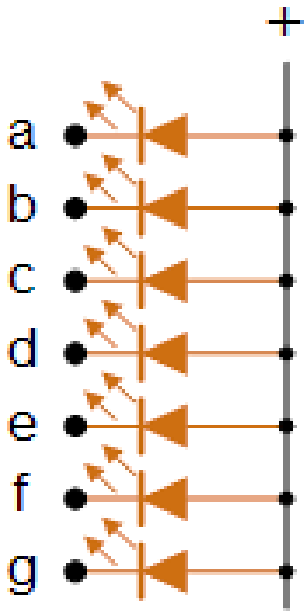
Common Cathode and Common Anode Format

Two important types of 7-segment LED digital display.

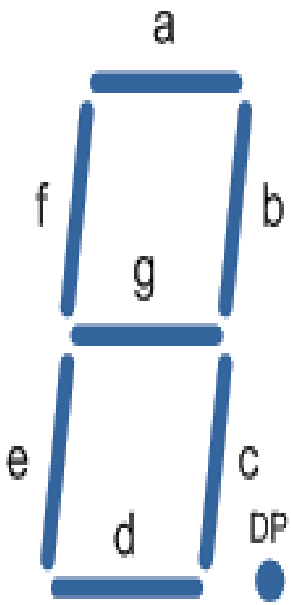
- 1. The Common Cathode Display (CCD) – In the common cathode display, all the cathode connections of the LED's are joined together to logic "0" or ground. The individual segments are illuminated by application of a "HIGH", logic "1" signal to the individual Anode terminals.
- 2. The Common Anode Display (CAD) – In the common anode display, all the anode connections of the LED's are joined together to logic "1" and the individual segments are illuminated by connecting the individual Cathode terminals to a "LOW", logic "0" signal.

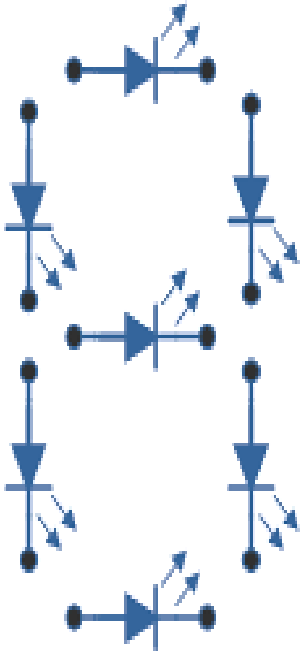


Common Cathode



Common Anode





Electrical connection of the individual diodes for a common cathode display and a common anode display and by illuminating each light emitting diode individually, they can be made to display a variety of numbers or characters.

So in order to display the number 3 for example, segments a, b, c, d and g would need to be illuminated. **Truth Table for a 7-segment display**

Individual Segments							Display
a	b	c	d	e	f	g	
×	×	×	×	×	×		0
	×	×					1
×	×		×	×		×	2
×	×	×	×			×	3
	×	×			×	×	4
×		×	×		×	×	5
×		×	×	×	×	×	6
×	×	×					7

Individual Segments							Display
a	b	c	d	e	f	g	
×	×	×	×	×	×	×	8
×	×	×	×		×	×	9
×	×	×		×	×	×	A
		×	×	×	×	×	b
×			×	×	×		C
	×	×	×	×		×	d
×			×	×	×	×	E
×				×	×	×	F

- it can be seen that to display any single digit number from 0 to 9 in binary or letters from A to F in hexadecimal, we would require 7 separate segment connections plus one additional connection for the LED's "common" connection.
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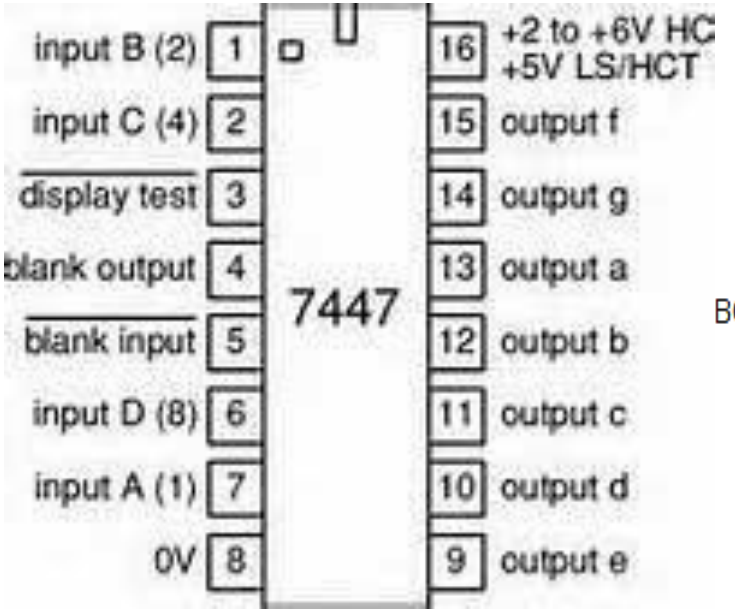
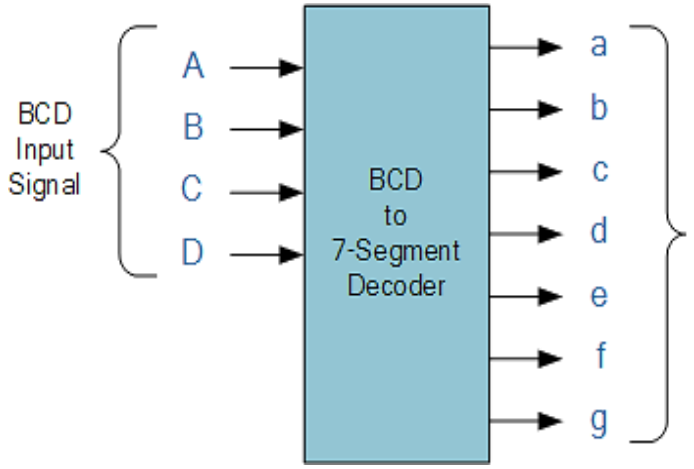
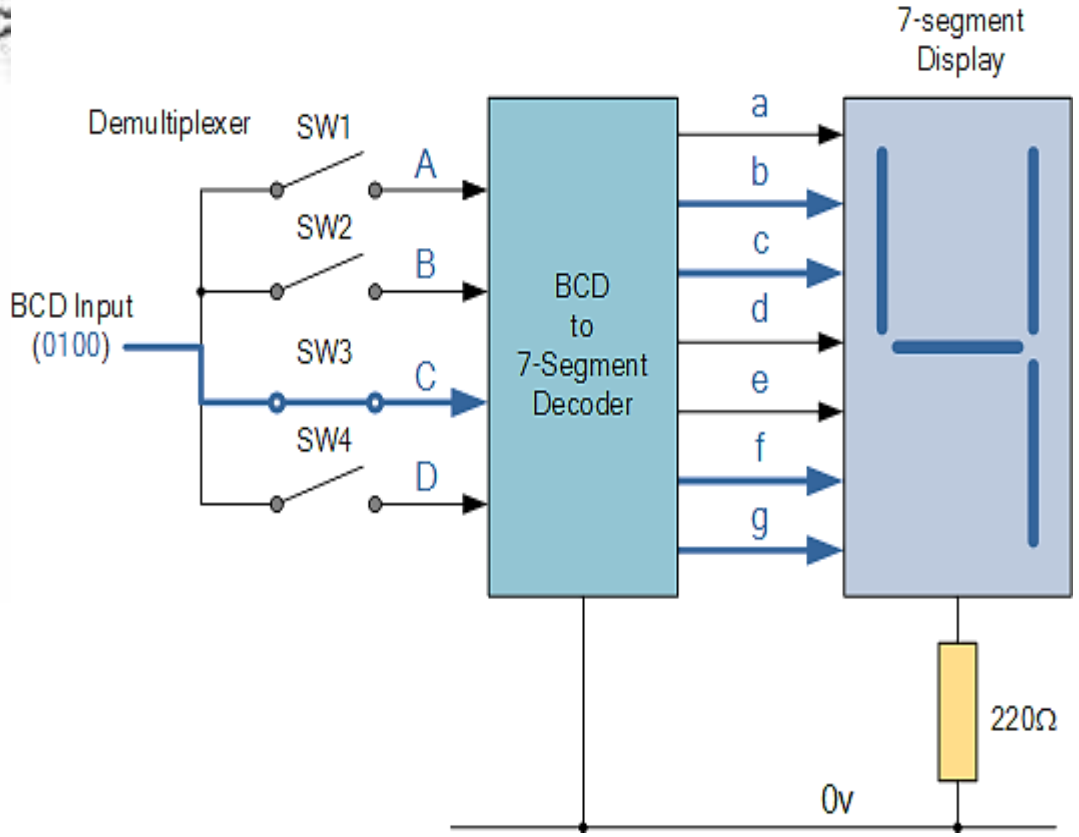
- Also as the segments are basically a standard light emitting diode**, the driving circuit would need to produce up to 20mA of current to illuminate each individual segment** and to display the number 8, all 7 segments would need to be lit resulting a total current of nearly 140mA, (8 x 20mA).

- Obviously, the use of so many connections and power consumption is impractical for some electronic or microprocessor based circuits and **so in order to reduce the number of signal lines required to drive just one single display, display decoders such as the BCD to 7-Segment Display Decoder and Driver IC's are used instead.**

BCD to 7-Segment Display Decoders







An example of the 4-bit BCD input (0100) representing the number 4

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