The background is a blue gradient with white circuit-like lines and circles in the corners. The text is centered in a white serif font.

# Chapter No:6

## Function of combinational logic

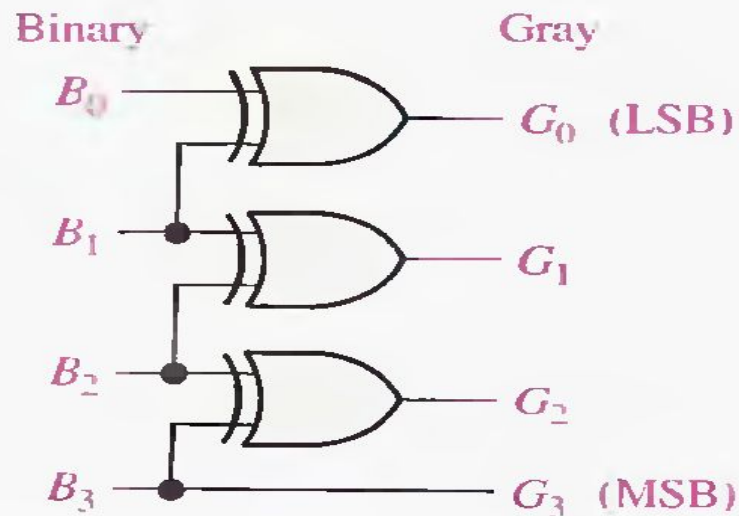
# TOPICS

1. Half and Full Adders
2. Parallel Binary Adders
3. Comparators
4. Decoders
5. Encoders
6. Code Converters
7. Multiplexers (Data Selectors)
8. Demultiplexers

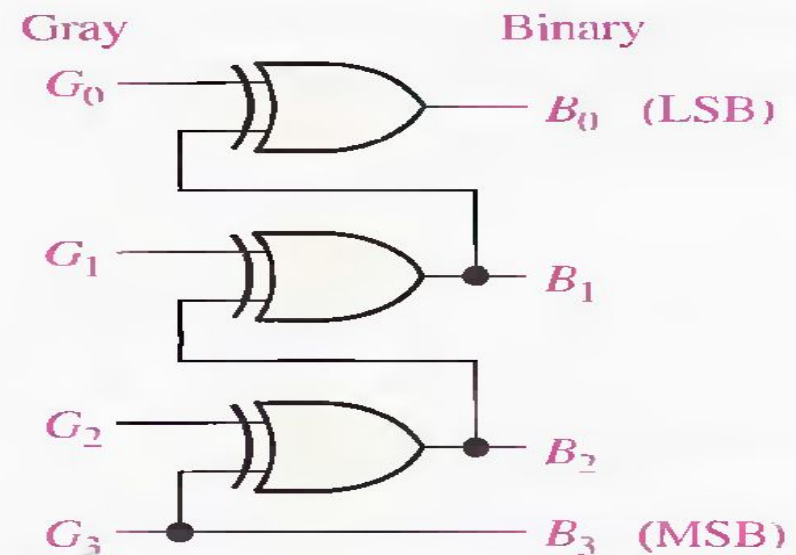
## Binary-to-Gray and Gray-to-Binary Conversion

There are various code converters that change one code to another. Two examples are the four bit binary-to-Gray converter and the Gray-to-binary converter.

Four-bit binary-to-Gray conversion logic.

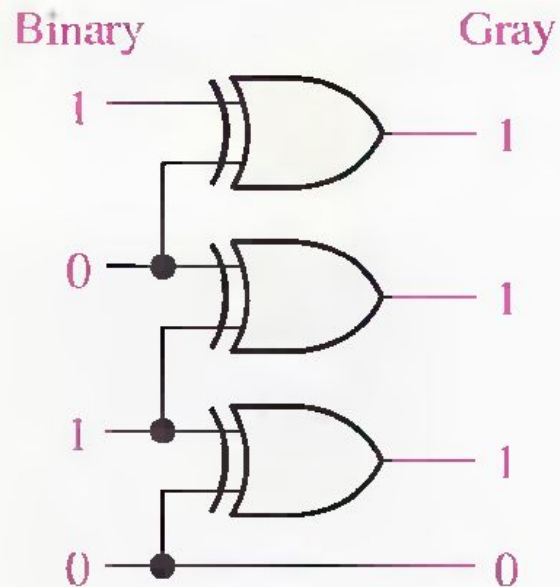


Four-bit Gray-to-binary conversion logic.

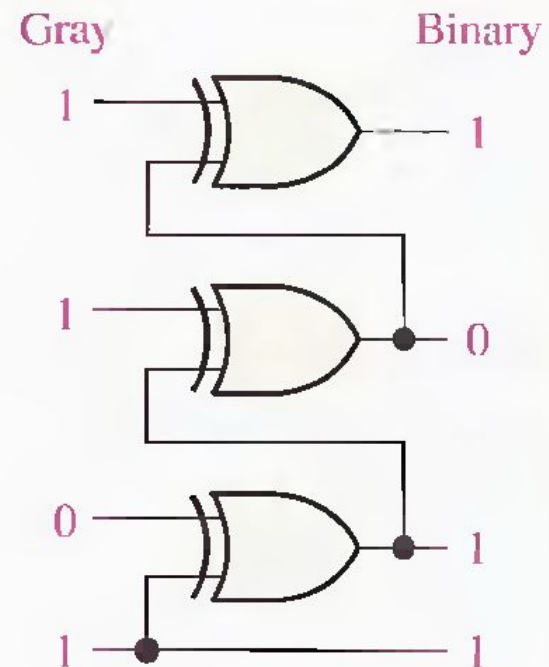


(a) Convert the binary number 0101 to Gray code with exclusive-OR gates.

(b) Convert the Gray code 1011 to binary with exclusive-OR gates.



(a)

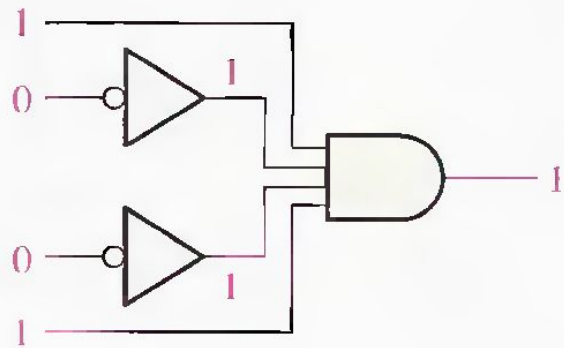


(b)

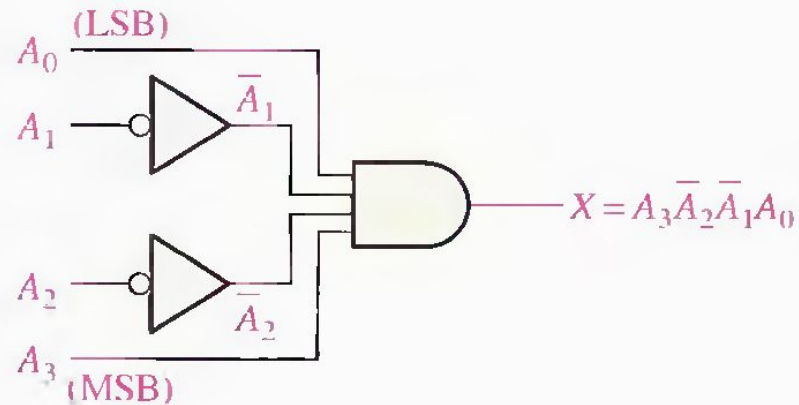
# DECODERS

*A decoder is a digital circuit that detects the presence of a specified combination of bits (code) on its inputs and indicates the presence of that code by a specified output level.*

Suppose you need to determine when a binary 1001 occurs on the inputs of a digital circuit.



(a)



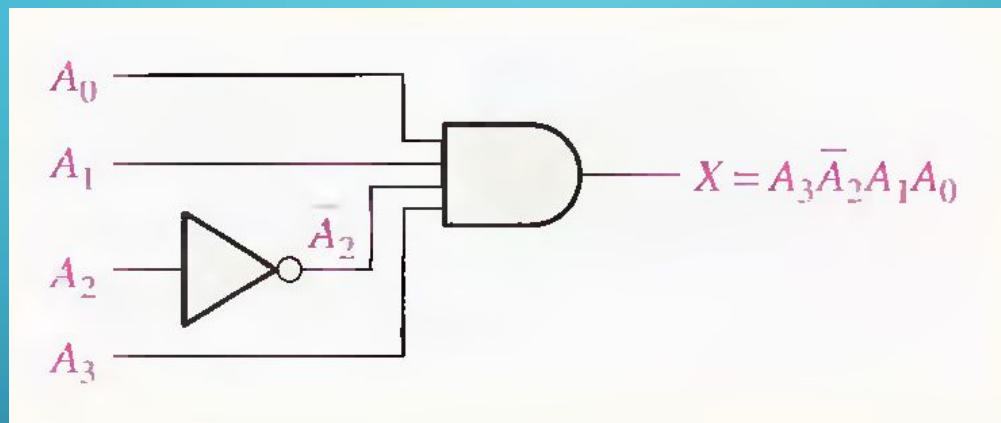
(b)

*If a NAND gate is used in place of the AND gate in Figure , a LOW output will indicate the presence of the proper binary code, which is 1001 in this case.*



## Example

Determine the logic required to decode the binary number 1011 by producing a HIGH level on the output.



Develop the logic required to detect the binary code 10010 and produce an active-LOW output.

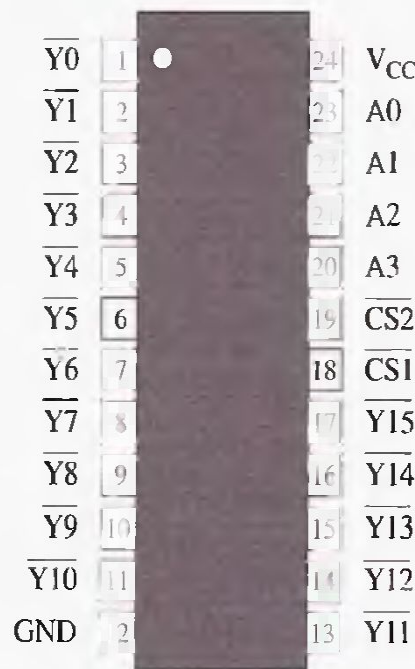
## The 4-Bit Decoder

Decoding functions and truth table for a 4-line-to-16-line (1-of-16) decoder with active-LOW outputs.

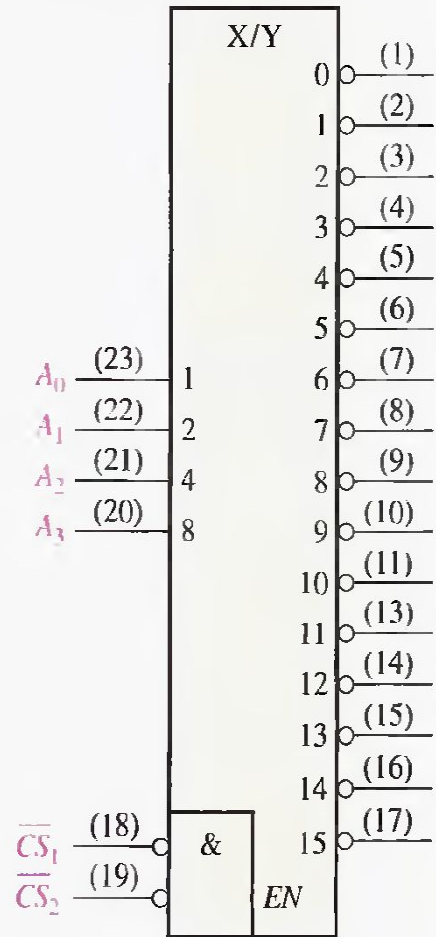
[illegible]

## THE 74HC154 1-OF-16 DECODER

The 74HC154 is a good example of an IC decoder. There is an enable function (EN) provided on this device, which is implemented with a NOR gate used as a negative-AND. A LOW level on each chip select input,  $CS1'$  and  $CS2'$ , is required in order to make the enable gate output (EN) HIGH. The enable gate output is connected to an input of each NAND gate in the decoder, so it must be HIGH for the NAND gates to be enabled. If the enable gate is not activated by a LOW on both inputs, then all sixteen decoder outputs (Y) will be HIGH regardless of the states of the four input variables.



(a) Pin diagram



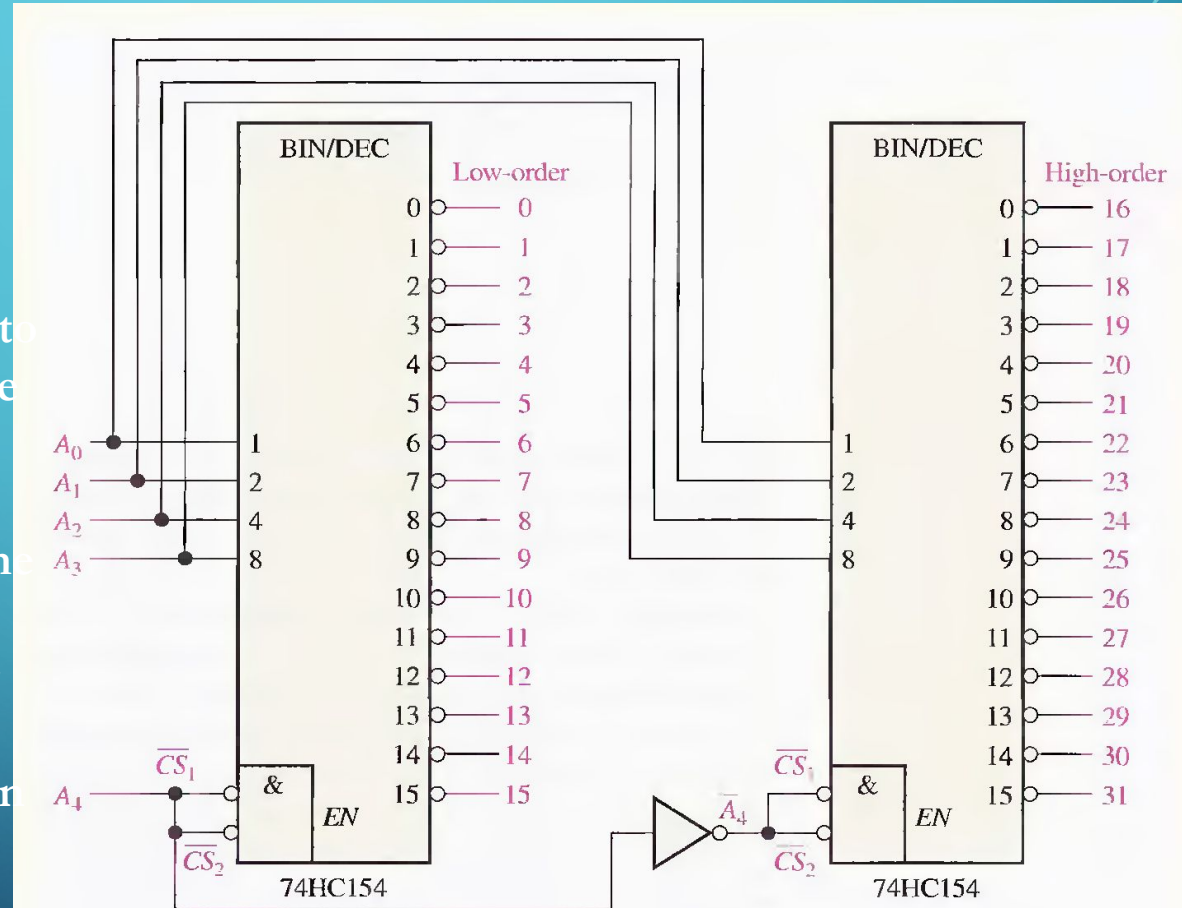
(b) Logic symbol



# EXAMPLE

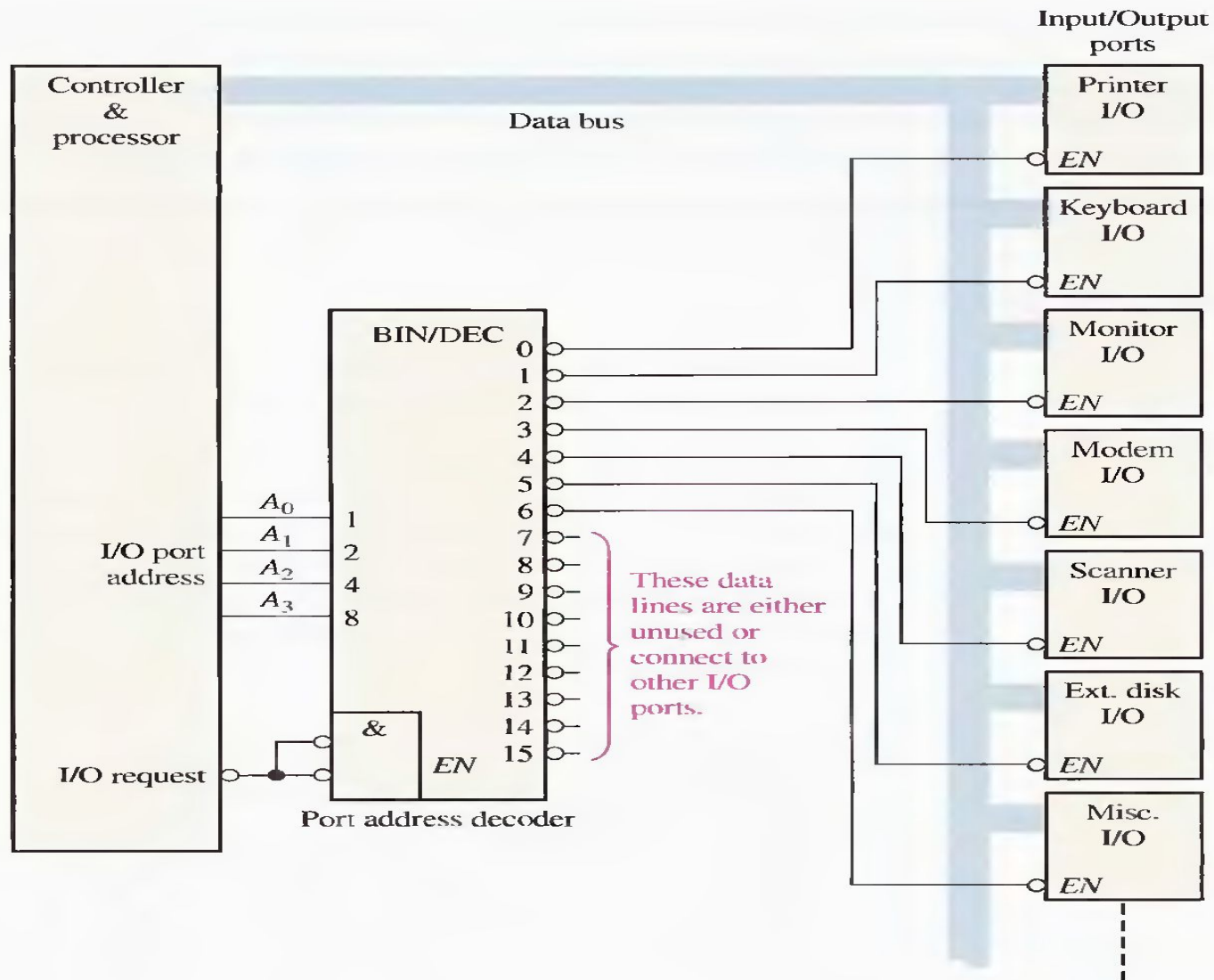
A certain application requires that a 5-bit number be decoded. Use 74HC154 decoders to implement the logic. The binary number is represented by the format  $A_4A_3A_2A_1A_0$ .

Since the 74HC154 can handle only four bits, two decoders must be used to decode five bits. The fifth bit,  $A_4$ , is connected to the chip select inputs,  $\overline{CS_1}$  and  $\overline{CS_2}$ , of one decoder, and  $A_4$  is connected to the  $\overline{CS_1}$  and  $\overline{CS_2}$  inputs of the other decoder, as shown in Figure . When the decimal number is 15 or less,  $A_4 = 0$ , the low-order decoder is enabled, and the high-order decoder is disabled. When the decimal number is greater than 15,  $A_4 = 1$  so  $A_4' = 0$ , the high-order decoder is enabled, and the low-order decoder is disabled.



# An Application

A simplified computer I/O port system with a port address decoder with only four address lines shown.



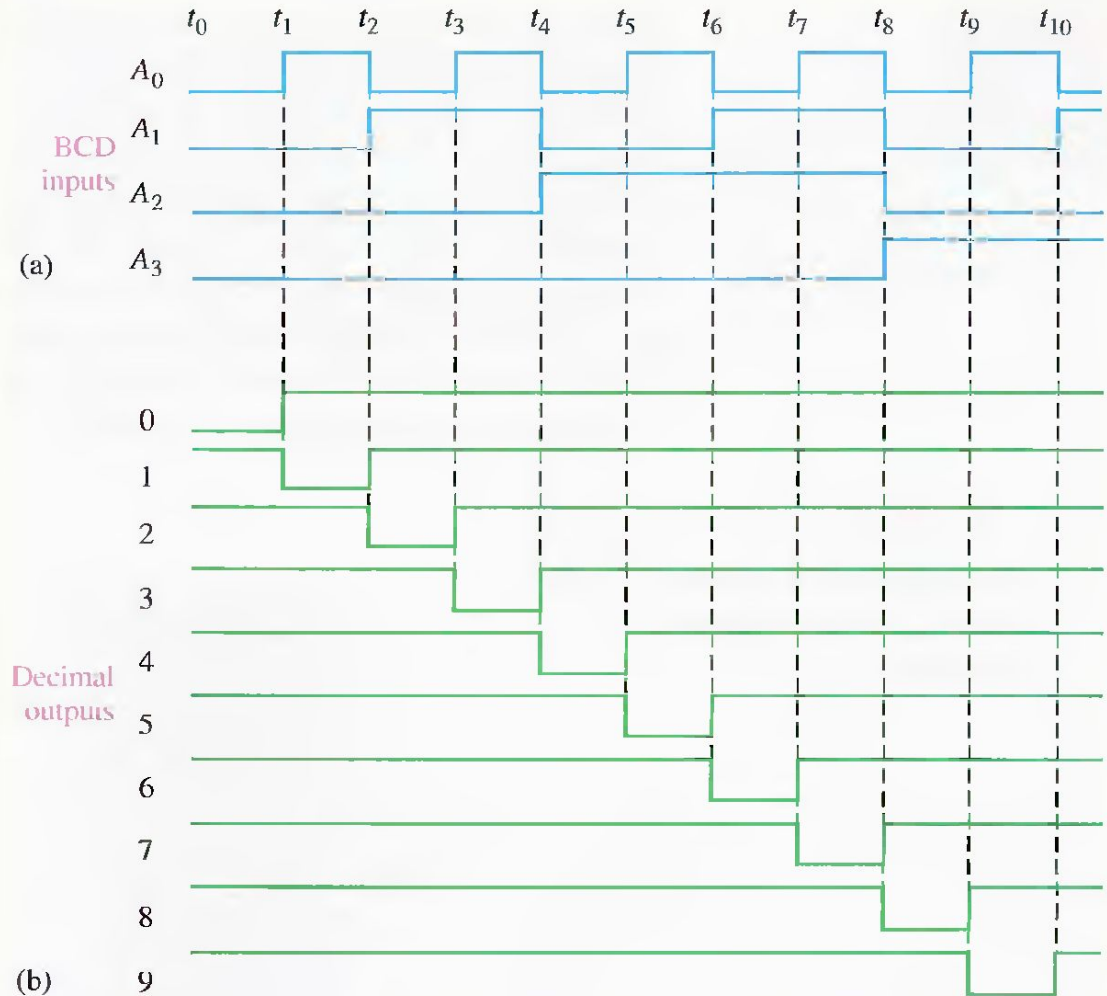
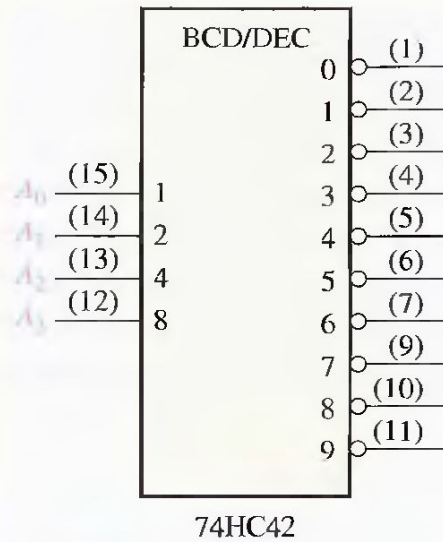
## The BCD-to-Decimal Decoder

The BCD-to-decimal decoder converts each BCD code (8421 code) into one of ten possible decimal digit indications. It is frequently referred as a *4-line-to-10-line decoder* or a *1-of-10 decoder*.

BCD decoding functions.

DECIMAL DIGIT	BCD CODE				DECODING FUNCTION
	$A_3$	$A_2$	$A_1$	$A_0$	
0	0	0	0	0	$\overline{A_3}\overline{A_2}\overline{A_1}\overline{A_0}$
1	0	0	0	1	$\overline{A_3}\overline{A_2}\overline{A_1}A_0$
2	0	0	1	0	$\overline{A_3}\overline{A_2}A_1\overline{A_0}$
3	0	0	1	1	$\overline{A_3}\overline{A_2}A_1A_0$
4	0	1	0	0	$\overline{A_3}A_2\overline{A_1}\overline{A_0}$
5	0	1	0	1	$\overline{A_3}A_2\overline{A_1}A_0$
6	0	1	1	0	$\overline{A_3}A_2A_1\overline{A_0}$
7	0	1	1	1	$\overline{A_3}A_2A_1A_0$
8	1	0	0	0	$A_3\overline{A_2}\overline{A_1}\overline{A_0}$
9	1	0	0	1	$A_3\overline{A_2}\overline{A_1}A_0$

The 74HC42 is an integrated circuit BCD-to-decimal decoder.



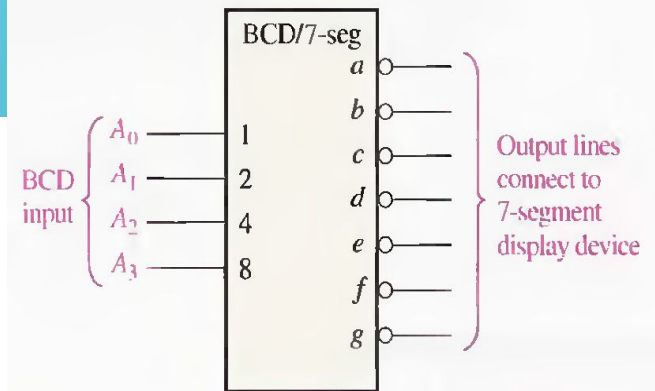
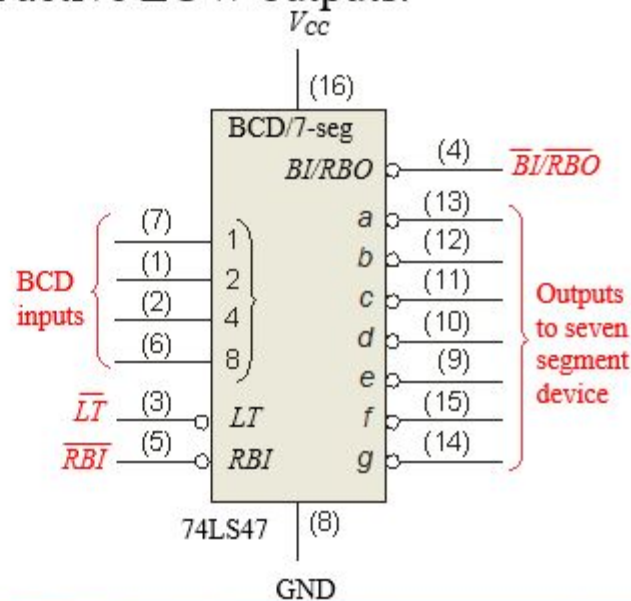


## The BCD-to-7-Segment Decoder

The BCD-to-7-segment decoder accepts the BCD code on its inputs and provides outputs to drive 7-segment display devices to produce a decimal readout. The logic diagram for a basic 7-segment decoder is shown in Figure 6-34.

Another useful decoder is the 74LS47. This is a BCD-to-seven segment display with active LOW outputs.

The *a-g* outputs are designed for much higher current than most devices (hence the word driver in the name).



## BCD Decoder/Driver

Here the 7447A is an connected to an LED seven segment display. Notice the current limiting resistors, required to prevent overdriving the LED display.

