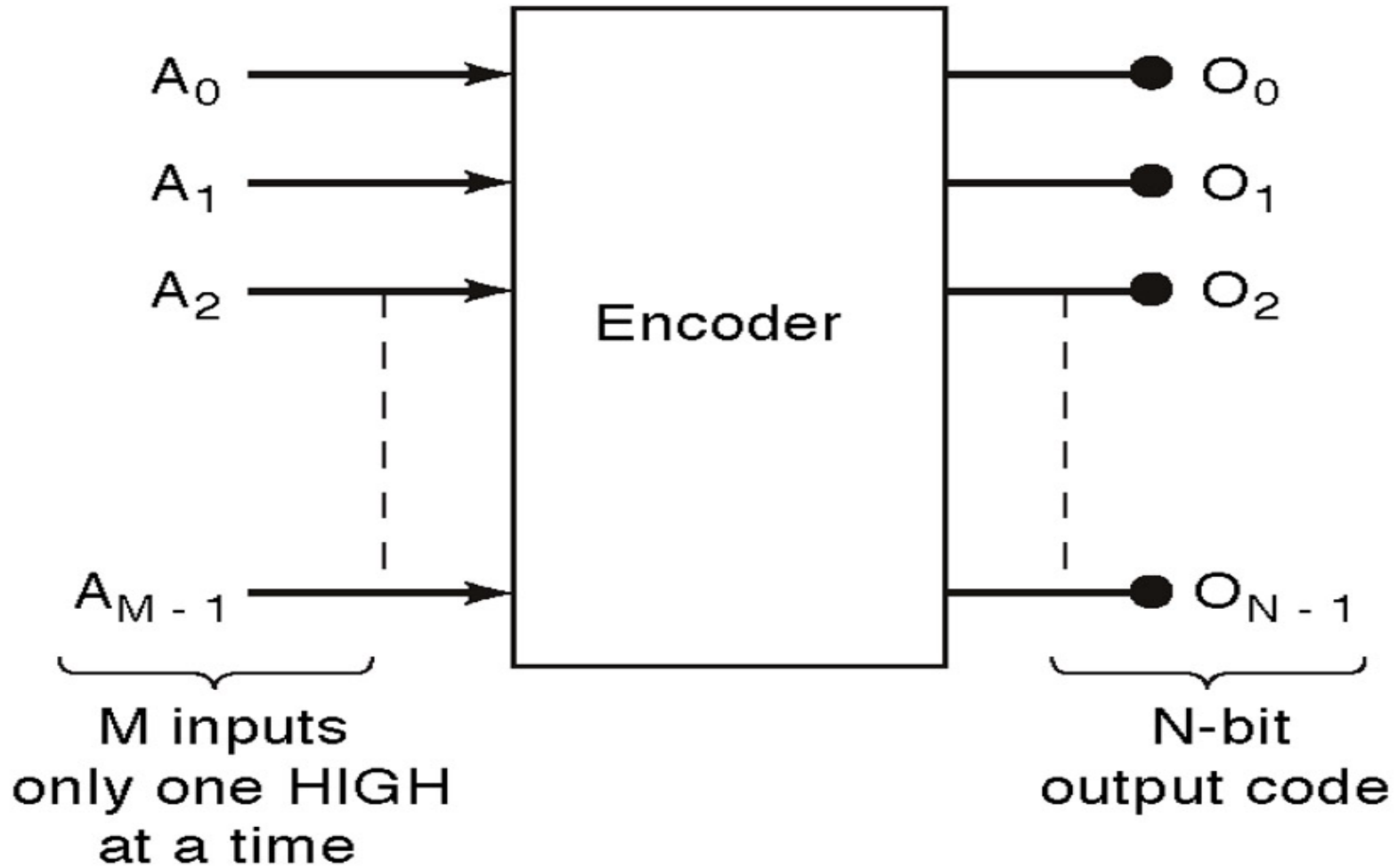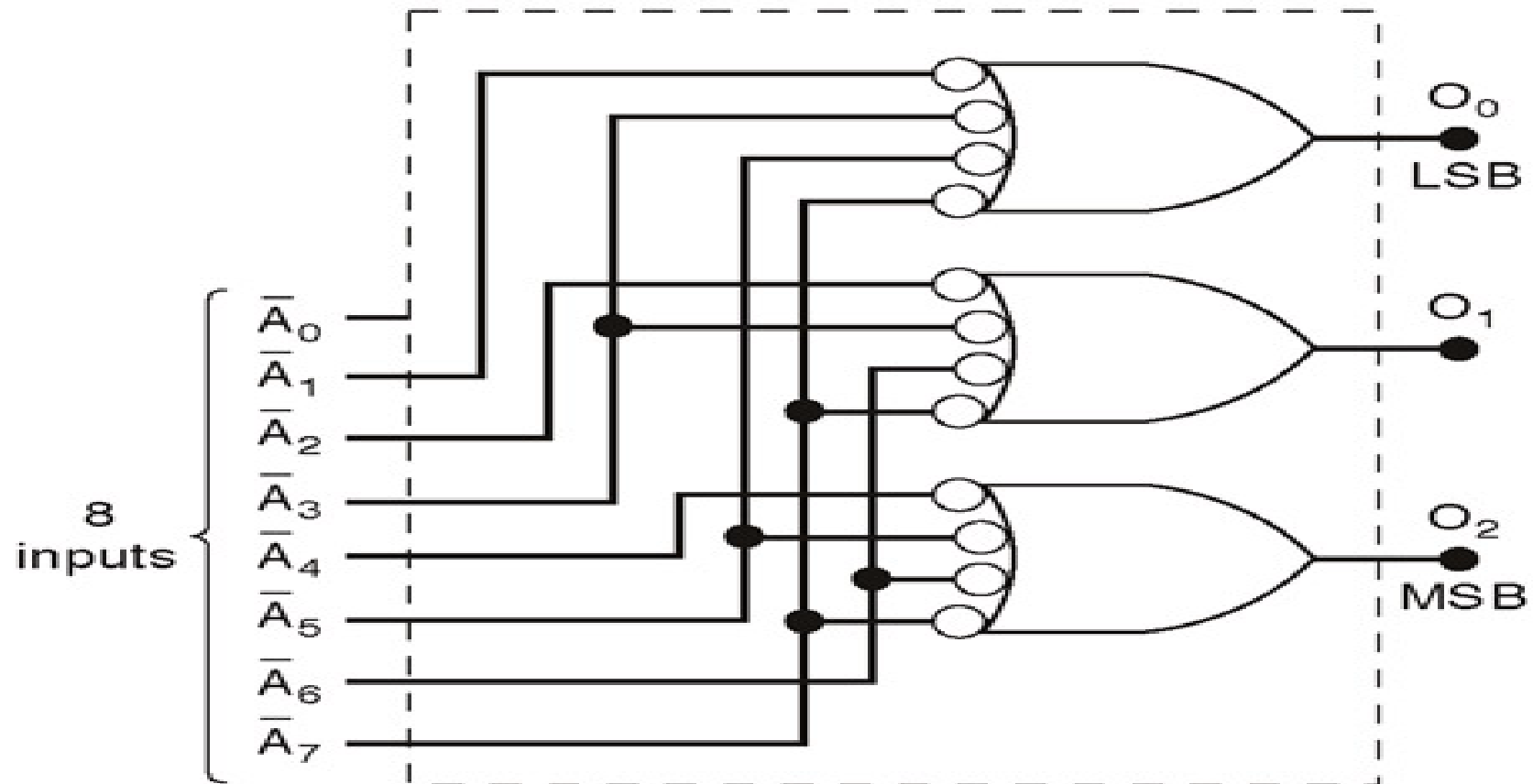# Encoders

Encoder

- An encoder is a combinational logic circuit that essentially performs a "reverse" of decoder functions.

- An encoder accepts an active level on one of its inputs, representing digit, such as a decimal or octal digits, and converts it to a coded output such as BCD or binary.

- Encoders can also be devised to encode various symbols and alphabetic characters.

- The process of converting from familiar symbols or numbers to a coded format is called ***encoding***.

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•Most decoders accept an input code and produce a HIGH

•(or a LOW) at one and only one output line. In otherworlds , a decoder identifies, recognizes, or detects a particular code. The opposite of this decoding process is called encoding and is performed by a logic circuit called an <u>encoder.</u>

•An encoder has a number of input lines, only one of which input is activated at a given time and produces an N-bit output code,depending on which input is activated.

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General encoder diagram

M inputs only one HIGH at a time

N-bit output code

Logic circuit for octal-to binary encoder [8-line-3-line]

Truth table for octal-to binary encoder [8-line- 3-line]

			Inputs						Outputs	
$\bar{A}_0$	$\bar{A}_1$	$\bar{A}_2$	$\bar{A}_3$	$\bar{A}_4$	$\bar{A}_5$	$\bar{A}_6$	$\bar{A}_7$	O_2	O_1	O_0
X	1	1	1	1	1	1	1	0	0	0
X	0	1	1	1	1	1	1	0	0	1
X	1	0	1	1	1	1	1	0	1	0
X	1	1	0	1	1	1	1	0	1	1
X	1	1	1	0	1	1	1	1	0	0
X	1	1	1	1	0	1	1	1	0	1
X	1	1	1	1	1	0	1	1	1	0
X	1	1	1	1	1	1	0	1	1	1

A low at any single input will produce the output binary code corresponding to that input. For instance , a low at A_3' will produce $O_2 = 0$, $O_1 = 1$ and $O_0 = 1$, which is binary code for 3. A_o' is not connected to the logic gates because the encoder outputs always be normally at 0000 when none of the inputs is LOW

Design of 4-input Priority Encoder
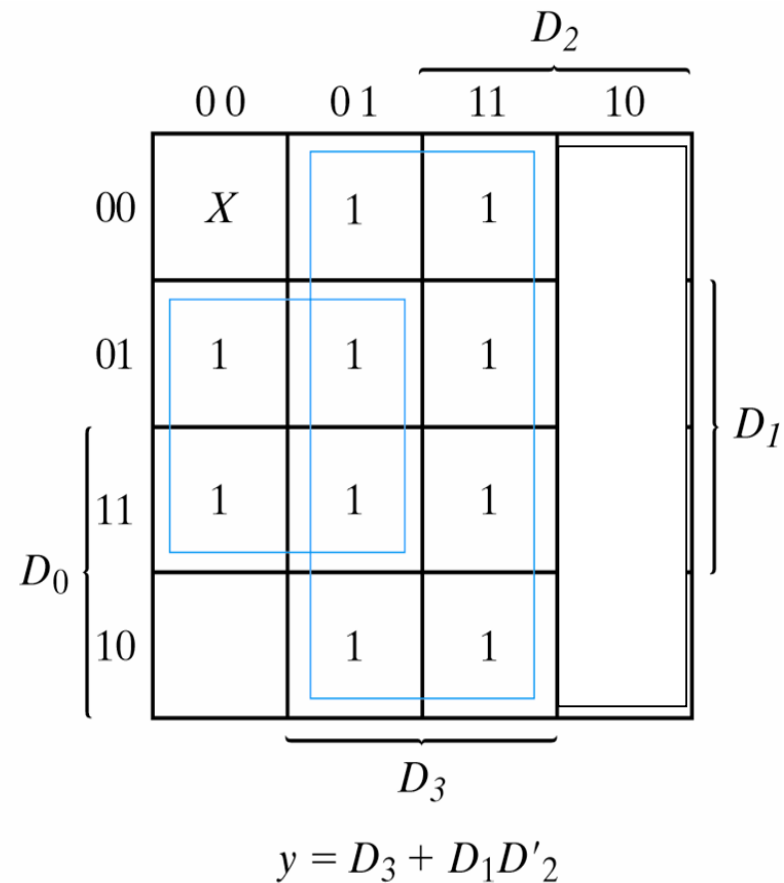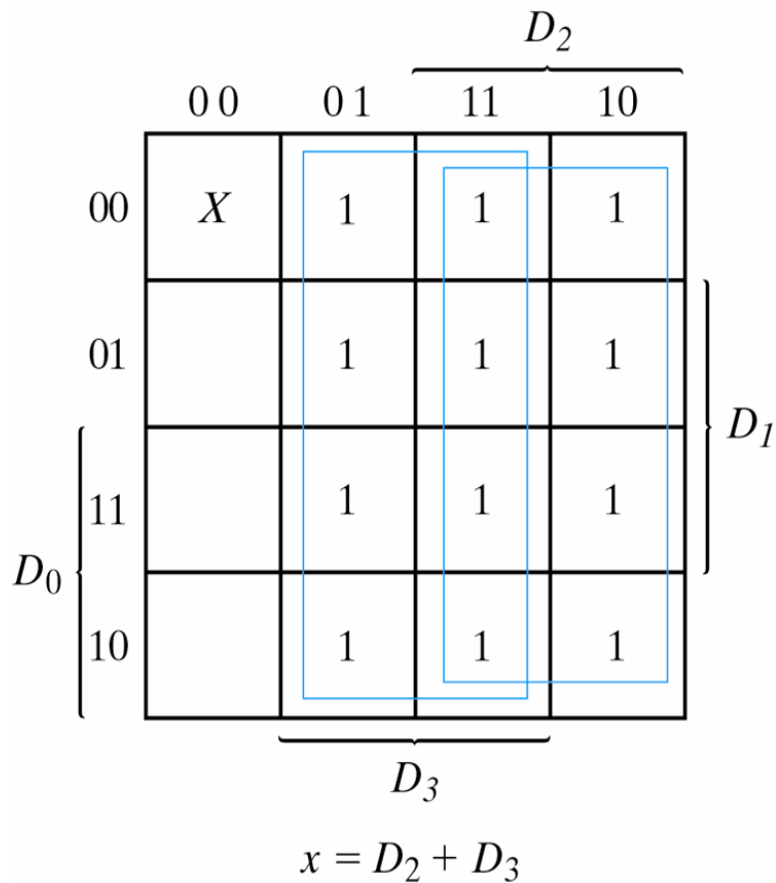## (4-line-to 2 line priority encoder) (1)…

- A priority encoder is an encoder that includes the priority function

- If two or more inputs are equal to 1 at the same time, the input having the highest priority will take precedence.

- **Truth Table of a 4-input Priority Encoder:**

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

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Design of 4-input Priority Encoder
(4-line-to 2 line priority encoder) (2)…

- In addition to two outputs x, and y, the truth table has a third output designated by V, which is a valid bit indicator that is set 1 when one or more inputs are equal to 1. If all inputs are 0, there is no valid input and V is equal to 0.

- X's in the output column indicate don't care conditions, the X's in the input columns are useful for representing a truth table in condensed form.

- The higher the subscript number, the higher the priority of the input. Input D3 has the highest priority, so regardless of the values of the other inputs, when this input is 1, the output for xy is 11 (binary 3)
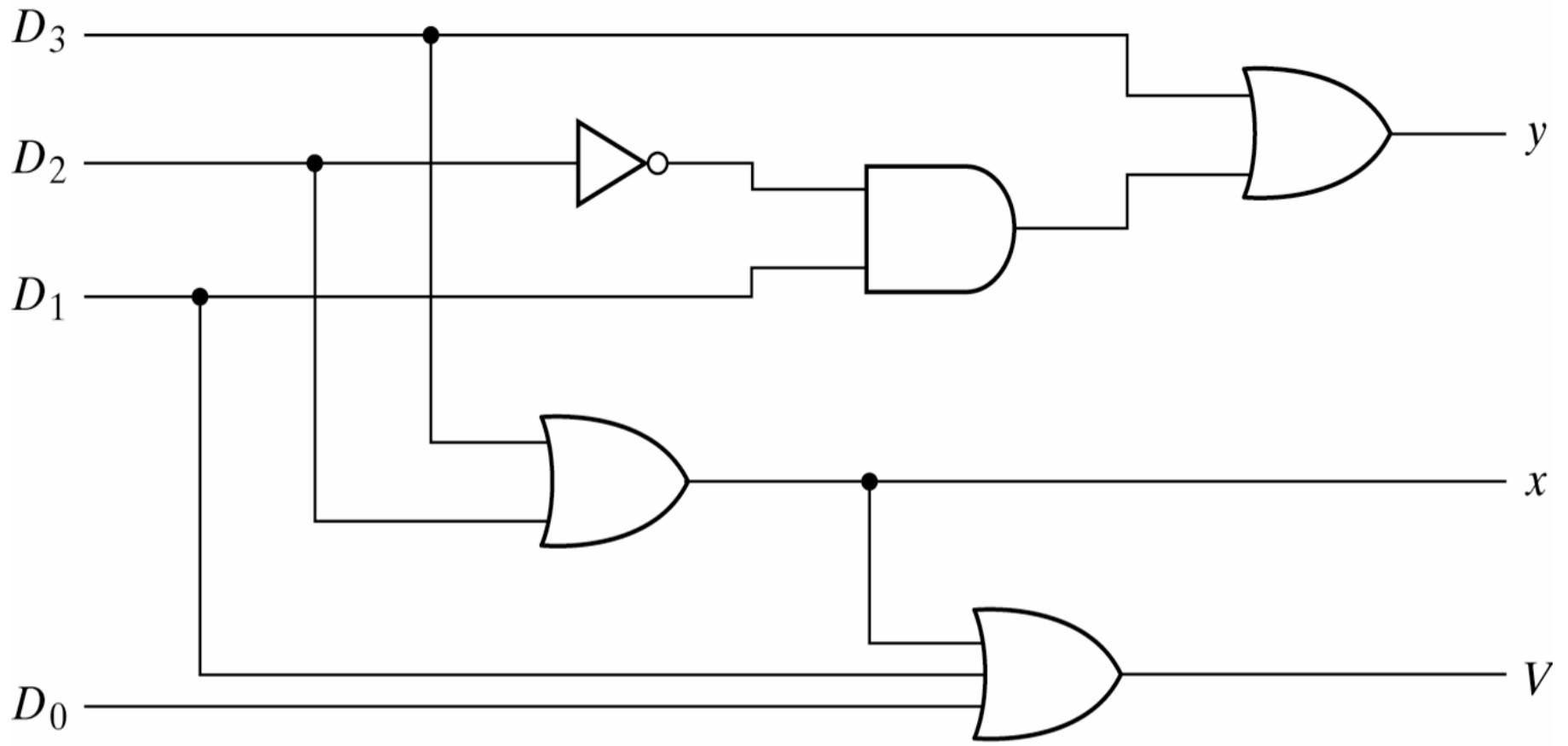
Design of 4-input Priority Encoder
(4-line-to 2 line priority encoder) (3)…

D_2

	0 0	0 1	11	10
00	X	1	1	1
01		1	1	1
11		1	1	1
10		1	1	1

D_3

$x = D_2 + D_3$

D_2

	0 0	0 1	11	10
00	X	1	1	
01	1	1	1	
11	1	1	1	
10		1	1	

D_3

$y = D_3 + D_1D'_2$

$V=D_0+D_1+D_2+D_3$

K-Maps for 4-input Priority Encoder

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Design of 4-input Priority Encoder
(4-line-to 2 line priority encoder) (4)

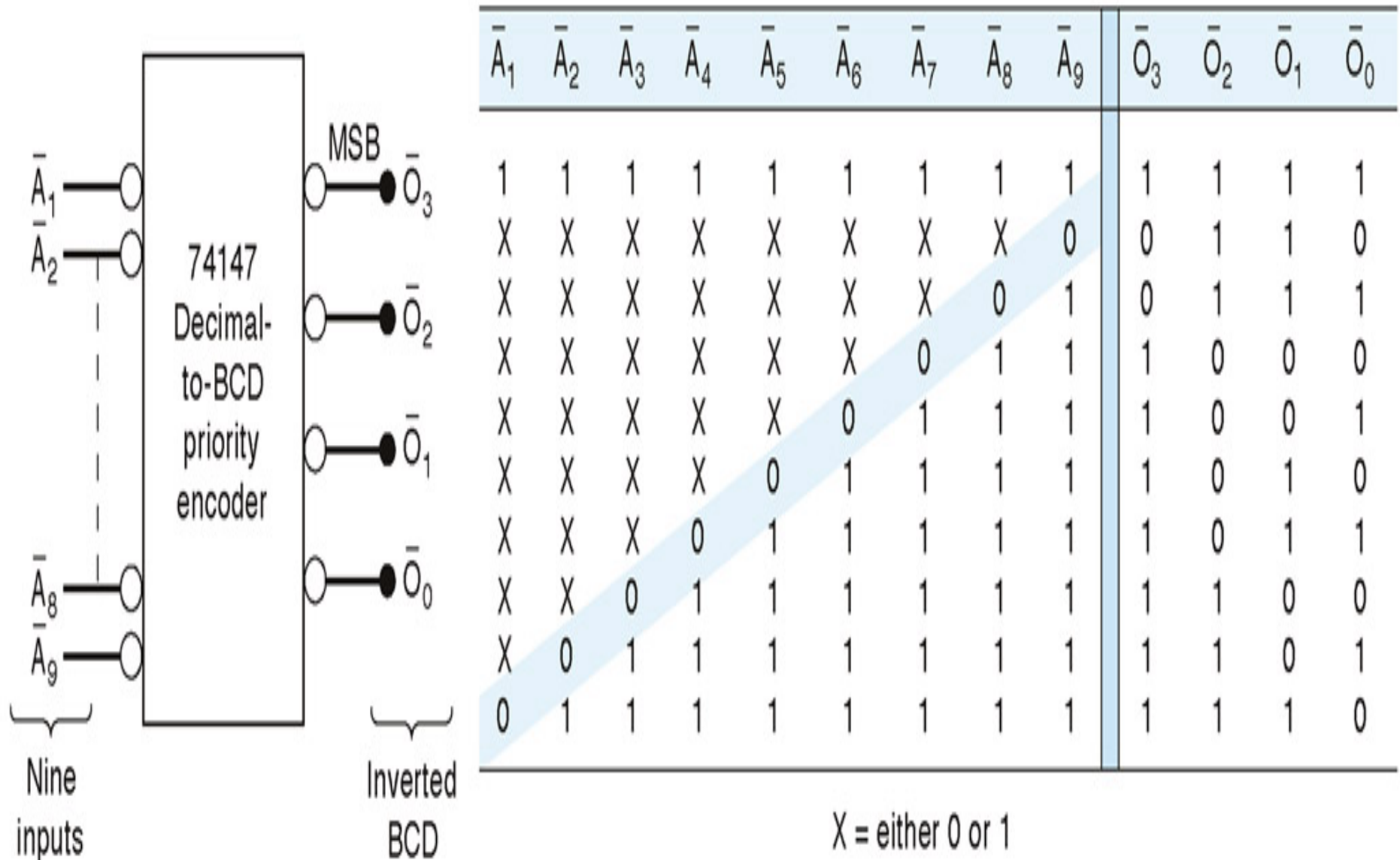Logic Diagram for 4-input priority encoder

• Encoder will produce a BCD output corresponding to the highest-order decimal digit input that is active and will ignore any other lower order active inputs.

• For instance if the input 6 and the 3 are active, the output will be 1001, which is the inverse value of BCD output 0110 (which represents decimal 6)

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74147 decimal-BCD priority encoder

$\bar{A}_1$	$\bar{A}_2$	$\bar{A}_3$	$\bar{A}_4$	$\bar{A}_5$	$\bar{A}_6$	$\bar{A}_7$	$\bar{A}_8$	$\bar{A}_9$	$\bar{O}_3$	$\bar{O}_2$	$\bar{O}_1$	$\bar{O}_0$
1	1	1	1	1	1	1	1	1	1	1	1	1
X	X	X	X	X	X	X	X	0	0	1	1	0
X	X	X	X	X	X	X	0	1	0	1	1	1
X	X	X	X	X	X	0	1	1	1	0	0	0
X	X	X	X	X	0	1	1	1	1	0	0	1
X	X	X	X	0	1	1	1	1	1	0	1	0
X	X	X	0	1	1	1	1	1	1	0	1	1
X	X	0	1	1	1	1	1	1	1	1	0	0
X	0	1	1	1	1	1	1	1	1	1	0	1
0	1	1	1	1	1	1	1	1	1	1	1	0

X = either 0 or 1

Nine inputs

Inverted BCD

MSB

74147 Decimal-to-BCD priority encoder

When A9' is low, the output is 0110, which is inverse of 1001 (eq to 9 in BCD)

Decimal- BCD switch decoder
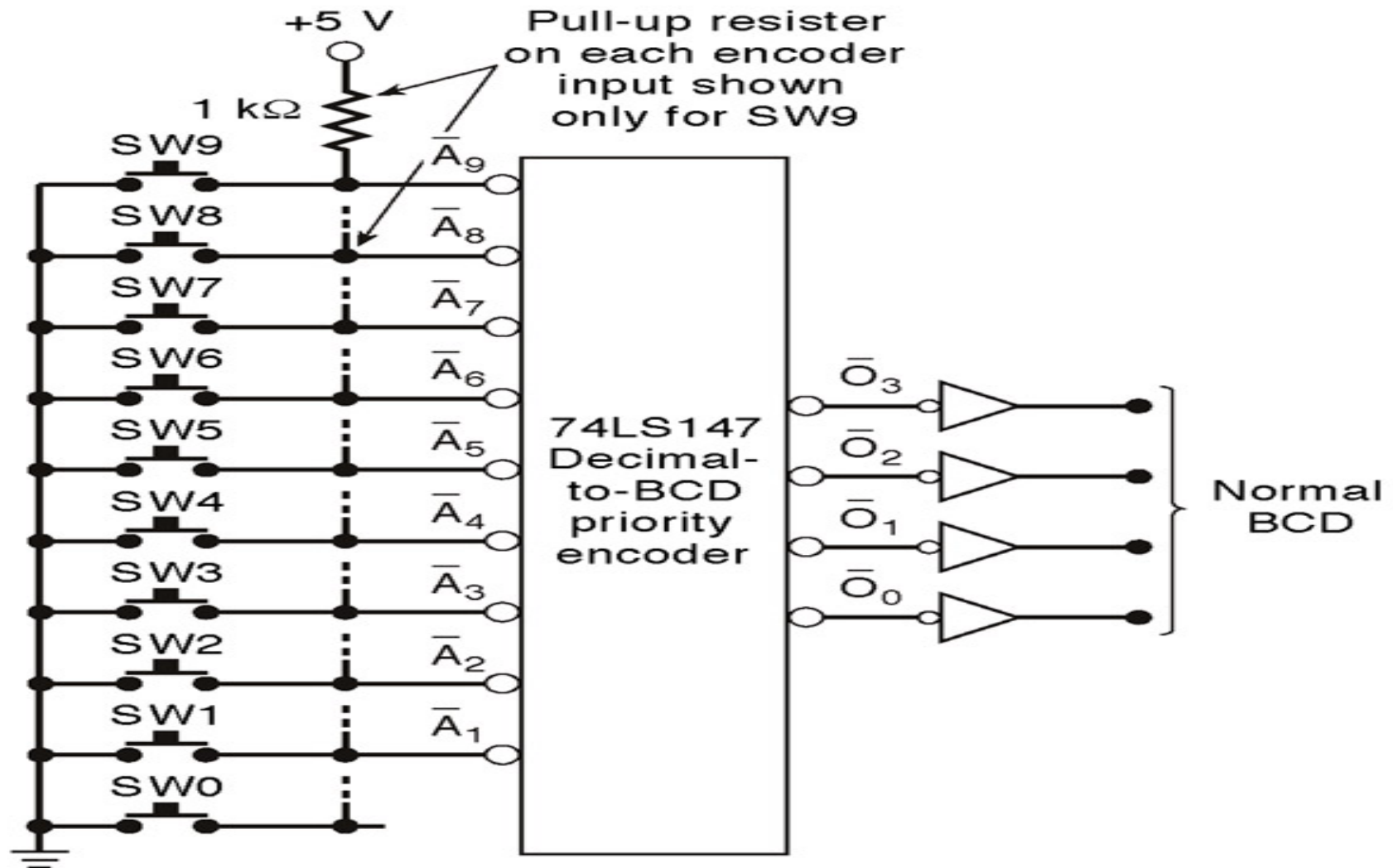
The output of the decoder are inversed to produce the normal BCD value

The Octal–to–Binary Priority Encoder- Example

- The 74LS148 is a priority encoder that has eight active *LOW* inputs and three active–*LOW* binary outputs

- To enable the device, the *EI* (enable input) must be *LOW*. It also has the *EO* (enable output) and *GS* (group signal output) for expansion purposes.

The Octal–to–Binary Encoder
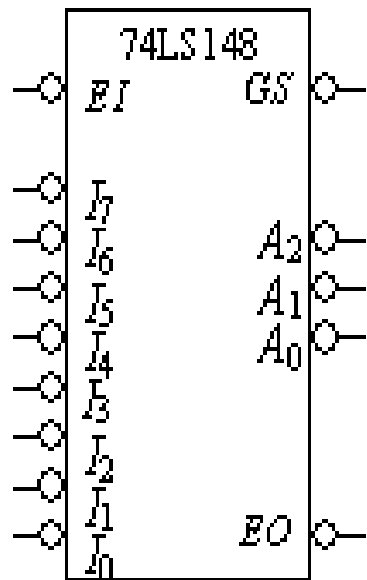
Inputs									Outputs				
$\overline{EI}$	$\overline{I_0}$	$\overline{I_1}$	$\overline{I_2}$	$\overline{I_3}$	$\overline{I_4}$	$\overline{I_5}$	$\overline{I_6}$	$\overline{I_7}$	$\overline{GS}$	$\overline{A_0}$	$\overline{A_1}$	$\overline{A_2}$	$\overline{EO}$
H	X	X	X	X	X	X	X	X	H	H	H	H	H
L	H	H	H	H	H	H	H	H	H	H	H	H	L
L	X	X	X	X	X	X	X	L	L	L	L	L	H
L	X	X	X	X	X	X	L	H	L	H	L	L	H
L	X	X	X	X	X	L	H	H	L	L	H	L	H
L	X	X	X	X	L	H	H	H	L	H	H	L	H
L	X	X	X	L	H	H	H	H	L	L	L	H	H
L	X	X	L	H	H	H	H	H	L	H	L	H	H
L	X	L	H	H	H	H	H	H	L	L	H	H	H
L	L	H	H	H	H	H	H	H	L	H	H	H	H

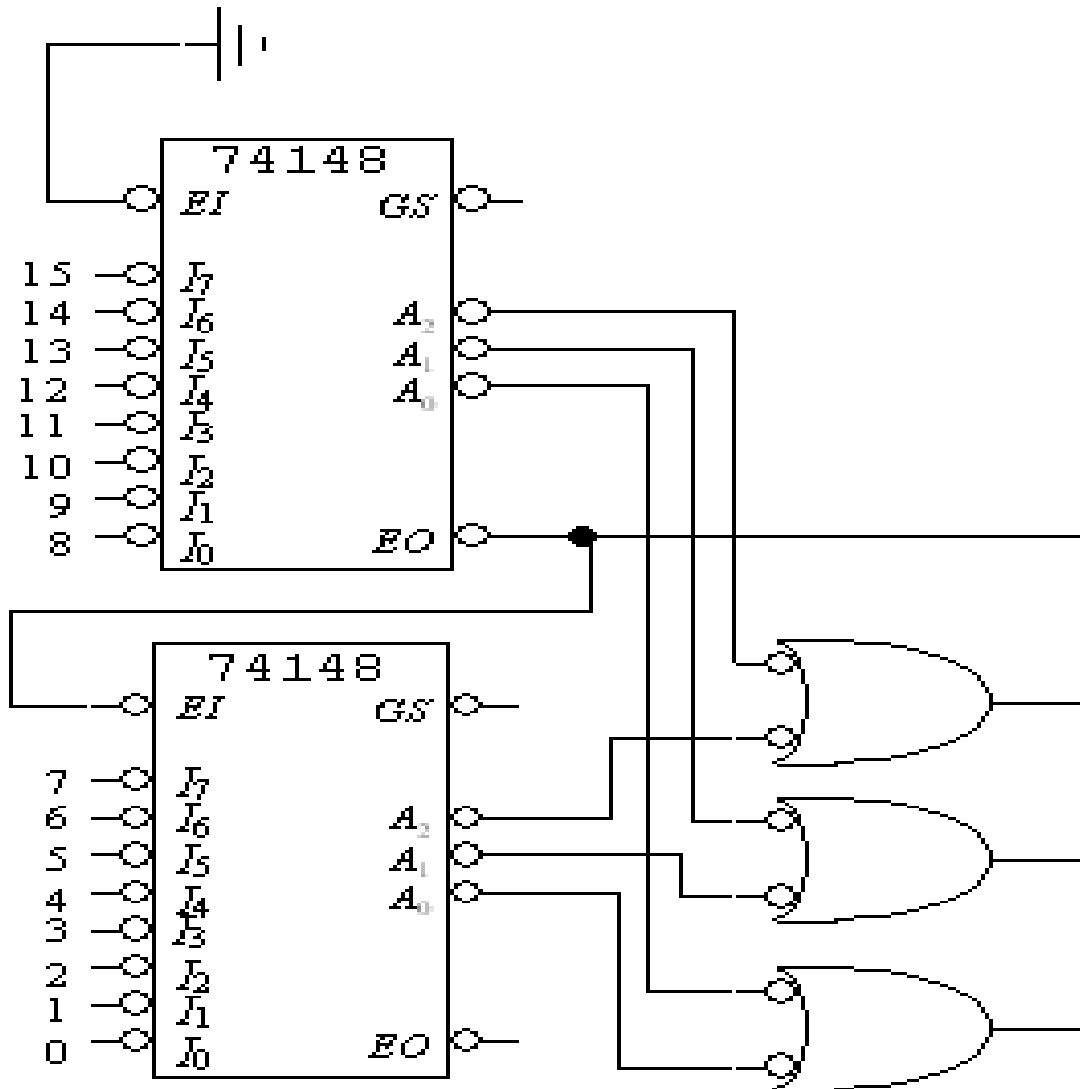Logic symbol and truth table for 74LS148 8–line–to–3–line priority encoder.

The Octal–to–Binary Encoder

- $\overline{EI}$ Active–*LOW* enable input, a *HIGH* on the input forces all outputs to their inactive state (*HIGH*).

- $\overline{EO}$ Active–*LOW* enable output, the output pin goes *LOW* when all inputs are inactive (*HIGH*) and is *LOW*.

- $\overline{GS}$ Active–*LOW* group signal output, this output pin goes *LOW* whenever any of the inputs are active (*LOW*) and is *LOW*.

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The 16 –to–4 Encoder

The 74LS148 can be expanded to a 16–line–to–4–line encoder by connecting the *EO* of the higher–order encoder to the *EI* of the lower–order encoder and negative–ORing the corresponding binary outputs as shown
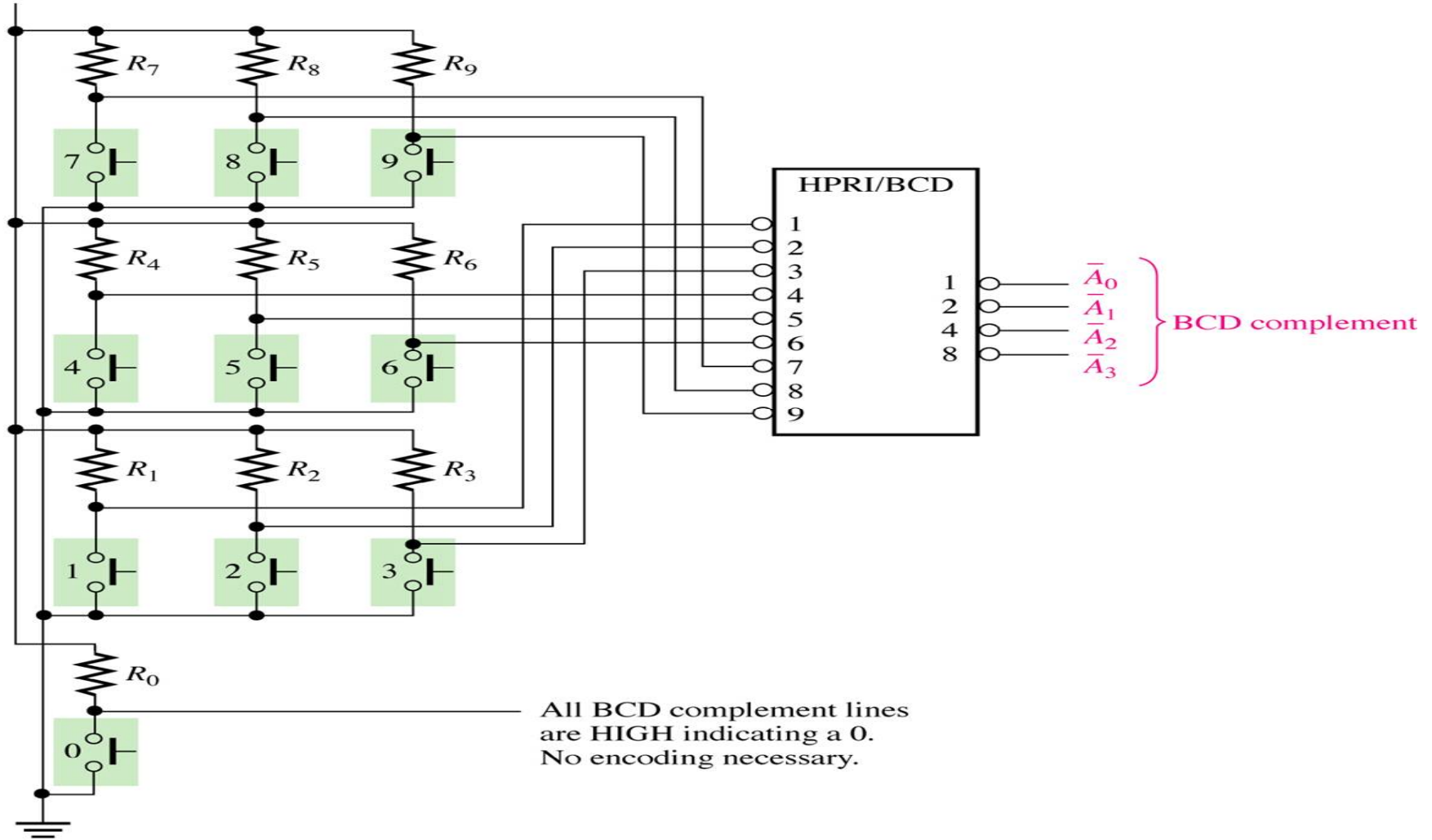
The 16 –to–4 Encoder

A 16–line–to–4–line encoder using 74LS148s and external logic.

Application example

A simplified keyboard encoder.

All BCD complement lines are HIGH indicating a 0. No encoding necessary.

•When one of the keys is pressed, the decimal digit is encoded to the corresponding BCD code

•The keys are represented by 10 push-button switches, each with a **pull-up resistor** to V+. The pull-up resistor ensures that the line is HIGH when a key is not depressed.

•When a key is depressed, the line is connected to ground, and a LOW is applied to the corresponding encoder input.

•The zero key is not connected because the BCD output represents zero when none of the other keys is depressed

•The BCD complement output of the encoder goes into a storage device, and each successive BCD code is stored until the entire number has been entered

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