

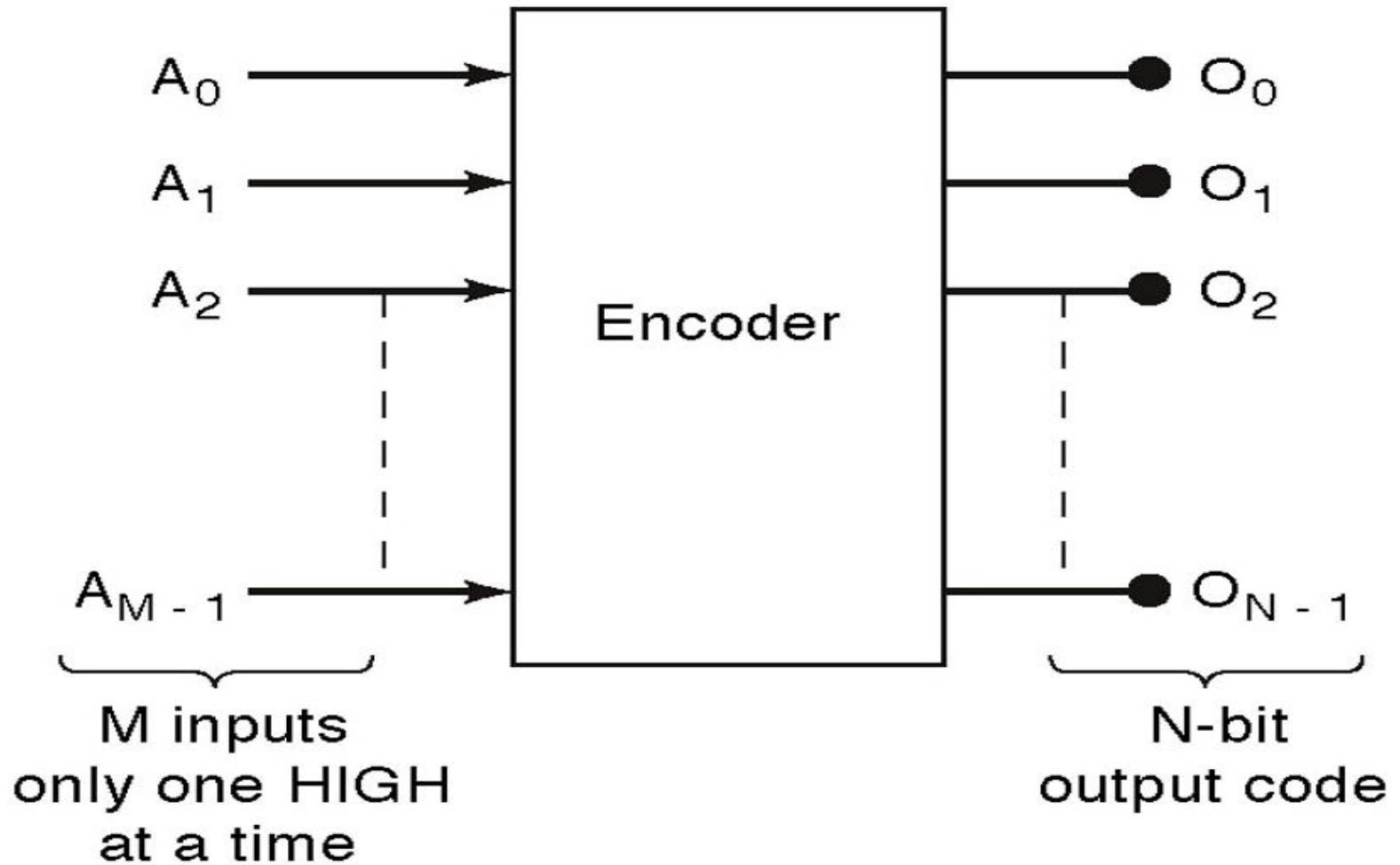
Encoders

Encoder

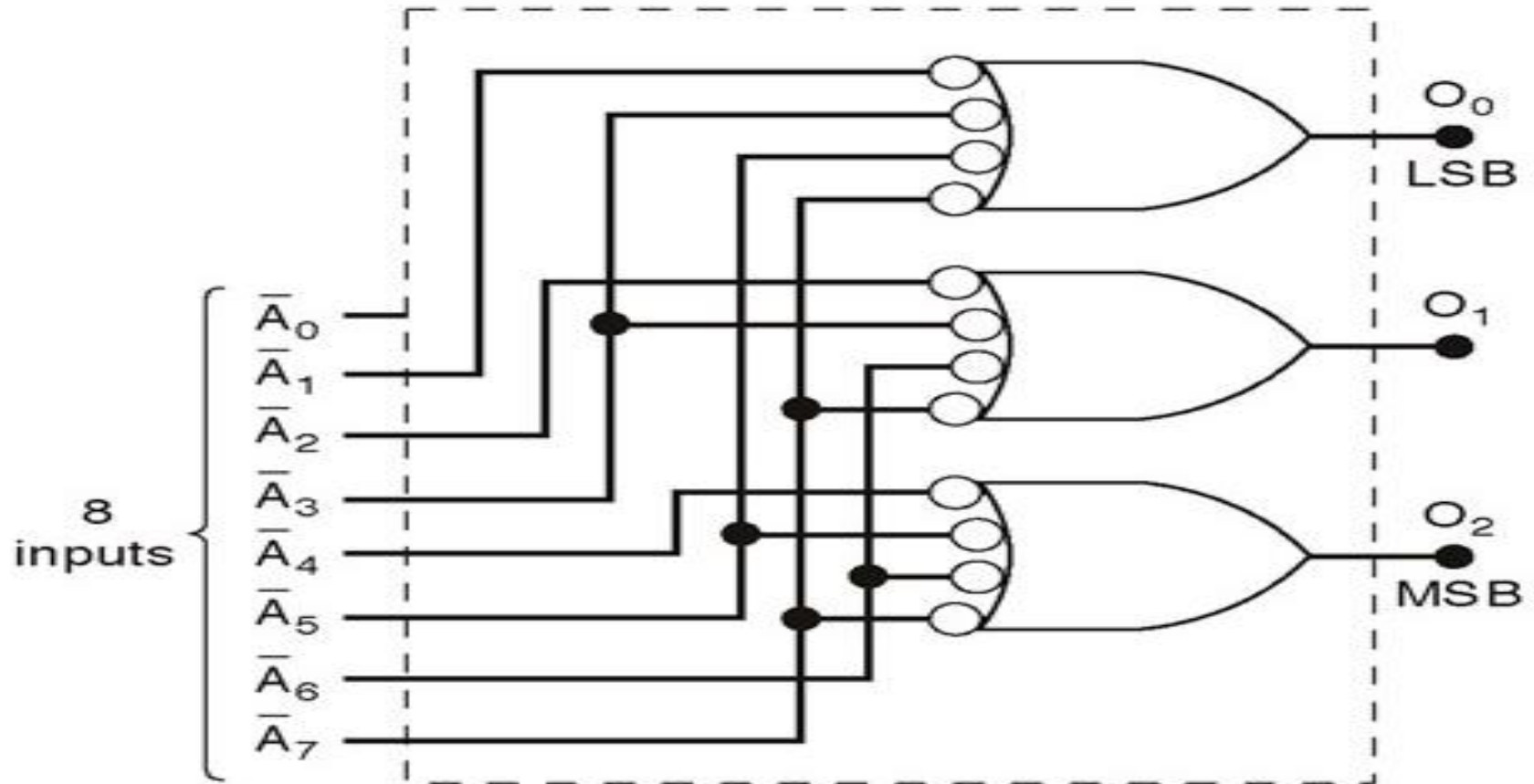
- An encoder is a combinational logic circuit that essentially performs a “reverse” of decoder functions.
- An encoder accepts an active level on one of its inputs, representing a digit, such as a decimal or octal digit, and converts it to a coded output such as BCD or binary.
- Encoders can also be devised to encode various symbols and alphabetic characters.
- The process of converting from familiar symbols or numbers to a coded format is called encoding.

- Most decoders accept an input code and produce a HIGH
- (or a LOW) at one and only one output line. In other words , 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 encoder.
- 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.

General encoder diagram



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



*Only one LOW input at a time

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_0' 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)...

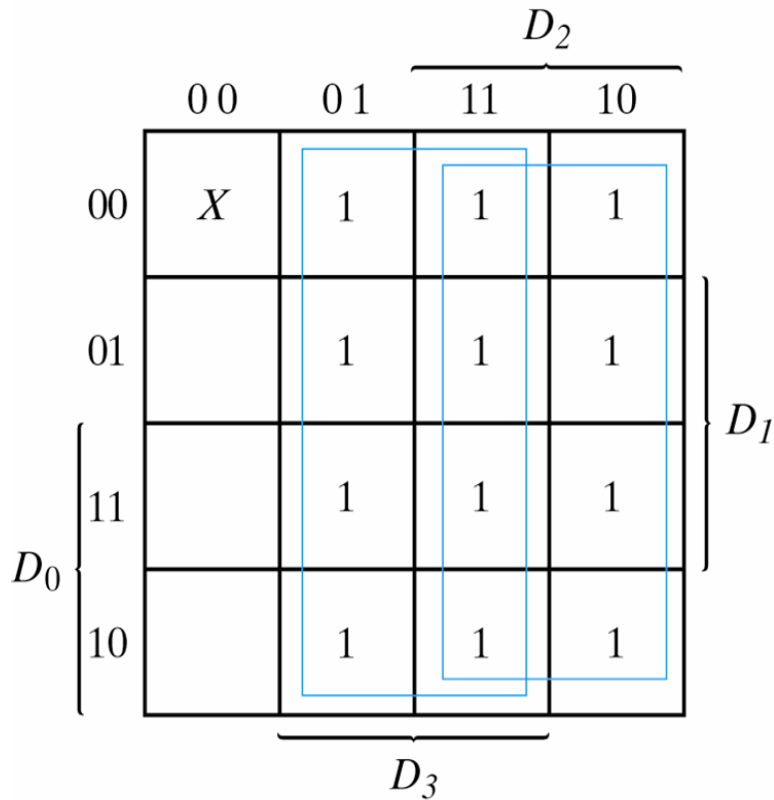
- A priority encoder is an encoder that includes the **priority function**
- If two or more inputs are equal to 1 at the same time, the input having the highest priority will take precedence.
- **Truth Table of a 4-input Priority Encoder:**

| 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 |

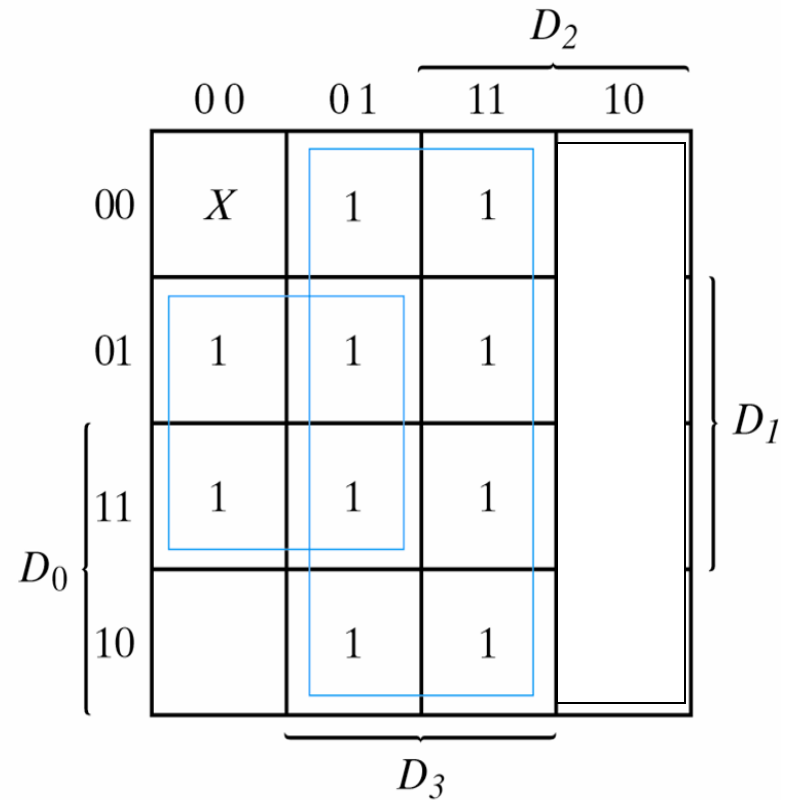
Design of 4-input Priority Encoder (4-line-to 2 line priority encoder) (2)...

- 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 D_3 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)...



$$x = D_2 + D_3$$

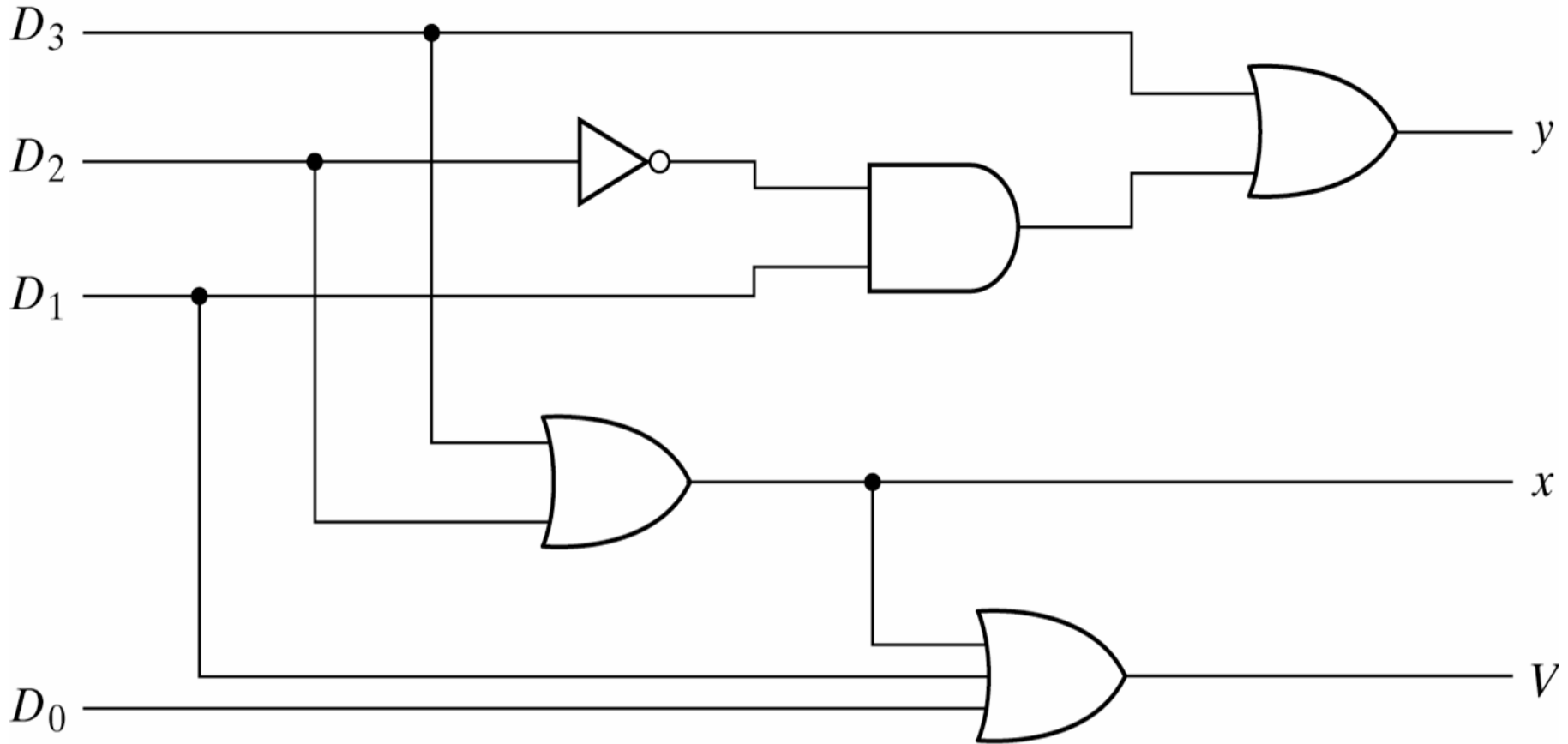


$$y = D_3 + D_1 D'_2$$

$$V = D_0 + D_1 + D_2 + D_3$$

K-Maps for 4-input Priority Encoder

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

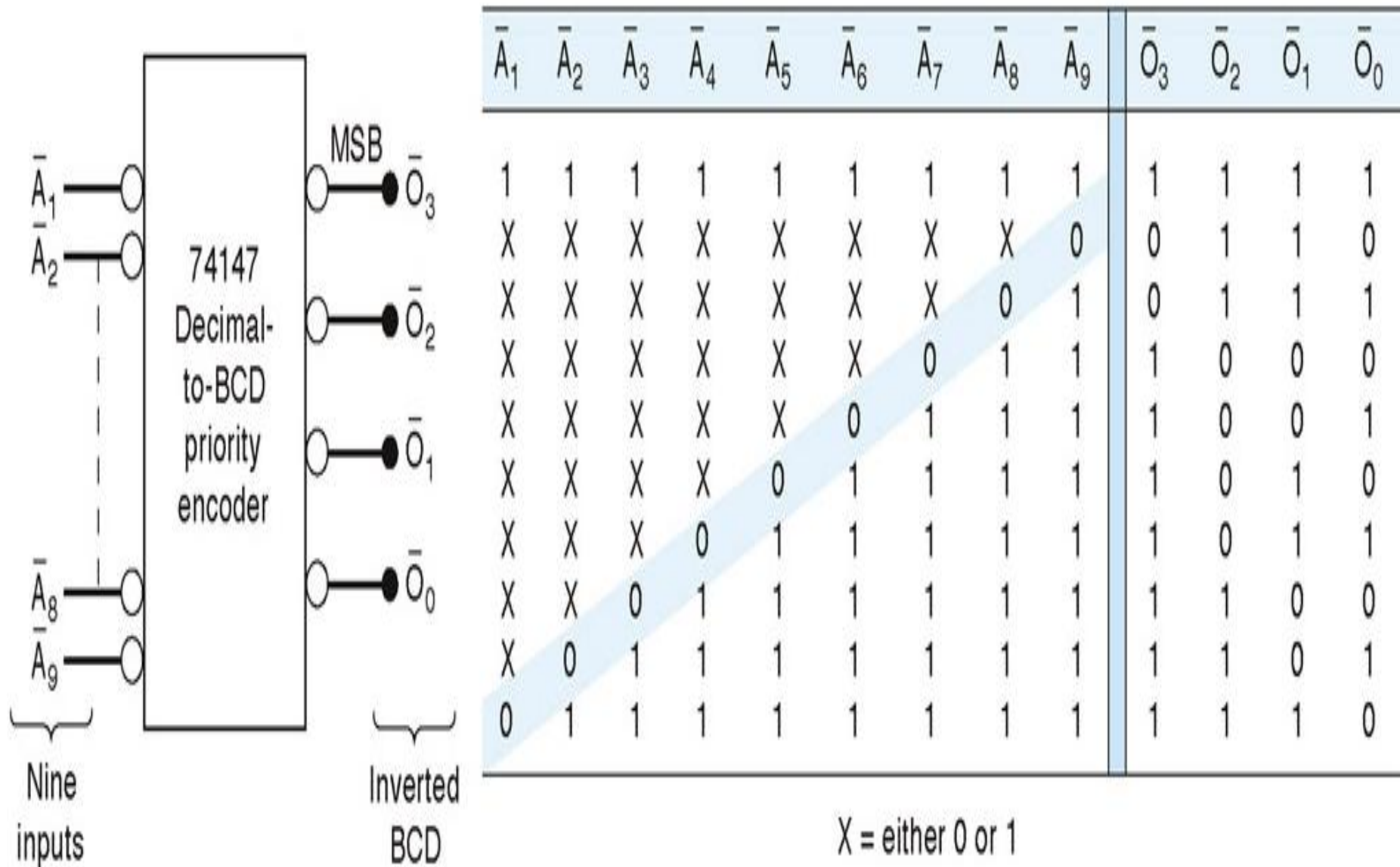


Logic Diagram for 4-input priority encoder

Decimal-BCD priority encoder

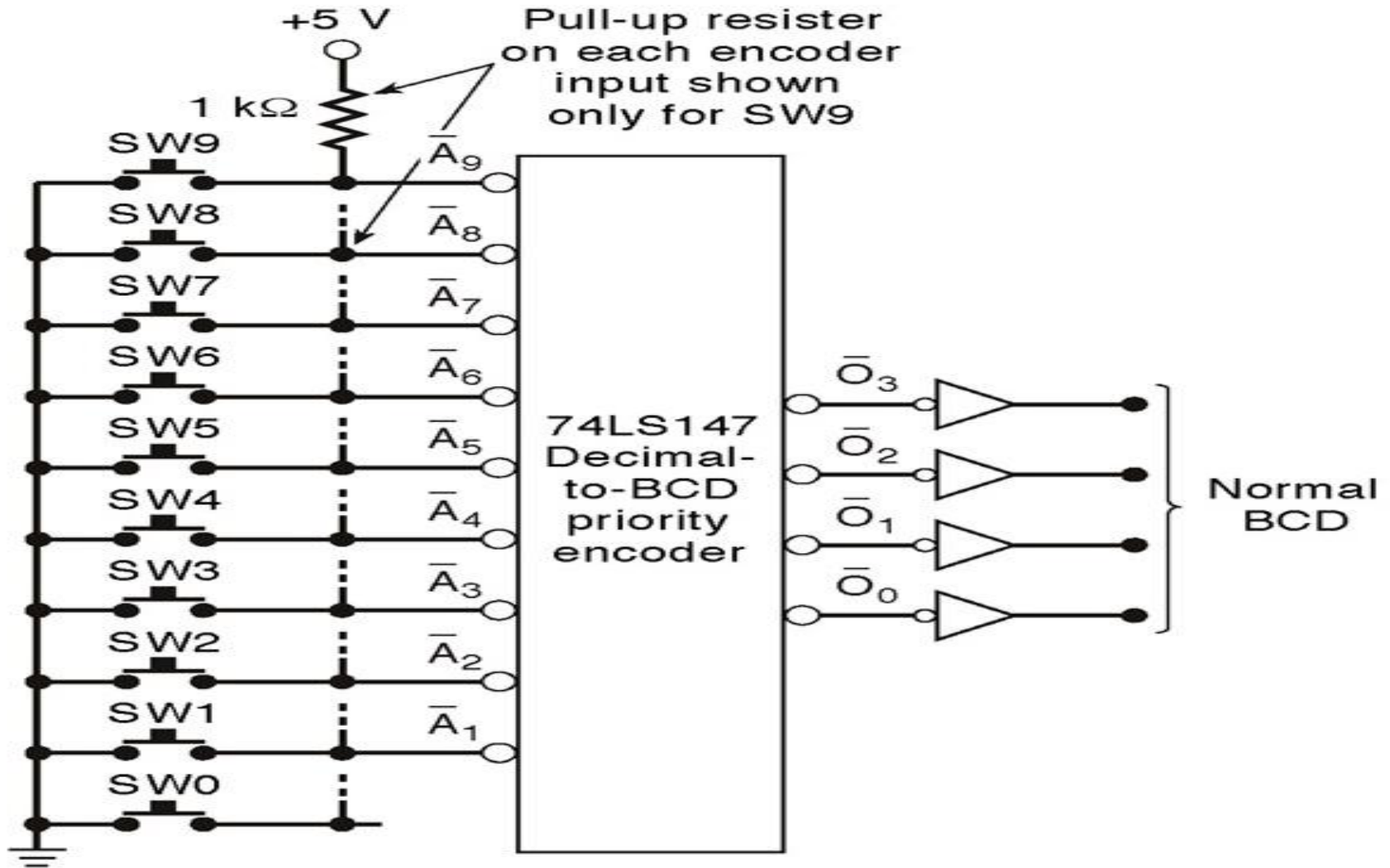
- Encoder will produce a BCD output corresponding to the highest-order decimal digit input that is active and will ignore any other lower order active inputs.
- For instance if the input 6 and the 3 are active, the output will be 1001, which is the inverse value of BCD output 0110 (which represents decimal 6)

74147 decimal-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

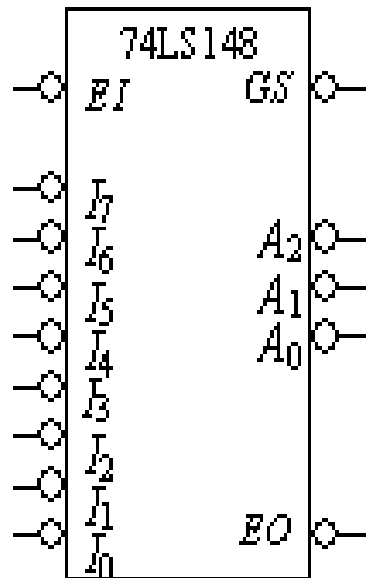


The output of the decoder are inverted to produce the normal
13 BCD value

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} | A_0 | A_1 | A_2 | \overline{O} |
| 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 | L | H | H | H | L | L | 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.

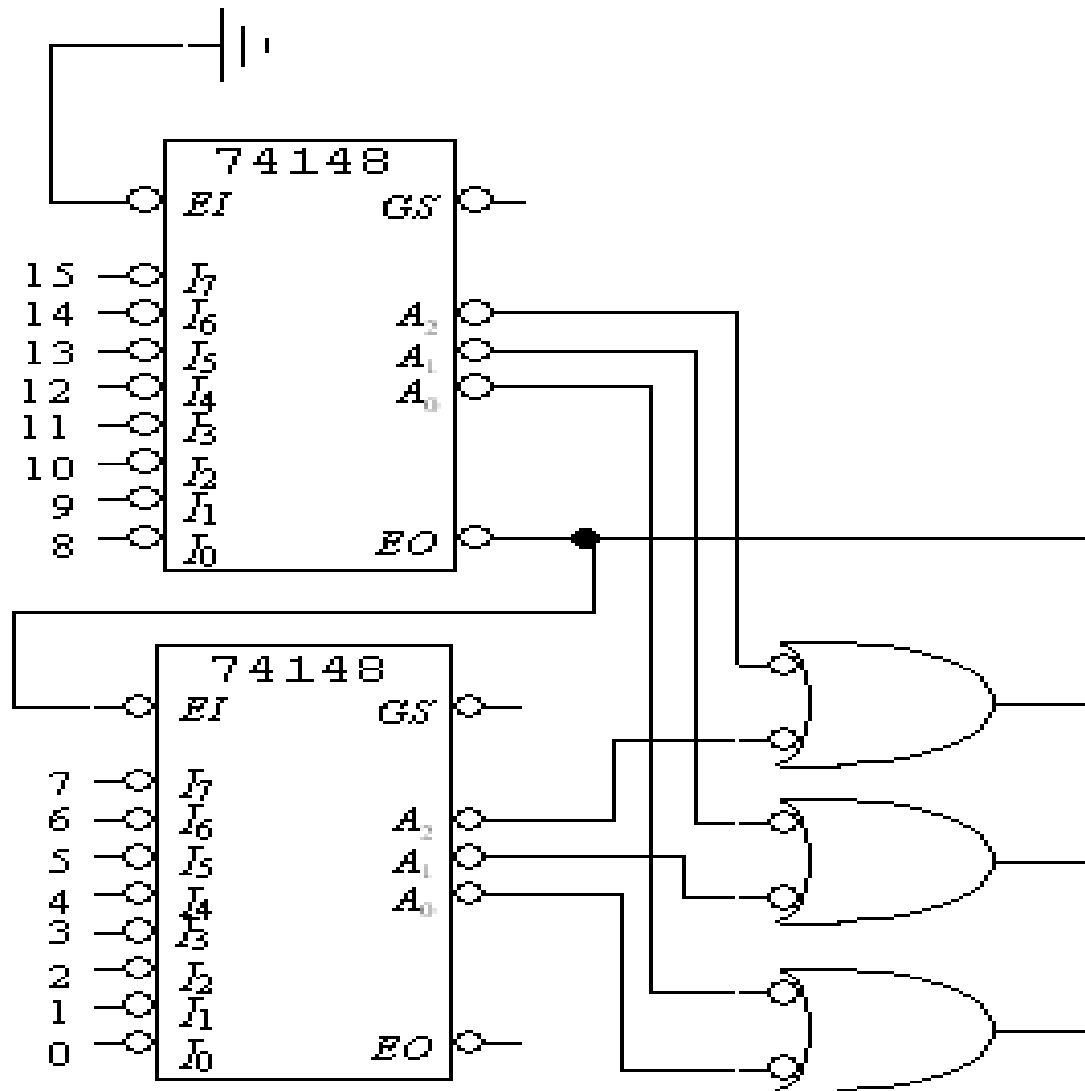
The Octal-to-Binary Encoder

- \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*.

The 16 –to–4 Encoder

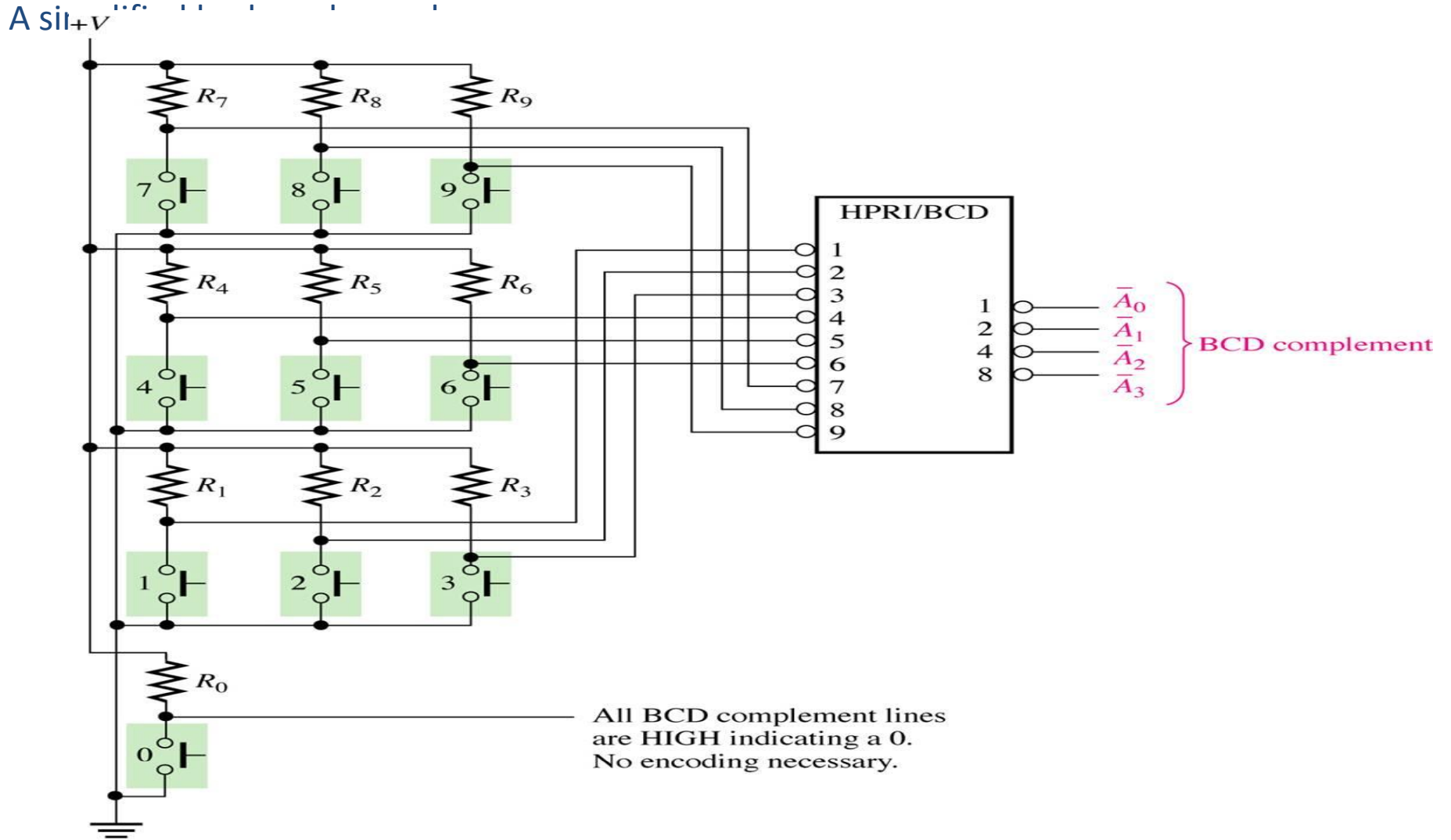
The 74LS148 can be expanded to a 16–line–to–4–line encoder by connecting the *EO* of the higher–order encoder to the *EI* of the lower–order encoder and negative–ORing the corresponding binary outputs as shown

The 16-to-4 Encoder



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

Application example



- 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