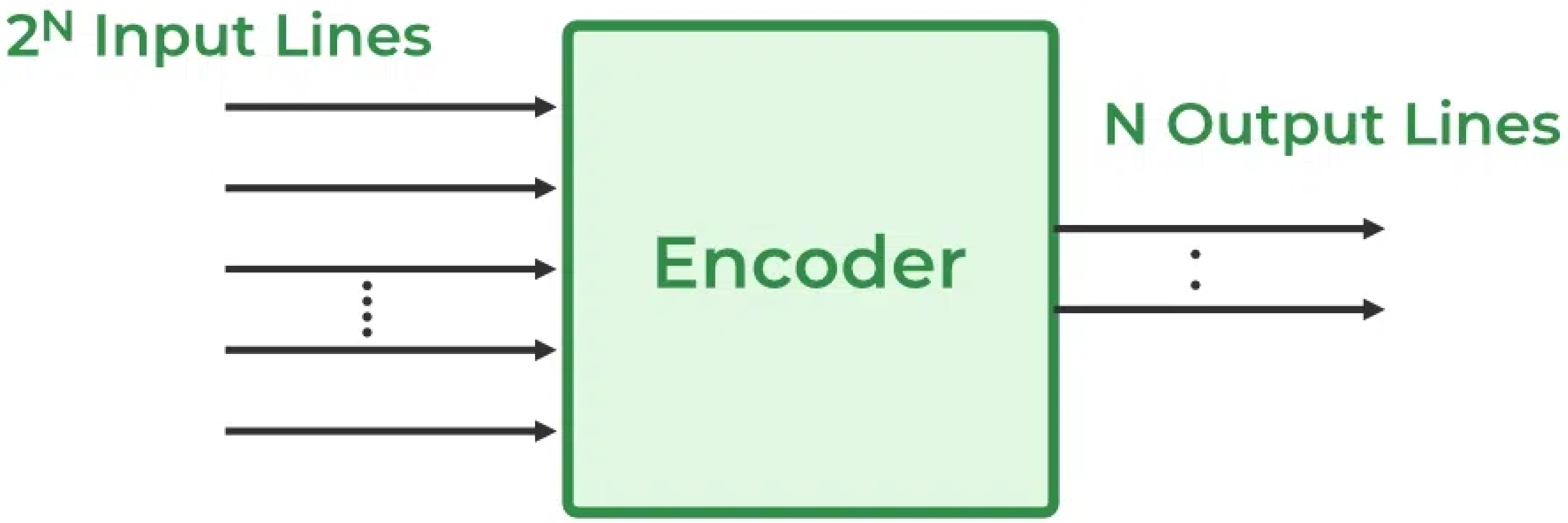
Encoder

- **An encoder is a digital circuit that converts a set of binary inputs into a unique binary code.**
- **The binary code represents the position of the input and is used to identify the specific input that is active**
- **The basic principle of an encoder is to assign a unique binary code to each possible input. For example, a 2-to-4 line encoder has 2 input lines and 4 output lines and assigns a unique 4-bit binary code to each of the 2^2 = 4 possible input combinations.**
- **It has a maximum of 2^n input lines and ‘n’ output lines, hence it encodes the information from 2^n inputs into an n-bit code. It will produce a binary code equivalent to the input, which is active High. Therefore, the encoder encodes 2^n input lines with ‘n’ bits.**

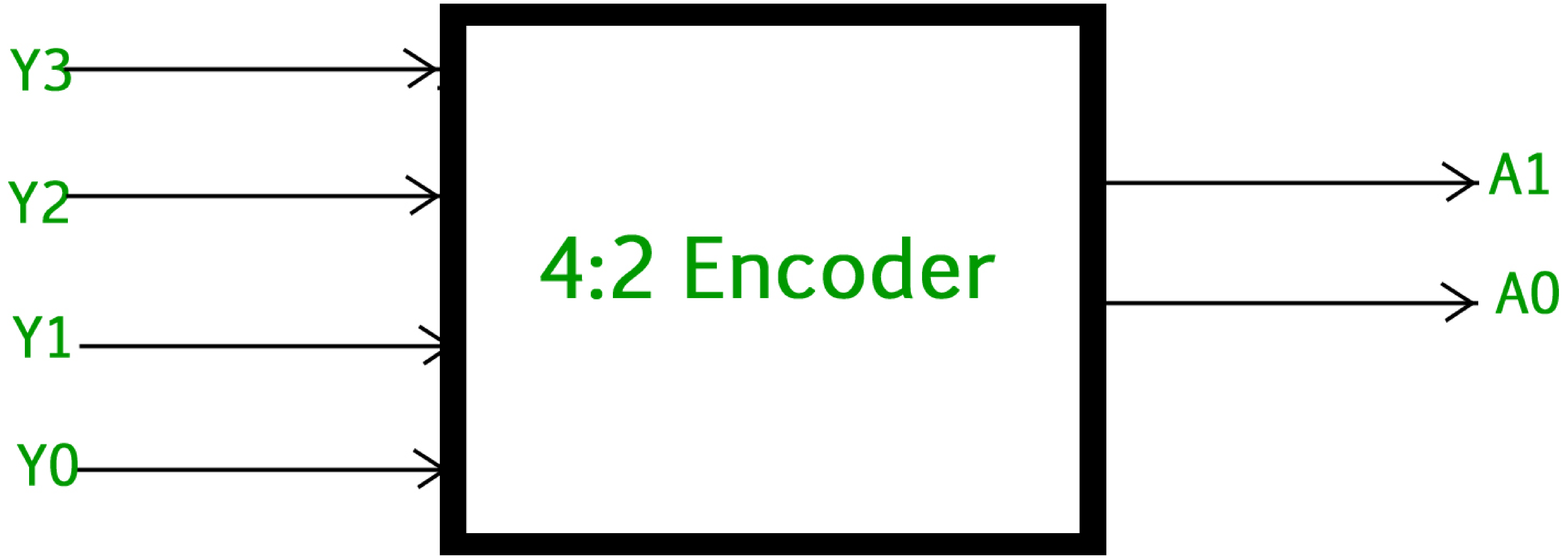

2N Input Lines
Encoder
N Output Lines

Types of Encoders

- 4 to 2 Encoder
- Octal to Binary Encoder (8 to 3 Encoder)
- Decimal to BCD Encoder
- Priority Encoder

4 to 2 Encoder

The 4 to 2 Encoder consists of four inputs Y3, Y2, Y1 & Y0, and two outputs A1 & A0.
At any time, only one of these 4 inputs can be ‘1’ in order to get the respective binary code at the output.

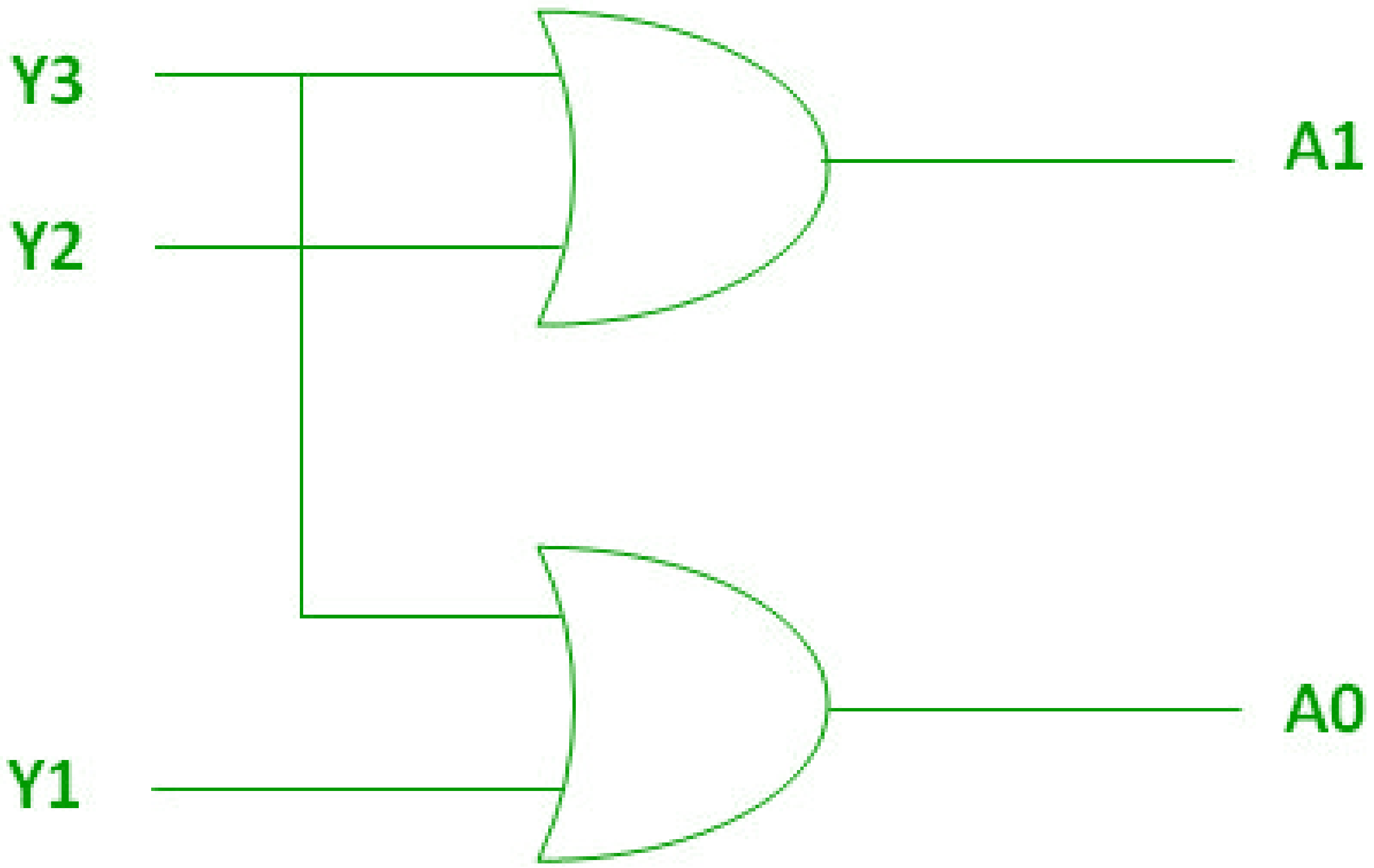


INPUTS				OUTPUTS	
Y3	Y2	Y1	Y0	A1	A0
0	0	0	1	0	0
0	0	1	0	0	1
0	1	0	0	1	0
1	0	0	0	1	1

Logical expression for A1 and A0:

$A1 = Y3 + Y2$

$A0 = Y3 + Y1$

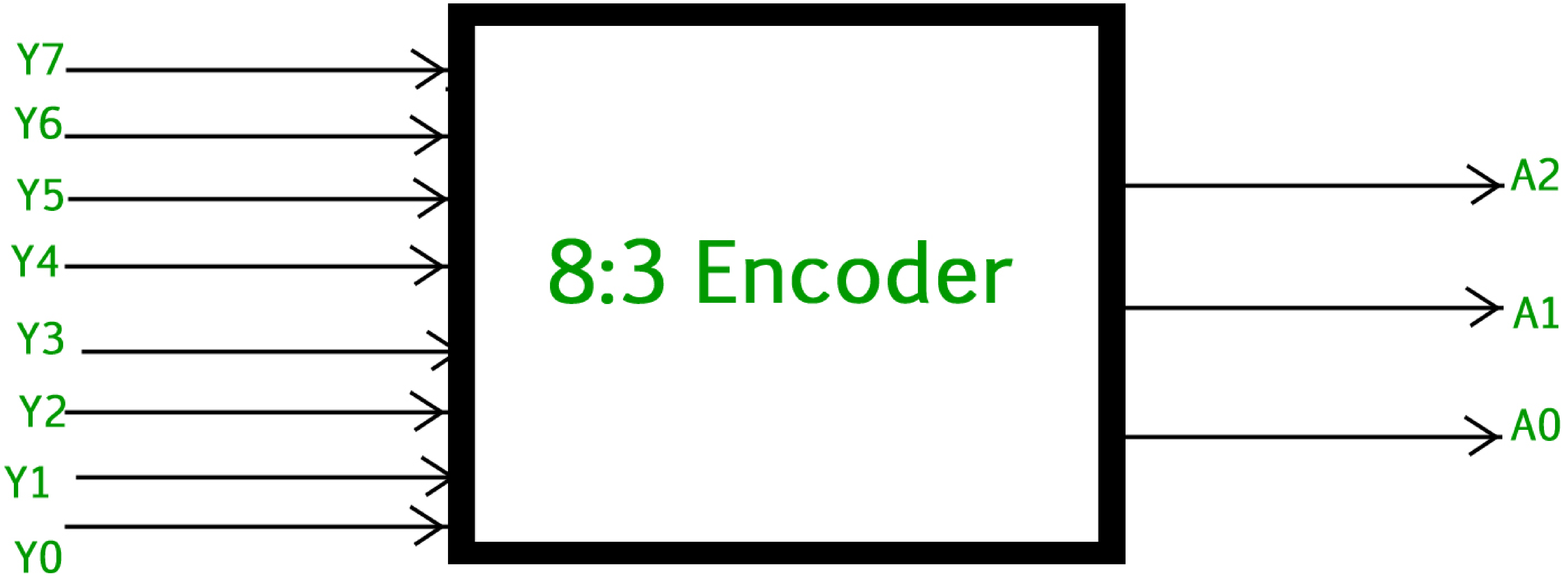


Logical expression for A1 and A0:

$$A1 = Y3 + Y2$$
$$A0 = Y3 + Y1$$

(8 to 3 Encoder)

The 8 to 3 Encoder consists of 8 inputs: Y7 to Y0 and 3 outputs: A2, A1 & A0.
Each input line corresponds to each octal digit and three outputs generate corresponding binary code



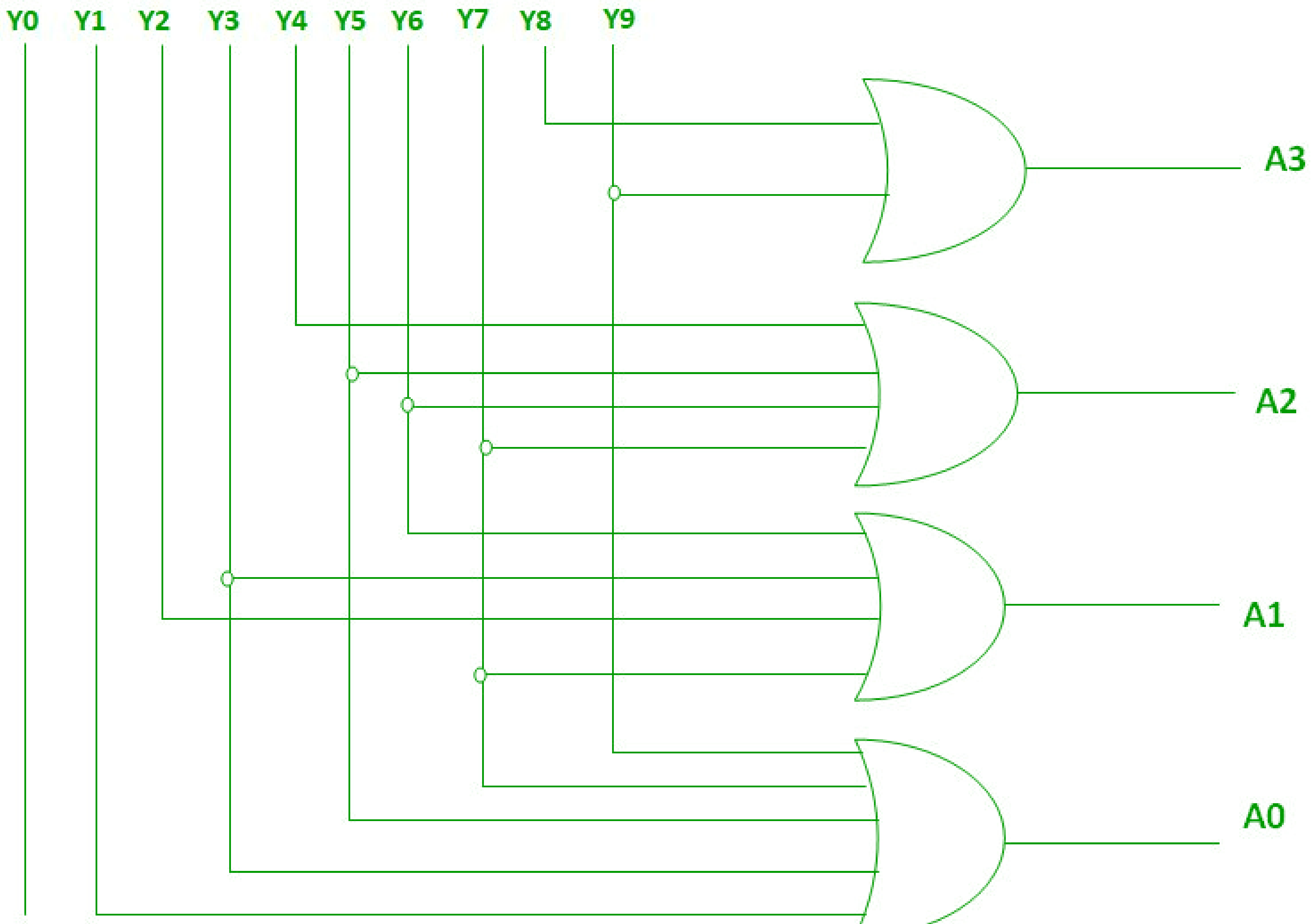
(8 to 3 Encoder)

INPUTS								OUTPUTS		
Y7	Y6	Y5	Y4	Y3	Y2	Y1	Y0	A2	A1	A0
0	0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	0	0	1
0	0	0	0	0	1	0	0	0	1	0
0	0	0	0	1	0	0	0	0	1	1
0	0	0	1	0	0	0	0	1	0	0
0	0	1	0	0	0	0	0	1	0	1
0	1	0	0	0	0	0	0	1	1	0
1	0	0	0	0	0	0	0	1	1	

(8 to 3 Encoder)

Logical expression for A2, A1, and A0.

$$A2 = Y7 + Y6 + Y5 + Y4$$
$$A1 = Y7 + Y6 + Y3 + Y2$$
$$A0 = Y7 + Y5 + Y3 + Y1$$

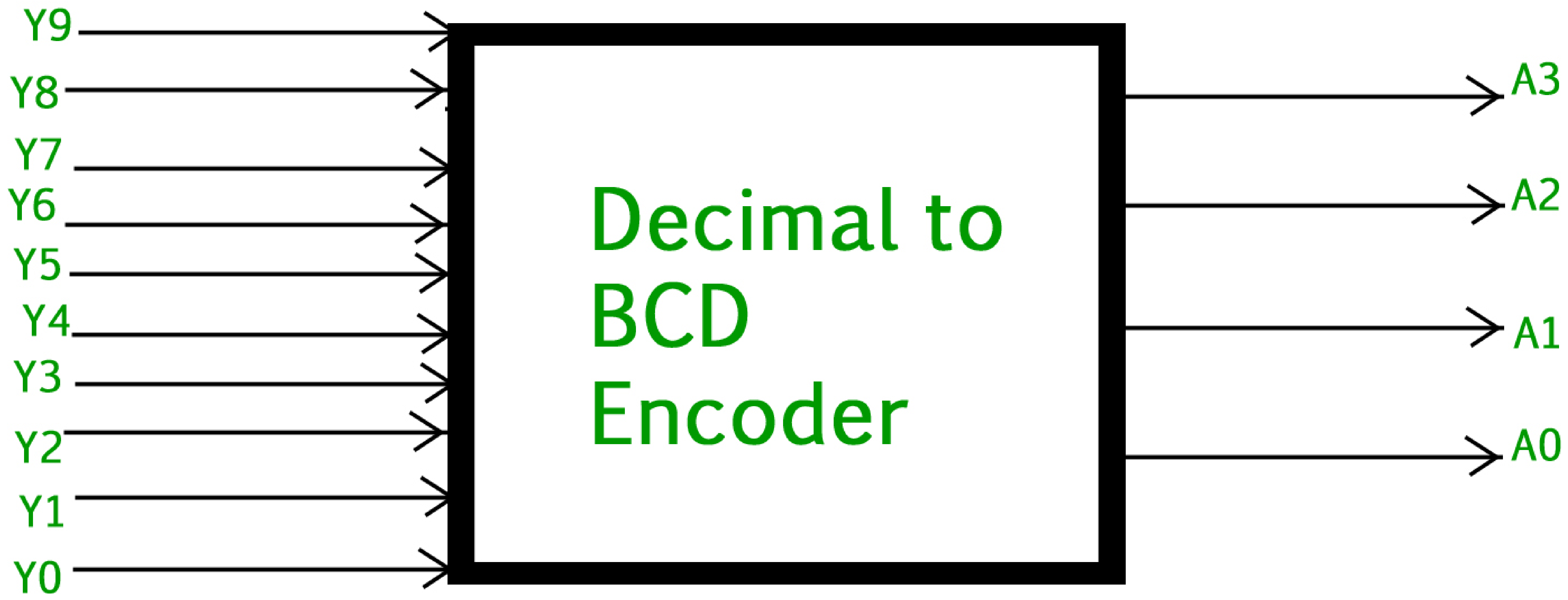

Y0
Y1
Y2
Y3
Y4
Y5
Y6
Y7
Y8
Y9
A3
A2
A1
A0

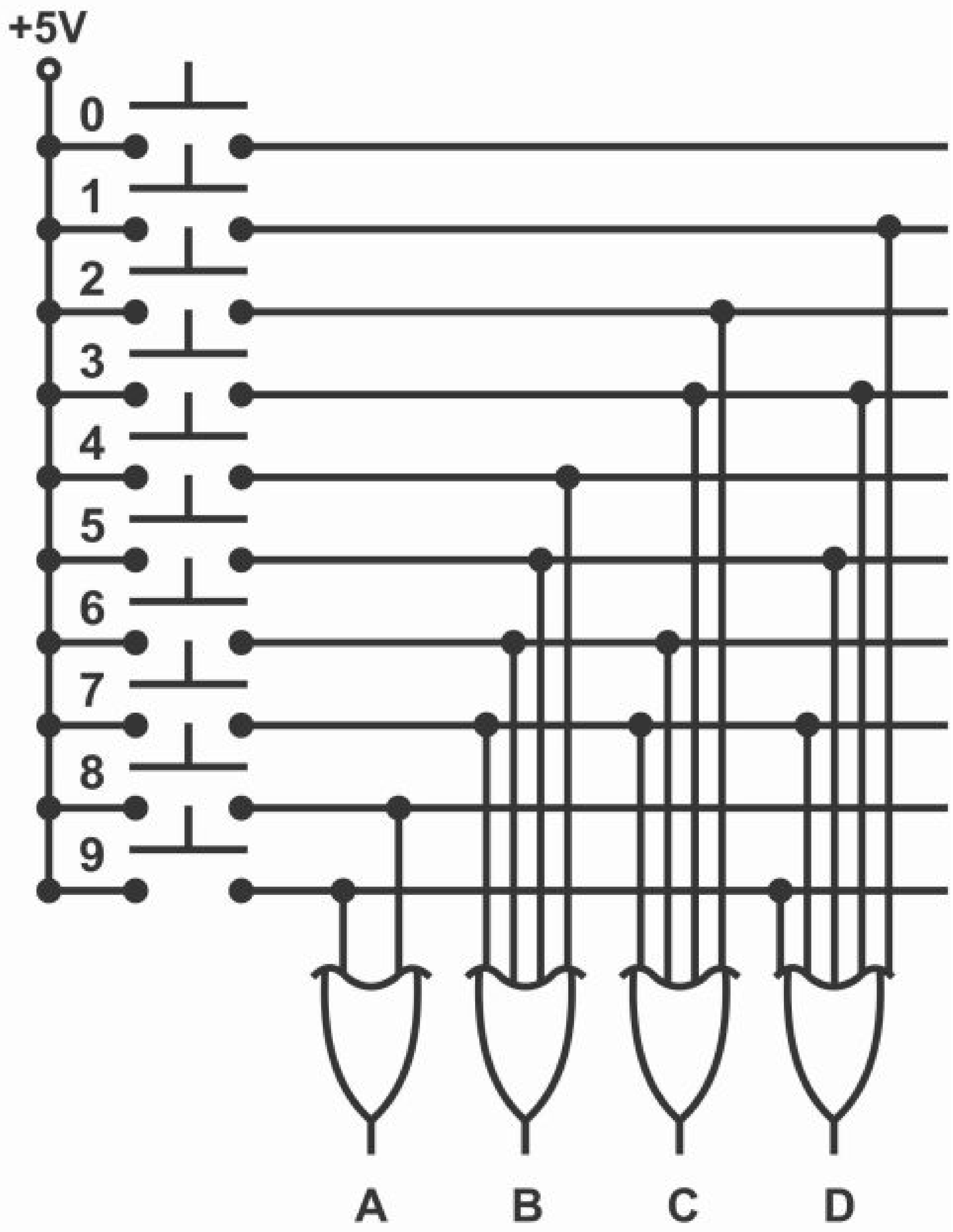
Decimal to BCD Encoder

The decimal-to-binary encoder usually consists of 10 input lines and 4 output lines.

Each input line corresponds to each decimal digit and 4 outputs correspond to the BCD code.

This encoder accepts the decoded decimal data as an input and encodes it to the BCD output which is available on the output lines


Y9
Y8
Y7
Y6
Y5
Y4
Y3
Y2
Y1
Y0
Decimal to BCD Encoder
A3
A2
A1
A0



decimal to BCD encoder, which comprises four OR gates, has been illustrated. The switches mounted on it are just similar to the push buttons of a pocket calculator

- When push button 3, which represents decimal 3, is pressed, inputs of C and D OR gates become high (as an output of OR gate becomes high in case any of its input is high). Thus, the following BCD code is obtained on output.

ABCD = 0011

- When push button 5 is pressed, inputs of B and D gates become 1 or high, while in such a scenario, inputs of A and C are low or zero. Resultantly, the following binary-coded output is received.

ABCD = 0101

- Likewise, when switch 9 is pushed, then A and D gates are high whereas C and B gates are low. Thus, following output results.

- ABCD = 1001

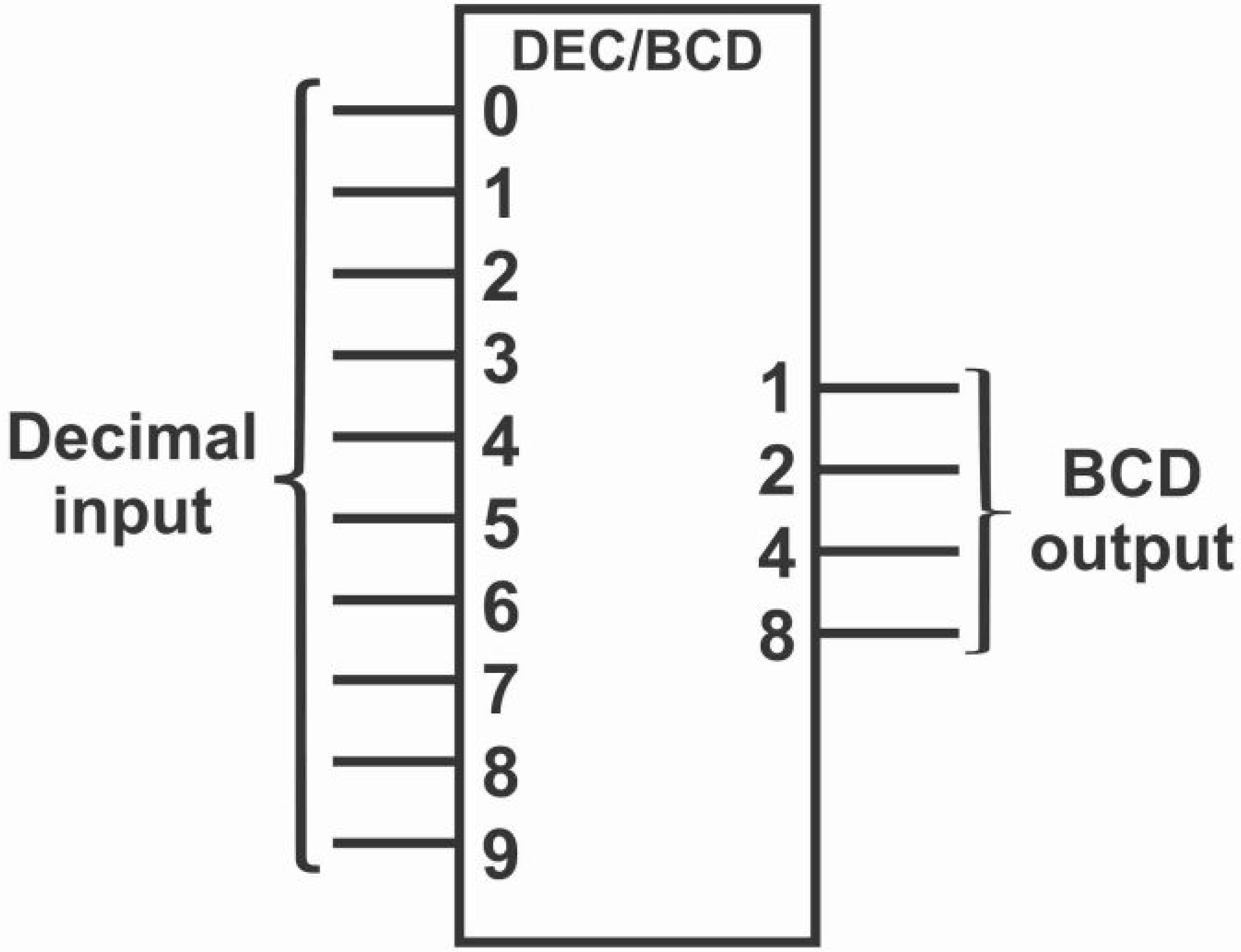


Fig 4.46
Logic symbol for a decimal-to-BCD encoder

Decimal to BCD

Decimal Digits	BCD Code			
0	A	B	C	D
1	0	0	0	0
2	0	0	0	1
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1

INPUTS										OUTPUTS			
Y9	Y8	Y7	Y6	Y5	Y4	Y3	Y2	Y1	Y0	A3	A2	A1	A0
0	0	0	0	0	0	0	0	0	1	0	0	0	0
0	0	0	0	0	0	0	0	1	0	0	0	0	1
0	0	0	0	0	0	0	1	0	0	0	0	1	0
0	0	0	0	0	0	1	0	0	0	0	0	1	1
0	0	0	0	0	1	0	0	0	0	0	1	0	0
0	0	0	0	1	0	0	0	0	0	0	1	0	1
0	0	0	1	0	0	0	0	0	0	0	1	1	0
0	0	1	0	0	0	0	0	0	0	0	1	1	1
0	1	0	0	0	0	0	0	0	0	1	0	0	0
1	0	0	0	0	0	0	0	0	0	1	0	0	1

Previous table can be written as;

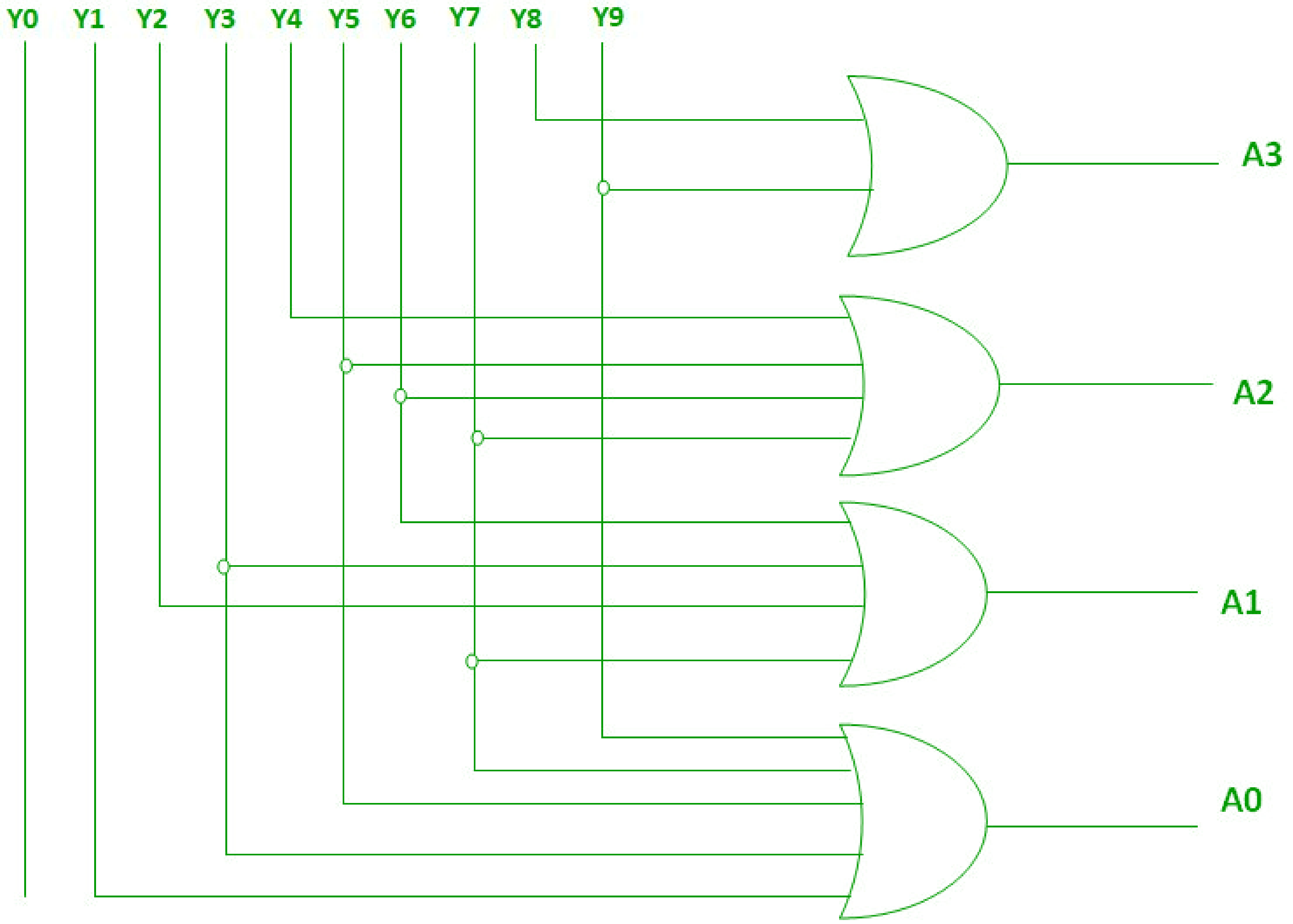
Logical expression for A3, A2, A1, and A0.

$$A3 = Y9 + Y8$$

$$A2 = Y7 + Y6 + Y5 + Y4$$

$$A1 = Y7 + Y6 + Y3 + Y2$$

$$A0 = Y9 + Y7 + Y5 + Y3 + Y1$$


Y0
Y1
Y2
Y3
Y4
Y5
Y6
Y7
Y8
Y9
A3
A2
A1
A0

PRIORITY ENCODER

- binary encoders are combinational logic circuits that integrate multiple inputs, consider all input lines simultaneously, and convert them into a single encoded output.
- It appears to be a disadvantage of the binary encoder.
- The n-bit digital encoder consists of 2n input lines and n output lines.
- Priority encoders were developed based on the high priority inputs to overcome the disadvantage of the binary encoder.
- Binary encoders produce an incorrect output when more than one input line is highly active. Priority encoder solves this problem. If greater than one input line is simultaneously active high (1), this encoder (priority encoder) prioritizes each input level and assigns the priority level to every input.

PRIORITY ENCODER

It is a combinational logic circuit that comprises 2n input lines and n output lines and depicts the high priority input between all the input lines.
When multiple input lines are simultaneously active, the highest priority input is considered first to produce output.
The output of this encoder corresponds to the highest priority input.
Only the highest priority input is assessed by ignoring all other input lines to get an output.
This is a binary encoder or an ordinary encoder with a priority function.
Larger magnitude input or highest priority inputs are encoded first instead of other input lines.
Therefore, the obtained output is based on the priority allocated to the inputs.

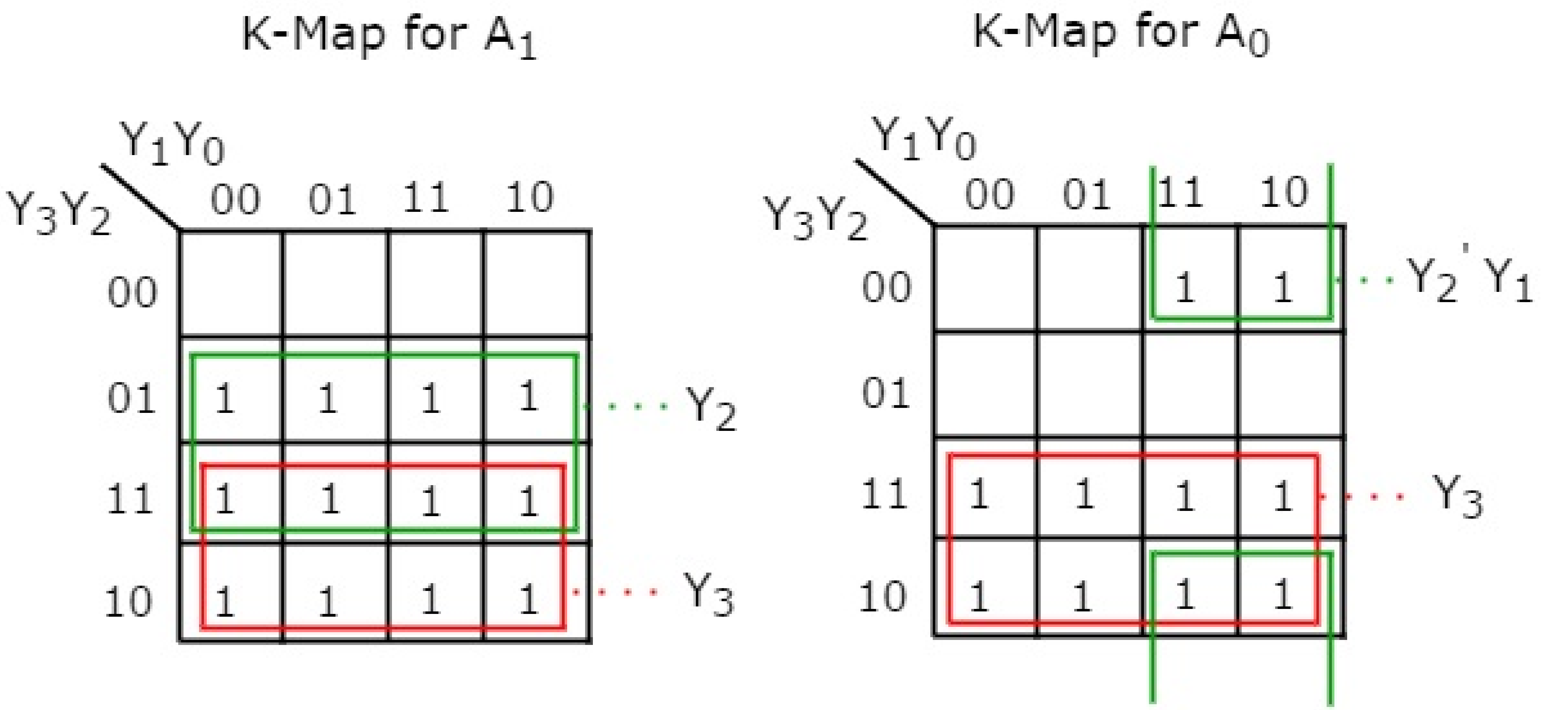
4 to 2 Priority Encoder

This is also called a 4-bit priority, which contains 4 inputs and 2 output lines as the encoder contains 2n number of input lines and n number output lines.

And, The third output is 'V', which is considered a valid indicator but is set to 1 if more than one input line is high or active (1).

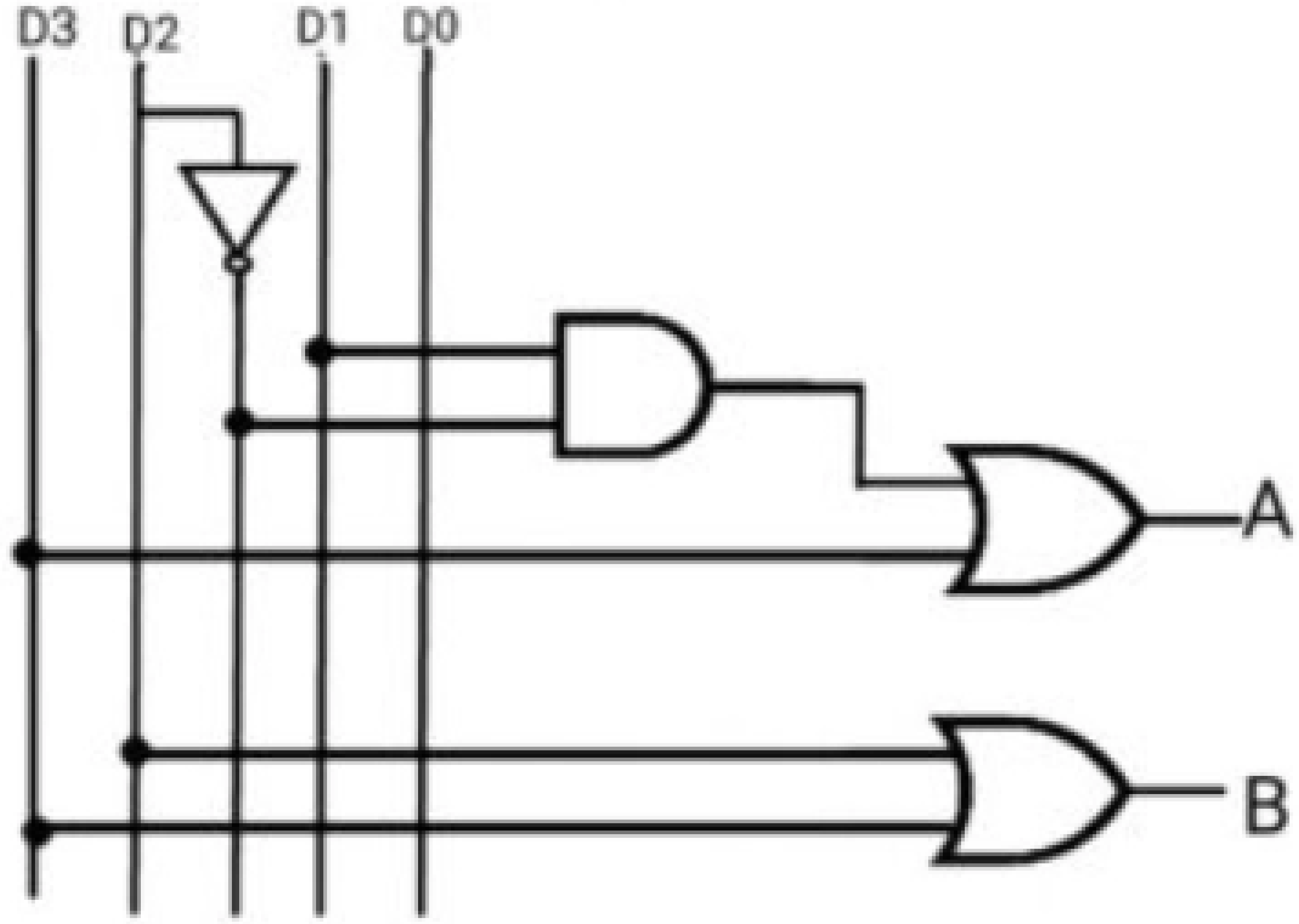
If the valid bit is '0', every input is '0'. Here, the other two output lines are depicted as don't care conditions symbolized by 'X'.

Y3	Y2	Y1	Y0	A1	A0	enable
0	0	0	0	X	X	0
0	0	0	1	0	0	1
0	0	1	x	0	1	1
0	1	x	x	1	0	1
1	X	X	x	1	1	1



A1=Y3+Y2

A0=Y3+Y2′Y1


D3
D2
D1
D0
A
B

8 to 3 Priority Encoder

- They consist of 8 inputs and 3 outputs. When multiple inputs are active high simultaneously, the input with the highest priority represents the output.

- Using an example, we can understand if D1, D2, and D3 inputs are active high or logic '1' irrespective of other input bits. The encoded output of the priority encoder will be D3, that is, 111. Here, the input bits D1 and D2 are irrelevant or don't care about conditions.

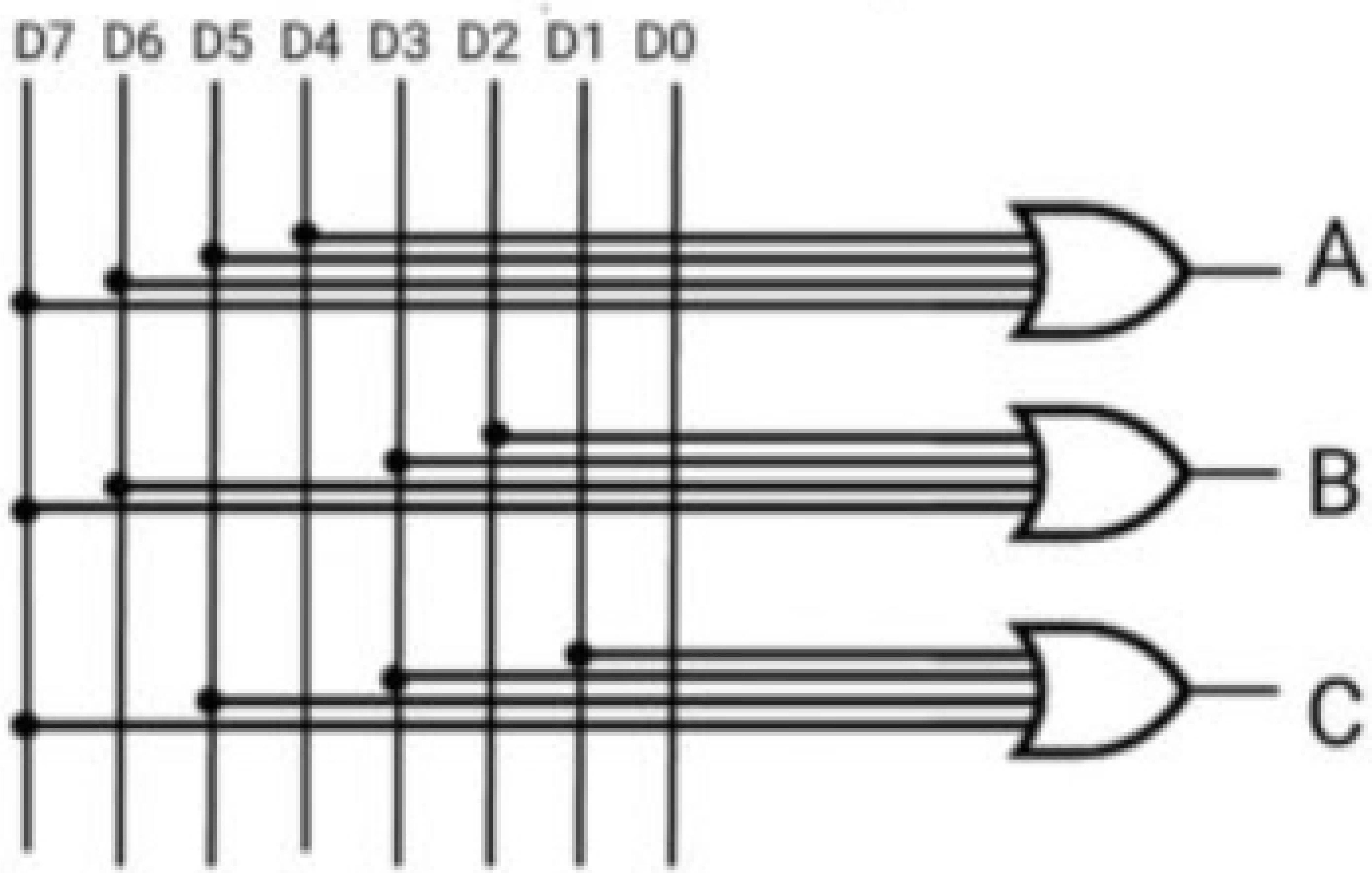
D7	D6	D5	D4	D3	D2	D1	D0	A	B	C
0	0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	X	0	0	1
0	0	0	0	0	1	X	X	0	1	0
0	0	0	0	1	X	X	X	0	1	1
0	0	0	1	X	X	X	X	1	0	0
0	0	1	X	X	X	X	X	1	0	1
0	1	X	X	X	X	X	X	1	1	0
1	X	X	X	X	X	X	X	1	1	1

Output expression is obtained as shown below,

A = D4 + D5 + D6 + D7

B = D2 + D3 + D6 + D7

C = D1 + D3 + D5 + D7


D7 D6 D5 D4 D3 D2 D1 D0
A
B
C

Following are the applications of priority encoder:

- It reduces the number of wires and connections needed for electronic circuit designing with multiple input lines, keypads, and keyboards.
- It is used to control the position in the ship's navigation and the location of the robot arm.
- It is used to acquire the highest priority inputs in various microprocessor interrupt control systems' applications.
- It protects the entire network from hackers by transmitting binary code to the network.
- It is used to adjust the speed of industrial motors.
- It is used in robotic vehicles.

Application of Encoders

- Encoders are very common electronic circuits used in all digital systems.
- Encoders are used to translate the decimal values to the binary in order to perform binary functions such as addition, subtraction, multiplication, etc.
- Other applications especially for Priority Encoders may include detecting interrupts in microprocessor applications.

Advantages of Using Encoders in Digital Logic

- Reduction in the number of lines: Encoders reduce the number of lines required to transmit information from multiple inputs to a single output, which can simplify the design of the system and reduce the cost of components.
- Improved reliability: By converting multiple inputs into a single serial code, encoders can reduce the possibility of errors in the transmission of information.
- Improved performance: Encoders can enhance the performance of a digital system by reducing the amount of time required to transmit information from multiple inputs to a single output.

DECODER

NOTE ; READ DECODER HERE;

https://www.allaboutcircuits.com/textbook/digital/chpt-9/decoder/