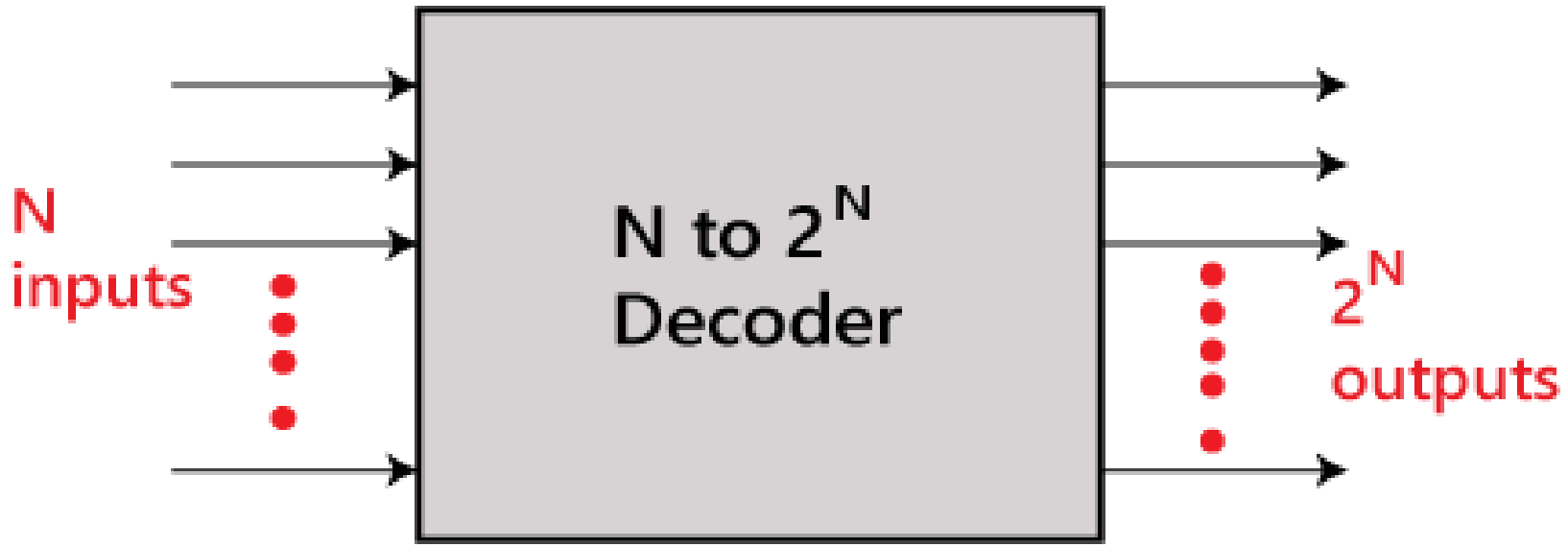
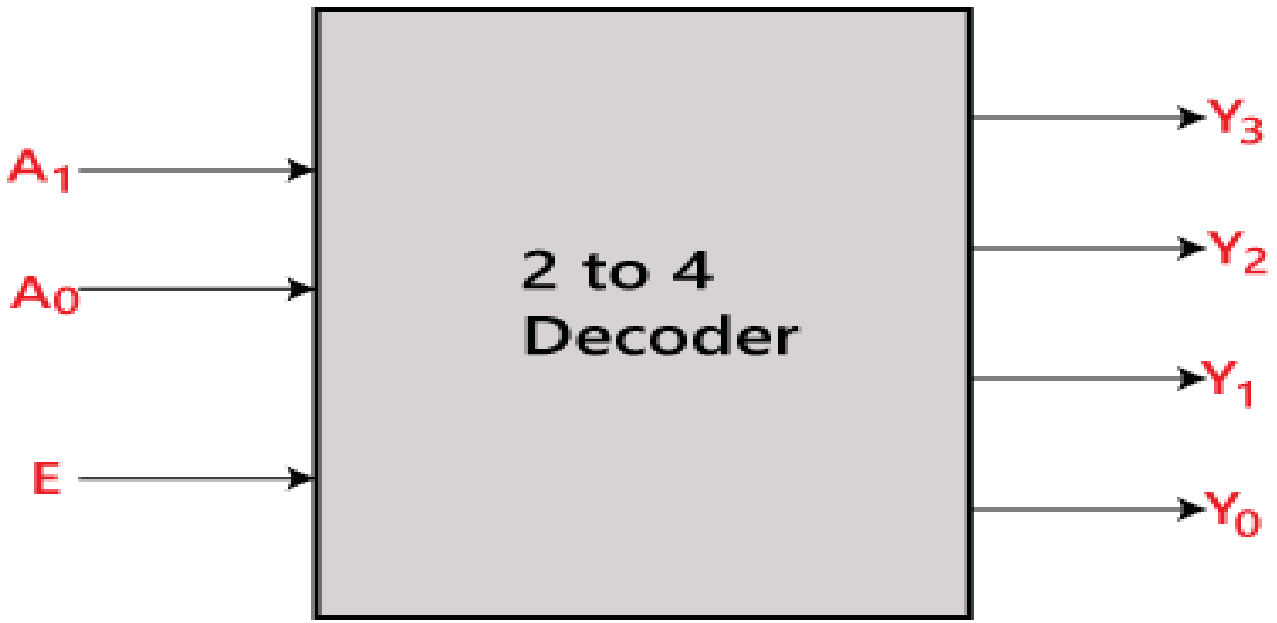
Decoder

The combinational circuit that change the binary information into 2^N output lines is known as **Decoders.** The binary information is passed in the form of N input lines. The output lines define the 2^N-bit code for the binary information. At a time, only one input line is activated for simplicity. The produced 2^N-bit output code is equivalent to the binary information.

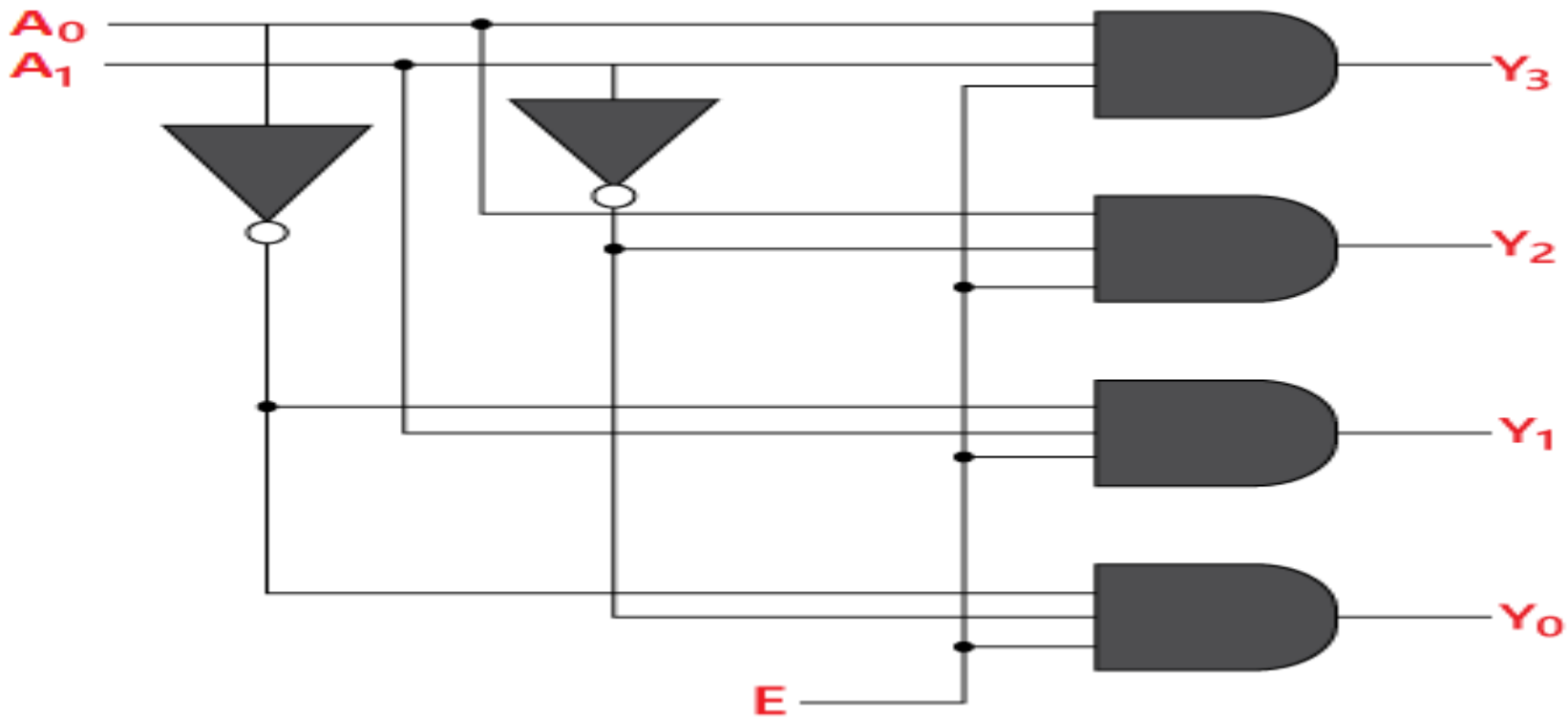

N
inputs
N to 2^N
Decoder
2^N
outputs

- 2 to 4 line decoder:
- In the 2 to 4 line decoder, there is a total of three inputs, i.e., A_0, and A_1 and E and four outputs, i.e., Y_0, Y_1, Y_2, and Y_3. For each combination of inputs, when the enable 'E' is set to 1, one of these four outputs will be 1.


A1
A0
E
2 to 4
Decoder
Y3
Y2
Y1
Y0

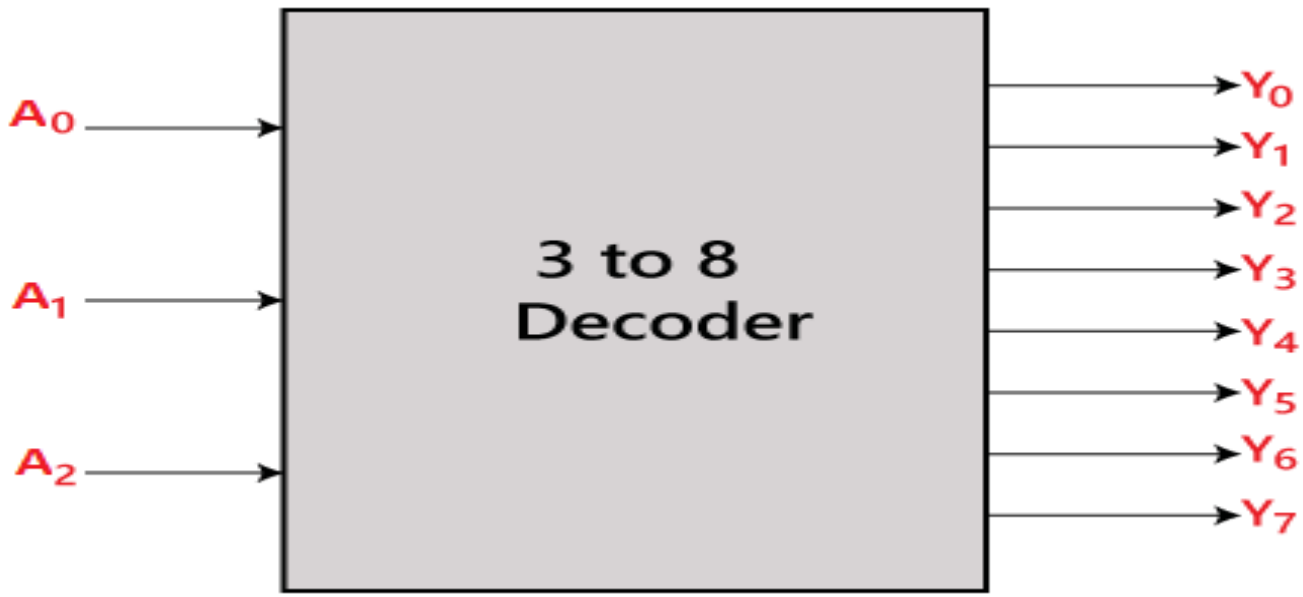
Enable	INPUTS		OUTPUTS			
E	A_1	A_0	Y_3	Y_2	Y_1	Y_0
0	X	X	0	0	0	0
1	0	0	0	0	0	1
1	0	1	0	0	1	0
1	1	0	0	1	0	0
1	1	1	1	0	0	0

- The logical expression of the term Y0, Y0, Y2, and Y3 is as follows:
- $Y_3=E.A_1.A_0$
  $Y_2=E.A_1.A_0'$
  $Y_1=E.A_1'.A_0$
  $Y0=E.A_1'.A_0'$
- Logical circuit of the above expressions is given below:


A0
A1
E
Y3
Y2
Y1
Y0

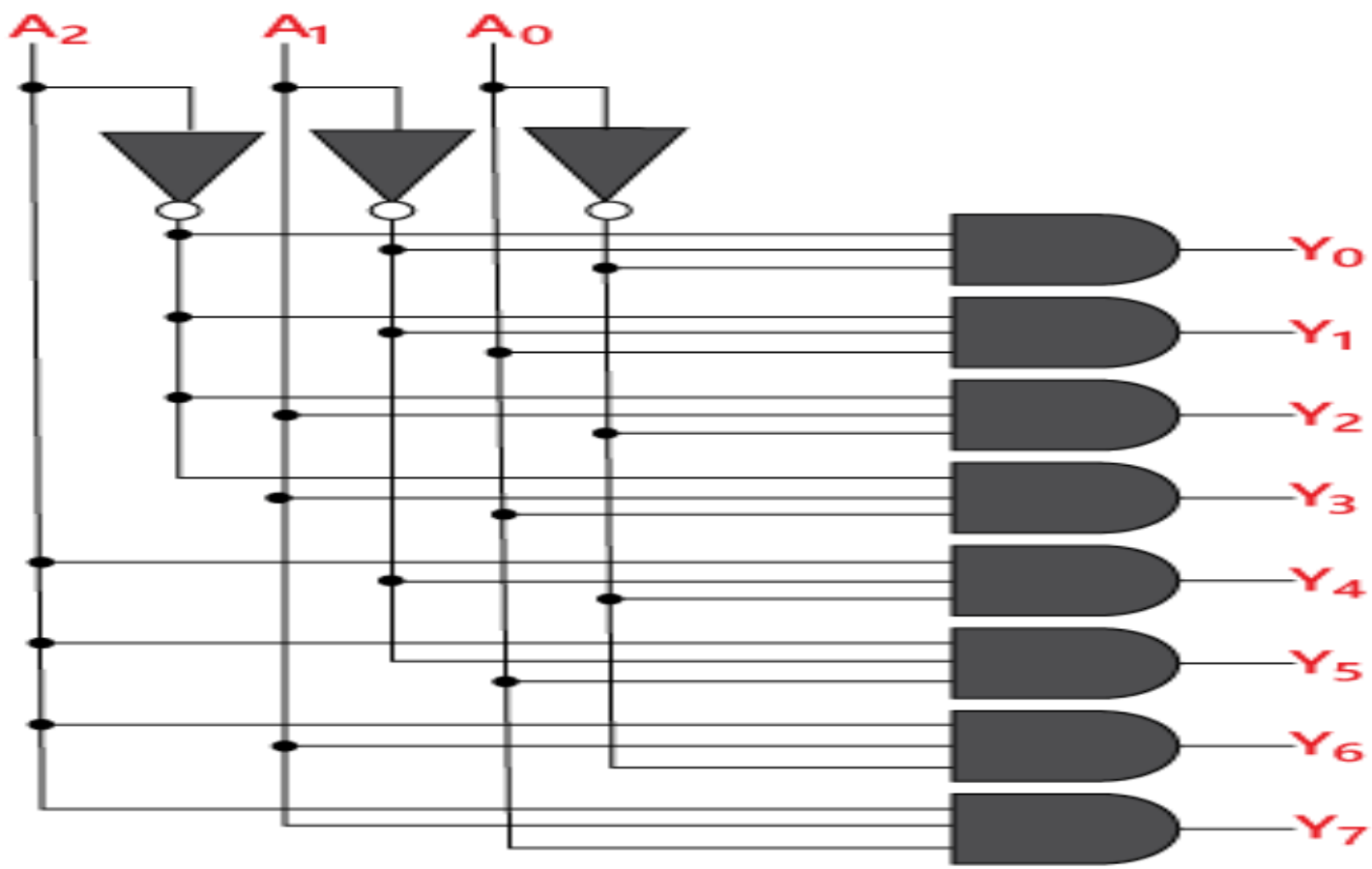
3 to 8 line decoder:

The 3 to 8 line decoder is also known as **Binary to Octal Decoder**.
In a 3 to 8 line decoder, there is a total of eight outputs, i.e., Y_0, Y_1, Y_2, Y_3, Y_4, Y_5, Y_6, and Y_7
and three outputs, i.e., A_0, A1, and A_2. This circuit has an enable input 'E'. Just like 2 to 4
line decoder, when enable 'E' is set to 1, one of these four outputs will be 1.


A0
A1
A2
3 to 8
Decoder
Y0
Y1
Y2
Y3
Y4
Y5
Y6
Y7

Enable	INPUTS			Outputs							
E	A_2	A_1	A_0	Y_7	Y_6	Y_5	Y_4	Y_3	Y_2	Y_1	Y_0
0	x	x	x	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	1
1	0	0	1	0	0	0	0	0	0	1	0
1	0	1	0	0	0	0	0	0	1	0	0
1	0	1	1	0	0	0	0	1	0	0	0
1	1	0	0	0	0	0	1	0	0	0	0
1	1	0	1	0	0	1	0	0	0	0	0
1	1	1	0	0	1	0	0	0	0	0	0
1	1	1	1	1	0	0	0	0	0	0	0

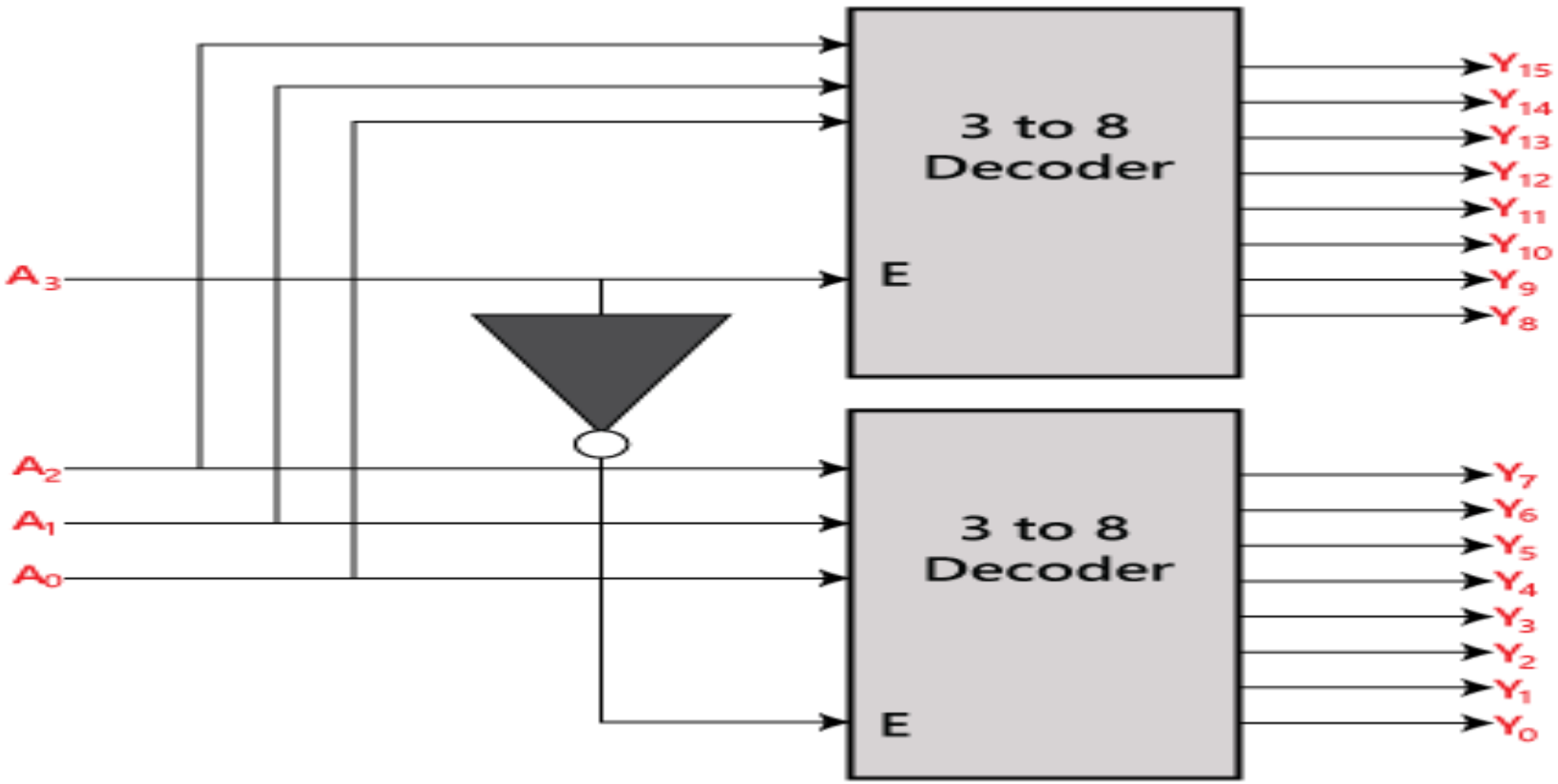
- The logical expression of the term Y_0, Y_1, Y_2, Y_3, Y_4, Y_5, Y_6, and Y_7 is as follows:
- $Y_0=A_0'.A_1'.A_2'$
  $Y_1=A_0.A_1'.A_2'$
  $Y_2=A_0'.A_1.A_2'$
  $Y_3=A_0.A_1.A_2'$
  $Y_4=A_0'.A_1'.A_2$
  $Y_5=A_0.A_1'.A_2$
  $Y_6=A_0'.A_1.A_2$
  $Y_7=A_0.A_1.A_2$


A2
A1
A0
Y0
Y1
Y2
Y3
Y4
Y5
Y6
Y7

$\frac{16}{8}$

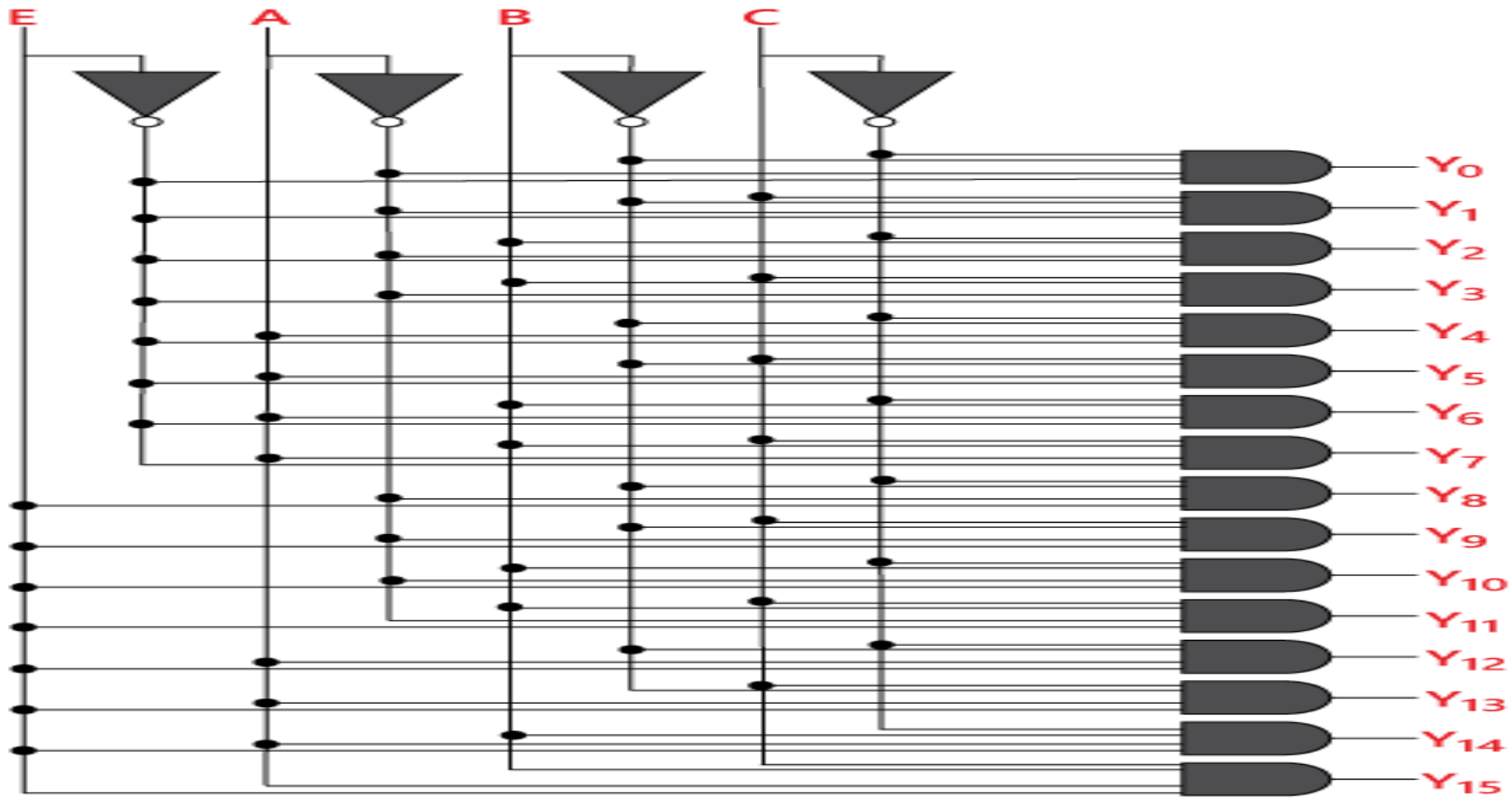
4 to 16 line Decoder

In the 4 to 16 line decoder,
there is a total of 16 outputs,
i.e., Y_0, Y_1, Y_2,……, Y_{16} and four inputs, i.e., A_0, A1, A_2, and A_3.
The 3 to 16 line decoder can be constructed using either 2 to 4 decoder or 3 to 8 decoder.
There is the following formula used to find the required number of lower-order decoders.
Required number of lower order decoders=m_2/m_1
$m_1 = 8$
$m_2 = 16$
Required number of 3 to 8 decoders= =2


3 to 8
Decoder
E
3 to 8
Decoder
E
A3
A2
A1
A0
Y15
Y14
Y13
Y12
Y11
Y10
Y9
Y8
Y7
Y6
Y5
Y4
Y3
Y2
Y1
Y0

INPUTS				OUTPUTS															
A_3	A_2	A_1	A_0	Y_{15}	Y_{14}	Y_{13}	Y_{12}	Y_{11}	Y_{10}	Y_9	Y_8	Y_7	Y_6	Y_5	Y_4	Y_3	Y_2	Y_1	Y_0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
0	0	1	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	0	0	0	0	0	0	1	0	0	0	0
0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
0	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
1	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	0	0	0	0	0
1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
1	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

- The logical expression of the term A0, A1, A2,…, A15 are as follows:
- $Y_0 = A_0'.A_1'.A_2'.A_3'$
  $Y_1 = A_0'.A_1'.A_2'.A_3$
  $Y_2 = A_0'.A_1'.A_2.A_3'$
  $Y_3 = A_0'.A_1'.A_2.A_3$
  $Y_4 = A_0'.A_1.A_2'.A_3'$
  $Y_5 = A_0'.A_1.A_2'.A_3$
  $Y_6 = A_0'.A_1.A_2.A_3'$
  $Y_7 = A_0'.A_1.A_2.A_3$
  $Y_8 = A_0.A_1'.A_2'.A_3'$
  $Y_9 = A_0.A_1'.A_2'.A_3$
  $Y_{10} = A_0.A_1'.A_2.A_3'$
  $Y_{11} = A_0.A_1'.A_2.A_3$
  $Y_{12} = A_0.A_1.A_2'.A_3'$
  $Y_{13} = A_0.A_1.A_2'.A_3$
  $Y_{14} = A_0.A_1.A_2.A_3'$
  $Y_{15} = A_0.A_1.A_2.A_3$


E
A
B
C
Y0
Y1
Y2
Y3
Y4
Y5
Y6
Y7
Y8
Y9
Y10
Y11
Y12
Y13
Y14
Y15