CS M51A
Logic Design of Digital Systems
Winter 2021

Some slides borrowed and modified from:
M.D. Ercegovac, T. Lang and J. Moreno, Introduction to Digital Systems.

BINARY DECODERS

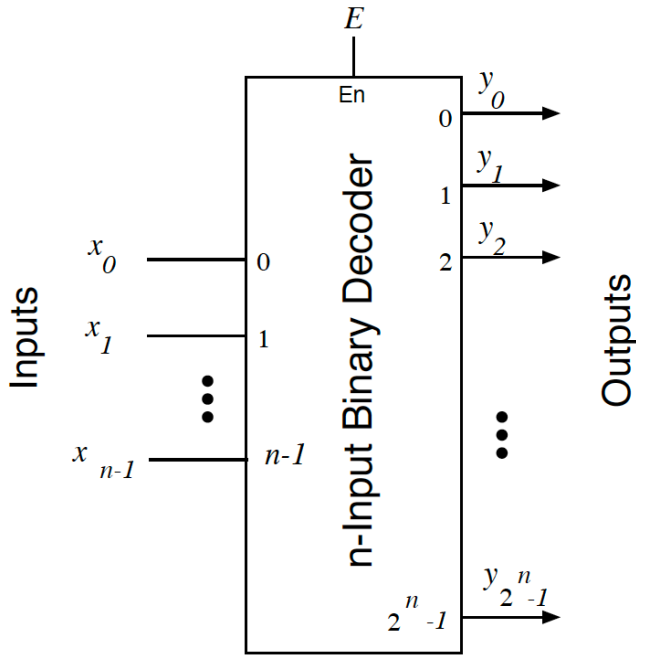
HIGH-LEVEL DESCRIPTION:

Inputs: $\underline{x} = (x_{n-1}, \ldots, x_0), \quad x_j \in \{0, 1\}$

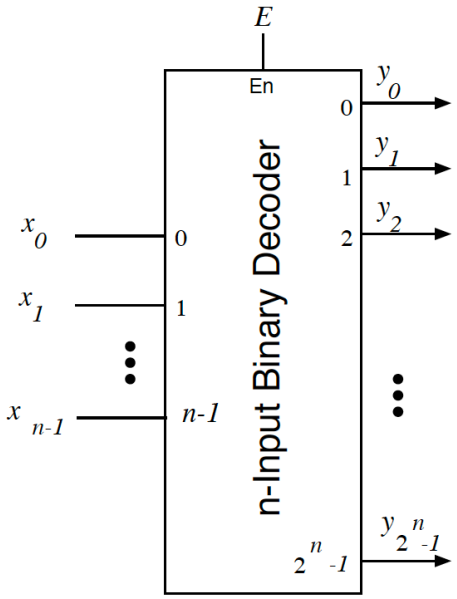
Enable $E \in \{0, 1\}$

Outputs: $\underline{y} = (y_{2^n-1}, \ldots, y_0), \quad y_i \in \{0, 1\}$

Function: $y_i = \begin{cases} 1 \text{ if } (x = i) \text{ and } (E = 1) \\ 0 \text{ otherwise} \end{cases}$



3-INPUT BINARY DECODER



E	x_2	x_1	x_0	x	y_7	y_6	y_5	y_4	y_3	y_2	y_1	y_0
1	0	0	0	0	0	0	0	0	0	0	0	1
1	0	0	1	1	0	0	0	0	0	0	1	0
1	0	1	0	2	0	0	0	0	0	1	0	0
1	0	1	1	3	0	0	0	0	1	0	0	0
1	1	0	0	4	0	0	0	1	0	0	0	0
1	1	0	1	5	0	0	1	0	0	0	0	0
1	1	1	0	6	0	1	0	0	0	0	0	0
1	1	1	1	7	1	0	0	0	0	0	0	0
0	-	-	-	-	0	0	0	0	0	0	0	0

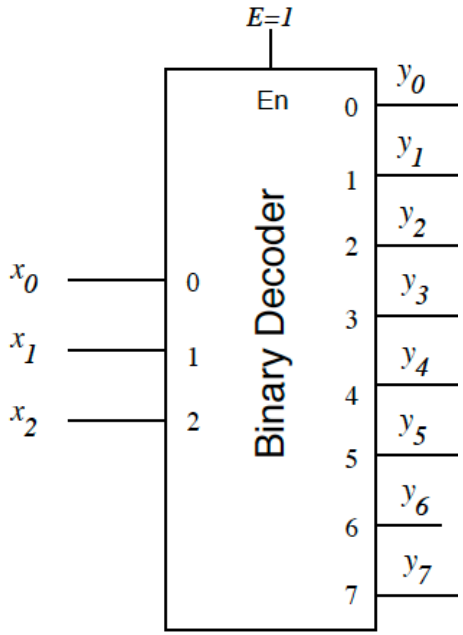
BINARY SPECIFICATION:

Inputs: $\underline{x} = (x_{n-1}, \ldots, x_0), \quad x_j \in \{0, 1\}$
$E \in \{0, 1\}$

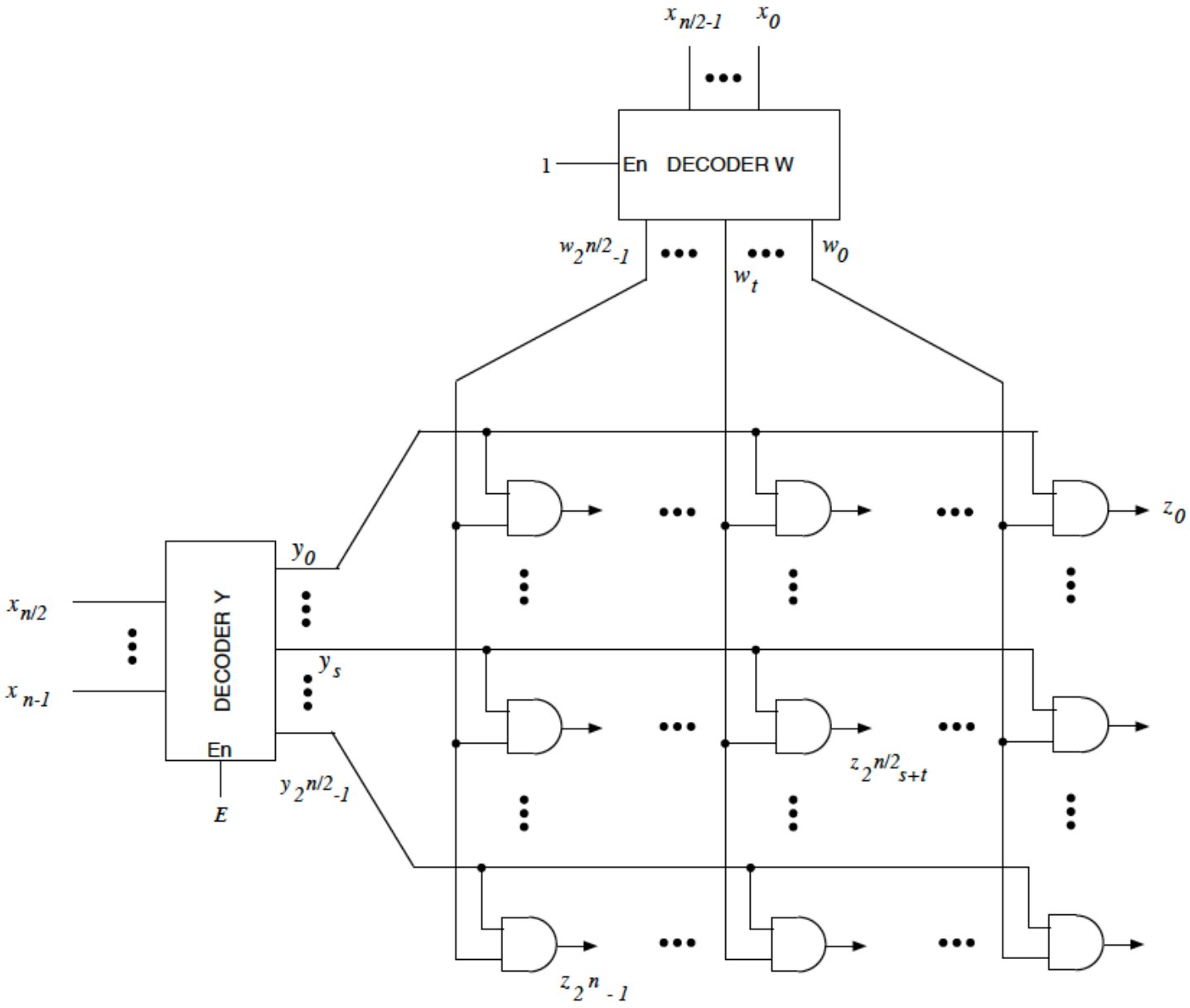
Outputs: $\underline{y} = (y_{2^n-1}, \ldots, y_0), \quad y_i \in \{0, 1\}$

Example

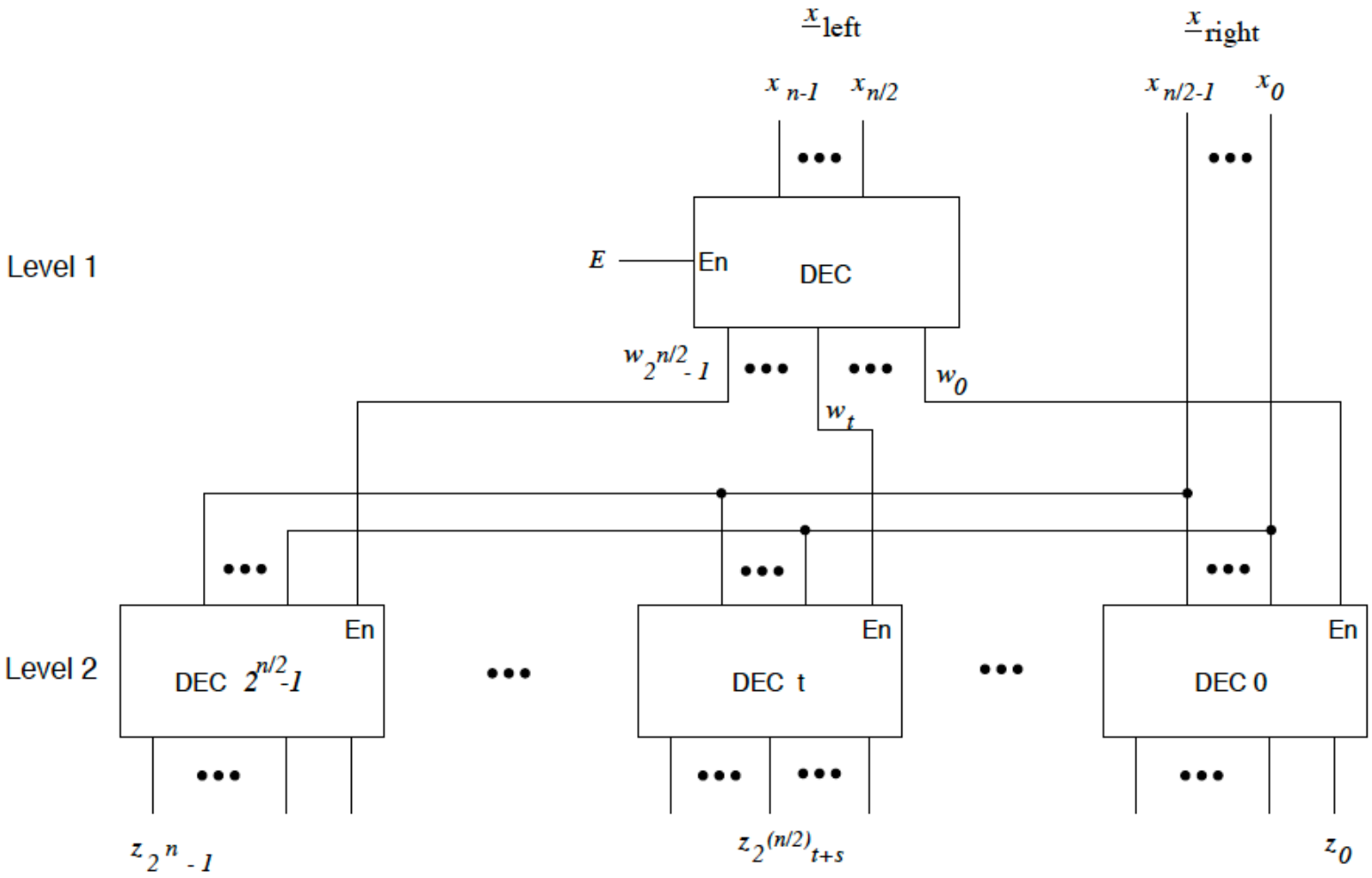
$x_2x_1x_0$	z_2	z_1	z_0
000	0	1	0
001	1	0	0
010	0	0	1
011	0	1	0
100	0	0	1
101	1	0	1
110	0	0	0
111	1	0	0



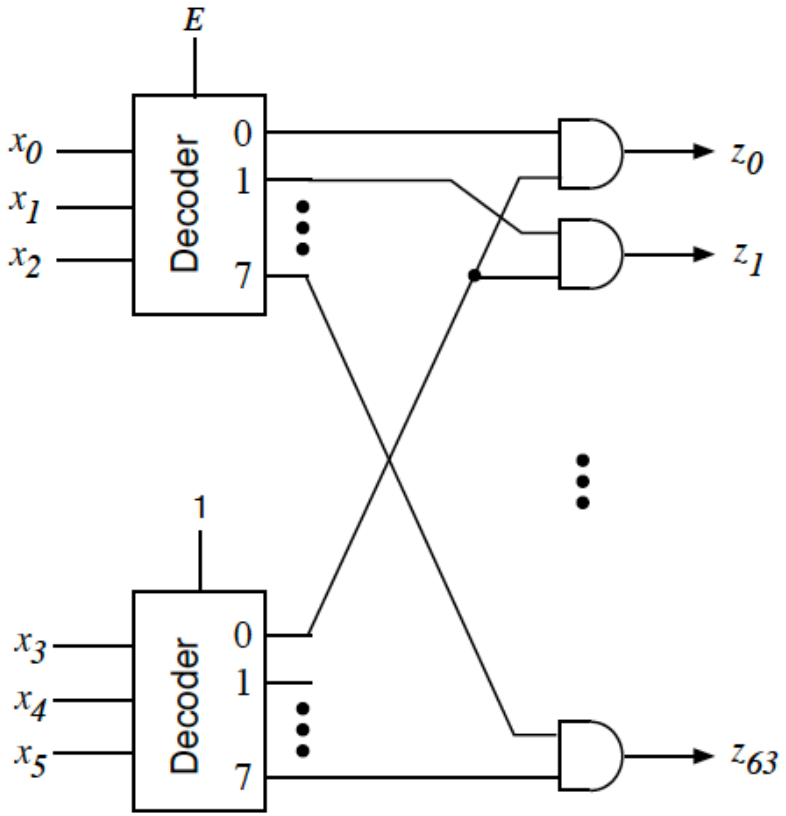
Coincident Decoder

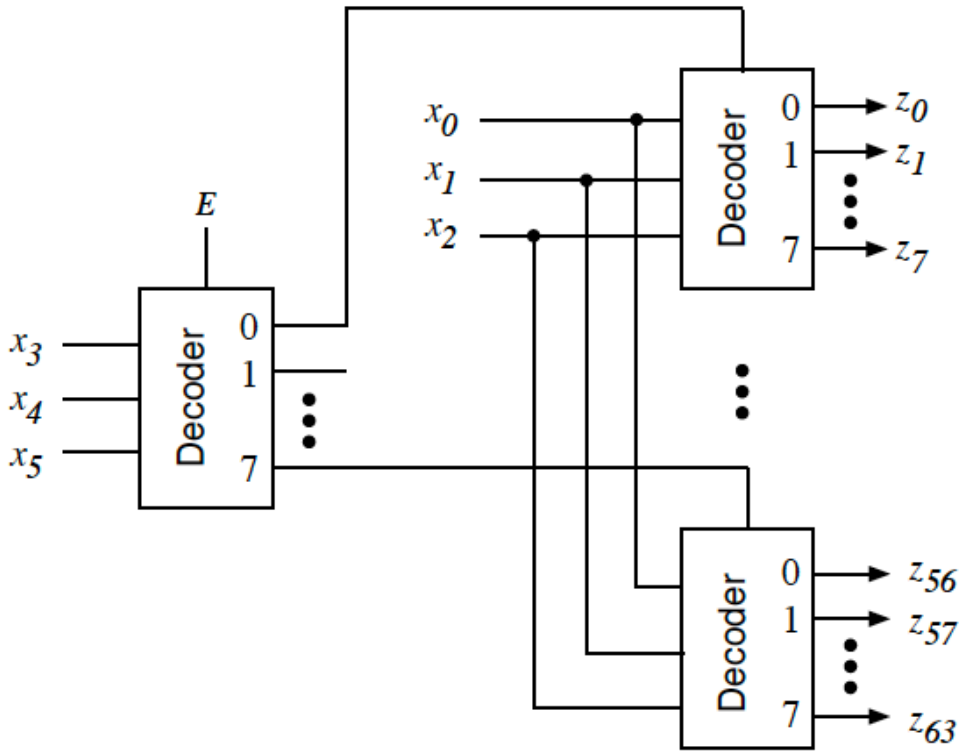


Tree Decoder

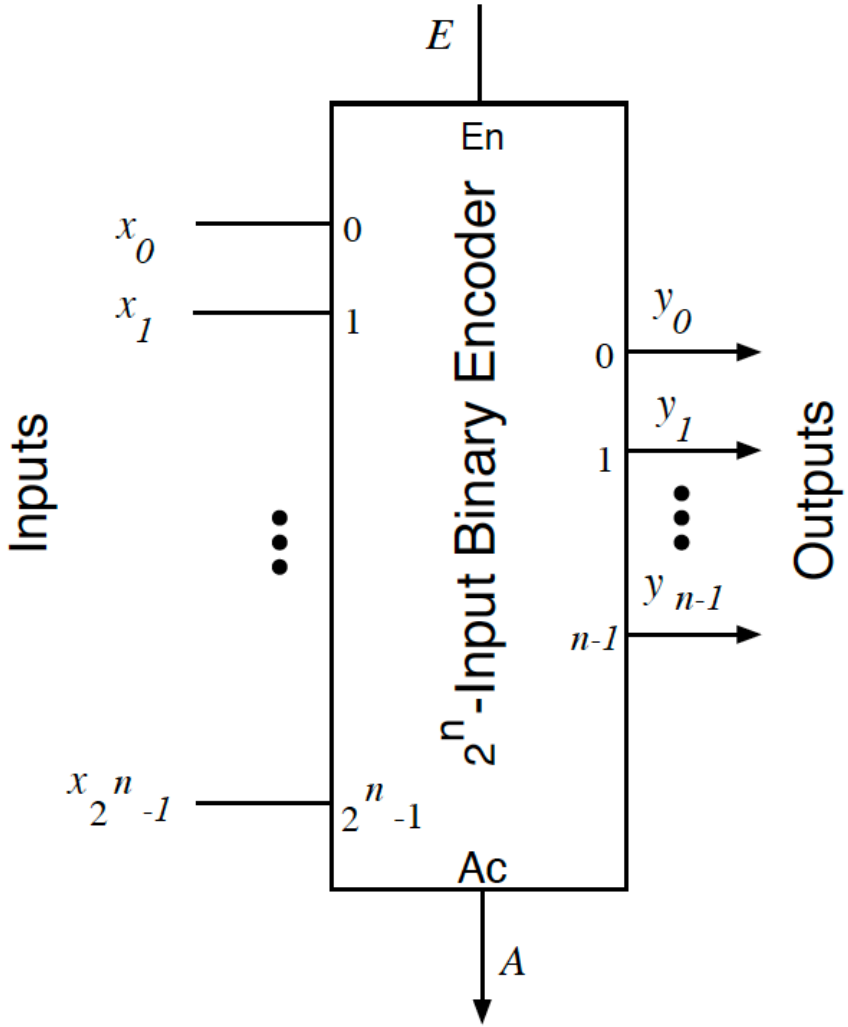


EXAMPLE: 6-INPUT DECODER



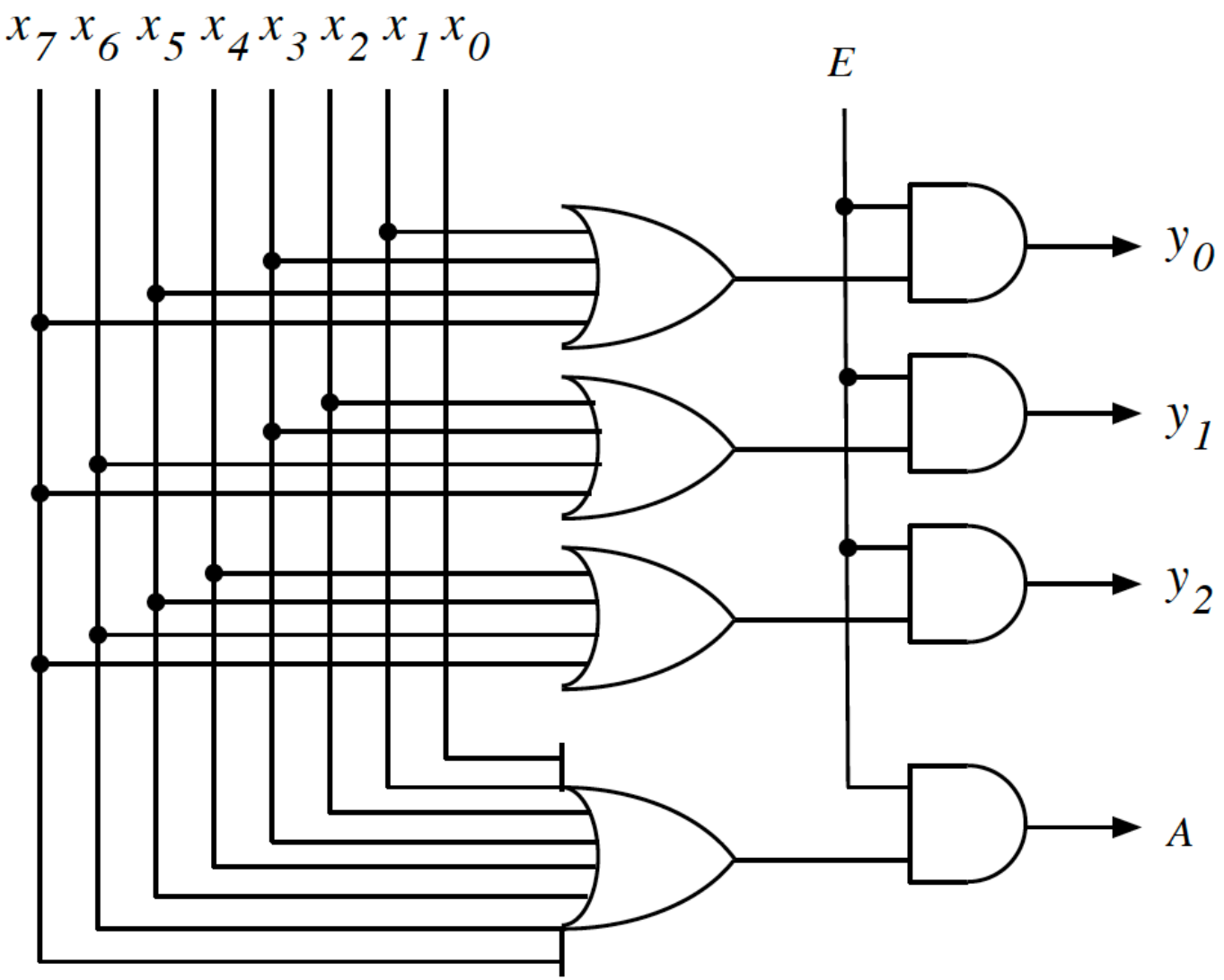


BINARY ENCODERS

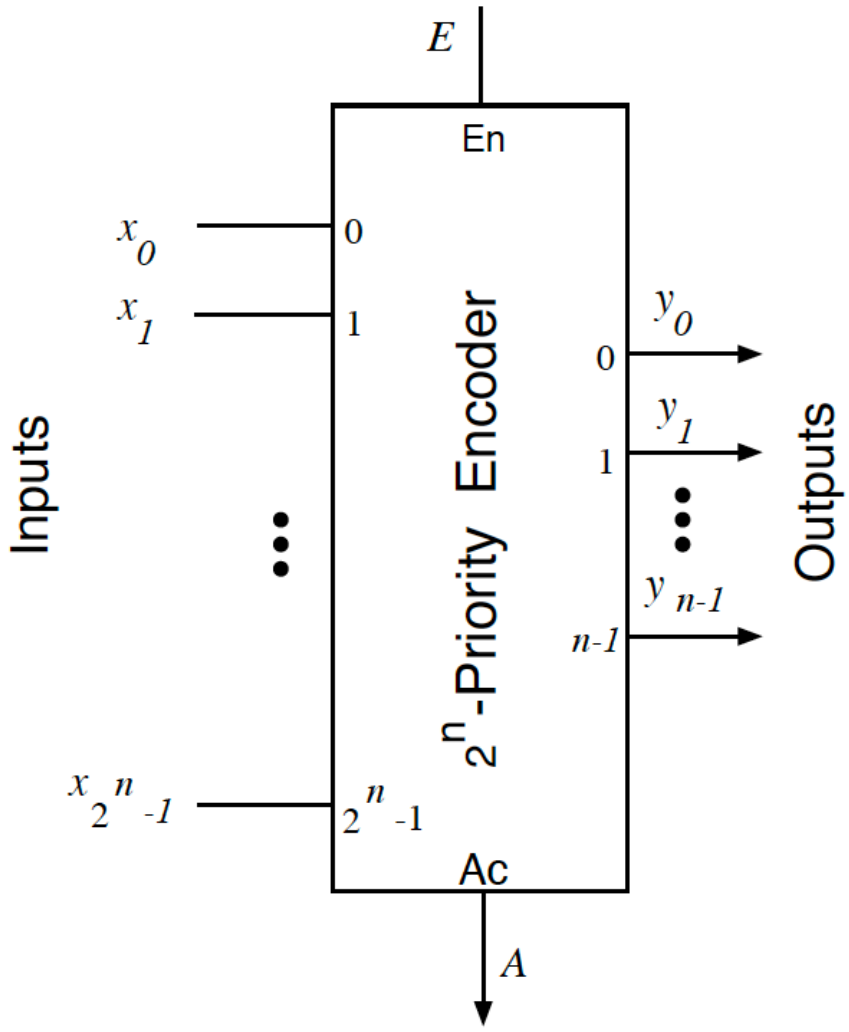


FUNCTION OF AN 8-INPUT BINARY ENCODER

E	x_7	x_6	x_5	x_4	x_3	x_2	x_1	x_0	y	y_2	y_1	y_0	A
1	0	0	0	0	0	0	0	1	0	0	0	0	1
1	0	0	0	0	0	0	1	0	1	0	0	1	1
1	0	0	0	0	0	1	0	0	2	0	1	0	1
1	0	0	0	0	1	0	0	0	3	0	1	1	1
1	0	0	0	1	0	0	0	0	4	1	0	0	1
1	0	0	1	0	0	0	0	0	5	1	0	1	1
1	0	1	0	0	0	0	0	0	6	1	1	0	1
1	1	0	0	0	0	0	0	0	7	1	1	1	1
1	0	0	0	0	0	0	0	0	0	0	0	0	0
0	-	-	-	-	-	-	-	-	0	0	0	0	0


x_7 x_6 x_5 x_4 x_3 x_2 x_1 x_0
E
y_0
y_1
y_2
A

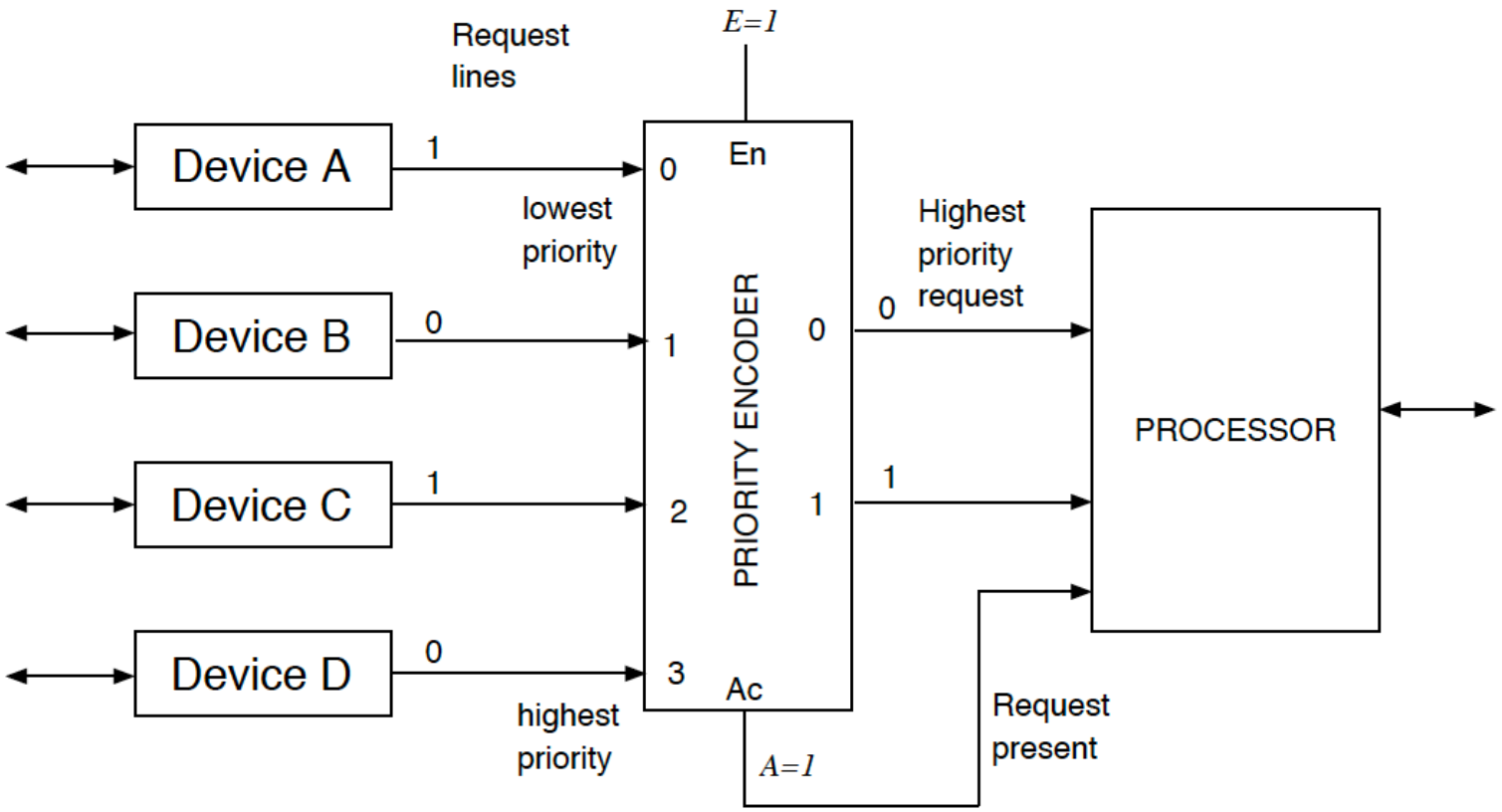
Priority BINARY ENCODERS



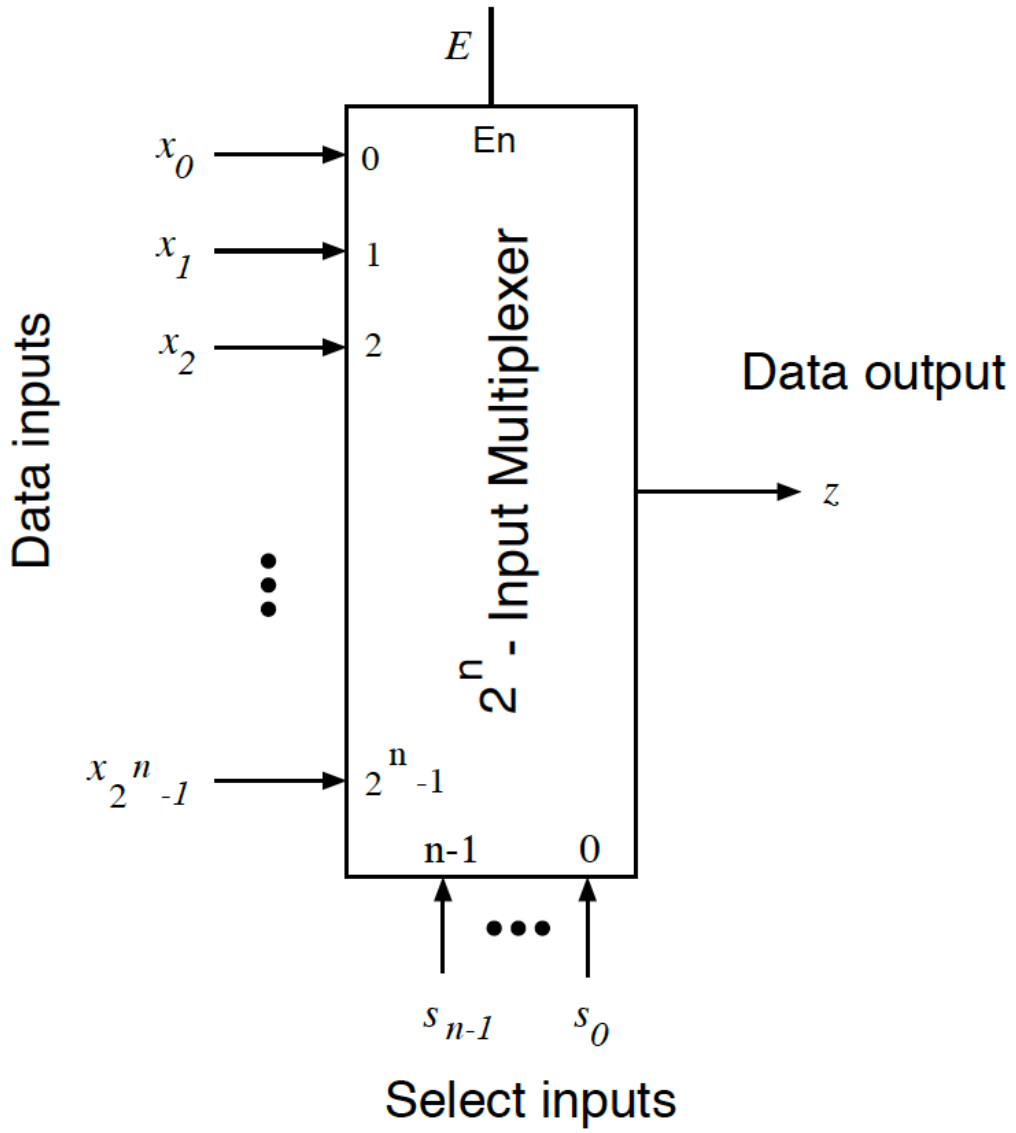
8-INPUT PRIORITY ENCODER

E	x_7	x_6	x_5	x_4	x_3	x_2	x_1	x_0	y_2	y_1	y_0	A
1	0	0	0	0	0	0	0	1	0	0	0	1
1	0	0	0	0	0	0	1	-	0	0	1	1
1	0	0	0	0	0	1	-	-	0	1	0	1
1	0	0	0	0	1	-	-	-	0	1	1	1
1	0	0	0	1	-	-	-	-	1	0	0	1
1	0	0	1	-	-	-	-	-	1	0	1	1
1	0	1	-	-	-	-	-	-	1	1	0	1
1	1	-	-	-	-	-	-	-	1	1	1	1
1	0	0	0	0	0	0	0	0	0	0	0	0
0	-	-	-	-	-	-	-	-	0	0	0	0

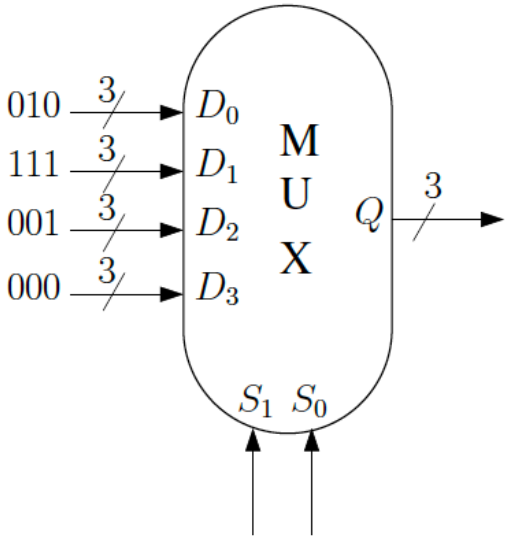
USES OF PRIORITY ENCODERS



MULTIPLEXERS (selectors)



Clicker Question



For select lines $S_1S_0 = 00$, what value does the output Q of the MUX have?

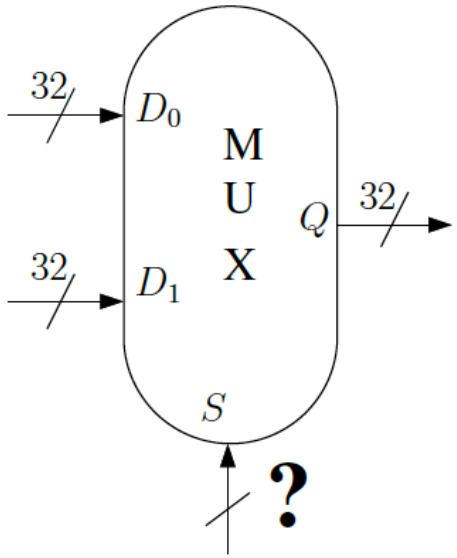
a 000

b 001

c 010

d 111

e None of the above



How many select lines does the pictured MUX have?

a 1

b 2

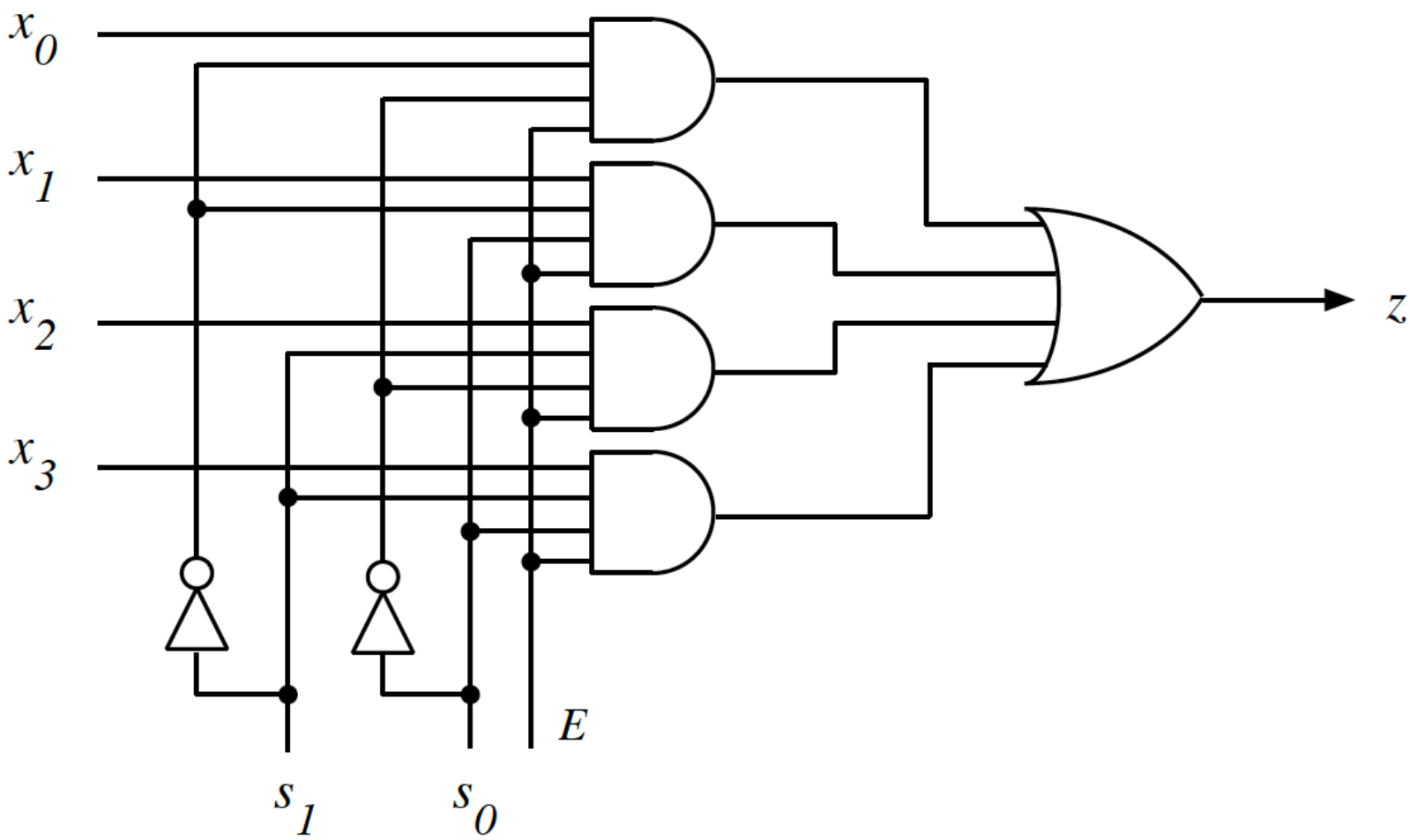
c 5

d 32

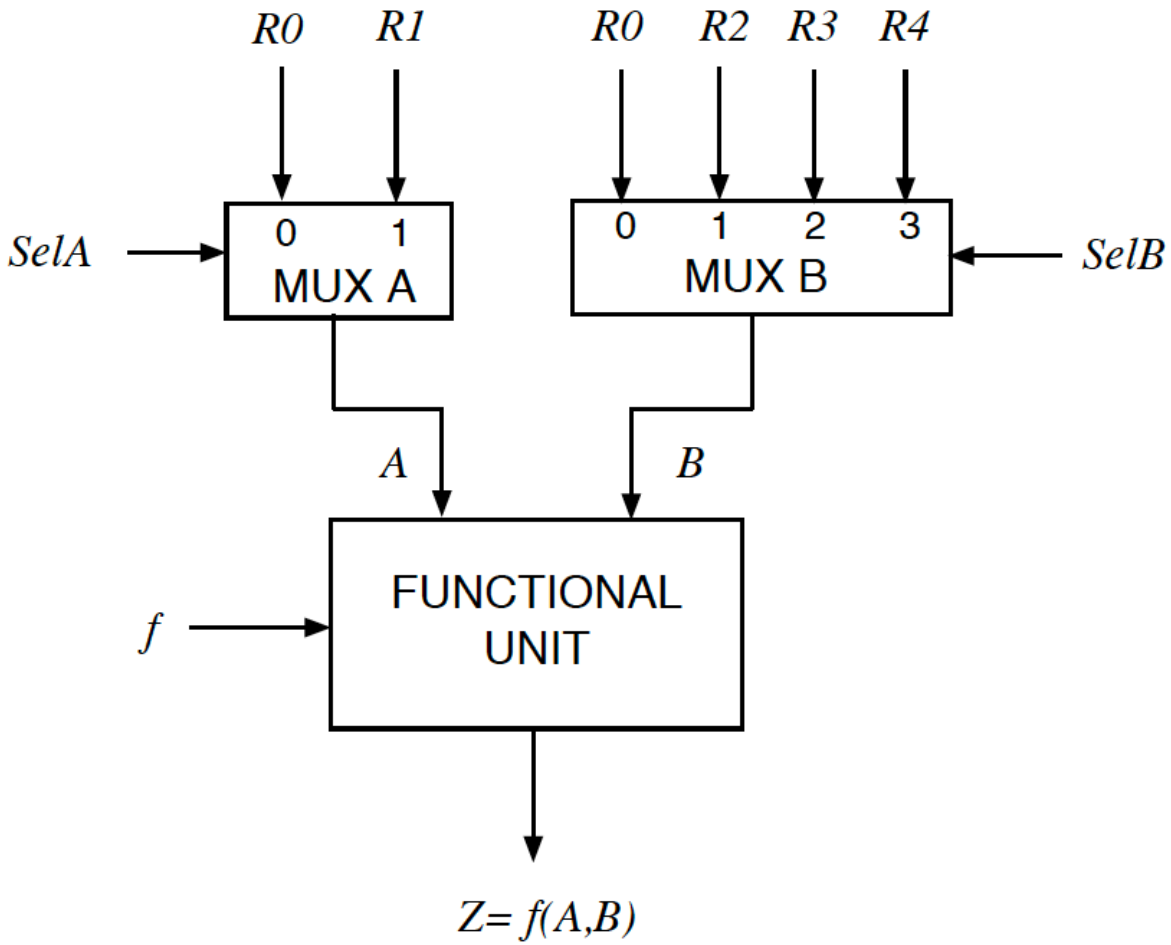
e None of the above

4-INPUT MULTIPLEXER

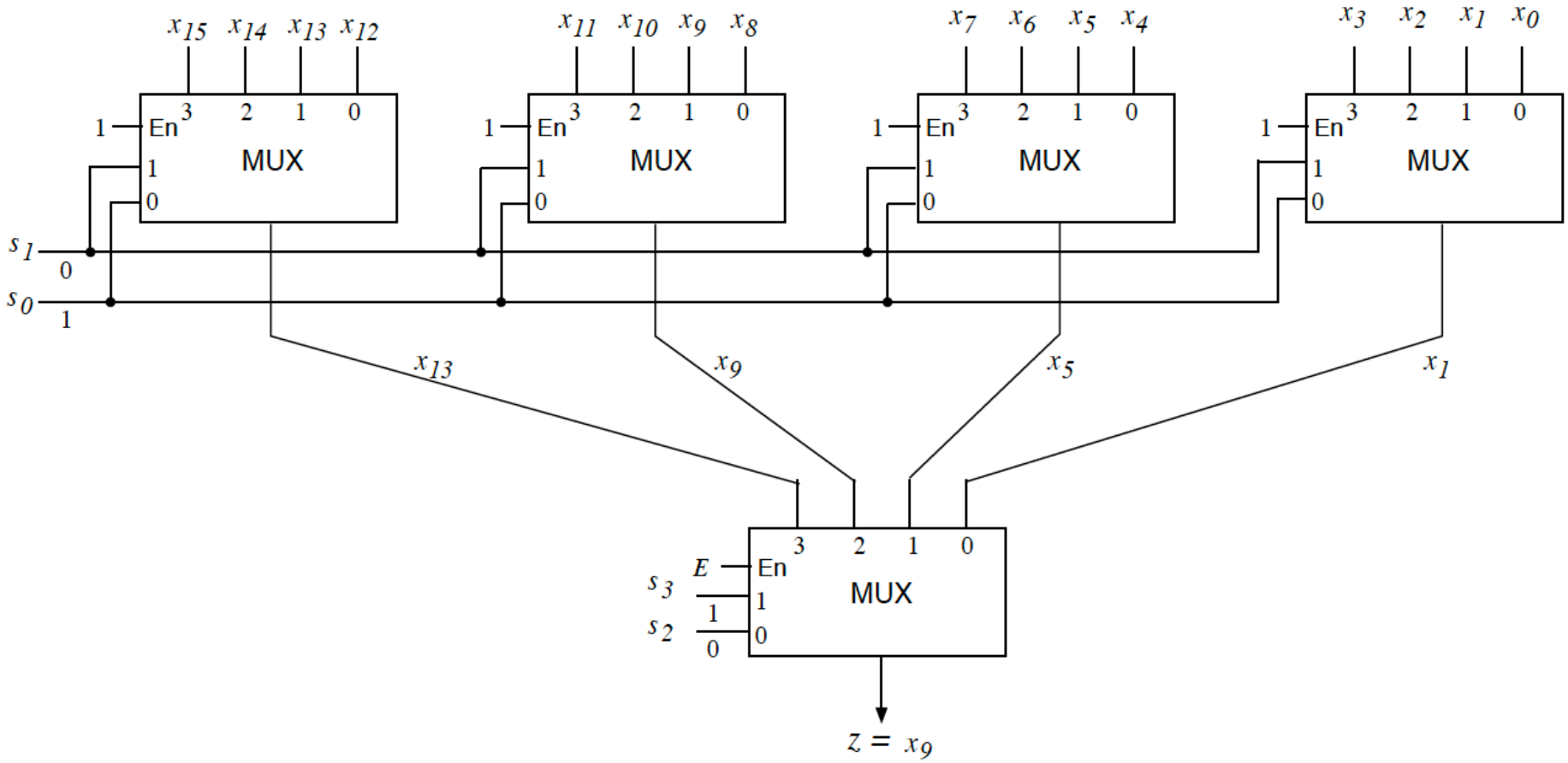
E	s_1	s_0	z
1	0	0	x_0
1	0	1	x_1
1	1	0	x_2
1	1	1	x_3
0	-	-	0


x_0
x_1
x_2
x_3
z
E
s_1
s_0

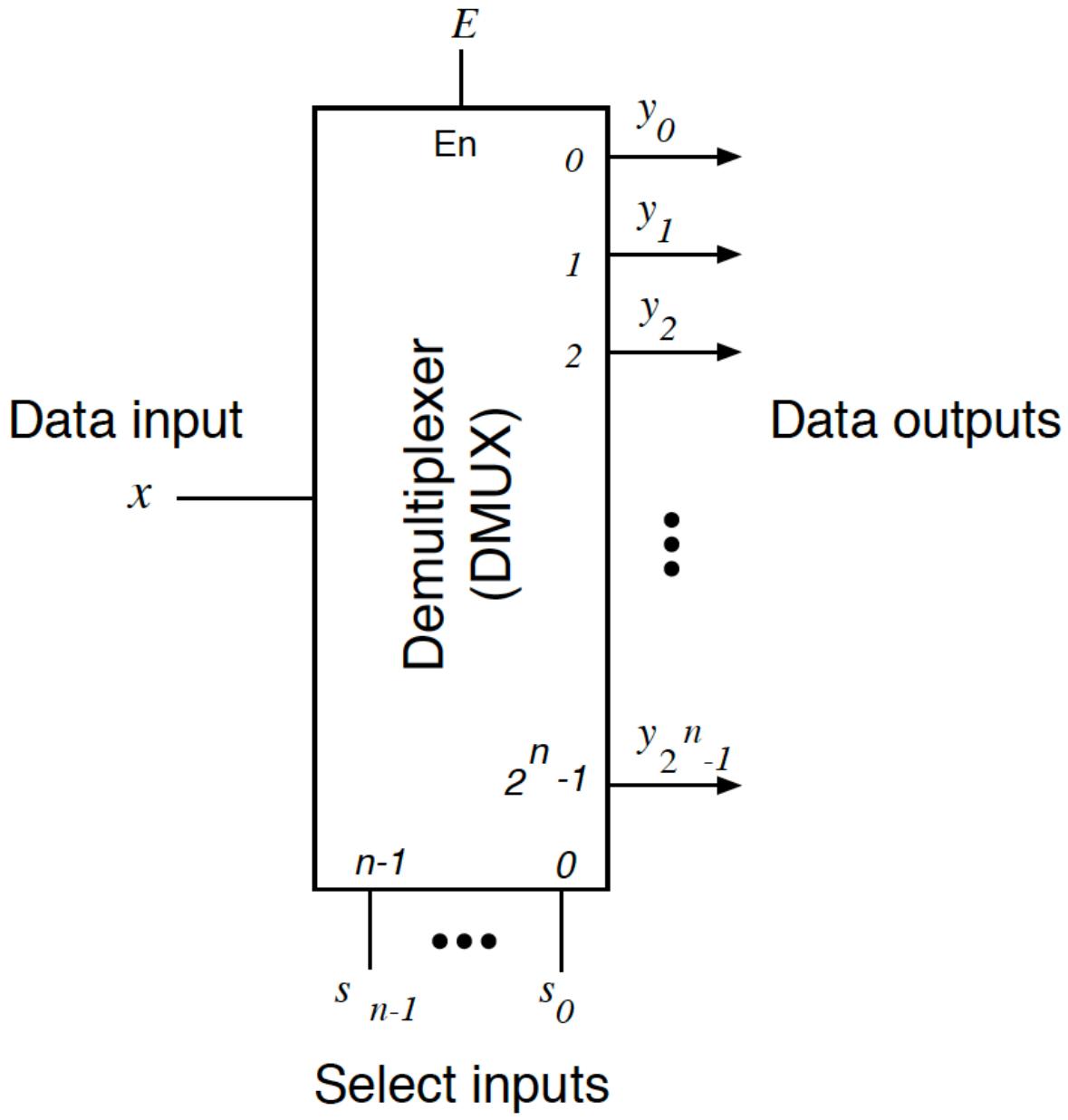
TYPICAL USES



16-INPUT TREE MULTIPLEXER

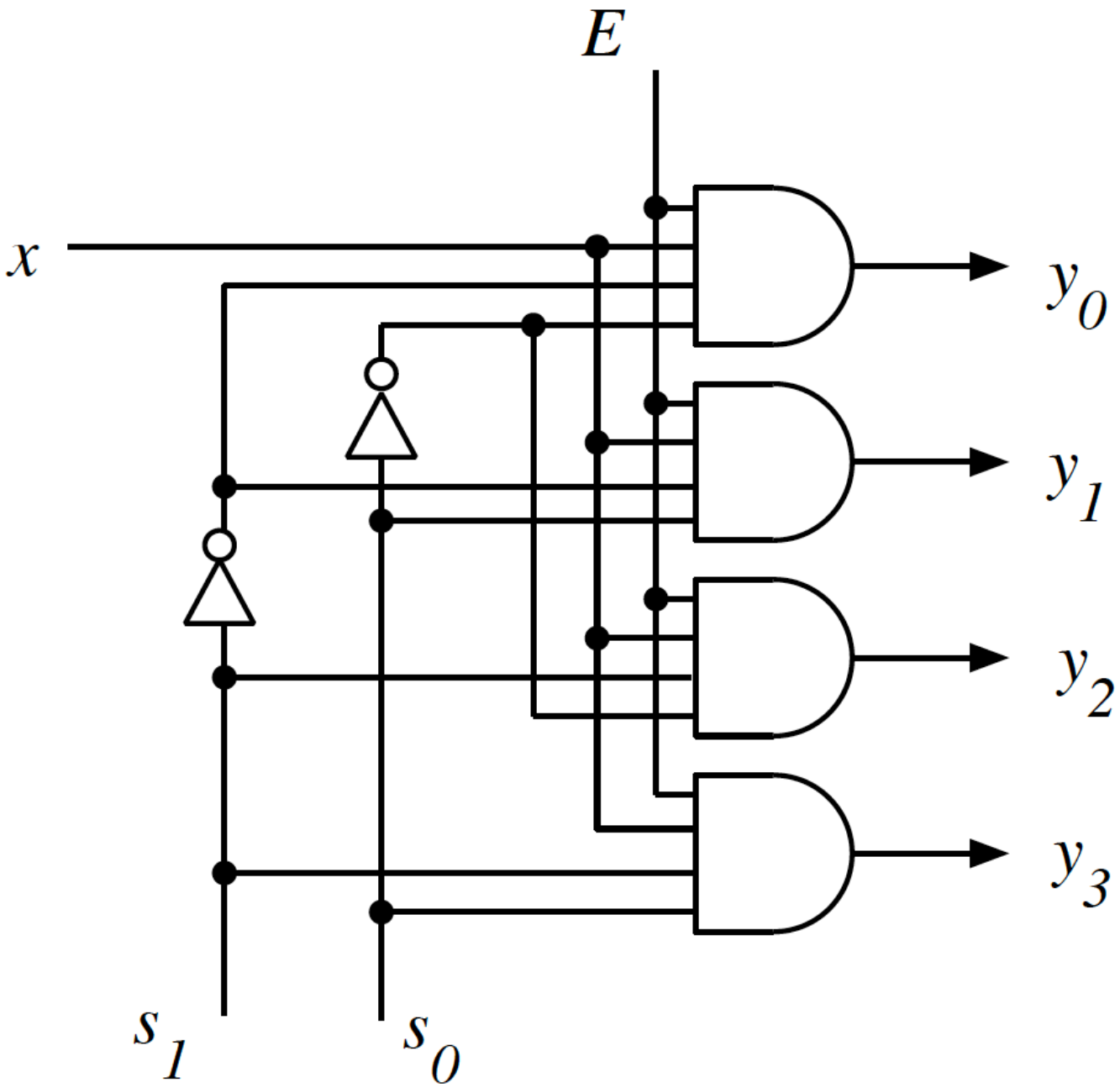


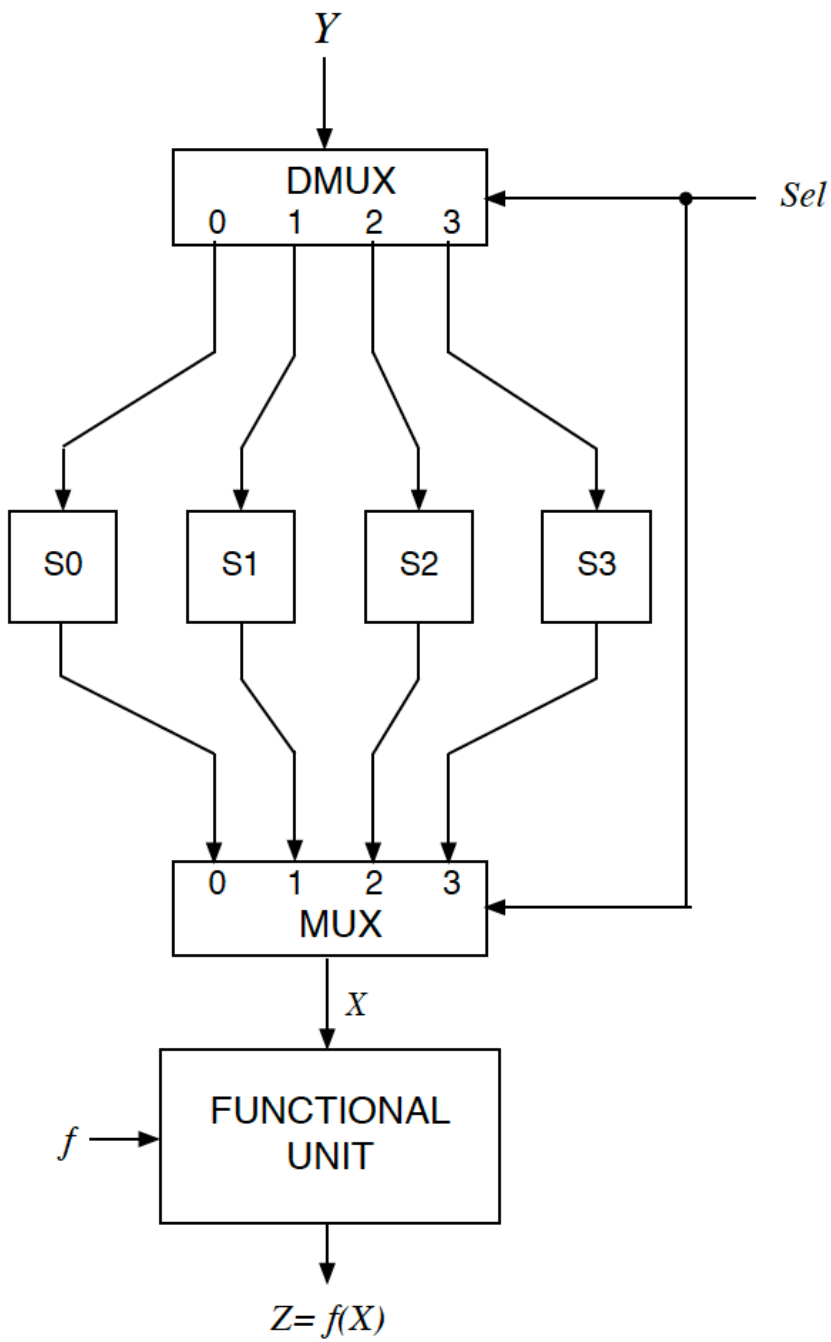
DEMULTIPLEXERS (distributors)



4-OUTPUT DEMULTIPLEXER

E	s_1	s_0	s	y_3	y_2	y_1	y_0
1	0	0	0	0	0	0	x
1	0	1	1	0	0	x	0
1	1	0	2	0	x	0	0
1	1	1	3	x	0	0	0
0	-	-	-	0	0	0	0


E
x
y0
y1
y2
y3
s1
s0


Y
DMUX
0 1 2 3
Sel
S0
S1
S2
S3
0 1 2 3
MUX
X
f
FUNCTIONAL
UNIT
Z= f(X)