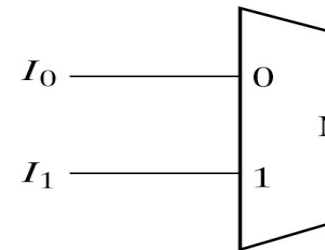
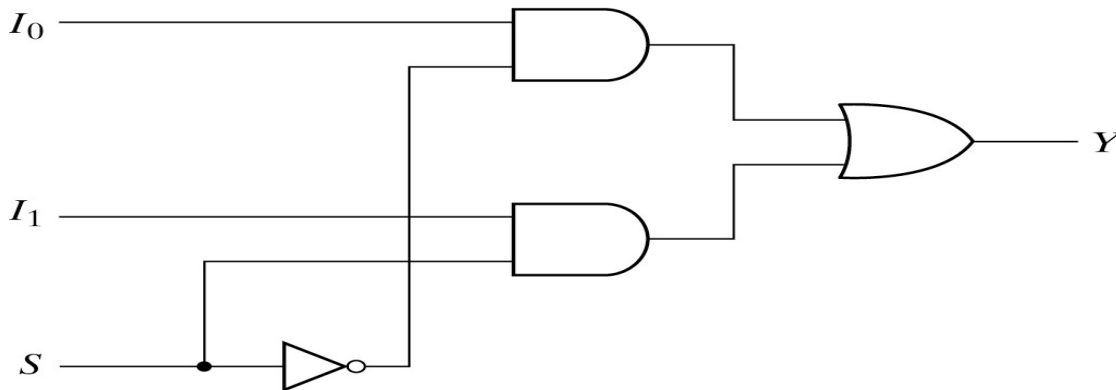


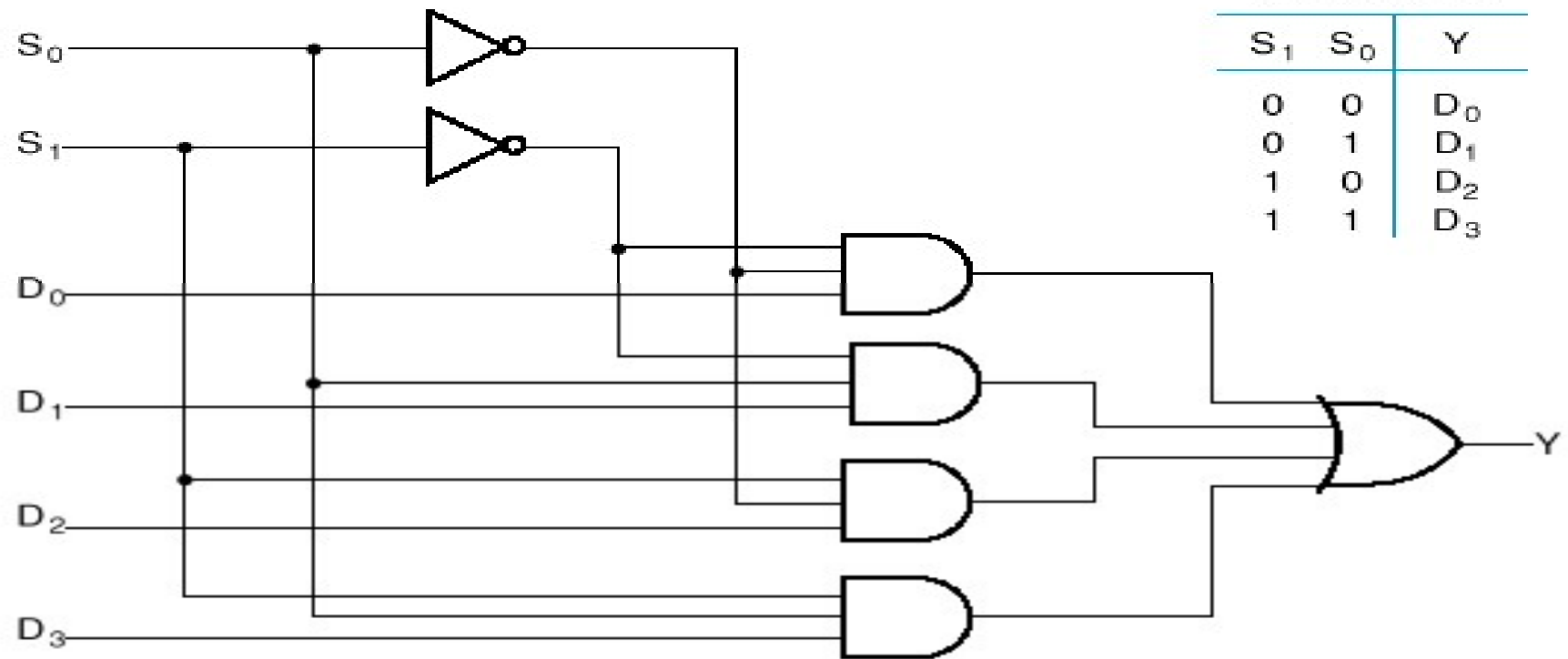
Combinational Circuit (Multiplexer Design)

Multiplexers

- Select an input value with one or more select bits
- Use for transmitting data
- Allows for **conditional** transfer of data
- Sometimes called a **mux**



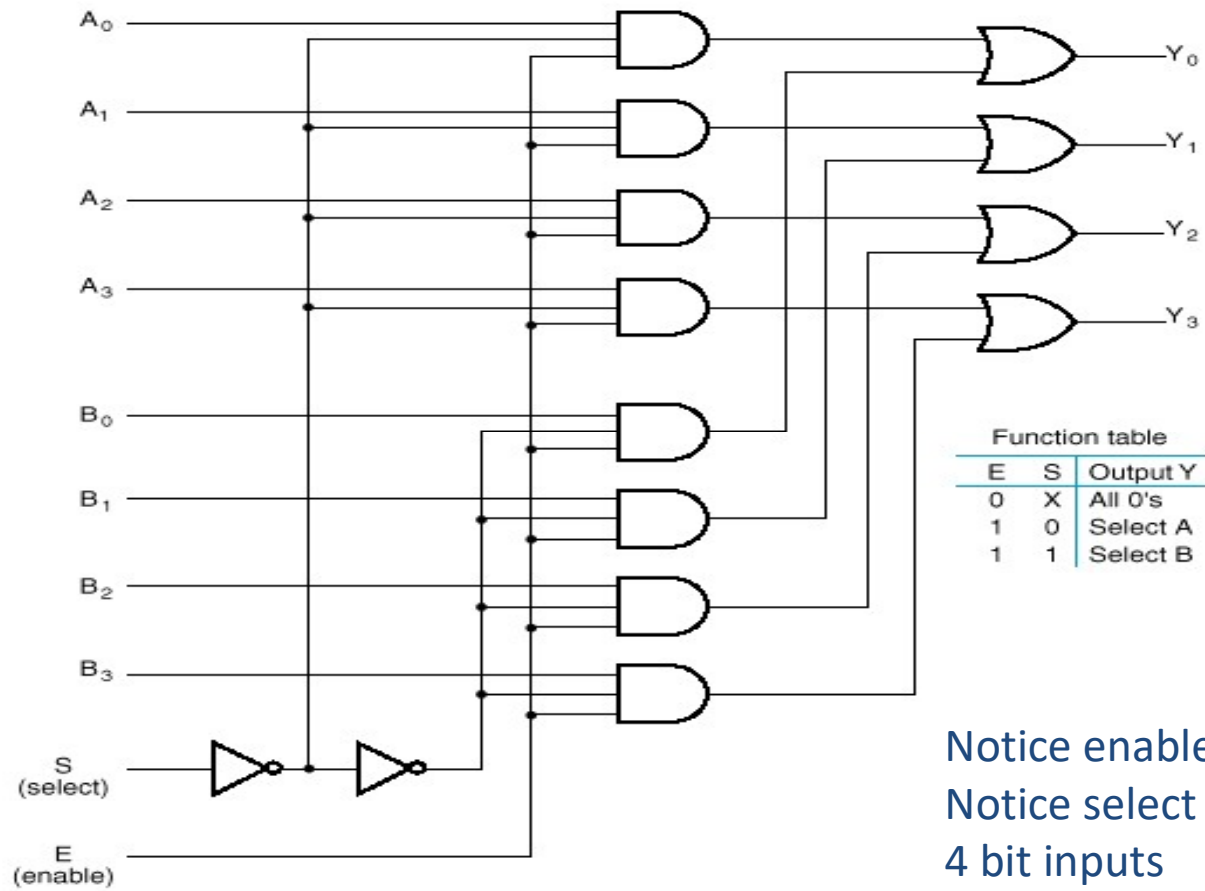
4- to- 1- Line Multiplexer



Function table

S_1	S_0	Y
0	0	D_0
0	1	D_1
1	0	D_2
1	1	D_3

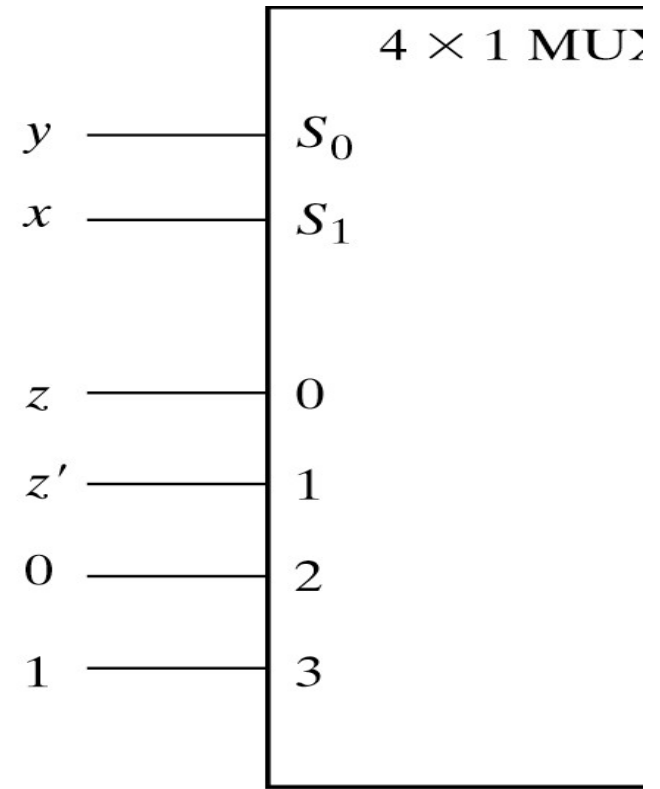
Quadruple 2-to-1-Line Multiplexer



Multiplexer as combinational modules

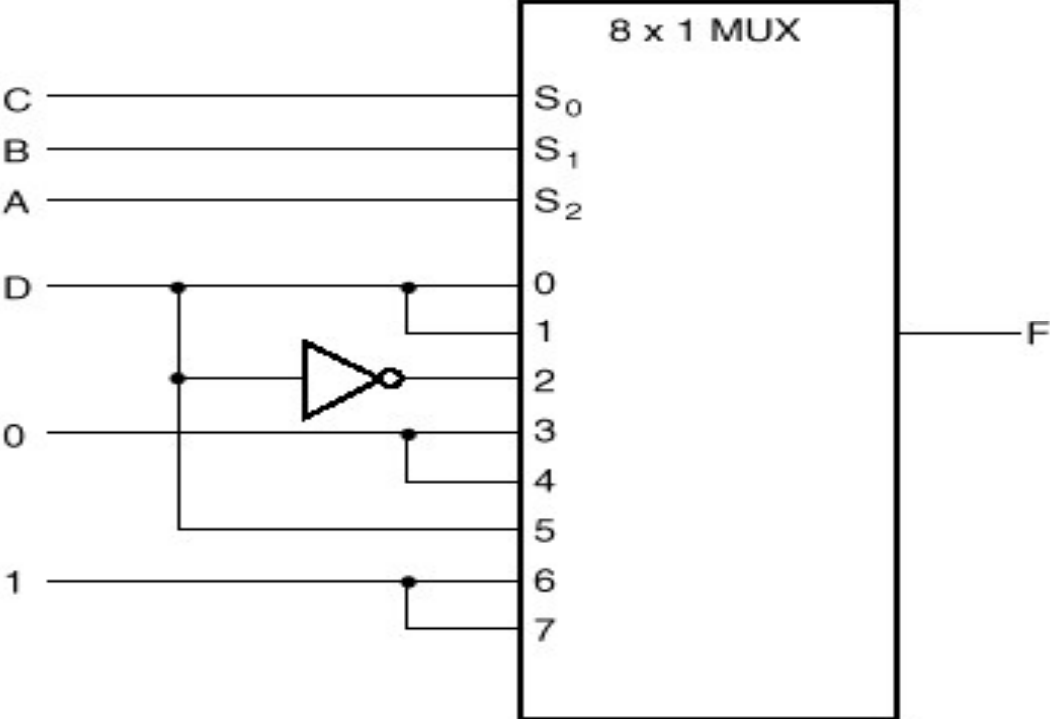
- Connect input variables to select inputs of multiplexer (*$n-1$ for n variables*)
- Set data inputs to multiplexer equal to values of function for corresponding assignment of select variables
- Using a variable at data inputs reduces size of the multiplexer

x	y	z	F	
0	0	0	0	
0	0	1	1	$F = z$
0	1	0	1	
0	1	1	0	$F = z'$
1	0	0	0	
1	0	1	0	$F = 0$
1	1	0	1	
1	1	1	1	$F = 1$



Implementing a Four- Input Function with a Multiplexer

A	B	C	D	F	
0	0	0	0	0	$F = D$
0	0	0	1	1	
0	0	1	0	0	$F = D$
0	0	1	1	1	
0	1	0	0	1	$F = \bar{D}$
0	1	0	1	0	
0	1	1	0	0	$F = 0$
0	1	1	1	0	
1	0	0	0	0	$F = 0$
1	0	0	1	0	
1	0	1	0	0	$F = D$
1	0	1	1	1	
1	1	0	0	1	$F = 1$
1	1	0	1	1	
1	1	1	0	1	$F = 1$
1	1	1	1	1	



Typical multiplexer uses

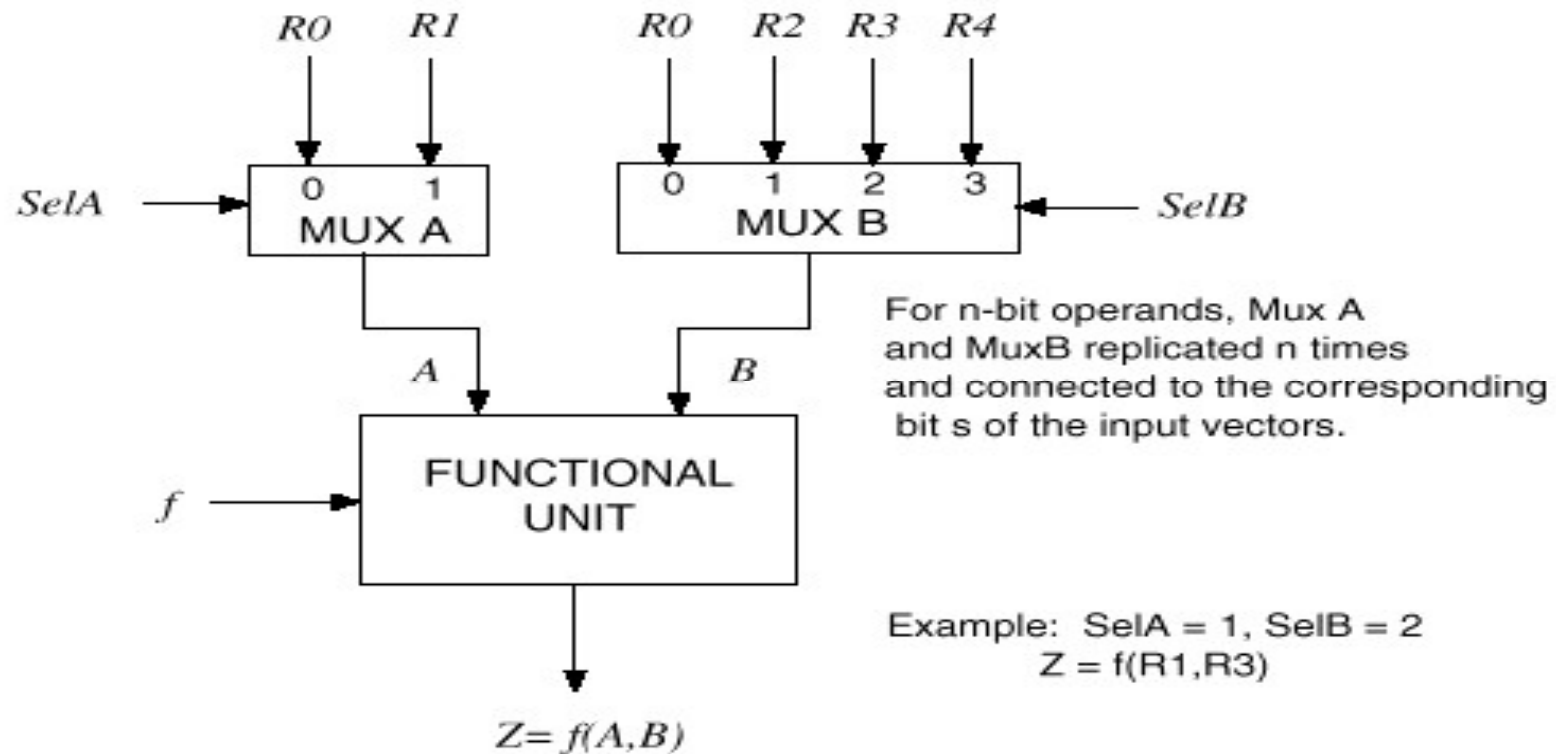
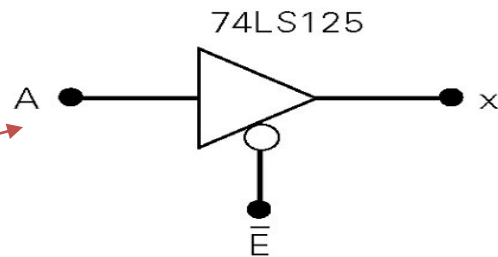


Figure 9.21: Multiplexer example of use.

Three-state gates

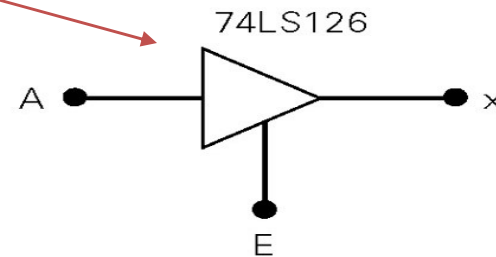
- A multiplexer can be constructed with three-state gates
- Output state: 0, 1, and high-impedance (open ckts)
- If the select input (E) is 0, the three-state gate has **no output**

Opposite true here,
No output if E is 1



\bar{E}	x
0	A
1	Hi-Z

(a)

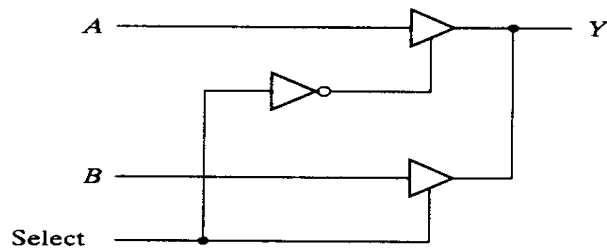


E	x
0	Hi-Z
1	A

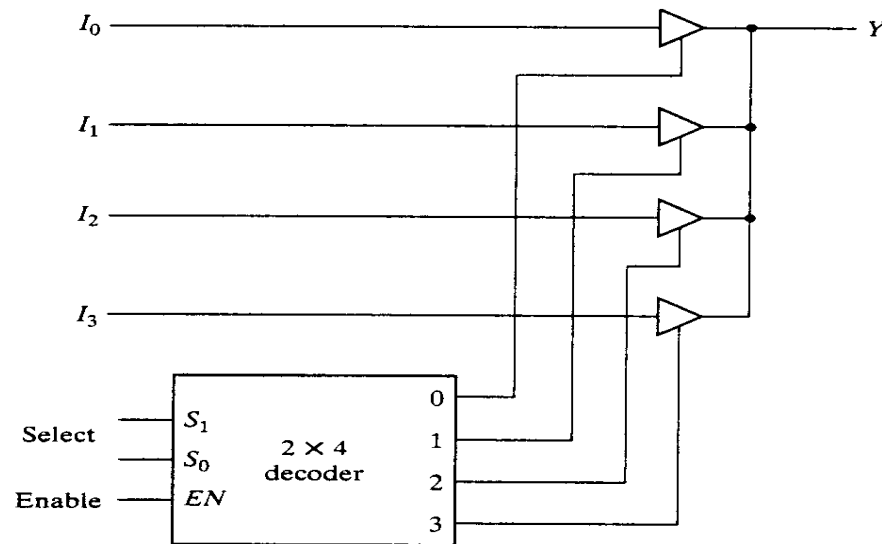
(b)

Three-state gates

- A multiplexer can be constructed with three-state gates
- Output state: 0, 1, and high-impedance (open ckts)
- If the select input is low, the three-state gate has **no output**



(a) 2-to-1- line mux



(b) 4 - to - 1 line mux

Summary

- Multiplexers are fundamental digital components
 - Can be used for logic
 - Useful for **data paths**
 - Scalable
- Tristate buffers have three types of outputs
 - 0, 1, high- impedance (Z)
 - Useful for data paths