

### Combinational Building Blocks

**2/1 Multiplexor (MUX)**

if  $S = 0$ , then  $Y = I_0$   
 if  $S = 1$ , then  $Y = I_1$   
 $Y = I_0 S' + I_1 S$

**Muxes often use to select groups of bits arranged in busses.**

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### What Good are Muxes ??

Sometimes want to have a bus be driven from multiple blocks, where only one block is driving the bus at a time.

**N to 1 mux will select 1 source; Select bus needs to be  $\log_2(N)$ . Note that only ONE input can be selected at a time!**

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### Higher Order Muxes

if  $S = "00"$ , then  $Y = I_0$   
 if  $S = "01"$ , then  $Y = I_1$   
 if  $S = "10"$ , then  $Y = I_2$   
 if  $S = "11"$ , then  $Y = I_3$

$Y = I_0 S_1' S_0' + I_1 S_1' S_0 + I_2 S_1 S_0' + I_3 S_1 S_0$

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### Logic for 2/1, 4/1 Muxes

$Y = I_0 S' + I_1 S$

$Y = I_0 S_1' S_0' + I_1 S_1' S_0 + I_2 S_1 S_0' + I_3 S_1 S_0$

These are called  
**COMBINATIONAL**  
muxes.

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### Tri State Buffer

There is another way to drive a line or bus from multiple sources. Use a TRISTATE buffer.

When  $EN = 1$ , then  $Y = A$ .

When  $EN = 0$ , then  $Y = \text{?????}$   
 $Y$  is *undriven*, this is called the **high impedance state**.

Designate high impedance by a 'Z'.

When  $EN = 0$ , then  $Y = 'Z'$  (high impedance)

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### Using TriState Buffers

Can use tristate buffers instead of a combinational 2/1 mux

Must make sure that  $ENA$ ,  $ENB$  are not both '1' at same time, or  $Y$  will be driven from multiple sources

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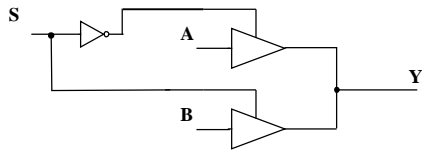
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### Using TriState Buffers (cont)

Only A or B is enabled at a time.



Implements 2/1 Mux function

If  $S=0$  then  $Y = A$   
If  $S=1$  then  $Y = B$

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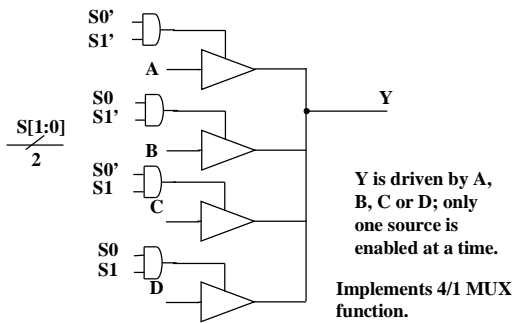
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### Using TriState Buffers (cont)



Y is driven by A, B, C or D; only one source is enabled at a time.

Implements 4/1 MUX function.

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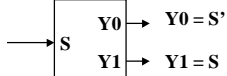
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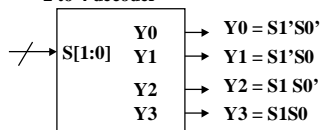
### Decoders

Logic common to both of the previous mux implementations was the *decoder* function.

1 to 2 decoder



2 to 4 decoder



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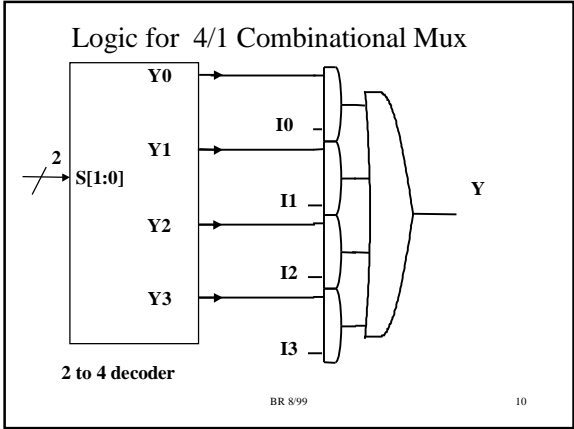
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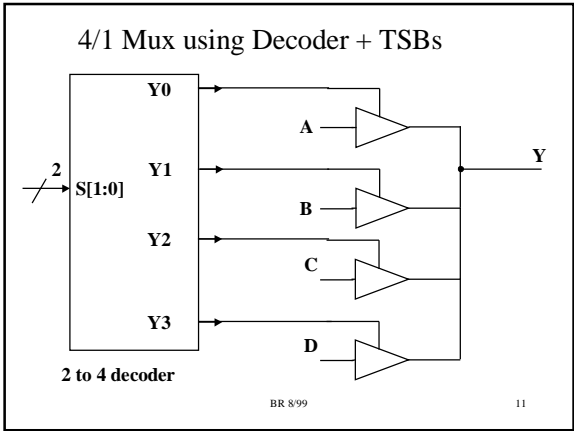
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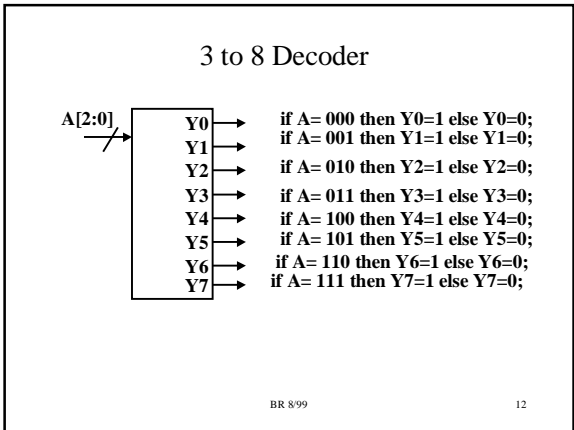
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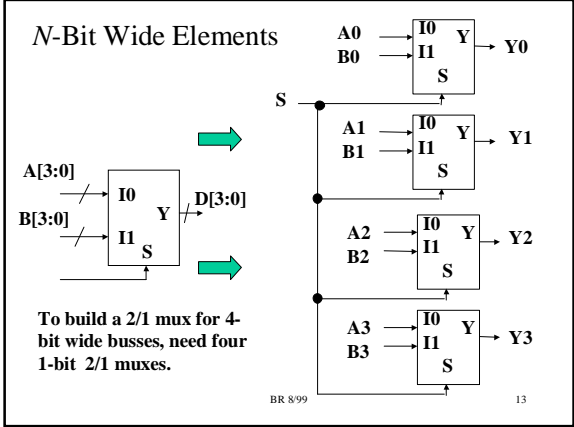
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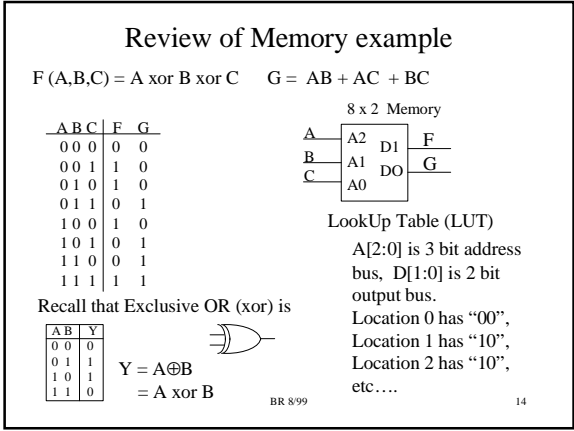
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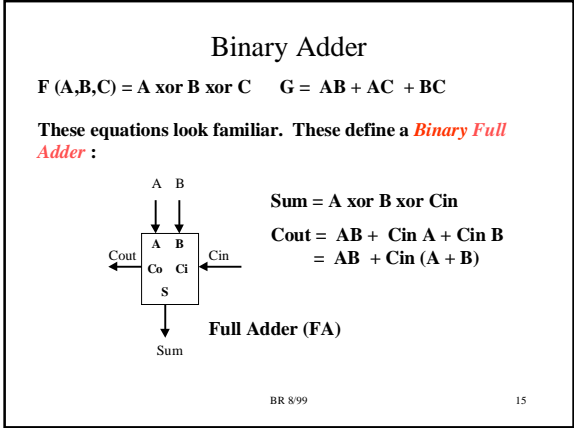
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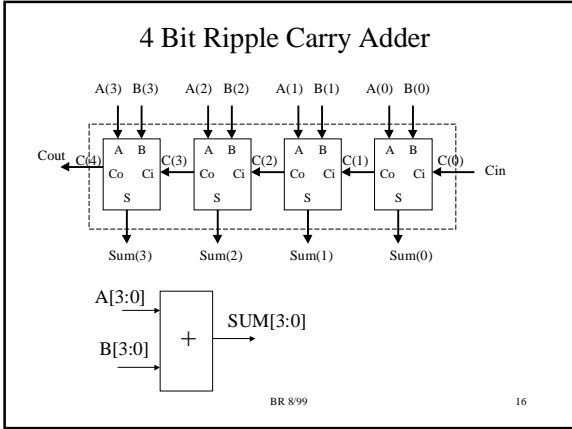
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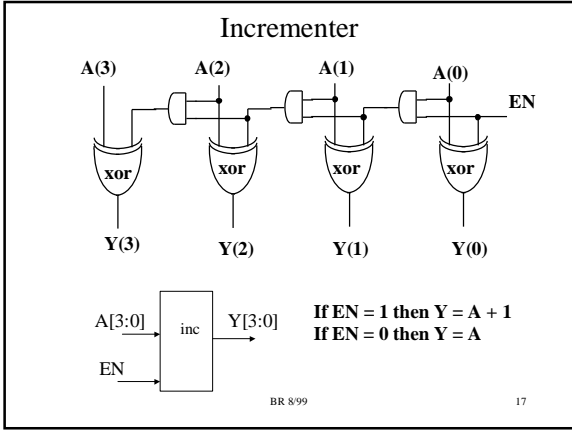
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### What do You have to know?

- Structures for Muxes, Decoders, Ripple Carry adder, Incrementer
- What a tristate buffer is
- How to build muxes from all combinational logic or from combinational logic + tristate buffers
- Bus naming convention
- How to build N-bit wide elements from 1-bit wide elements

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