Multiplexers in Verilog

By Jake D. Karas

Multiplexers in Verilog
Jake D. Karas
U0000008780
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Objective:

This lab's objective was to design multiplexers utilizing several methods of modeling with ModelSim. That is, the goals of this lab were to create a 4x1 MUX utilizing both gate-level modeling and behavioral modeling. Additionally, hierarchical design was utilized to construct an 8x1 MUX from 4x1 and 2x1 MUX.

Equipment Used:

- Verilog ModelSim

ModelSim Circuit Programs:

2x1 MUX:

```
module twoXOneMux (Y, I0, I1, S);

output Y;
input I0, I1, S;
wire T0, T1, Sbar;

not (Sbar, S);
and (T0, I0, Sbar);
and (T1, I1, S);
or (Y, T0, T1);

endmodule
```

2x1 MUX Testbench:

```
module twoXOneMux_tb();
wire Y_out;
reg I0_in, I1_in, S_in;

twoXOneMux uut(.Y(Y_out), .I0(I0_in), .I1(I1_in), .S(S_in));

initial
begin
I0_in=1'b0;
I1_in=1'b0;
S_in=1'b0;
end

always #20 I0_in=~I0_in;
always #10 I1_in=~I1_in;
always #5 S_in=~S_in;

always@(I0_in or I1_in or S_in)
begin
$monitor("At time %t, I0_in = %b, I1_in = %b, S_in = %b, Y_out = %b", $time, I0_in, I1_in, S_in, Y_out);
end
endmodule
```

4x1 MUX A:

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```
module fourXOneMuxA(Y, I0, I1, I2, I3, S0, S1);

output Y;
input I0, I1, I2, I3, S0, S1;
wire T0, T1, T2, T3, S0bar, S1bar;

not (S0bar, S0);
not (S1bar, S1);
and (T0, I0, S1bar, S0bar);
and (T1, I1, S1bar, S0);
and (T2, I2, S1, S0bar);
and (T3, I3, S1, S0);
or (Y, T0, T1, T2, T3);


endmodule

```

4x1 MUX A Testbench:

```
module fourXOneMuxA_tb();
wire Y_out;
reg I0_in, I1_in, I2_in, I3_in, S0_in, S1_in;

fourXOneMuxA uut(.Y(Y_out), .I0(I0_in), .I1(I1_in), .I2(I2_in), .I3(I3_in), .S0(S0_in), .S1(S1_in));

initial
begin
I0_in=1'b0;
I1_in=1'b0;
I2_in=1'b0;
I3_in=1'b0;
S0_in=1'b0;
S1_in=1'b0;
end

always #160 I0_in=~I0_in;
always #80 I1_in=~I1_in;
always #40 I2_in=~I2_in;
always #20 I3_in=~I3_in;
always #10 S1_in=~S1_in;
always #5 S0_in=~S0_in;

always@(I0_in or I1_in or I2_in or I3_in or S1_in or S0_in)
begin
$monitor("At time = %t, I0_in = %b, , I1_in = %b, I2_in = %b, I3_in = %b, S1_in = %b, S0_in = %b, Y_out = %b", $time, I0_in, I1_in, I2_in, I3_in, S1_in, S0_in, Y_out);
end
endmodule
```

4x1 MUX B:

```
module fourXOneMuxB(Y, I0, I1, I2, I3, S0, S1);
input I0, I1, I2, I3, S0, S1;
output Y;
reg Y;

always @ (S1 or S0)
case ({S1, S0})
        2'b00:
                Y = I0;
        2'b01:
                Y = I1;
        2'b10:
                Y = I2;
        2'b11:
                Y = I3;
endcase
endmodule
```

4x1 MUX B Testbench:

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```
module fourXOneMuxB_tb();
wire Y_out;
reg I0_in, I1_in, I2_in, I3_in, S0_in, S1_in;

fourXOneMuxB uut(.Y(Y_out), .I0(I0_in), .I1(I1_in), .I2(I2_in), .I3(I3_in), .S0(S0_in), .S1(S1_in));

initial
begin
I0_in=1'b0;
I1_in=1'b0;
I2_in=1'b0;
I3_in=1'b0;
S0_in=1'b0;
S1_in=1'b0;
end

always #160 I0_in=~I0_in;
always #80 I1_in=~I1_in;
always #40 I2_in=~I2_in;
always #20 I3_in=~I3_in;
always #10 S1_in=~S1_in;
always #5 S0_in=~S0_in;

always@(I0_in or I1_in or I2_in or I3_in or S1_in or S0_in)
begin
$monitor("At time = %t, I0_in = %b, , I1_in = %b, I2_in = %b, I3_in = %b, S1_in = %b, S0_in = %b, Y_out = %b", $time, I0_in, I1_in, I2_in, I3_in, S1_in, S0_in, Y_out);
end
endmodule
```

8x1 MUX:

```
module eightXOneMux(Y, I0, I1, I2, I3, I4, I5, I6, I7, S0, S1, S2);
input I0, I1, I2, I3, I4, I5, I6, I7, S0, S1, S2;
output Y;
wire T0, T1;

fourXOneMuxA FXOA (T0, I0, I1, I2, I3, S0, S1);
fourXOneMuxA FXOB (T1, I4, I5, I6, I7, S0, S1);
twoXOneMux TXO (Y, T0, T1, S2);

endmodule
```

8x1 MUX Testbench:

```
module eightXOneMux_tb();
reg I0_in, I1_in, I2_in, I3_in, I4_in, I5_in, I6_in, I7_in, S0_in, S1_in, S2_in;
wire Y_out;

eightXOneMux uut(.Y(Y_out), .I0(I0_in), .I1(I1_in), .I2(I2_in), .I3(I3_in), .I4(I4_in), .I5(I5_in), .I6(I6_in), .I7(I7_in), .S0(S0_in), .S1(S1_in), .S2(S2_in));

initial
begin
I0_in=1'b0;
I1_in=1'b0;
I2_in=1'b0;
I3_in=1'b0;
I4_in=1'b0;
I5_in=1'b0;
I6_in=1'b0;
I7_in=1'b0;
S0_in=1'b0;
S1_in=1'b0;
S2_in=1'b0;
end

always #5120 I0_in=~I0_in;
always #2560 I1_in=~I1_in;
always #1280 I2_in=~I2_in;
always #640 I3_in=~I3_in;
always #320 I4_in=~I4_in;
always #160 I5_in=~I5_in;
always #80 I6_in=~I6_in;
always #40 I7_in=~I7_in;
always #20 S2_in=~S2_in;
always #10 S1_in=~S1_in;
always #5 S0_in=~S0_in;

always@(I0_in or I1_in or I2_in or I3_in or I4_in or I5_in or I6_in or I7_in or S2_in or S1_in or S0_in)
begin
$monitor("At time = %t, I0_in = %b, , I1_in = %b, I2_in = %b, I3_in = %b, I4_in = %b, I5_in = %b, I6_in = %b, I7_in = %b, S2_in = %b, S1_in = %b, S0_in = %b, Y_out = %b", $time, I0_in, I1_in, I2_in, I3_in, I4_in, I5_in, I6_in, I7_in, S2_in, S1_in, S0_in, Y_out);
end
endmodule
```

Output:

2x1 MUX:

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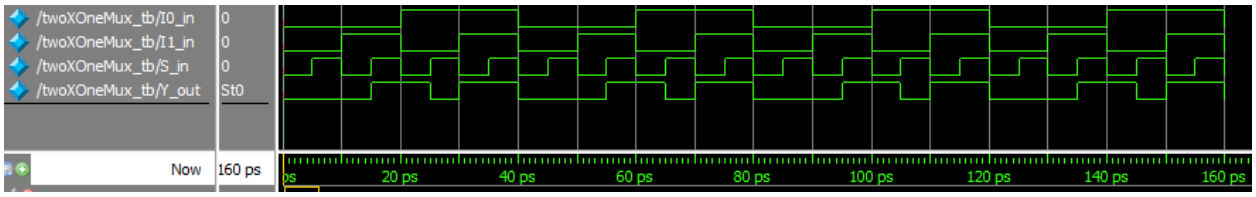
```
# At time                0, I0_in = 0, I1_in = 0, S_in = 0, Y_out = 0
# At time                5, I0_in = 0, I1_in = 0, S_in = 1, Y_out = 0
# At time               10, I0_in = 0, I1_in = 1, S_in = 0, Y_out = 0
# At time               15, I0_in = 0, I1_in = 1, S_in = 1, Y_out = 1
# At time               20, I0_in = 1, I1_in = 0, S_in = 0, Y_out = 1
# At time               25, I0_in = 1, I1_in = 0, S_in = 1, Y_out = 0
# At time               30, I0_in = 1, I1_in = 1, S_in = 0, Y_out = 1
# At time               35, I0_in = 1, I1_in = 1, S_in = 1, Y_out = 1
# At time               40, I0_in = 0, I1_in = 0, S_in = 0, Y_out = 0
# At time               45, I0_in = 0, I1_in = 0, S_in = 1, Y_out = 0
# At time               50, I0_in = 0, I1_in = 1, S_in = 0, Y_out = 0
# At time               55, I0_in = 0, I1_in = 1, S_in = 1, Y_out = 1
# At time               60, I0_in = 1, I1_in = 0, S_in = 0, Y_out = 1
# At time               65, I0_in = 1, I1_in = 0, S_in = 1, Y_out = 0
# At time               70, I0_in = 1, I1_in = 1, S_in = 0, Y_out = 1
# At time               75, I0_in = 1, I1_in = 1, S_in = 1, Y_out = 1
# At time               80, I0_in = 0, I1_in = 0, S_in = 0, Y_out = 0
# At time               85, I0_in = 0, I1_in = 0, S_in = 1, Y_out = 0
# At time               90, I0_in = 0, I1_in = 1, S_in = 0, Y_out = 0
# At time               95, I0_in = 0, I1_in = 1, S_in = 1, Y_out = 1
# At time              100, I0_in = 1, I1_in = 0, S_in = 0, Y_out = 1
# At time              105, I0_in = 1, I1_in = 0, S_in = 1, Y_out = 0
# At time              110, I0_in = 1, I1_in = 1, S_in = 0, Y_out = 1
# At time              115, I0_in = 1, I1_in = 1, S_in = 1, Y_out = 1
# At time              120, I0_in = 0, I1_in = 0, S_in = 0, Y_out = 0
# At time              125, I0_in = 0, I1_in = 0, S_in = 1, Y_out = 0
# At time              130, I0_in = 0, I1_in = 1, S_in = 0, Y_out = 0
# At time              135, I0_in = 0, I1_in = 1, S_in = 1, Y_out = 1
# At time              140, I0_in = 1, I1_in = 0, S_in = 0, Y_out = 1
# At time              145, I0_in = 1, I1_in = 0, S_in = 1, Y_out = 0
# At time              150, I0_in = 1, I1_in = 1, S_in = 0, Y_out = 1
# At time              155, I0_in = 1, I1_in = 1, S_in = 1, Y_out = 1
```



4x1 MUX A:

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```
# At time =   0, I0_in = 0, , I1_in = 0, I2_in = 0, I3_in = 0, S1_in = 0, S0_in = 0, Y_out = 0
# At time =   5, I0_in = 0, , I1_in = 0, I2_in = 0, I3_in = 0, S1_in = 0, S0_in = 1, Y_out = 0
# At time =  10, I0_in = 0, , I1_in = 0, I2_in = 0, I3_in = 0, S1_in = 1, S0_in = 0, Y_out = 0
# At time =  15, I0_in = 0, , I1_in = 0, I2_in = 0, I3_in = 0, S1_in = 1, S0_in = 1, Y_out = 0
# At time =  20, I0_in = 0, , I1_in = 0, I2_in = 0, I3_in = 1, S1_in = 0, S0_in = 0, Y_out = 0
# At time =  25, I0_in = 0, , I1_in = 0, I2_in = 0, I3_in = 1, S1_in = 0, S0_in = 1, Y_out = 0
# At time =  30, I0_in = 0, , I1_in = 0, I2_in = 0, I3_in = 1, S1_in = 1, S0_in = 0, Y_out = 0
# At time =  35, I0_in = 0, , I1_in = 0, I2_in = 0, I3_in = 1, S1_in = 1, S0_in = 1, Y_out = 1
# At time =  40, I0_in = 0, , I1_in = 0, I2_in = 1, I3_in = 0, S1_in = 0, S0_in = 0, Y_out = 0
# At time =  45, I0_in = 0, , I1_in = 0, I2_in = 1, I3_in = 0, S1_in = 0, S0_in = 1, Y_out = 0
# At time =  50, I0_in = 0, , I1_in = 0, I2_in = 1, I3_in = 0, S1_in = 1, S0_in = 0, Y_out = 1
# At time =  55, I0_in = 0, , I1_in = 0, I2_in = 1, I3_in = 0, S1_in = 1, S0_in = 1, Y_out = 0
# At time =  60, I0_in = 0, , I1_in = 0, I2_in = 1, I3_in = 1, S1_in = 0, S0_in = 0, Y_out = 0
# At time =  65, I0_in = 0, , I1_in = 0, I2_in = 1, I3_in = 1, S1_in = 0, S0_in = 1, Y_out = 0
# At time =  70, I0_in = 0, , I1_in = 0, I2_in = 1, I3_in = 1, S1_in = 1, S0_in = 0, Y_out = 1
# At time =  75, I0_in = 0, , I1_in = 0, I2_in = 1, I3_in = 1, S1_in = 1, S0_in = 1, Y_out = 1
# At time =  80, I0_in = 0, , I1_in = 1, I2_in = 0, I3_in = 0, S1_in = 0, S0_in = 0, Y_out = 0
# At time =  85, I0_in = 0, , I1_in = 1, I2_in = 0, I3_in = 0, S1_in = 0, S0_in = 1, Y_out = 1
# At time =  90, I0_in = 0, , I1_in = 1, I2_in = 0, I3_in = 0, S1_in = 1, S0_in = 0, Y_out = 0
# At time =  95, I0_in = 0, , I1_in = 1, I2_in = 0, I3_in = 0, S1_in = 1, S0_in = 1, Y_out = 0
# At time = 100, I0_in = 0, , I1_in = 1, I2_in = 0, I3_in = 1, S1_in = 0, S0_in = 0, Y_out = 0
# At time = 105, I0_in = 0, , I1_in = 1, I2_in = 0, I3_in = 1, S1_in = 0, S0_in = 1, Y_out = 1
# At time = 110, I0_in = 0, , I1_in = 1, I2_in = 0, I3_in = 1, S1_in = 1, S0_in = 0, Y_out = 0
# At time = 115, I0_in = 0, , I1_in = 1, I2_in = 0, I3_in = 1, S1_in = 1, S0_in = 1, Y_out = 1
# At time = 120, I0_in = 0, , I1_in = 1, I2_in = 1, I3_in = 0, S1_in = 0, S0_in = 0, Y_out = 0
# At time = 125, I0_in = 0, , I1_in = 1, I2_in = 1, I3_in = 0, S1_in = 0, S0_in = 1, Y_out = 1
# At time = 130, I0_in = 0, , I1_in = 1, I2_in = 1, I3_in = 0, S1_in = 1, S0_in = 0, Y_out = 1
# At time = 135, I0_in = 0, , I1_in = 1, I2_in = 1, I3_in = 0, S1_in = 1, S0_in = 1, Y_out = 0
# At time = 140, I0_in = 0, , I1_in = 1, I2_in = 1, I3_in = 1, S1_in = 0, S0_in = 0, Y_out = 0
# At time = 145, I0_in = 0, , I1_in = 1, I2_in = 1, I3_in = 1, S1_in = 0, S0_in = 1, Y_out = 1
# At time = 150, I0_in = 0, , I1_in = 1, I2_in = 1, I3_in = 1, S1_in = 1, S0_in = 0, Y_out = 1
# At time = 155, I0_in = 0, , I1_in = 1, I2_in = 1, I3_in = 1, S1_in = 1, S0_in = 1, Y_out = 1

# At time = 160, I0_in = 1, , I1_in = 0, I2_in = 0, I3_in = 0, S1_in = 0, S0_in = 0, Y_out = 1
# At time = 165, I0_in = 1, , I1_in = 0, I2_in = 0, I3_in = 0, S1_in = 0, S0_in = 1, Y_out = 0
# At time = 170, I0_in = 1, , I1_in = 0, I2_in = 0, I3_in = 0, S1_in = 1, S0_in = 0, Y_out = 0
# At time = 175, I0_in = 1, , I1_in = 0, I2_in = 0, I3_in = 0, S1_in = 1, S0_in = 1, Y_out = 0
# At time = 180, I0_in = 1, , I1_in = 0, I2_in = 0, I3_in = 1, S1_in = 0, S0_in = 0, Y_out = 1
# At time = 185, I0_in = 1, , I1_in = 0, I2_in = 0, I3_in = 1, S1_in = 0, S0_in = 1, Y_out = 0
# At time = 190, I0_in = 1, , I1_in = 0, I2_in = 0, I3_in = 1, S1_in = 1, S0_in = 0, Y_out = 0
# At time = 195, I0_in = 1, , I1_in = 0, I2_in = 0, I3_in = 1, S1_in = 1, S0_in = 1, Y_out = 1
# At time = 200, I0_in = 1, , I1_in = 0, I2_in = 1, I3_in = 0, S1_in = 0, S0_in = 0, Y_out = 1
# At time = 205, I0_in = 1, , I1_in = 0, I2_in = 1, I3_in = 0, S1_in = 0, S0_in = 1, Y_out = 0
# At time = 210, I0_in = 1, , I1_in = 0, I2_in = 1, I3_in = 0, S1_in = 1, S0_in = 0, Y_out = 1
# At time = 215, I0_in = 1, , I1_in = 0, I2_in = 1, I3_in = 0, S1_in = 1, S0_in = 1, Y_out = 0
# At time = 220, I0_in = 1, , I1_in = 0, I2_in = 1, I3_in = 1, S1_in = 0, S0_in = 0, Y_out = 1
# At time = 225, I0_in = 1, , I1_in = 0, I2_in = 1, I3_in = 1, S1_in = 0, S0_in = 1, Y_out = 0
# At time = 230, I0_in = 1, , I1_in = 0, I2_in = 1, I3_in = 1, S1_in = 1, S0_in = 0, Y_out = 1
# At time = 235, I0_in = 1, , I1_in = 0, I2_in = 1, I3_in = 1, S1_in = 1, S0_in = 1, Y_out = 1
# At time = 240, I0_in = 1, , I1_in = 1, I2_in = 0, I3_in = 0, S1_in = 0, S0_in = 0, Y_out = 1
# At time = 245, I0_in = 1, , I1_in = 1, I2_in = 0, I3_in = 0, S1_in = 0, S0_in = 1, Y_out = 1
# At time = 250, I0_in = 1, , I1_in = 1, I2_in = 0, I3_in = 0, S1_in = 1, S0_in = 0, Y_out = 0
# At time = 255, I0_in = 1, , I1_in = 1, I2_in = 0, I3_in = 0, S1_in = 1, S0_in = 1, Y_out = 0
# At time = 260, I0_in = 1, , I1_in = 1, I2_in = 0, I3_in = 1, S1_in = 0, S0_in = 0, Y_out = 1
# At time = 265, I0_in = 1, , I1_in = 1, I2_in = 0, I3_in = 1, S1_in = 0, S0_in = 1, Y_out = 1
# At time = 270, I0_in = 1, , I1_in = 1, I2_in = 0, I3_in = 1, S1_in = 1, S0_in = 0, Y_out = 0
# At time = 275, I0_in = 1, , I1_in = 1, I2_in = 0, I3_in = 1, S1_in = 1, S0_in = 1, Y_out = 1
# At time = 280, I0_in = 1, , I1_in = 1, I2_in = 1, I3_in = 0, S1_in = 0, S0_in = 0, Y_out = 1
# At time = 285, I0_in = 1, , I1_in = 1, I2_in = 1, I3_in = 0, S1_in = 0, S0_in = 1, Y_out = 1
# At time = 290, I0_in = 1, , I1_in = 1, I2_in = 1, I3_in = 0, S1_in = 1, S0_in = 0, Y_out = 1
# At time = 295, I0_in = 1, , I1_in = 1, I2_in = 1, I3_in = 0, S1_in = 1, S0_in = 1, Y_out = 0
# At time = 300, I0_in = 1, , I1_in = 1, I2_in = 1, I3_in = 1, S1_in = 0, S0_in = 0, Y_out = 1
# At time = 305, I0_in = 1, , I1_in = 1, I2_in = 1, I3_in = 1, S1_in = 0, S0_in = 1, Y_out = 1
# At time = 310, I0_in = 1, , I1_in = 1, I2_in = 1, I3_in = 1, S1_in = 1, S0_in = 0, Y_out = 1
# At time = 315, I0_in = 1, , I1_in = 1, I2_in = 1, I3_in = 1, S1_in = 1, S0_in = 1, Y_out = 1
```

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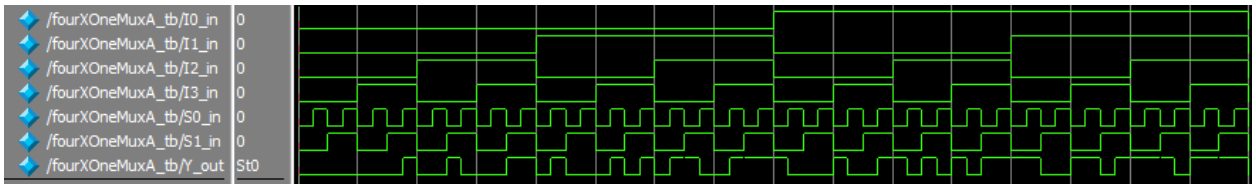

4x1 MUX B:

```
# At time =                0, I0_in = 0, , I1_in = 0, I2_in = 0, I3_in = 0, S1_in = 0, S0_in = 0, Y_out = 0
# At time =                5, I0_in = 0, , I1_in = 0, I2_in = 0, I3_in = 0, S1_in = 0, S0_in = 1, Y_out = 0
# At time =               10, I0_in = 0, , I1_in = 0, I2_in = 0, I3_in = 0, S1_in = 1, S0_in = 0, Y_out = 0
# At time =               15, I0_in = 0, , I1_in = 0, I2_in = 0, I3_in = 0, S1_in = 1, S0_in = 1, Y_out = 0
# At time =               20, I0_in = 0, , I1_in = 0, I2_in = 0, I3_in = 1, S1_in = 0, S0_in = 0, Y_out = 0
# At time =               25, I0_in = 0, , I1_in = 0, I2_in = 0, I3_in = 1, S1_in = 0, S0_in = 1, Y_out = 0
# At time =               30, I0_in = 0, , I1_in = 0, I2_in = 0, I3_in = 1, S1_in = 1, S0_in = 0, Y_out = 0
# At time =               35, I0_in = 0, , I1_in = 0, I2_in = 0, I3_in = 1, S1_in = 1, S0_in = 1, Y_out = 1
# At time =               40, I0_in = 0, , I1_in = 0, I2_in = 1, I3_in = 0, S1_in = 0, S0_in = 0, Y_out = 0
# At time =               45, I0_in = 0, , I1_in = 0, I2_in = 1, I3_in = 0, S1_in = 0, S0_in = 1, Y_out = 0
# At time =               50, I0_in = 0, , I1_in = 0, I2_in = 1, I3_in = 0, S1_in = 1, S0_in = 0, Y_out = 1
# At time =               55, I0_in = 0, , I1_in = 0, I2_in = 1, I3_in = 0, S1_in = 1, S0_in = 1, Y_out = 0
# At time =               60, I0_in = 0, , I1_in = 0, I2_in = 1, I3_in = 1, S1_in = 0, S0_in = 0, Y_out = 0
# At time =               65, I0_in = 0, , I1_in = 0, I2_in = 1, I3_in = 1, S1_in = 0, S0_in = 1, Y_out = 0
# At time =               70, I0_in = 0, , I1_in = 0, I2_in = 1, I3_in = 1, S1_in = 1, S0_in = 0, Y_out = 1
# At time =               75, I0_in = 0, , I1_in = 0, I2_in = 1, I3_in = 1, S1_in = 1, S0_in = 1, Y_out = 1
# At time =               80, I0_in = 0, , I1_in = 1, I2_in = 0, I3_in = 0, S1_in = 0, S0_in = 0, Y_out = 0
# At time =               85, I0_in = 0, , I1_in = 1, I2_in = 0, I3_in = 0, S1_in = 0, S0_in = 1, Y_out = 1
# At time =               90, I0_in = 0, , I1_in = 1, I2_in = 0, I3_in = 0, S1_in = 1, S0_in = 0, Y_out = 0
# At time =               95, I0_in = 0, , I1_in = 1, I2_in = 0, I3_in = 0, S1_in = 1, S0_in = 1, Y_out = 0
# At time =              100, I0_in = 0, , I1_in = 1, I2_in = 0, I3_in = 1, S1_in = 0, S0_in = 0, Y_out = 0
# At time =              105, I0_in = 0, , I1_in = 1, I2_in = 0, I3_in = 1, S1_in = 0, S0_in = 1, Y_out = 1
# At time =              110, I0_in = 0, , I1_in = 1, I2_in = 0, I3_in = 1, S1_in = 1, S0_in = 0, Y_out = 0
# At time =              115, I0_in = 0, , I1_in = 1, I2_in = 0, I3_in = 1, S1_in = 1, S0_in = 1, Y_out = 1
# At time =              120, I0_in = 0, , I1_in = 1, I2_in = 1, I3_in = 0, S1_in = 0, S0_in = 0, Y_out = 0
# At time =              125, I0_in = 0, , I1_in = 1, I2_in = 1, I3_in = 0, S1_in = 0, S0_in = 1, Y_out = 1
# At time =              130, I0_in = 0, , I1_in = 1, I2_in = 1, I3_in = 0, S1_in = 1, S0_in = 0, Y_out = 1
# At time =              135, I0_in = 0, , I1_in = 1, I2_in = 1, I3_in = 0, S1_in = 1, S0_in = 1, Y_out = 0
# At time =              140, I0_in = 0, , I1_in = 1, I2_in = 1, I3_in = 1, S1_in = 0, S0_in = 0, Y_out = 0
# At time =              145, I0_in = 0, , I1_in = 1, I2_in = 1, I3_in = 1, S1_in = 0, S0_in = 1, Y_out = 1
# At time =              150, I0_in = 0, , I1_in = 1, I2_in = 1, I3_in = 1, S1_in = 1, S0_in = 0, Y_out = 1
# At time =              155, I0_in = 0, , I1_in = 1, I2_in = 1, I3_in = 1, S1_in = 1, S0_in = 1, Y_out = 1
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# At time =          160, I0_in = 1, , I1_in = 0, I2_in = 0, I3_in = 0, S1_in = 0, S0_in = 0, Y_out = 1
# At time =          165, I0_in = 1, , I1_in = 0, I2_in = 0, I3_in = 0, S1_in = 0, S0_in = 1, Y_out = 0
# At time =          170, I0_in = 1, , I1_in = 0, I2_in = 0, I3_in = 0, S1_in = 1, S0_in = 0, Y_out = 0
# At time =          175, I0_in = 1, , I1_in = 0, I2_in = 0, I3_in = 0, S1_in = 1, S0_in = 1, Y_out = 0
# At time =          180, I0_in = 1, , I1_in = 0, I2_in = 0, I3_in = 1, S1_in = 0, S0_in = 0, Y_out = 1
# At time =          185, I0_in = 1, , I1_in = 0, I2_in = 0, I3_in = 1, S1_in = 0, S0_in = 1, Y_out = 0
# At time =          190, I0_in = 1, , I1_in = 0, I2_in = 0, I3_in = 1, S1_in = 1, S0_in = 0, Y_out = 0
# At time =          195, I0_in = 1, , I1_in = 0, I2_in = 0, I3_in = 1, S1_in = 1, S0_in = 1, Y_out = 1
# At time =          200, I0_in = 1, , I1_in = 0, I2_in = 1, I3_in = 0, S1_in = 0, S0_in = 0, Y_out = 1
# At time =          205, I0_in = 1, , I1_in = 0, I2_in = 1, I3_in = 0, S1_in = 0, S0_in = 1, Y_out = 0
# At time =          210, I0_in = 1, , I1_in = 0, I2_in = 1, I3_in = 0, S1_in = 1, S0_in = 0, Y_out = 1
# At time =          215, I0_in = 1, , I1_in = 0, I2_in = 1, I3_in = 0, S1_in = 1, S0_in = 1, Y_out = 0
# At time =          220, I0_in = 1, , I1_in = 0, I2_in = 1, I3_in = 1, S1_in = 0, S0_in = 0, Y_out = 1
# At time =          225, I0_in = 1, , I1_in = 0, I2_in = 1, I3_in = 1, S1_in = 0, S0_in = 1, Y_out = 0
# At time =          230, I0_in = 1, , I1_in = 0, I2_in = 1, I3_in = 1, S1_in = 1, S0_in = 0, Y_out = 1
# At time =          235, I0_in = 1, , I1_in = 0, I2_in = 1, I3_in = 1, S1_in = 1, S0_in = 1, Y_out = 1
# At time =          240, I0_in = 1, , I1_in = 1, I2_in = 0, I3_in = 0, S1_in = 0, S0_in = 0, Y_out = 1
# At time =          245, I0_in = 1, , I1_in = 1, I2_in = 0, I3_in = 0, S1_in = 0, S0_in = 1, Y_out = 1
# At time =          250, I0_in = 1, , I1_in = 1, I2_in = 0, I3_in = 0, S1_in = 1, S0_in = 0, Y_out = 0
# At time =          255, I0_in = 1, , I1_in = 1, I2_in = 0, I3_in = 0, S1_in = 1, S0_in = 1, Y_out = 0
# At time =          260, I0_in = 1, , I1_in = 1, I2_in = 0, I3_in = 1, S1_in = 0, S0_in = 0, Y_out = 1
# At time =          265, I0_in = 1, , I1_in = 1, I2_in = 0, I3_in = 1, S1_in = 0, S0_in = 1, Y_out = 1
# At time =          270, I0_in = 1, , I1_in = 1, I2_in = 0, I3_in = 1, S1_in = 1, S0_in = 0, Y_out = 0
# At time =          275, I0_in = 1, , I1_in = 1, I2_in = 0, I3_in = 1, S1_in = 1, S0_in = 1, Y_out = 1
# At time =          280, I0_in = 1, , I1_in = 1, I2_in = 1, I3_in = 0, S1_in = 0, S0_in = 0, Y_out = 1
# At time =          285, I0_in = 1, , I1_in = 1, I2_in = 1, I3_in = 0, S1_in = 0, S0_in = 1, Y_out = 1
# At time =          290, I0_in = 1, , I1_in = 1, I2_in = 1, I3_in = 0, S1_in = 1, S0_in = 0, Y_out = 1
# At time =          295, I0_in = 1, , I1_in = 1, I2_in = 1, I3_in = 0, S1_in = 1, S0_in = 1, Y_out = 0
# At time =          300, I0_in = 1, , I1_in = 1, I2_in = 1, I3_in = 1, S1_in = 0, S0_in = 0, Y_out = 1
# At time =          305, I0_in = 1, , I1_in = 1, I2_in = 1, I3_in = 1, S1_in = 0, S0_in = 1, Y_out = 1
# At time =          310, I0_in = 1, , I1_in = 1, I2_in = 1, I3_in = 1, S1_in = 1, S0_in = 0, Y_out = 1
# At time =          315, I0_in = 1, , I1_in = 1, I2_in = 1, I3_in = 1, S1_in = 1, S0_in = 1, Y_out = 1
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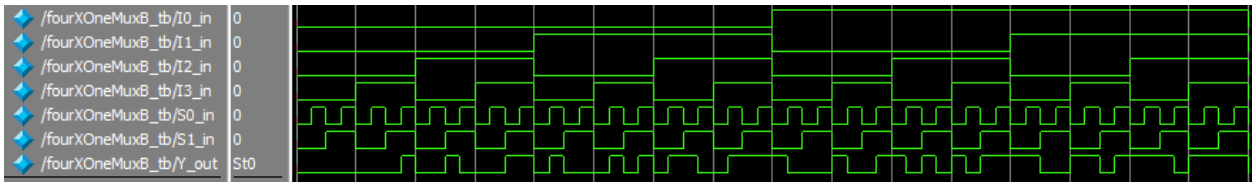
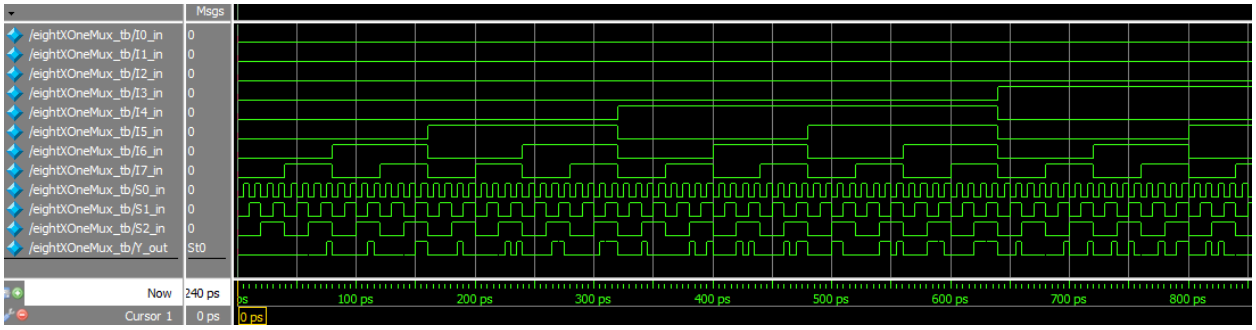
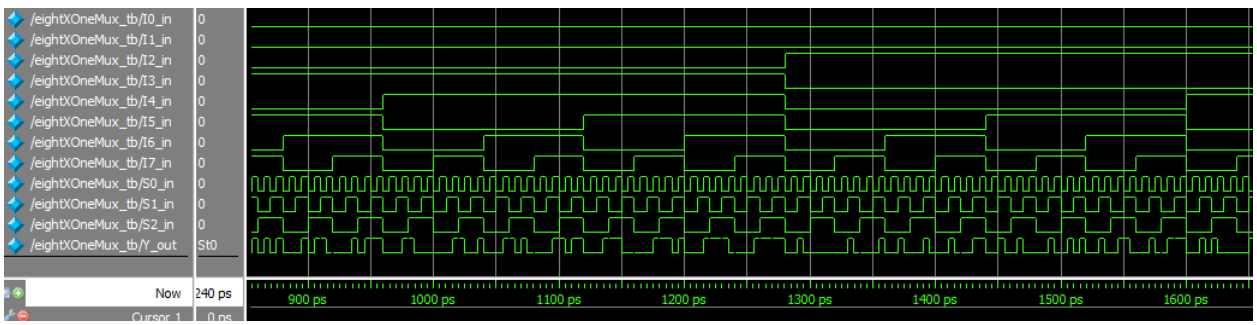


8x1 MUX:





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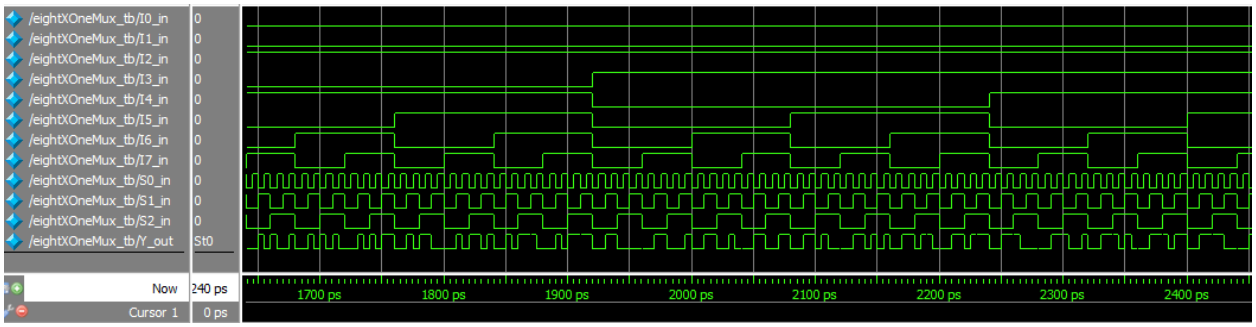

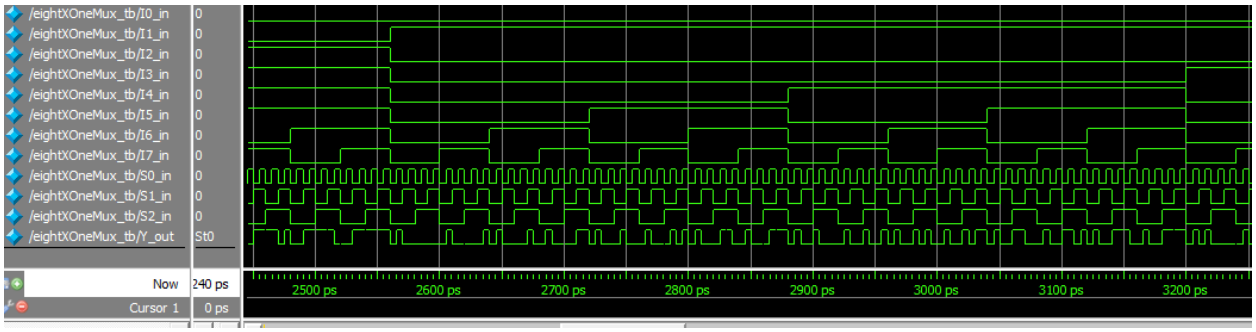

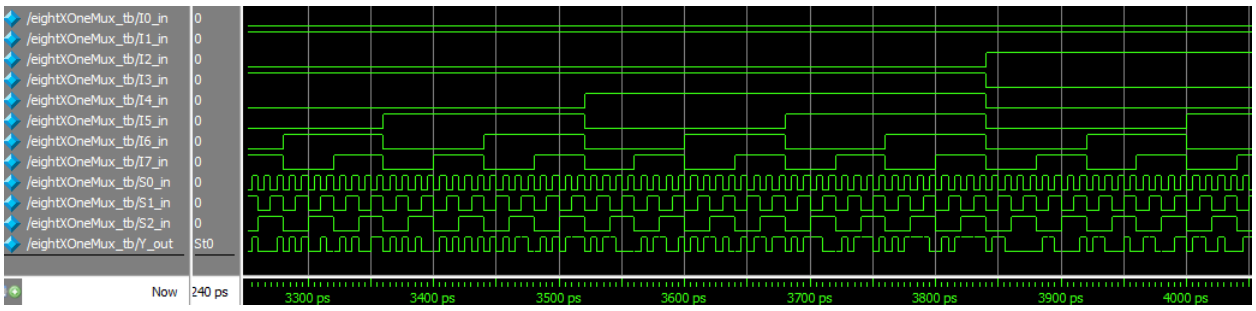

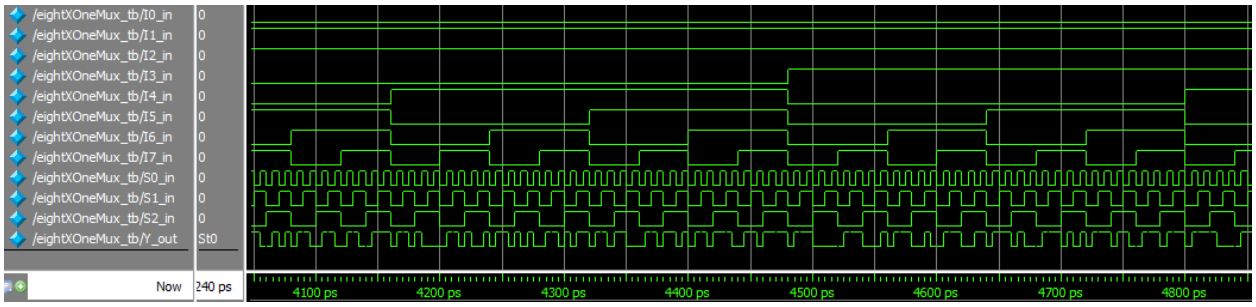

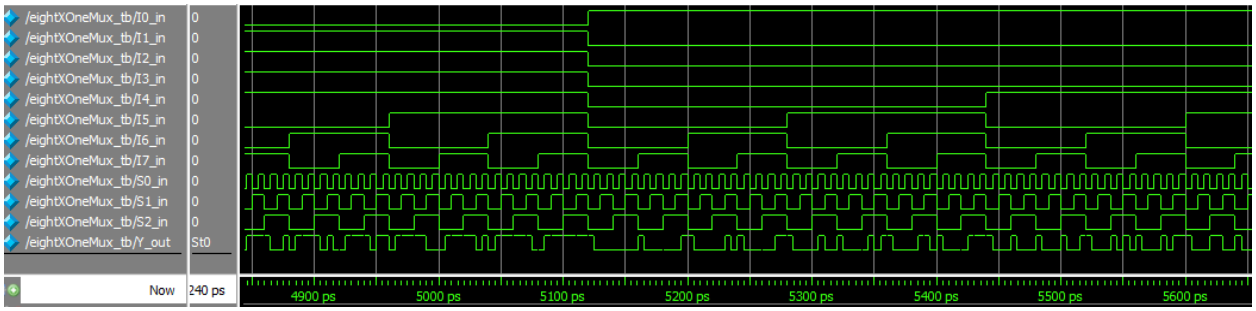

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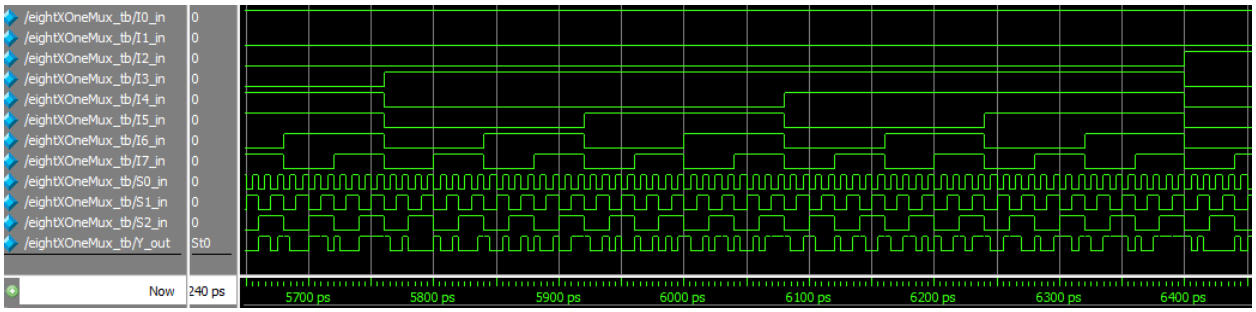

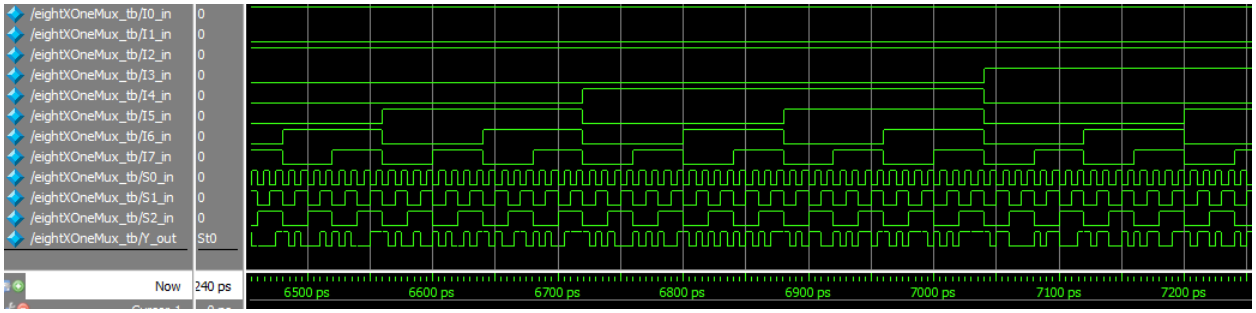

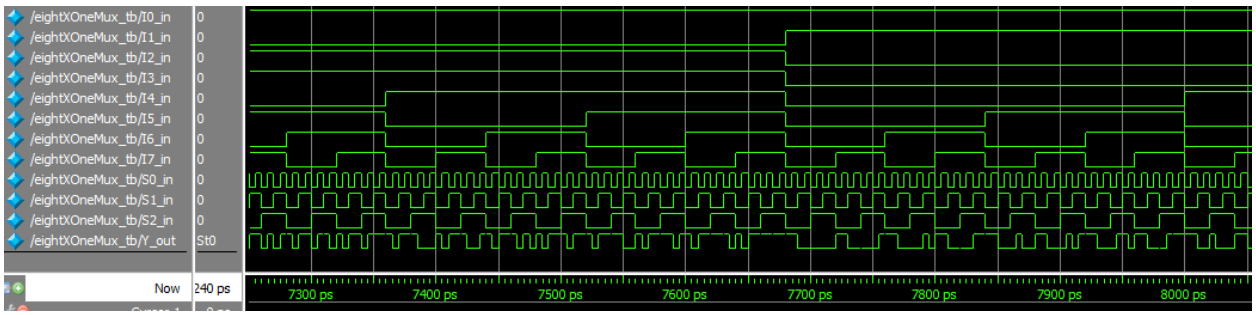

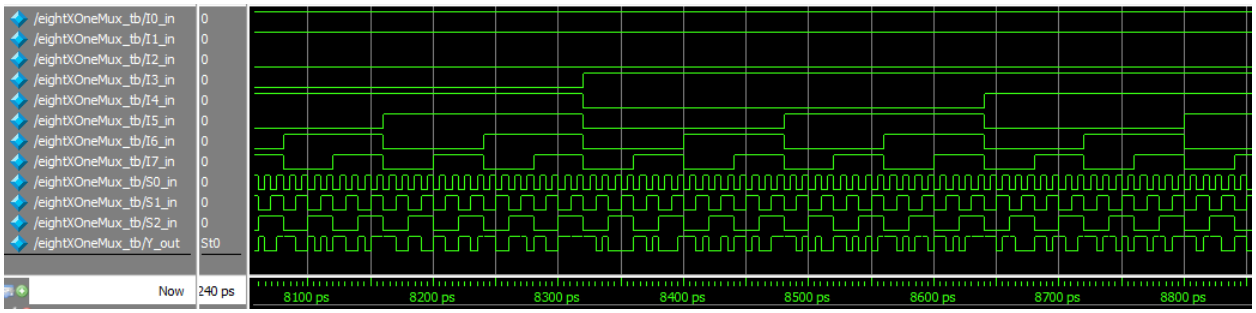

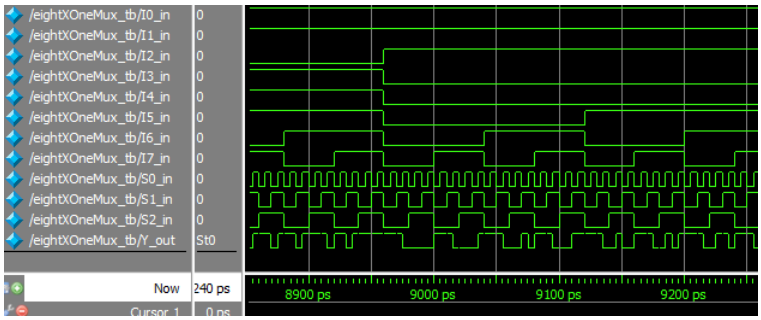

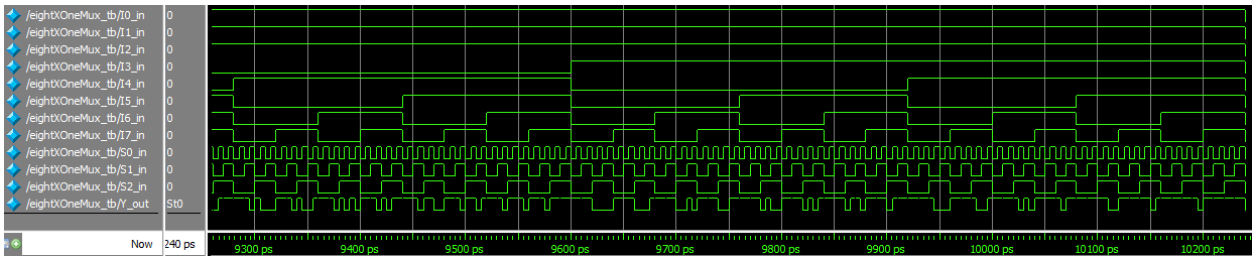

Conclusion:

A multiplexer only outputs true when the input number is equivalent to the binary number denoted by its select lines. For instance, when there are two select lines, both of which are set to logic 1's (making a binary 3), input I3 controls the output. As demonstrated in this lab, multiplexers can be chained together to function together as a single multiplexer with more inputs and select lines.