

7.20 Muxes

Basics

A **multiplexor** is a combinational circuit that passes one of multiple data inputs through to a single output, selecting which additional control inputs. **Mux** is short for multiplexor. A mux's control inputs are called **select lines**.

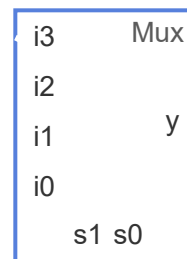
Analogy: Due to road construction, four lanes (the data inputs) may be reduced to a single lane (the single output). A police inputs) selects which one lane currently passes through by blocking the other lanes.

A **4x1 mux**, spoken as "4 to 1 mux", has 4 data inputs, 1 data output, and requires 2 select inputs.

PARTICIPATION ACTIVITY

7.20.1: A 4x1 mux.

Start ☐ 2x speed



1 1

s1	s0	y
0	0	i0
0	1	i1
1	0	i2
1	1	i3

**PARTICIPATION
ACTIVITY**

7.20.2: Muxes.

Given a 4x1 mux. Assume $i_3 i_2 i_1 i_0$ are 0 1 1 0.

1) If $s_1 s_0 = 00$, then $y = \underline{\hspace{1cm}}$.

- ☐ 1
☐ 0

2) If $s_1 s_0 = 10$, then $y = \underline{\hspace{1cm}}$.

- ☐ 1
☐ 0

3) $s_1 s_0 = \underline{\hspace{1cm}}$ allows i_3 to pass through to y .

- ☐ 10
☐ 11

4) Suppose $s_1 s_0 = 11$, and i_3 is 0, so $y = 0$.
Then, suppose i_3 changes from 0 to 1.
What will y become?

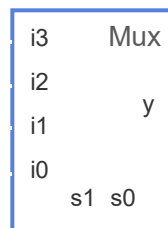
- ☐ 1
☐ 0

Mux equation and circuit

A mux's truth table can be converted to an equation, and then to a circuit.

**PARTICIPATION
ACTIVITY**

7.20.3: A 4x1 mux's behavior can be captured as an equation.

Start ☐ 2x speed

s1	s0	y
0	0	i0
0	1	i1
1	0	i2
1	1	i3

$$y = s1's0'i0 + s1's0'i1 + s1s0'i2 + s1s0'i3$$

Let $s1s0 = 11$

$$y = (1)'(1)'i0 + (1)'(1)i1 + (1)(1)'i2 + (1)(1)i3$$

$$y = (0)(0)i0 + (0)(1)i1 + (1)(0)i2 + (1)(1)i3$$

$$y = 0 + 0 + 0 + i3$$

$$y = i3$$

PARTICIPATION ACTIVITY

7.20.4: The equation for a 4x1 mux is easily converted to a circuit.

Start ☐ 2x speed

$$y = s1's0'i0 + s1's0'i1 + s1s0'i2 + s1s0'i3$$

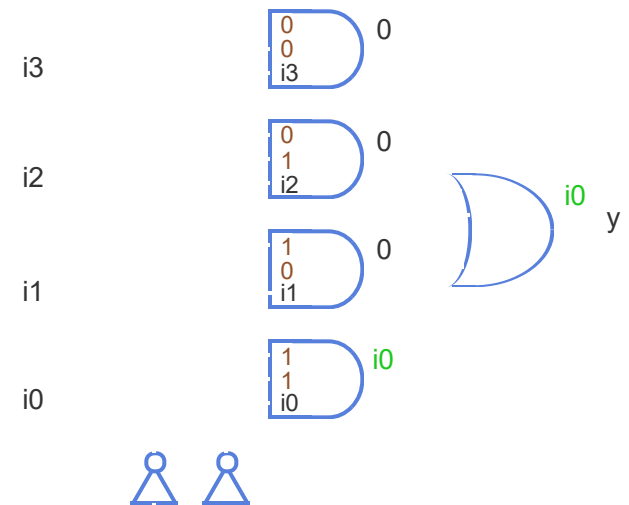
Let $s1s0 = 00$

$$y = (0)'(0)'i0 + (0)'(0)i1 + (0)(0)'i2 + (0)(0)i3$$

$$y = (1)(1)i0 + (1)(0)i1 + (0)(1)i2 + (0)(0)i3$$

$$y = i0 + 0 + 0 + 0$$

$$y = i0$$



s_1
0 s_0
0**PARTICIPATION
ACTIVITY**

7.20.5: Mux design.

- 1) How many select lines does a 4x1 mux require?

Check**Show answer**

- 2) If $s_1s_0 = 01$, then $y = \underline{\hspace{1cm}}$.
Type: i0, i1, i2, or i3

Check**Show answer**

- 3) $y = \underline{\hspace{1cm}} + s_1's_0i_1 + s_1s_0'i_2 + s_1s_0i_3$

Check**Show answer****Example: Jet cockpit engine status display**

A jet cockpit has limited space for switches and lights. A particular jet has four "Engine OK" inputs coming from sensors at engines. The cockpit has a single "Engine temperature OK" light, and two switches for pilots to select among the four Engin

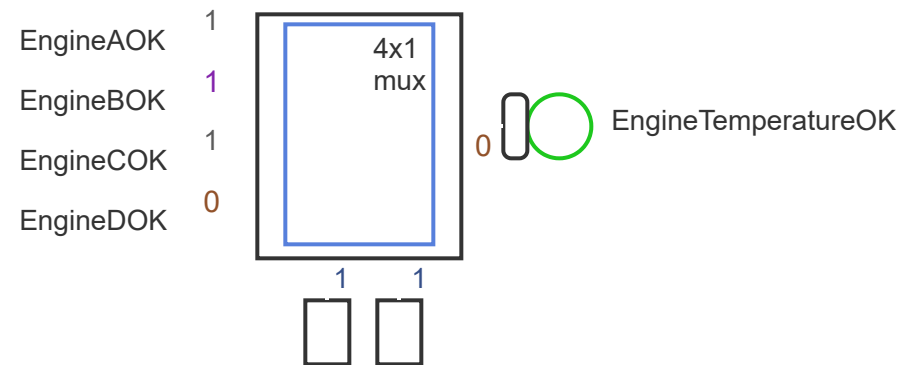
circuit should pass the selected sensor input to the light.

A 4x1 mux readily achieves the desired behavior.

**PARTICIPATION
ACTIVITY**

7.20.6: Mux example: Jet cockpit status light display.

Start ☐ 2x speed



**PARTICIPATION
ACTIVITY**

7.20.7: Engine status display.

Consider the example above.

1) If the pilots set the switches to 00, will the light illuminate?

- ☐ Yes
☐ No

2) If the pilots set the switches to 11, will

the light illuminate?

- ☐ Yes
- ☐ No

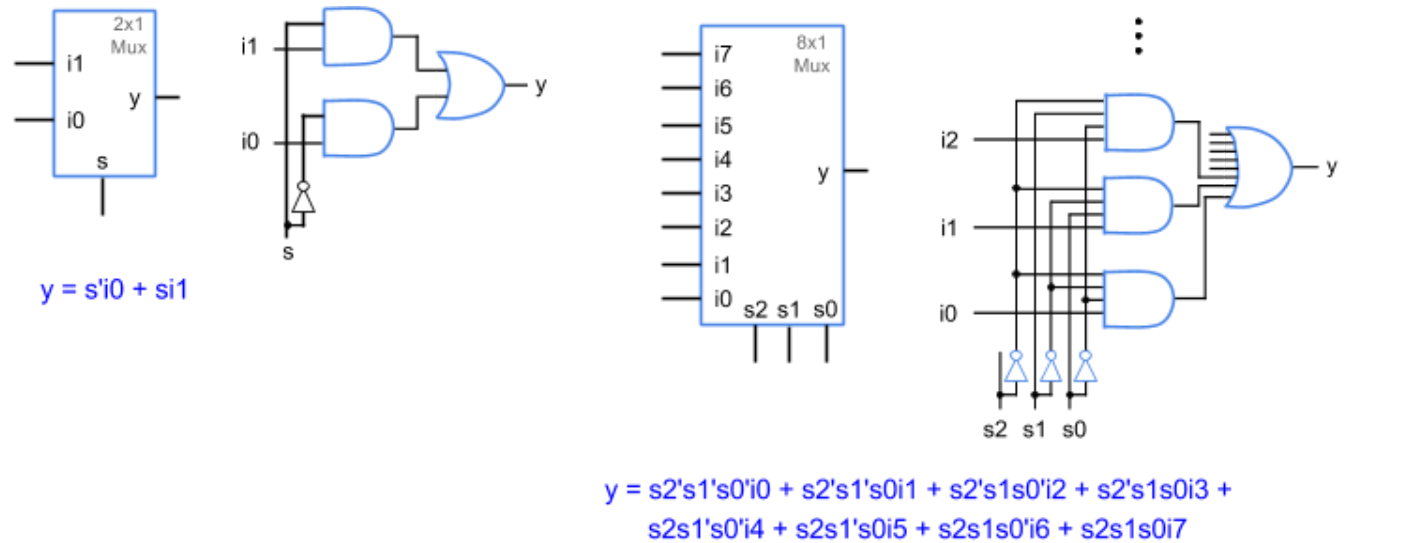
- 3) Suppose the switches are set to 11, and Engine D's status input is 0, so the light is not illuminated. Now suppose the pilots fix the problem with Engine D, such that D's status changes from 0 to 1. Will the light illuminate?

- ☐ Yes
- ☐ No

Mux sizes

Mux sizes may be 2x1, 4x1, 8x1, 16x1, etc. For N data inputs, a mux requires $\log_2 N$ select inputs.

Figure 7.20.1: 2x1 and 8x1 muxes.



PARTICIPATION ACTIVITY

7.20.8: Muxes.

- 1) How many select lines does a 2x1 mux require?

Check

Show answer

- 2) How many select lines does an 8x1 mux require?

Check

Show answer

- 3) How many select lines does a 16x1 mux require?

Check**Show answer**

4) How many AND gates does a 2x1 mux require?

Check**Show answer**

5) How many AND gates does an 8x1 mux require?

Check**Show answer**

 **Provide feedback on this section**