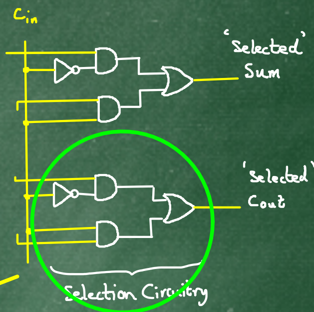
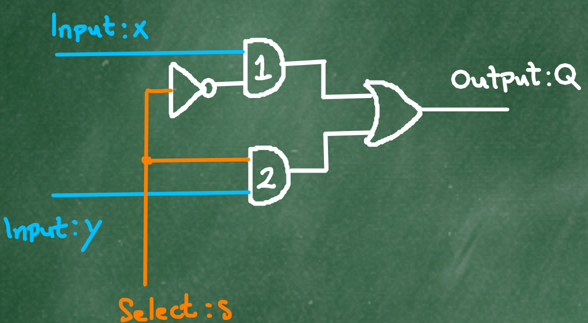
Multiplexing

Let's consider the Selection Circuitry of our Implementation of the full-adder In more detail with view to understanding it better and to generalizing it.

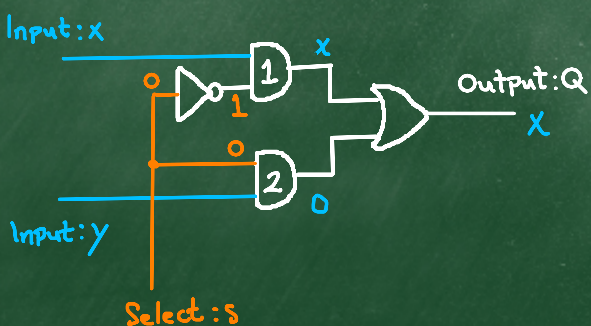


Consider a part of that Circuit In detail



Let's Look at how this Circuit behaves for each value of S:

For S = 0

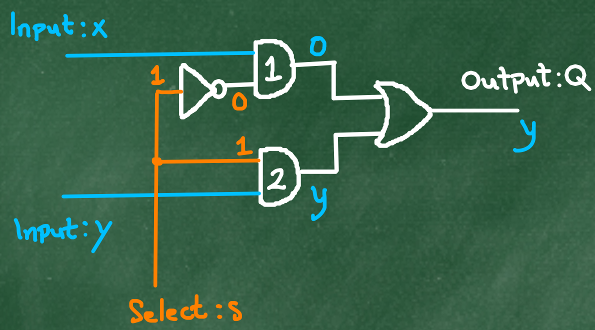


AND Gate 1 is 'turned-on': Input x is passed to output.

AND Gate 2 is 'turned-off': 0 Is passed to output.

$$Q = X + 0 = X$$

For $S=1$



AND Gate 1 is 'turned-off':
0 is passed to output.

AND Gate 2 is 'turned-on':
Input y is passed to output.

$$Q = y + 0 = y$$

So, by construction, the value of S will select either x or y.

If we wish to select y when $S=0$, we can just wire the inputs differently.

This circuit is called a 2-1 Line Multiplexer.

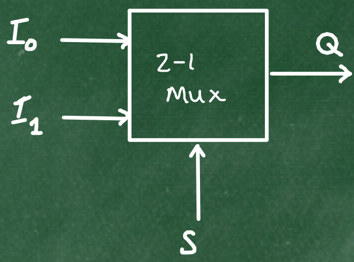
(also written as 2-1 Line Mux, or just 2-1 Mux)

We see that we have two of these in our F.A. Implementation:

One for each of the circuit outputs

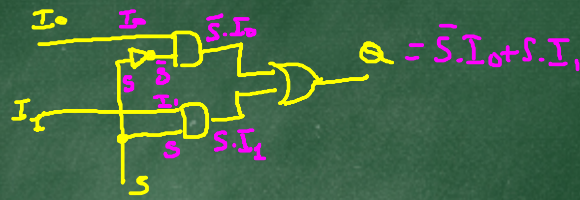
This is a very important circuit – it allow us to choose between different pathways in our circuit by using a control value – usually called a Select Input.

Abstracted away into a 'Black-Box'



$$Q = \bar{S}.I_0 + S I_1$$

A	B	A.B
0	0	0
0	1	0
1	0	0
1	1	1



for $S = 0$ (i.e., $\bar{S} = 1$):

$$S.I_1 = 0.I_1 = 0$$

$$\bar{S} I_0 = 1.I_0 = I_0$$

$$\text{So } Q = I_0 + 0 = I_0$$

for $S = 1$ (i.e., $\bar{S} = 0$):

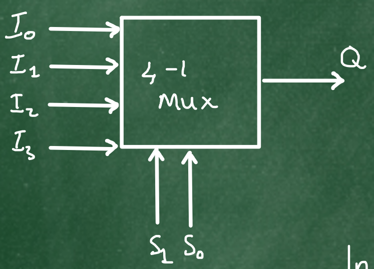
$$S.I_1 = 1.I_1 = I_1$$

$$\bar{S} I_0 = 0.I_0 = 0$$

$$\text{So } Q = 0 + I_1 = I_1$$

How would we choose between 4 inputs?

→ Use a 4-1 Mux



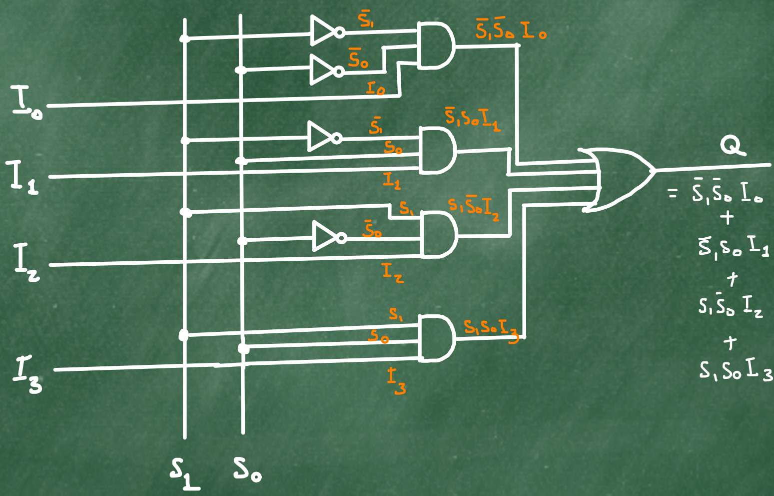
If $S_1 S_0 = 00$; $Q = I_0$

$S_1 S_0 = 01$; $Q = I_1$

$S_1 S_0 = 10$; $Q = I_2$

$S_1 S_0 = 11$; $Q = I_3$

In general : $Q = \bar{S}_1\bar{S}_0 I_0 + \bar{S}_1 S_0 I_1 + S_1\bar{S}_0 I_2 + S_1 S_0 I_3$

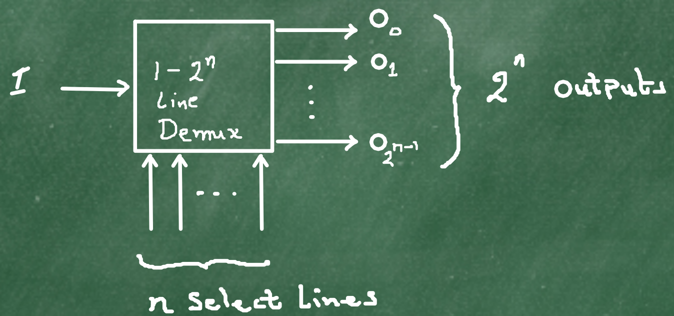


In general, we can have $2^n - 1$ Multiplexing, where 2^n Is the number of Inputs, n Is the number of Select Lines and there Is 1 output.

Demultiplexing

Demultiplexing Is the Inverse process of multiplexing

A $1 - 2^n$ line Demultiplexer has 1 Input, n select lines and 2^n outputs.



Challenge: Draw the Circuit Diagram for a 1-4 DeMux.