

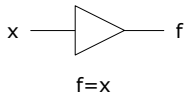
ECE380 Digital Logic

Implementation Technology:
Buffers, Tri-state gates,
Transmission gates

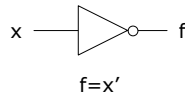
Buffers

- In circuits where a logic gate has to drive a large capacitive load, **buffers** are often used to improved performance
- Buffers can be created with different amounts of drive capability (depending on the size of the transistors used to construct them)
 - Larger transistors => more current handling capability
 - A common use of a buffer is to control a light-emitting diode (LED)
- Buffers have greater **fan-out** than other (regular) logic gates

Buffers



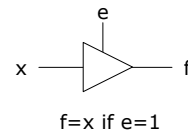
A non-inverting buffer



An inverting buffer

Tri-state Buffers (Gates)

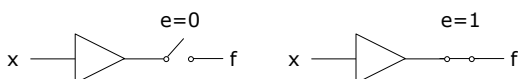
- A tri-state buffer (gate) has
 - One input (x)
 - One output (f)
 - One control input (e)



A tri-state buffer

Tri-state Buffers (Gates)

- When $e=1$, the buffer drives the value of x onto f , causing $f=x$
- When $e=0$, the buffer is completely disconnected from the output f



Equivalent circuit

Tri-state Buffers (Gates)

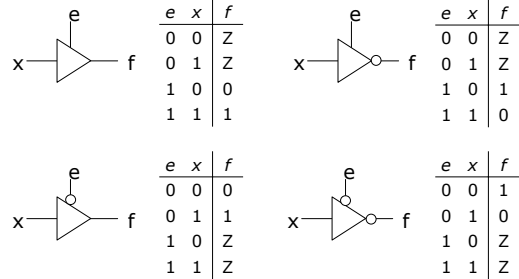
- In truth table form,
- For the rows where $e=0$, the output is denoted by the logic value Z
- This Z is called the high-impedance state
- The name tri-state derives from the fact that there are two normal states for a logic signal (0 and 1) and Z represents a third state that has no output

e	x	f
0	0	Z
0	1	Z
1	0	0
1	1	1

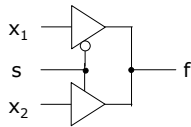
Four type of tri-state buffers

- There are four possible configurations of tri-state buffers
 - based on two types of outputs
 - Inverting and non-inverting outputs
 - and two types of control signals (e)
 - Active high and active low enables
- Active low enables implies the output is active ($f=x$) when the enable is low ($e=0$)

Four type of tri-state buffers



Tri-state buffer application

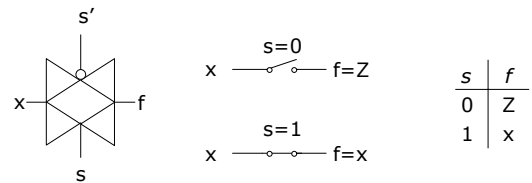


s	x1	x2	f
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

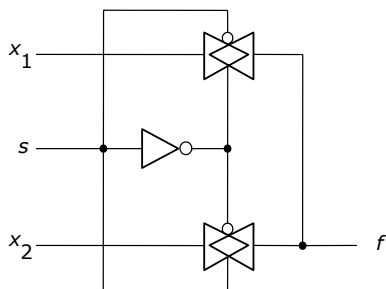
- Note the outputs of the tri-state gates are wired together
 - This is possible only because we know that (in this configuration) one or the other of the tri-state gates will be in the high impedance (Z) state
 - This type of wired connection is not possible with ordinary logic gates

Transmission gate

- A **transmission gate** acts as a switch, connecting an input (x) to an output (f)
 - Commonly used to implement XOR gate and multiplexer circuits



Multiplexer with transmission gates



XOR with transmission gates

