

Electronics

Logic Gates: Tri-State Output

Terry Sturtevant

Wilfrid Laurier University

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Types of logic gate outputs

- Totem pole

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Output is HIGH or LOW.

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 - Output is **HIGH** or **LOW**.
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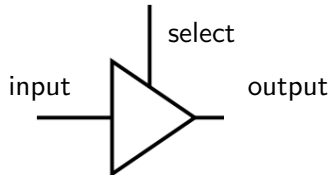
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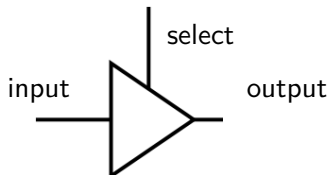
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Tri-state outputs

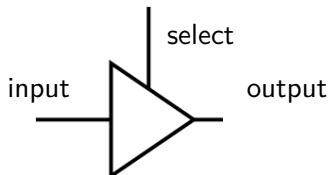


Tri-state outputs



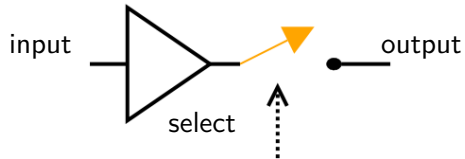
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Tri-state outputs

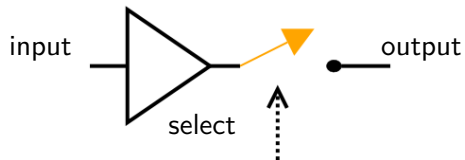


- **input** is to make output LOW or HIGH,
- **select** is to make output float or follow input

Tri-state output equivalent circuit



Tri-state output equivalent circuit



- The **select** determines whether the output is floating or not.

Types of logic gate outputs

Microprocessor buses

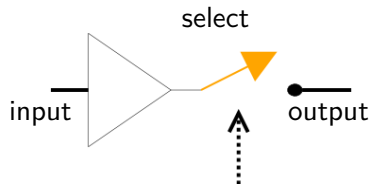
Determining whether a pin is floating

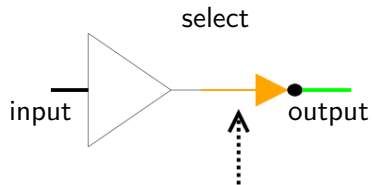
Three types of outputs

Tri-state output

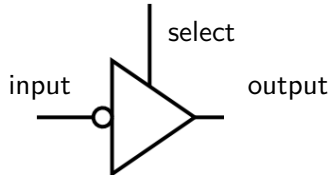
Tri-state output equivalent circuit

Tri-state output (inverting)

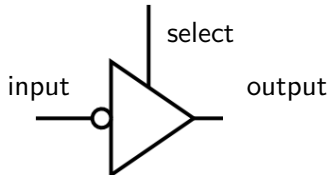




Tri-state output (inverting)

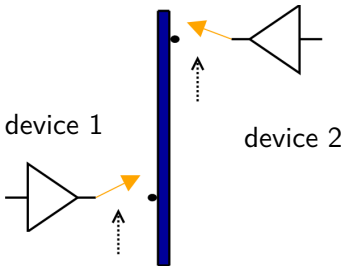


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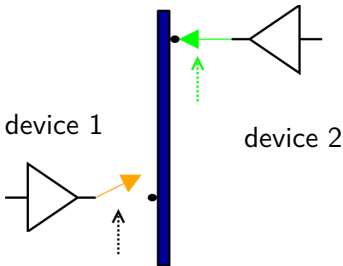
- Gates can be inverting, like other gates.

Microprocessor buses



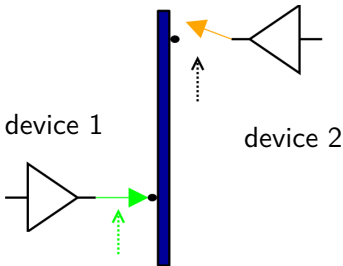
- A **bus** is created if several tristate devices are connected together.
- As long as only one is selected at a time, there is no problem.

Microprocessor buses



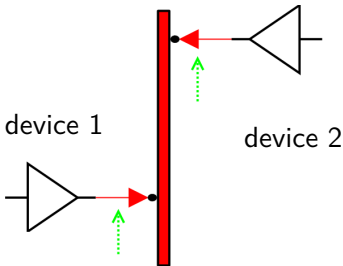
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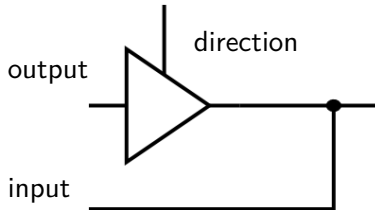
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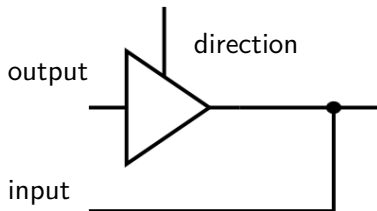


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Tri-state (I/O) pins

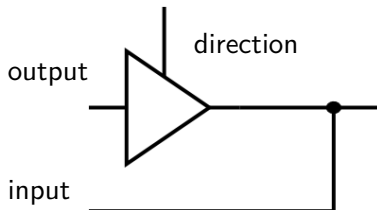


Tri-state (I/O) pins



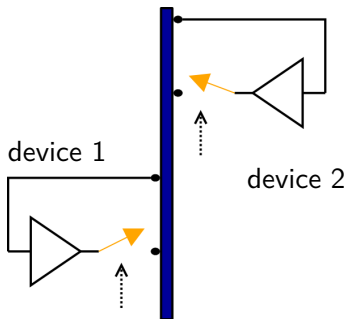
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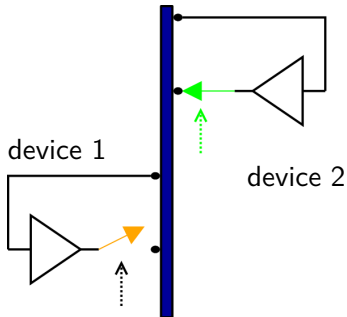
- Tri-state pins allow input and output on the same pin.
- The **direction** input indicates output or input (i.e. floating).

Tri-state buses



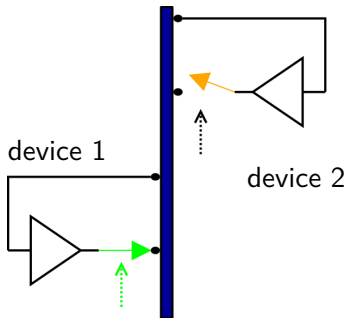
- Tri-state buses allow several devices to input and output on the same lines.
- Uses I/O signal and address decoding

Tri-state buses



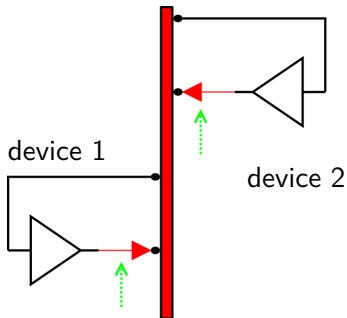
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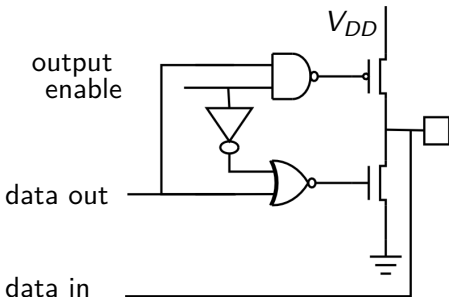
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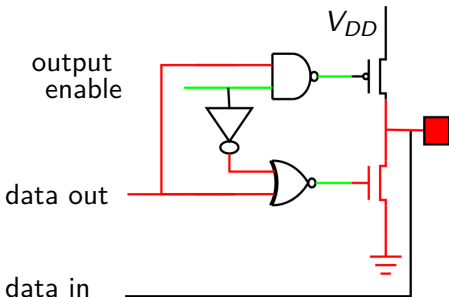
Internal view (CMOS)



Here's what a CMOS tri-state output looks like inside.

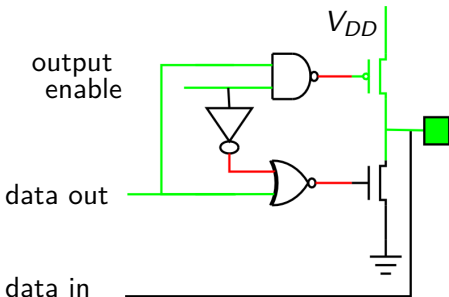
(Note the top transistor is turned on by a low, but the bottom transistor is turned on by a high.)

Internal view (CMOS)



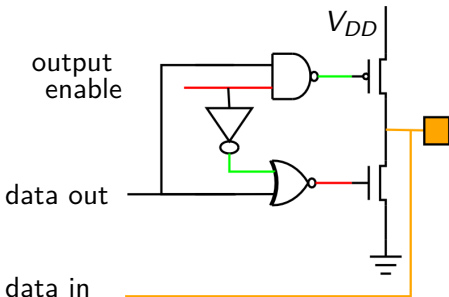
When output is enabled, and data out is low,
the output will be low. (Only bottom transistor on.)

Internal view (CMOS)



When output is enabled, and data out is high, the output will be high.(Only top transistor on.)

Internal view (CMOS)



When output is not enabled,
the output will float (to become an input). (Both transistors
off.)

Determining whether a pin is floating

Determining whether a pin is floating

- If a pin is supposed to be HIGH, you can measure the voltage and see if it is above $V_{OH_{min}}$.

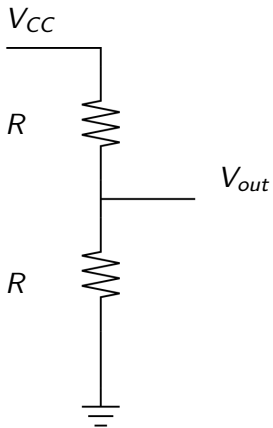
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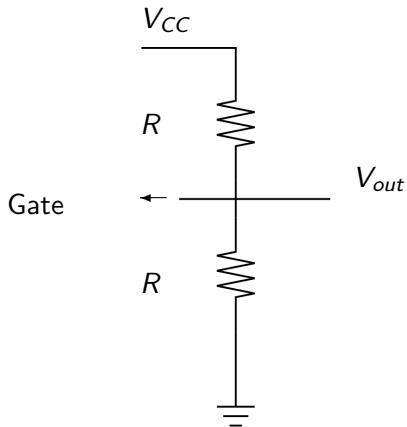
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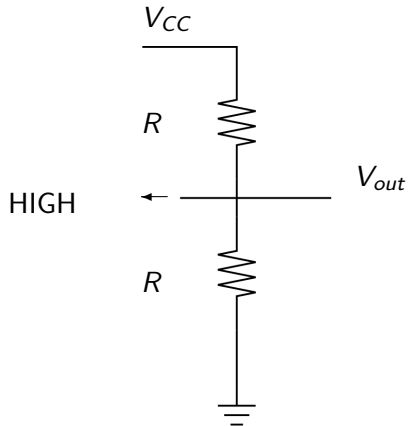
How can you tell if it is *floating*?



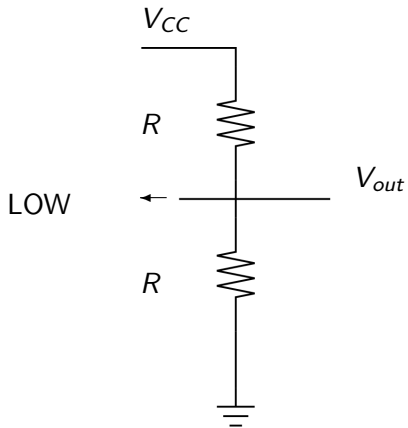
What should V_{out} be?



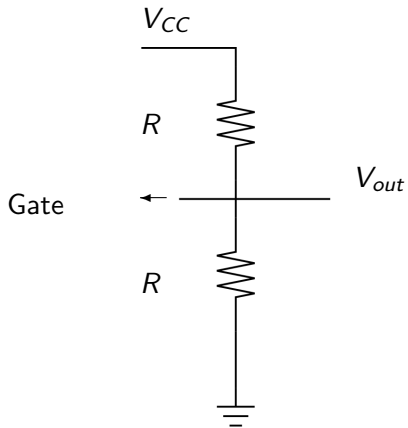
What should V_{out} be if it is tied to the output of a gate?



What should V_{out} be if the gate output is HIGH?



What should V_{out} be if the gate output is LOW?



Should V_{out} depend on the value of R ?