Electronics
H-Bridges and DC Motors

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April 22, 2019

DC motor

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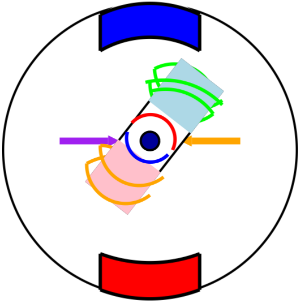
- direction controlled by polarity
- continuous motion

Permanent magnet DC motor



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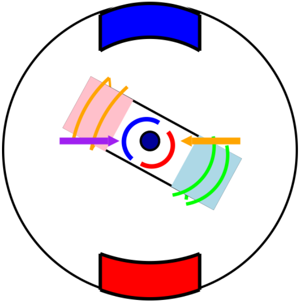

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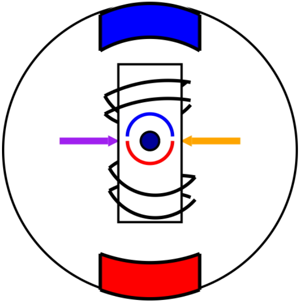

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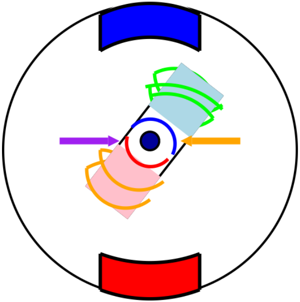

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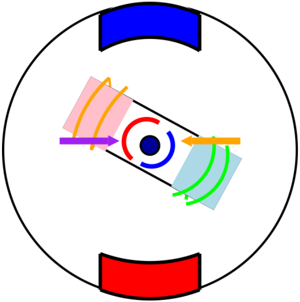

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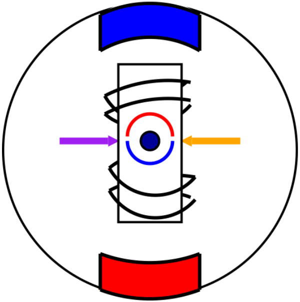

H-Bridge

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- only two transistors are “on” at a time

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- Transistors are often used in voltage dividers to act as variable resistors.

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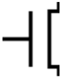
FET symbol



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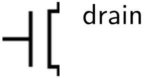

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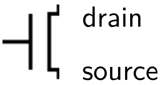

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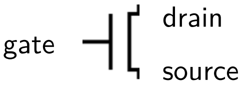

FET operation

- FETS are *voltage* amplifiers; a small **gate** *voltage* controls a much larger **drain/source** *current*.

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Actually it's the voltage between the gate and the source which matters.

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In an H-bridge, you want E-MOSFETS so no current flows with no applied gate-source voltage.

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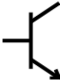
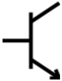
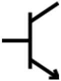
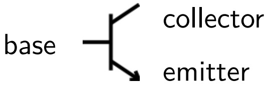
The current from the collector to the emitter is controlled by the *current* into the base.





collector


collector
emitter


base
collector
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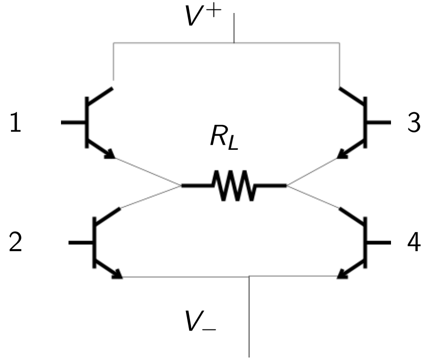
- *You should always have a base resistor with a BJT!*

H bridge (shown with BJTs)



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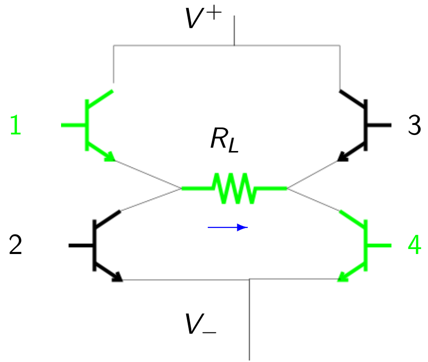
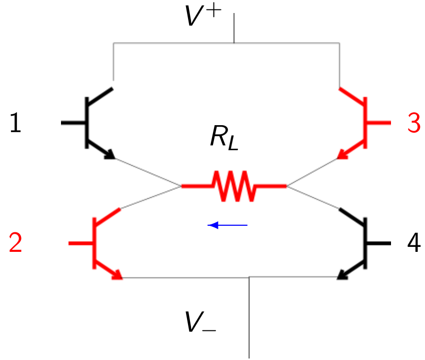


Current flows from left to right.

H bridge (shown with BJTs)



Current flows from right to left.

EMF considerations

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- a motor is an inductive load

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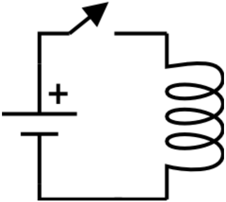
  A zener diode can limit voltages the other way to about the zener voltage.

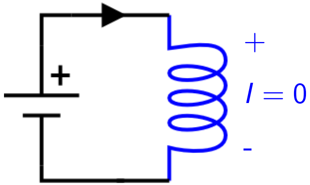
No diode to reduce induced EMF



$I \equiv 0$

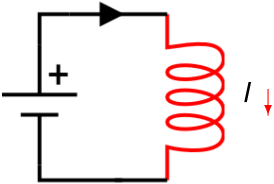
Initially $I = 0$.

No diode to reduce induced EMF



Induced voltage tries to maintain $I = 0$.

No diode to reduce induced EMF



Eventually current is established determined by resistance in circuit.

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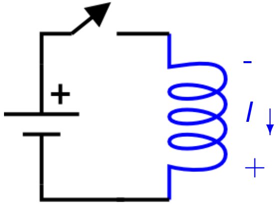

Induced voltage tries to maintain I at the previous value.

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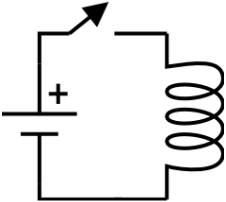

Eventually current is reduced to $I = 0$.

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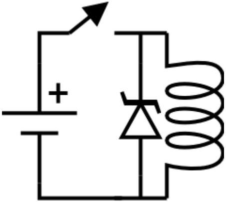

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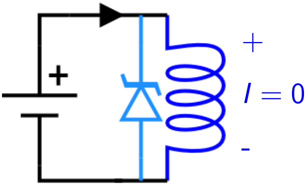
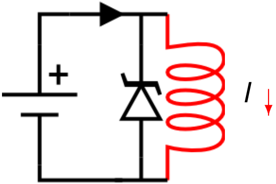


Induced voltage tries to maintain $I = 0$, *but cannot exceed* V_Z.

Diode to reduce induced EMF



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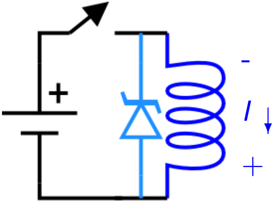

Induced voltage tries to maintain I *but cannot exceed* $\approx 0.7V$.

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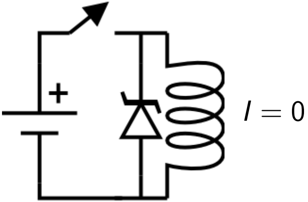

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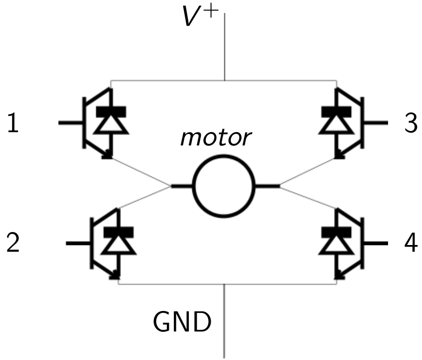
H bridge with diodes included



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- This includes the base or gate.
- This will prevent spike getting to *whatever is controlling it*.

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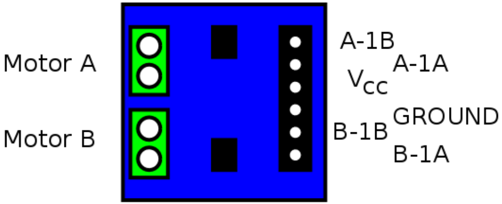
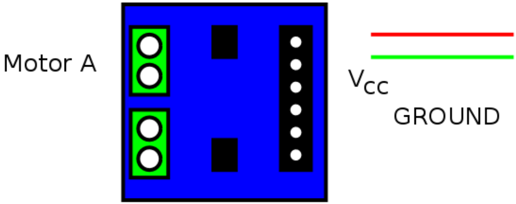
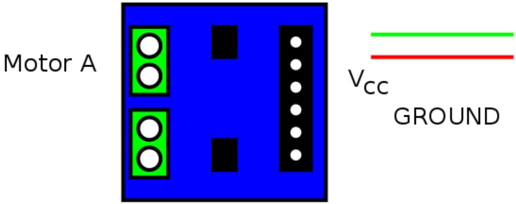
- There are boards with two allowing independent control of two motors.



All the two motors have in common are the supply voltages.



If the 1A input is HIGH and the 1B input is LOW, the motor will run in one direction.



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Controlling Speed

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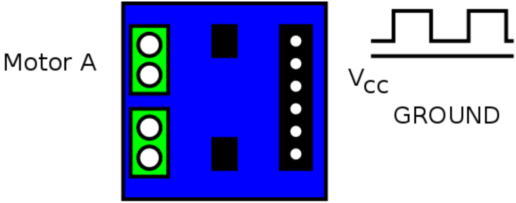
As long as the frequency is high enough, mechanical inertia will make the motion smooth.

Pulse width modulation to limit current



PWM can be used on one input..

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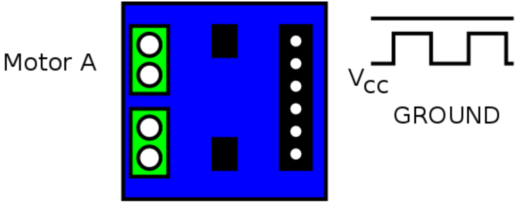

or the other.

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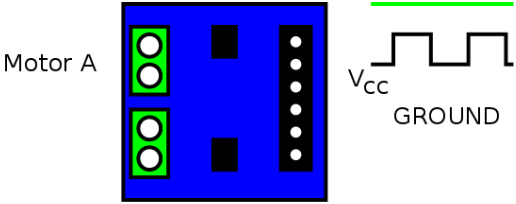
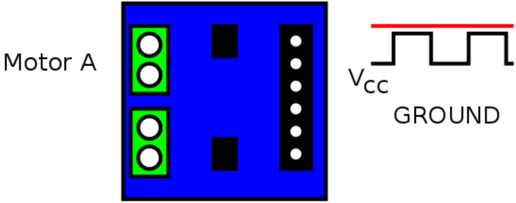


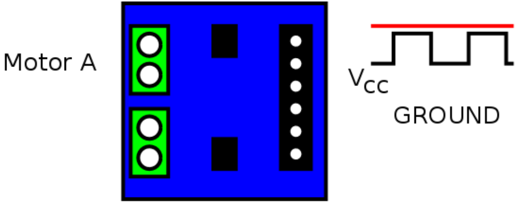
Alternatively, you can use PWM on one input..

Pulse width modulation to limit current



and control direction with the other.

Pulse width modulation to limit current



In this case *decreasing* the duty cycle will *increase* power in one direction.