Electronics
Inductive Output Transducers

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Wilfrid Laurier University

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Output transducers

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  resistive

  inductive
- inductive loads require a few special considerations

Solenoid

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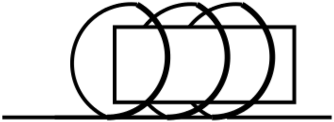
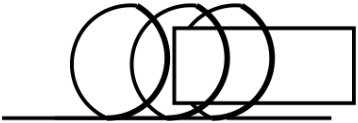


- plunger in

Solenoid



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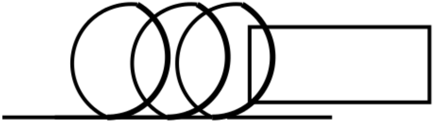

- plunger out

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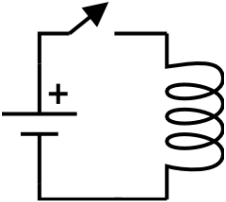
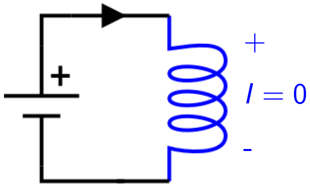
  A zener diode can limit voltages the other way to about the zener voltage.

No diode to reduce induced EMF



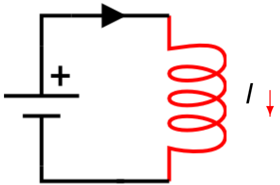
Initially $I = 0$.

No diode to reduce induced EMF



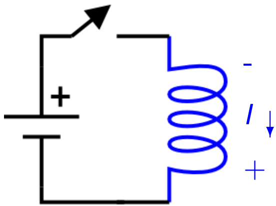
Induced voltage tries to maintain $I = 0$.

No diode to reduce induced EMF



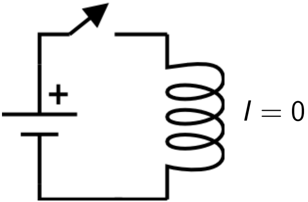
Eventually current is established determined by resistance in circuit.

No diode to reduce induced EMF



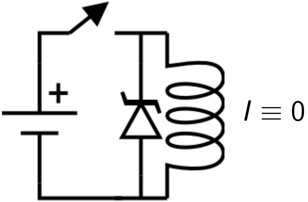
Induced voltage tries to maintain I at the previous value.

No diode to reduce induced EMF



Eventually current is reduced to $I = 0$.

Diode to reduce induced EMF



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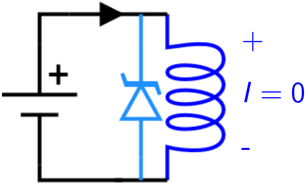
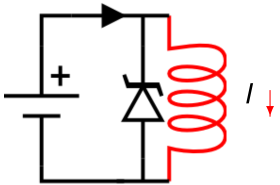


Induced voltage tries to maintain $I = 0$, *but cannot exceed* V_Z.

Diode to reduce induced EMF



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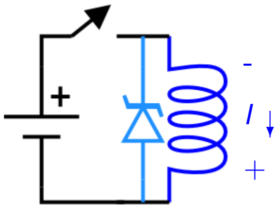
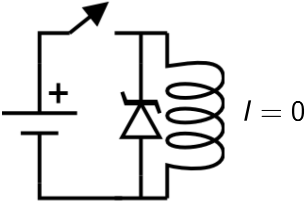


Induced voltage tries to maintain I *but cannot exceed* $\approx 0.7V$.

Diode to reduce induced EMF



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Current requirements

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  Maintaining current larger than necessary wastes power and produces heat.
- Several options exist for adjusting current between moving the plunger and holding it.

Series resistor

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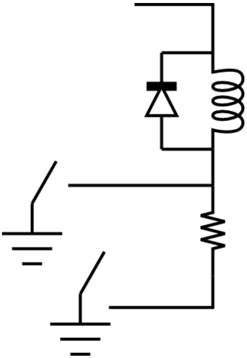

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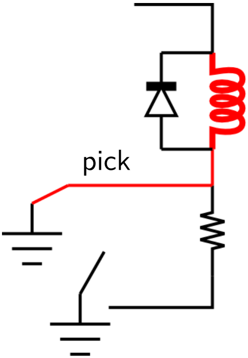
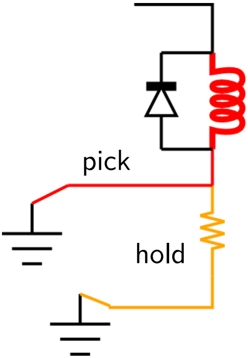


Series resistor



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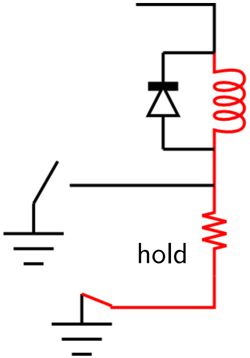

Multiple supplies

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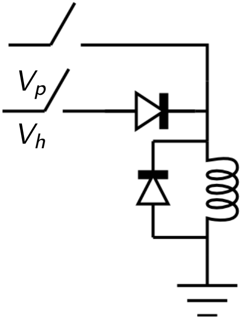

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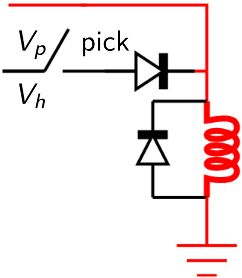

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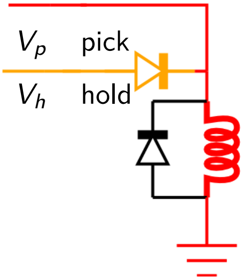

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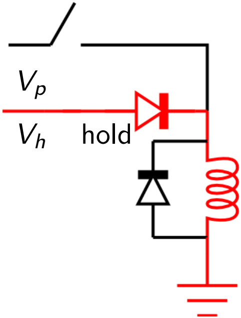

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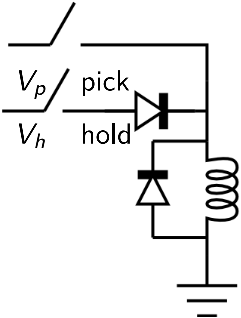
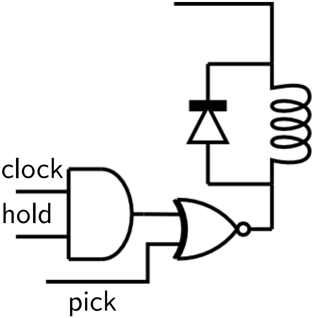


$V_p > V_h$

Pulse width modulation to limit current



Solenoids in action: Relays

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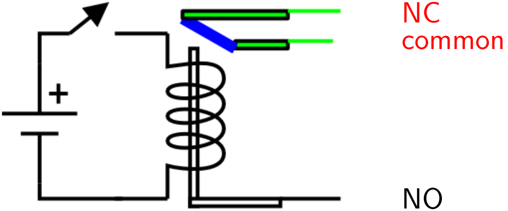
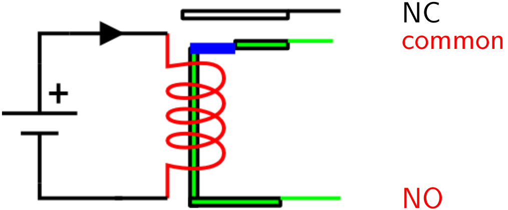
The solenoid is used to open and close a switch.

An internal spring returns the solenoid to its original position.

Relay **OFF**



Relay ON



DC motor types

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  Servo

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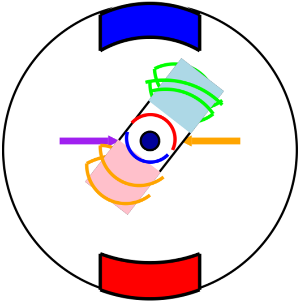
- continuous motion

Permanent magnet DC motor



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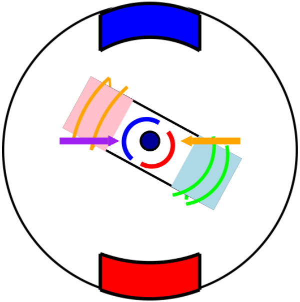

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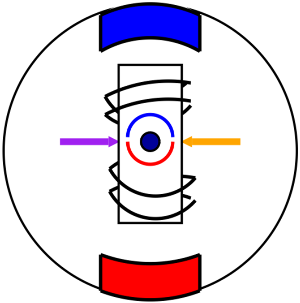

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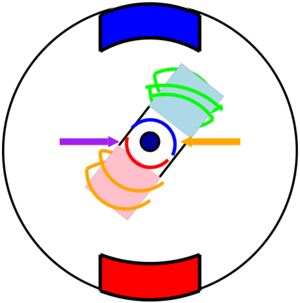

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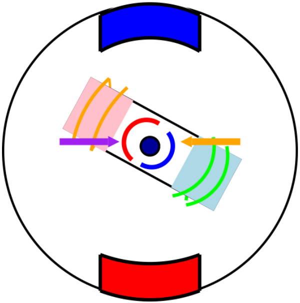

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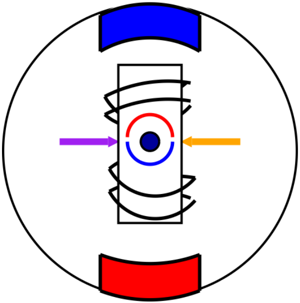

Brushless DC motor

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  can use a hall effect sensor or sense induced voltage in unused coils

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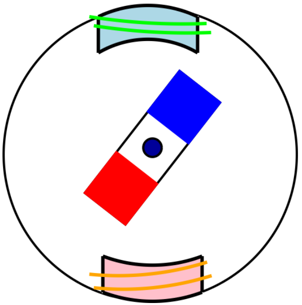

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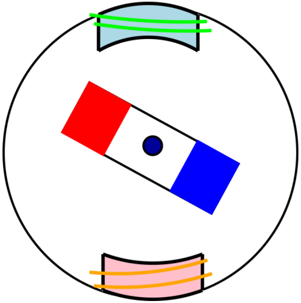

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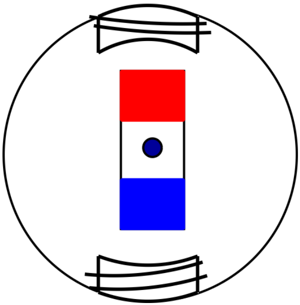

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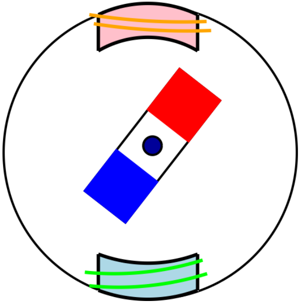

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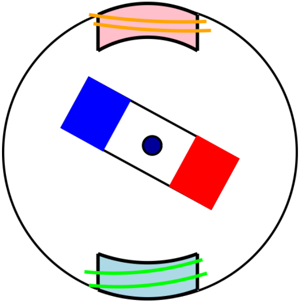

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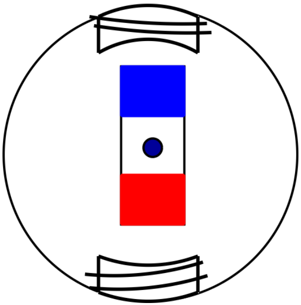

Stepper motor

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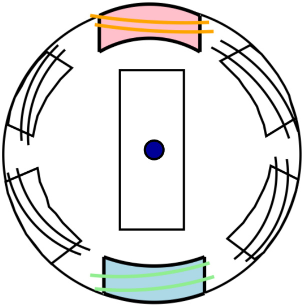
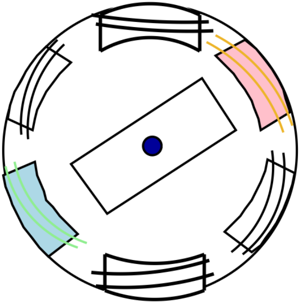
- discrete steps
- drive electronics controls speed and direction
- half-stepping is possible
- can hold in position



Single stepping



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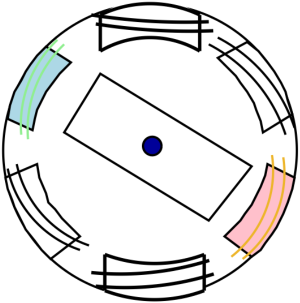

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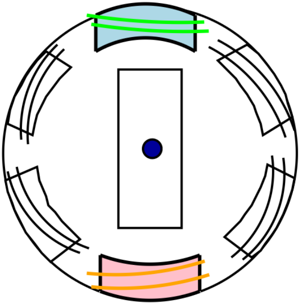

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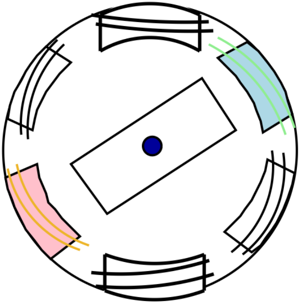

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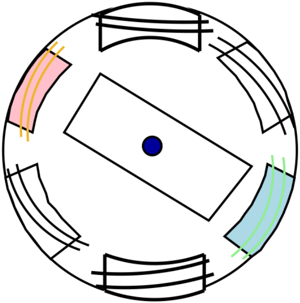

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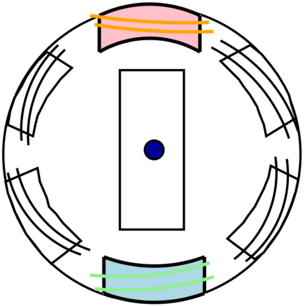
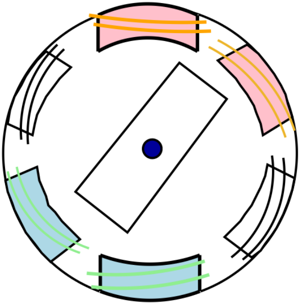


Half stepping



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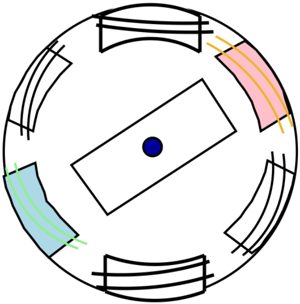

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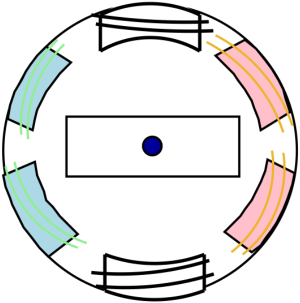

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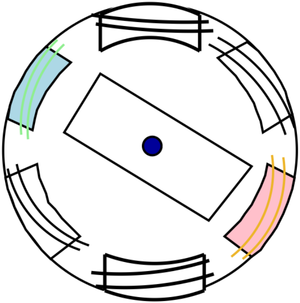

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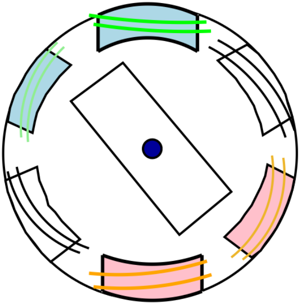

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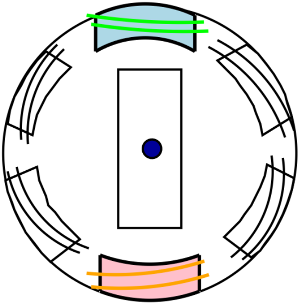

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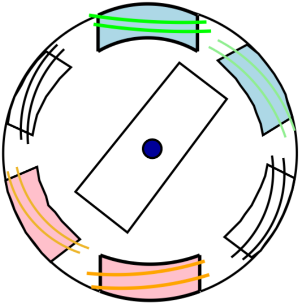

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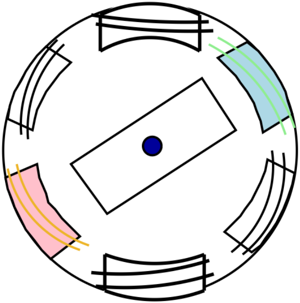

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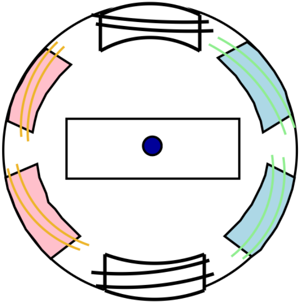

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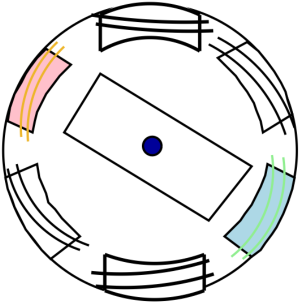

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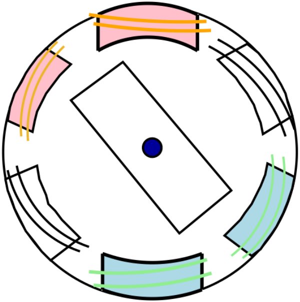

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Servo motor

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- internal electronics

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- uses a digital pulse to control

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Servo motor

- PMDC motor with position sensing and feedback
- internal electronics
- uses a digital pulse to control

  default width keeps motor stationary (e.g. 1.5 ms)

  longer pulse makes motor rotate in one direction

Servo motor

- PMDC motor with position sensing and feedback
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- uses a digital pulse to control

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Servo motor

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  can produce big voltage spikes
- Diodes across the coils can be used the same way

Methods to reverse current to PM DC motor

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- dpdt switch

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- bipolar supply

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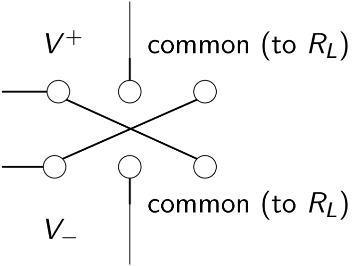
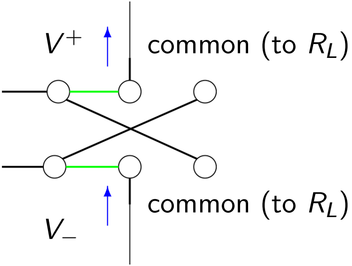
- H bridge

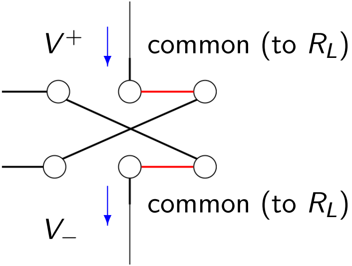
DPDT switch



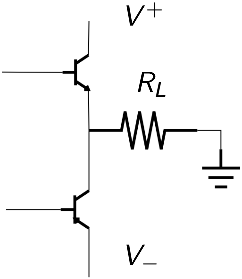
DPDT switch



DPDT switch



Bipolar supply



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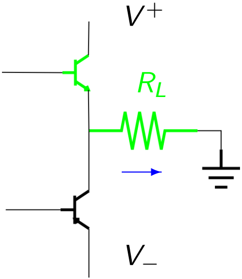

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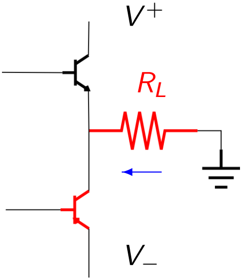
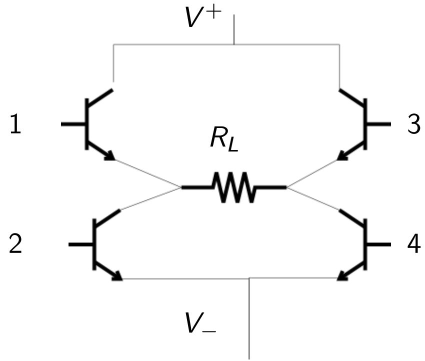


H bridge



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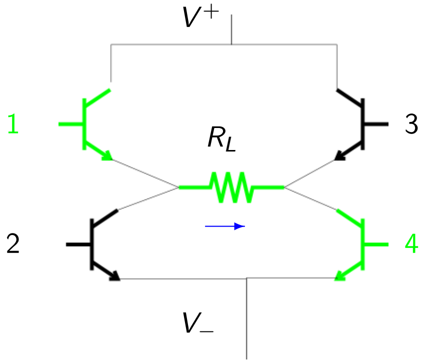

H bridge