

ECSESS

Roboelectronics

H-bridges and motor control

Topics Covered

- DC motor basics
- DC motor requirements
- H-bridges
- Controlling motors using H-bridges



Permanent magnet brushed DC motors

- Many small low cost DC motors are permanent magnet brushed dc motors (PMDC)
- These motors use a permanent magnet to setup the stator field for the rotor, allowing for a simple two pin connection
- There are several advantages to these motors
 - Linear voltage to speed relationship
 - Linear current to torque relationship

FIGURE 1: SIMPLE TWO-POLE BRUSHED DC MOTOR

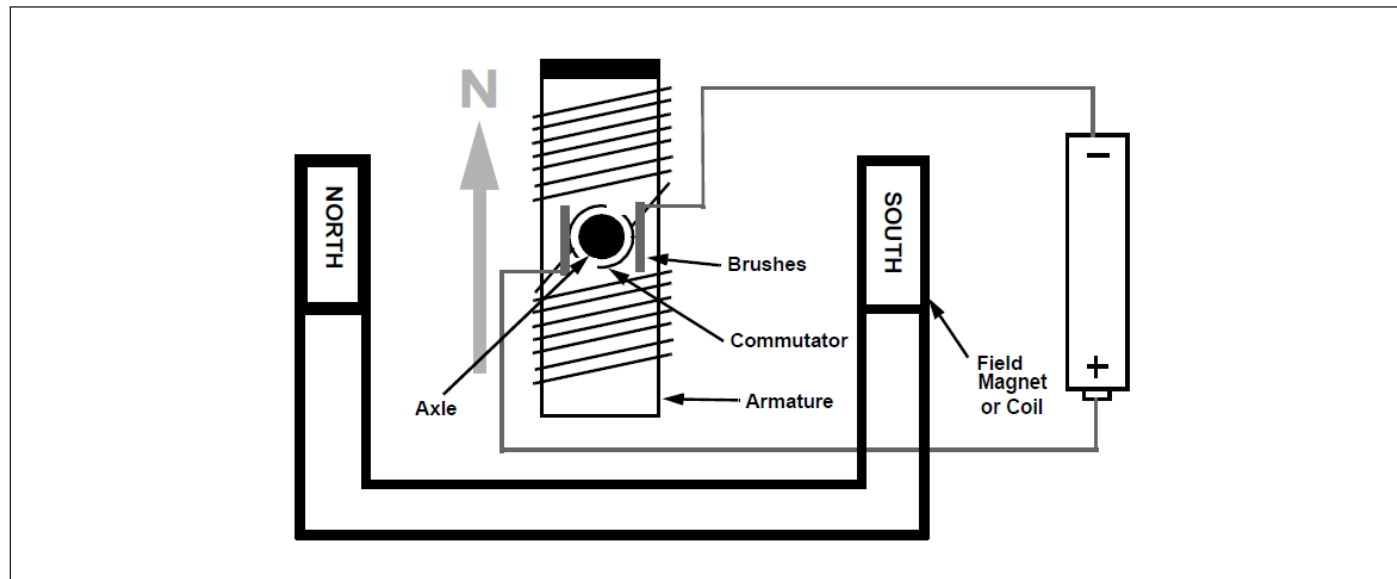
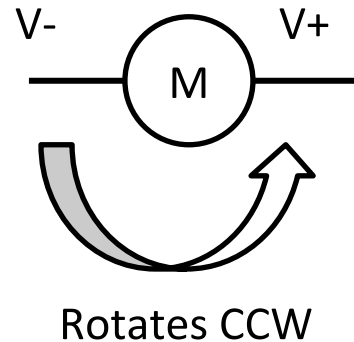
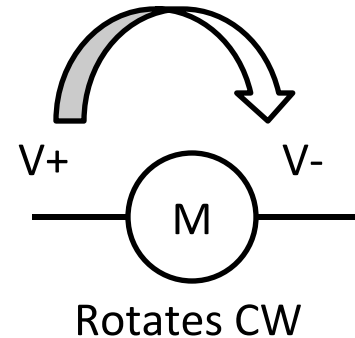


Figure 1 from Microchip Application note A950

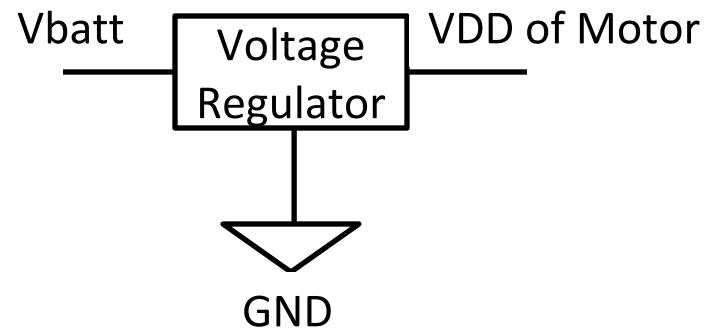
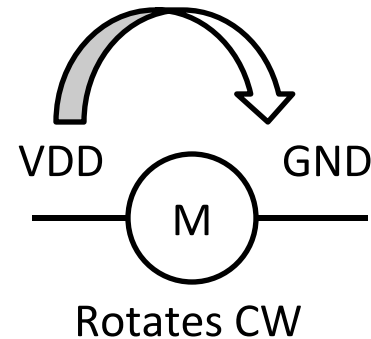
PMDC continued

- These motors are a two pole device, where the polarity of the applied voltage affects the direction of rotation
- By changing the polarity of the voltage we can change the direction of rotation
- To determine what polarity turns the motor in which direction, simply try applying a voltage and noting the direction of rotation



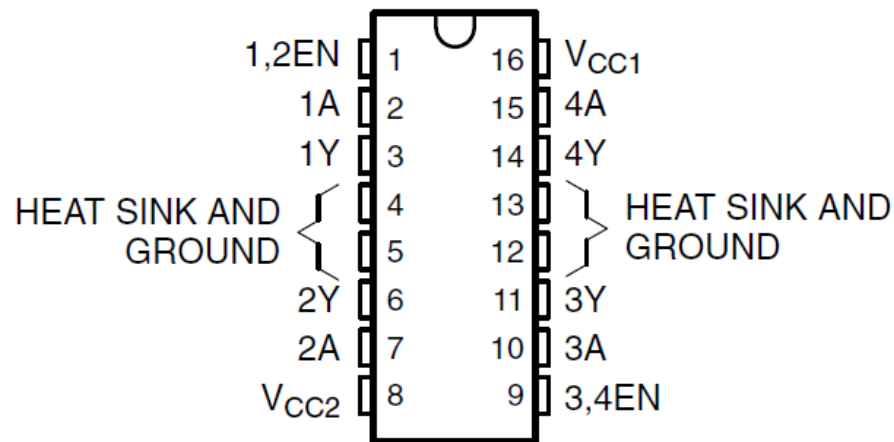
Powering the PMDC

- Since a potential needs to be applied to the motor, it has certain electrical requirements
- To achieve the voltage difference described in the previous slides, we can apply VDD and GND to each pole of the motor
- The motor's datasheet indicates the maximum voltage that can be applied to the motor
- Typically, we want to power our motors off of a battery, but the voltage of the batteries does not match that of the motor
 - Voltage regulators become essential to powering our setup



H-bridges

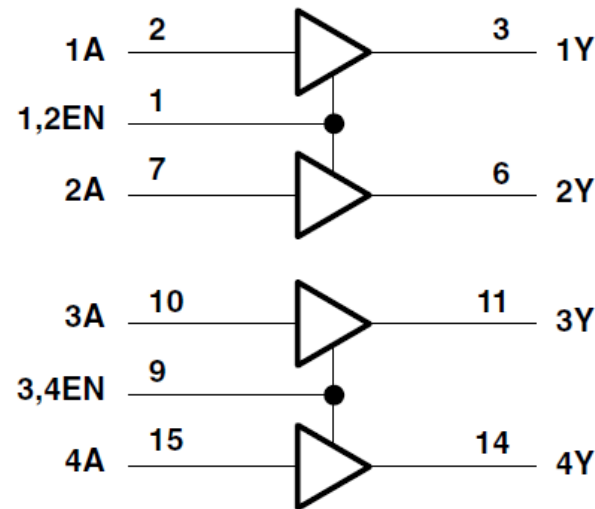
- H-bridges allow us to control the direction a motor rotates without physically changing the wiring of the motor
 - In order to change the direction of rotation we have to control the polarity applied to the motor
 - The H-bridge provides control pins to select what polarity is applied to the motor. However, since it is an IC it also needs to be powered
 - The control pins can be set by the micro controller to turn the motor CW or CCW



L293 H-bridge pin out
where two H-bridges are on
board to control two
motors

Connecting an H-bridge to a motor

- The H-bridge has a set of inputs and outputs, where the outputs drive the motor, and the inputs are the control lines connected to the micro controller
- The diagram shows two H-bridges, such that two motors can be driven, where Y is the output and A is the input
- Each motor would be connected to the Y pins



FUNCTION TABLE
(each driver)

INPUTS [†]		OUTPUT Y
A	EN	
H	H	H
L	H	L
X	L	Z

H = high level, L = low level, X = irrelevant,
Z = high impedance (off)

[†] In the thermal shutdown mode, the output is in the high-impedance state, regardless of the input levels.

Connecting the H-bridge to a controller

- Using the pin out in the datasheet, it is clear that we need two pins to control each motor
- Using a table provided with the datasheet we can determine what values to set on the pins to turn the motors CW or CCW
 - Note, which direction corresponds to CW and CCW is based on your wiring and motor

EN	1A	2A	FUNCTION
H	L	H	Turn right
H	H	L	Turn left
H	L	L	Fast motor stop
H	H	H	Fast motor stop
L	X	X	Fast motor stop

L = low, H = high, X = don't care

Resources

- Datasheets

- L293 (H-bridge): <http://www.ti.com/lit/ds/symlink/l293d.pdf>
- PIC16F88: <http://ww1.microchip.com/downloads/en/DeviceDoc/30487D.pdf>
- Motors: http://www.pololu.com/file/download/fa_130ra.pdf?file_id=0J11

- Further Reading

- Microchip application note about DC Motors: <http://ww1.microchip.com/downloads/en/appnotes/00905a.pdf>