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# What is a Motor Driver?

Introduction:

A motor driver, also known as a motor controller or motor driver circuit, is an electronic component or device that **controls the operation of an electric motor**. It is an essential part of various electromechanical systems, such as robotics, automotive applications, industrial machinery, and consumer electronics. The primary purpose of a motor driver is to convert low-level control signals (**usually from a microcontroller, such as an Arduino, or other control system**) into high-power output signals that can drive and control the motion of a motor.

Types of Motor Drivers:

* **DC Motor Drivers, (we will be using this for the RC Car project)**: Designed for direct current (DC) motors, these drivers can be used to control the speed and direction of DC motors commonly found in applications like toys, appliances, and small robotics.
* Stepper Motor Drivers: Specifically tailored for stepper motors, these drivers provide precise control over stepper motor movements, enabling them to move in discrete steps or rotate continuously.
* Brushless DC (BLDC) Motor Drivers: BLDC motor drivers are used with brushless motors, which are known for their efficiency and reliability. They are commonly found in applications like computer cooling fans, drones, and electric vehicles.
* Servo Motor Drivers: Servo motor drivers are used with servo motors and are known for their high precision and accuracy. They are widely used in applications requiring precise control of position and speed, such as CNC machines and industrial automation.

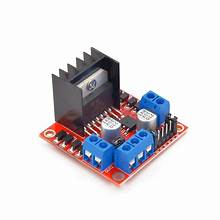
Motor Drivers Control…

* Motor Direction: Motor drivers can control the direction of rotation of a motor, allowing it to move forward or backward.
* Motor Speed: They regulate the motor's speed by adjusting the voltage and current supplied to the motor.
* Motor Torque: Some motor drivers can control the torque or force exerted by the motor, which is especially important in applications like robotics.
* Current Limiting: Motor drivers often include protection mechanisms to limit the current supplied to the motor, preventing overheating and damage.
* Feedback Control: Advanced motor drivers can incorporate feedback mechanisms, such as encoders or sensors, to provide precise control and feedback on the motor's position, speed, or load.

# H Bridges

What is an H Bridge?

An H-bridge is an electronic circuit that is commonly used to control the direction and speed of a DC motor or other loads. It is called an "H-bridge" because the configuration of the switches or transistors in the circuit resembles the letter "H." H-bridges provide a way to reverse the polarity of the voltage applied to a load, allowing you to change the direction of its rotation or movement.



L298N microcontroller, functions using an H Bridge [4].

Configuration:

The basic H-bridge configuration consists of four switches, typically transistors or relays, arranged in the following manner:

* Two switches on the top (often labeled S1 and S2) connect to the positive terminal of the power supply.
* Two switches on the bottom (often labeled S3 and S4) connect to the negative terminal of the power supply.

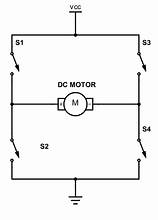
By selectively turning on and off these switches in different combinations, you can control the direction and speed of a DC motor.

# H Bridges (cont.)

Operating Principles:

* Forward Motion: To make the motor rotate in one direction (e.g., clockwise), you turn on S1 and S4 (connecting the positive voltage to one side of the motor) while keeping S2 and S3 off. This allows current to flow through the motor in one direction, causing it to rotate in the desired direction.
* Reverse Motion: To make the motor rotate in the opposite direction (e.g., counterclockwise), you turn on S2 and S3 (connecting the negative voltage to one side of the motor) while keeping S1 and S4 off. This reverses the direction of current flow through the motor, causing it to rotate in the opposite direction, (see schematic below) [3].
* Braking: To stop the motor quickly, you can short-circuit the motor terminals by turning on both the top and bottom switches (S1 and S3 or S2 and S4). This creates a brief "braking" effect by rapidly dissipating the motor's kinetic energy as heat.
* Coast or Off: Turning off all the switches disconnects the motor from the power supply, allowing it to coast to a stop.
* PWM Control: H-bridges are often used in combination with Pulse Width Modulation (PWM) to control the motor's speed. By rapidly switching the H-bridge transistors on and off with a variable duty cycle, you can control the average voltage applied to the motor and, consequently, its speed.

H Bridge Schematic:



H Bridge Schematic working with DC Motor [3]

# Common Motor Controllers

L293D:

* H-Bridge Configuration: The L293D is a dual H-bridge motor driver, which means **it can control two DC motors independently**, allowing forward and reverse motion for each motor.
* Voltage Rating: The L293D is designed for lower voltage applications, typically up to 36 volts. It is well-suited for low-voltage projects and smaller motors.
* Current Handling: The L293D can handle a maximum continuous current of around 600mA per channel and can handle peak currents up to 1.2A per channel. This makes it suitable for driving smaller DC motors.
* Integrated Diodes: It includes **built-in diodes to handle back electromotive force** (EMF) when the motors are turned off. **These diodes help protect the circuit from voltage spikes** that can occur when a motor stops.
* Logic Compatibility: The L293D is often used with 5V logic level control signals, making it **compatible with many microcontrollers and Arduino boards.**

L298N:

* [Component Datasheet](https://www.st.com/resource/en/datasheet/l298.pdf) [5]
* H-Bridge Configuration: The L298N is also an H-bridge motor driver, but it is a dual full-bridge driver. This means **it can control two DC motors independently**, just like the L293D.
* Voltage Rating: **The L298N can handle higher voltages compared to the L293D**, typically up to 46 volts. This makes it suitable for applications requiring higher voltage motor control.
* Current Handling: The L298N can handle higher current loads compared to the L293D. It can typically handle a continuous current of around 2A per channel and peak currents up to 3A per channel, which makes it suitable for driving medium-sized DC motors.
* Uses Bipolar Trasnsistors, (see previous section LINK), which have a moderate voltage drop associated with them, (1.35 - 2 V for 1 - 2 A load respectively). This lost voltage is dissipated as heat, hence the heat sink on the unit.
* External Diodes Required: Unlike the L293D, the L298N does not have integrated diodes for back EMF protection. **External diodes must be added to the circuit to protect against voltage spikes.**
* Logic Compatibility: The L298N also works with 5V logic level control signals and **is compatible with microcontrollers and Arduino boards.**

# References

[1] “L298N | how to control dc motor with Arduino | Motor speed and direction control,” *www.youtube.com*. https://youtu.be/5RMwtuV7BM0?si=yB1vyJaiodmOpfic (accessed Nov. 08, 2023).

[2] “Driving DC Motors with Microcontrollers,” *www.youtube.com*. https://youtu.be/ygrsIqWOh3Y?si=JPi351uzQ7y4zIiS (accessed Nov. 08, 2023).

[3] “What is an H-Bridge?,” *Build Electronic Circuits*, Dec. 05, 2018. https://www.build-electronic-circuits.com/h-bridge/

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