

Motor Drivers

A Motor Driver is an integrated circuit (IC) or module that acts as an intermediate “bridge” between a microcontroller and a motor. It amplifies low-current control signals from the microcontroller into the high-current and high-voltage power required to drive motors, while isolating sensitive logic circuits from electrical damage.

Why is it Required? You cannot connect a motor directly to a microcontroller (like an Arduino, ESP32, or STM32) for three critical reasons. Doing so will likely result in immediate permanent damage to your microcontroller:

- 1. Current Incompatibility (The Main Killer):** - **Microcontroller Limit:** A standard GPIO pin can typically supply only 20mA to 40mA of current.
- **Motor Requirement:** Even small hobby DC motors often require 250mA to 500mA just to spin unloaded, and can draw 1A to 3A+ when stalled or starting.
- **Result:** Connecting directly forces the motor to pull more current than the chip can handle, causing the internal transistors of the microcontroller to burn out instantly.

2. Voltage Differences:

- Microcontrollers operate at low “logic voltages” (usually 3.3V or 5V).
- Motors often require higher “drive voltages” (e.g., 12V, 24V, or 48V) to operate efficiently.

A motor driver allows you to use a separate, high-voltage power source for the motor while controlling it with low-voltage logic.

Commonly Used Commercial Motor Drivers Motor drivers are categorized by the type of motor they drive and their power handling capabilities.

- 1. For Brushed DC Motors (Robotics & Hobby) - L298N (Dual H-Bridge):** Status: The “classic” workhorse for education and hobby robotics. Specs: Controls 2 DC motors or 1 Stepper. Handles up to 2A per channel and 35V. Pros/Cons: Very cheap and widely supported, but inefficient (drops ~2V internally) and requires a large heatsink because it generates significant heat.
- **L293D (Quad Half-H Driver):** Status: Standard for small, low-power projects. Specs: Handles 600mA continuous current per channel. Usage: Often found in “Motor Shield” boards for Arduino to drive small toy motors.
- **TB6612FNG:** Status: The modern, efficient replacement for the L298N. Specs: 1.2A continuous, 3.2A peak. Uses MOSFETs instead of BJTs, so it runs much cooler and doesn’t waste as much battery power as heat.

2. For Stepper Motors (3D Printers & CNC) - A4988 & DRV8825: Usage: The industry standard for desktop 3D printers (like Ender 3) and small CNC machines. Feature: “Microstepping” capability (dividing steps into smaller increments for smoother motion).

- **TB6600:** Usage: Industrial-grade or heavy-duty CNC applications. Specs: Handles significantly higher voltage (up to 42V) and current (up to 4A) with a large enclosed heatsink.

3. High-Power & Industrial Drivers - BTS7960: Usage: High-power robotics (e.g., combat robots, electric skateboards). Specs: A massive 43A current handling capacity, often used for large DC motors.

- **VFD (Variable Frequency Drive):** Usage: Industrial applications requiring variable speed control. Specs: Handles up to 400V and 100A.

Frequency Drive: Usage: Industrial automation. Function: Used to control massive 3-phase AC Induction motors (like conveyor belts and large fans) by varying the frequency of the AC power. - **ESC (Electronic Speed Controller):** Usage: Drones and RC Vehicles. Function: Specifically designed for high-speed Brushless DC (BLDC) motors.