

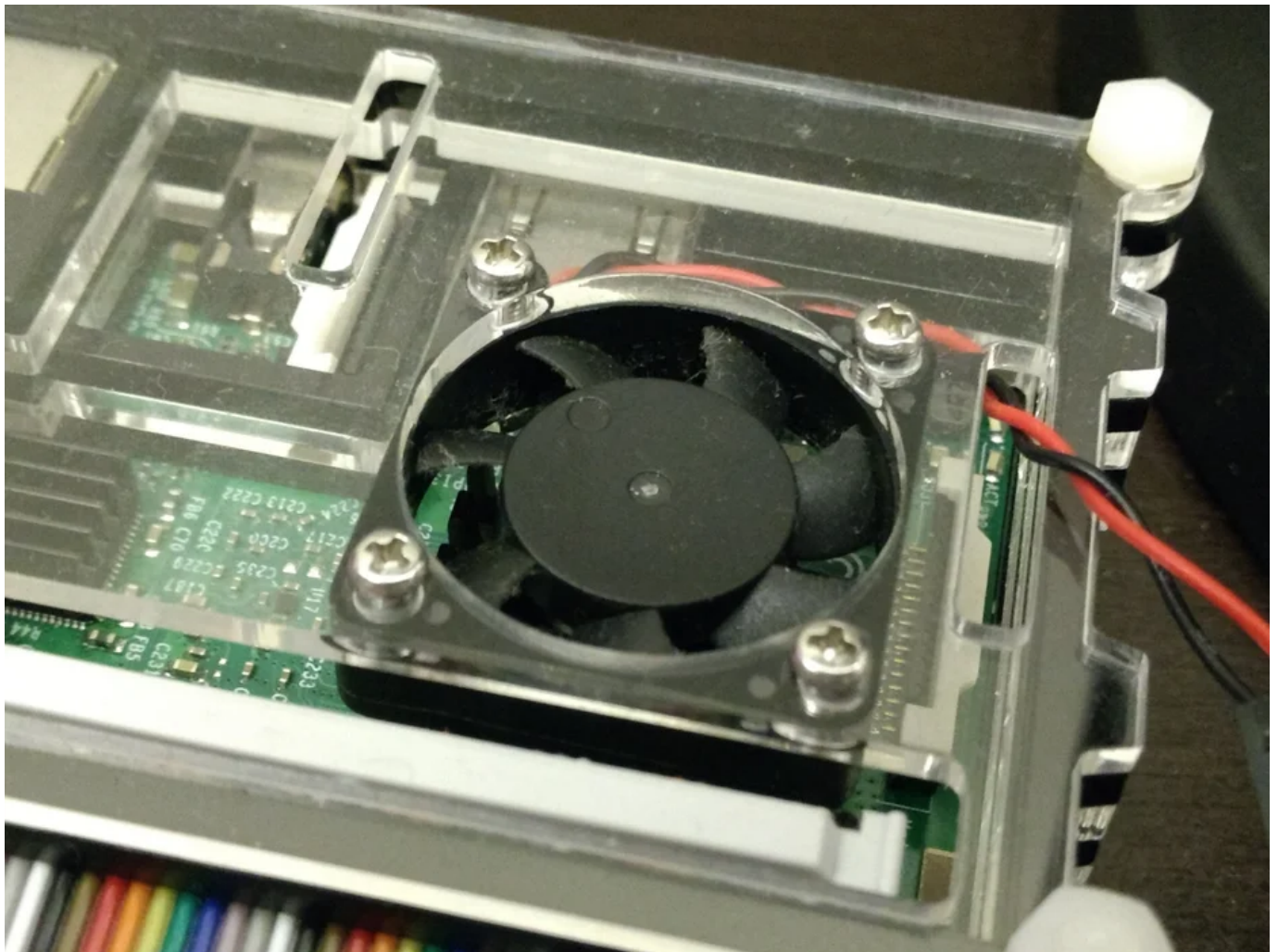
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PWM Regulated Fan Based on CPU Temperature for Raspberry Pi

By [Aerandir14](#) in [CircuitsRaspberry Pi](#)



Introduction: PWM Regulated Fan Based on CPU Temperature for Raspberry Pi



Many cases for Raspberry Pi come with a little 5V fan in order to help cooling the CPU. However, these fans are usually pretty noisy and many people plug it on the 3V3 pin to reduce the noise. These fans are usually rated for 200mA which is pretty high for the 3V3 regulator on the RPi. This project will teach you how to regulate the fan speed based on CPU temperature. Unlike most of tutorials covering this subject, we won't only turn on or off the fan, but will control its speed like it's done on mainstream PC, using Python.

Step 1: Parts Needed

For this project, we will use only a few components that are usually included in electronics kits for hobbyist that you can find on Amazon, [like this one](#).

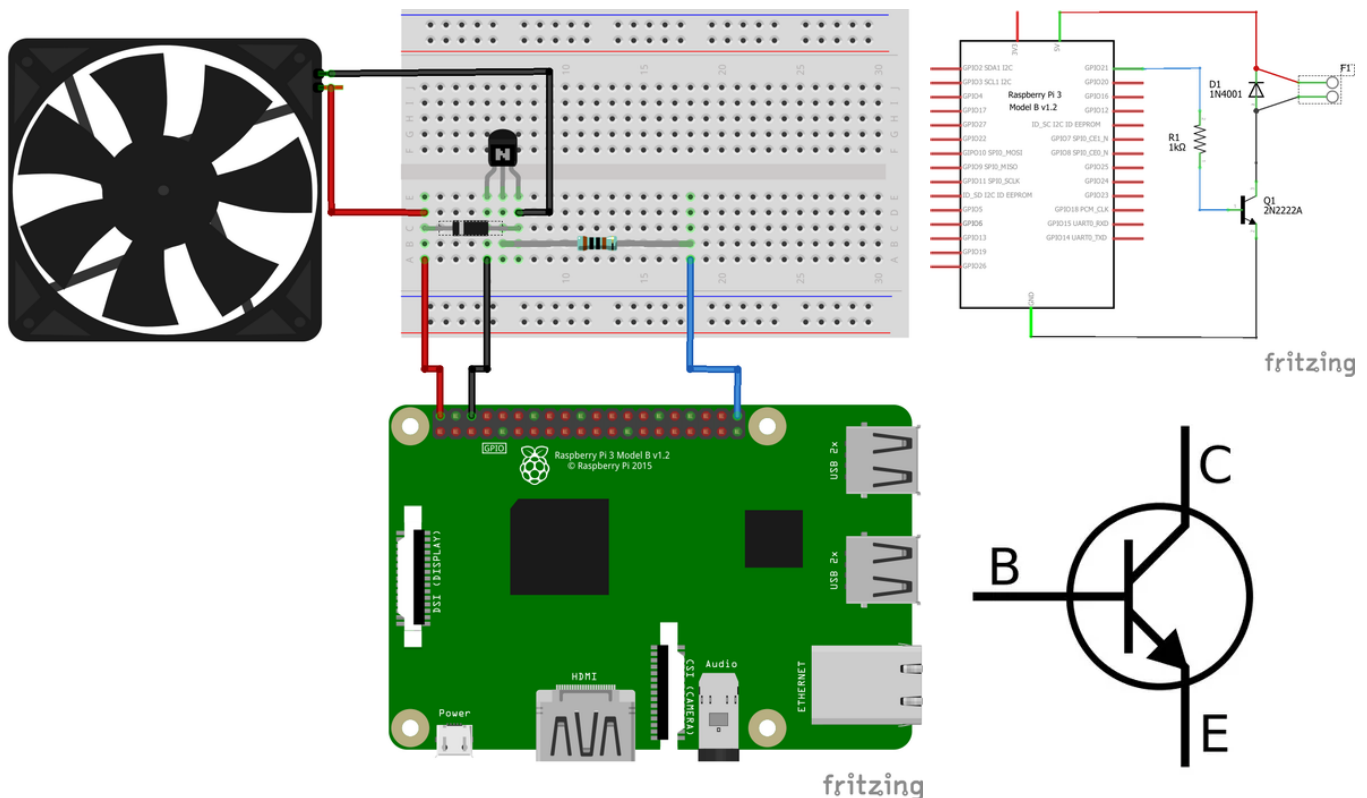
- Raspberry Pi running Raspbian (but should work with other distros).
- 5V Fan (but a 12V fan could be used with an adapted transistor and a 12V power supply).
- NPN transistor that supports at least 300mA, like a 2N2222A.
- 1K resistor.
- 1 diode.

Optional, to put the components inside the case (but not done yet):

- A little piece of protoboard, to solder the components.
- Large heat shrink, to protect the board.

For those who might not want to build their own circuit board, you can buy a ready-to-use board made by [Jeremy Cook](#) on tindie.com: <https://www.tindie.com/products/jeremycook/ez-fan2-tiny-raspberry-pi-fan-controller/>

Step 2: Electrical Connections



Resistor can be plug in either way, but be careful about transistor's and diode's direction. Diode's cathode must be connected to the +5V (red) wire, and anode must be connected to the GND (black) wire. Check your transistor doc for Emitter, Base and Collector pins. Fan's ground must be connected to the Collector, and Rpi's ground must be connected to Emitter.

In order to control the fan, we need to use a transistor that will be used in **open collector configuration**. By doing this, we have a switch that will connect or disconnect the ground wire from the fan to the ground of the raspberry pi.

A **NPN BJT** transistor conducts depending on the current that flows in its gate. The current that will be allowed to flow from the collector (C) to the emitter (E) is:

$$I_c = B * I_b$$

I_c is the current that flows through the collector the emitter, I_b is the current that flows through the base to the emitter, and B (beta) is a value depending on each transistor. We approximate **B = 100**.

As our fan is rated as **200mA**, we need at least 2mA through the base of the transistor. The tension between the base and the emitter (V_{be}) is considered constant and **$V_{be} = 0,7V$** . This means that when the GPIO is on, we have **$3.3 - 0.7 = 2.6V$ at the resistor**. To have 2mA through that resistor, we need a resistor of, maximum, **$2.6 / 0.002 = 1300 \text{ ohm}$** . We use a resistor of **1000 ohm** to simplify and keep a margin of error. We will have 2.6mA through the GPIO pin which is totally safe.

As a fan is basically an electrical motor, it is an **inductive charge**. This means when the transistor stops conducting, the current in the fan will continue flowing as an inductive charge tries to keep the current constant. This would results in a high voltage on the ground pin of the fan and **could damage the transistor**. That's why we need a diode in parallel with the fan