Bathroom Fan Controller

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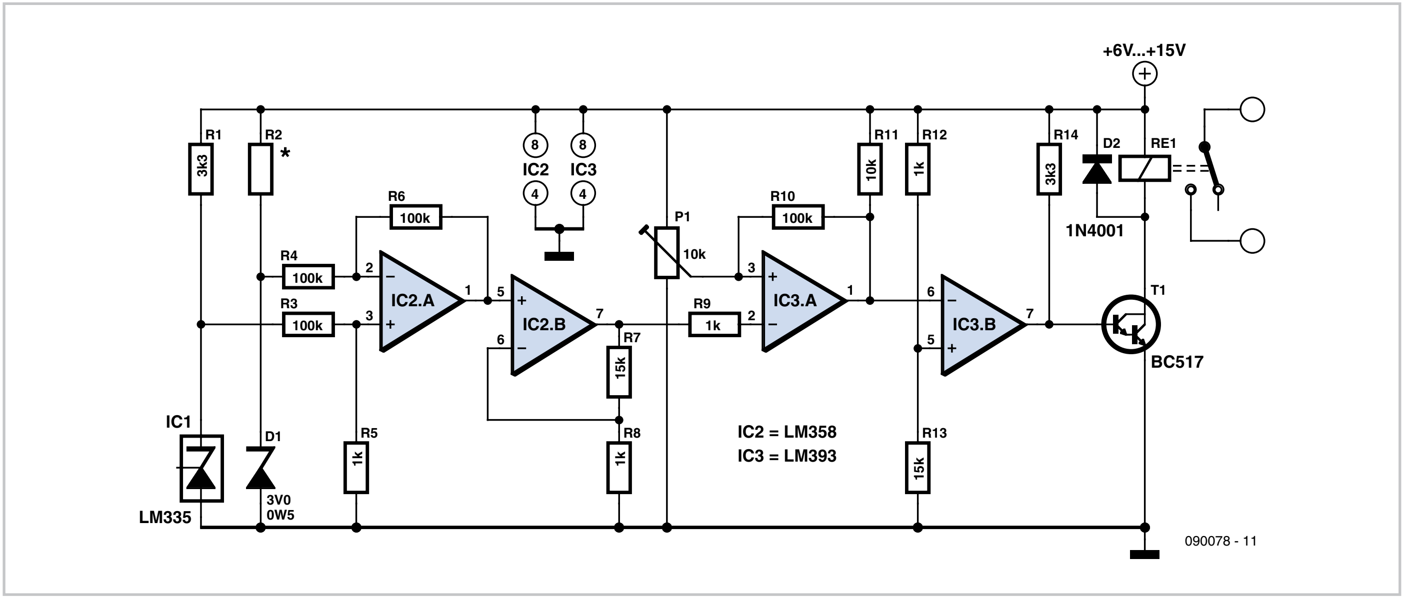
Many bathrooms are fitted with a fan to vent excess humidity while someone is showering. This fan can be connected to the light switch, but then it runs even if you only want to brush your teeth. A better solution is to equip the fan with a humidity sensor. A disadvantage of this approach is that by the time the humidity sensor switches on the fan, the room is already too humid.

Consequently, we decided to build a circuit that operates by sensing the temperature of the hot water line to the shower. The fan runs as soon as the water line becomes hot. It continues to run for a few minutes after the line cools down, so that you have considerably fewer problems with humidity in the bathroom without having the fan run for no reason. Naturally, this is only possible if you can fit a temperature sensor somewhere on the hot water line and the line does not become warm if hot water is used somewhere else.

We use an LM335 as the temperature sensor. It generates an output voltage of 10 mV per Kelvin. The output voltage is 3.03 V at 30 °C, 3.13 V at 40 °C, 3.23 V at 50 °C, and so on. We want to have the fan switch on at a temperature somewhere between 40 and 50 °C (approx. 100–150 °F). To do this accurately, we first use the opamps in IC2 to improve the control range. Otherwise we would have an unstable circuit because the voltage differences at the output of IC1 are relatively small.

IC2a subtracts a voltage of exactly 3.0 V from the output voltage of IC1. It uses Zener diode D1 for this purpose, so this is not dependent on the value of the supply voltage. The value of R2 must be selected according to the actual supply voltage so that the current through D1 is approximately 5 mA. It is 600 Ω with a 6-V supply (560 Ω is also okay), or 2400 Ω (2.2 kΩ) with a 15-V supply. If you have to choose between two values, use the lower value.



IC2b amplifies the output voltage of IC2a by a factor of 16 ((R7 + R8) ÷ R8). As a result, the voltage at the output of IC2b is 0.48 V at 30 °C, 2.08 V at 40 °C (104 °F), and 3.68 V at 50 °C (122 °F). Comparator IC3a compares this voltage to a reference voltage set by P1. Due to variations resulting from the tolerances of the resistor values, the setting of P1 is best determined experimentally. A voltage of 2.5 V on the wiper should be a good starting point (in theory, this corresponds to 42.6 °C). When the water line is warm enough, the output of IC3 goes Low.

R10 provides hysteresis at the output of IC3a by pulling the voltage on the wiper of the setting potentiometer down a bit when the output of IC3a goes Low. IC3b acts as an inverter so that relay Re1 is energised via T1, which causes the fan to start running. After the water line cools down, the relay is de-energised and the fan stops. If this happens too quickly, you can reduce the value of R11 (to 33 kΩ, for example). This increases the hysteresis.

The circuit does not draw much current, and the supply voltage is non-critical. A charging adapter from a discarded mobile phone can thus be used to power the circuit. If the supply voltage drops slightly when the relay is energised, this will not create any problem. In this case the voltage on the wiper of P1 will also drop slightly, which provides a bit more hysteresis on IC3a.

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