How to Set Up a 5V Relay on the Arduino

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One of the most useful things you can do with an Arduino is control higher voltage (120-240V) devices like fans, lights, heaters, and other household appliances. Since the Arduino operates at 5V it can't control these higher voltage devices directly, but you can use a 5V relay to switch the 120-240V current and use the Arduino to control the relay.

The Arduino can be programmed to turn on the relay when a certain event occurs, for example when the temperature of a thermistor gets higher than 30°C. Or when the resistance of a photoresistor drops below 400 Ohms. Almost any sensor can be used to trigger the relay to turn on or off. The trigger doesn't even need to be from a sensor. It can occur at set time intervals, it can be triggered from the press of a button, or even when you get an email.

I'll be using the SRD-05VDC-SL-C 5V relay in this tutorial because it's very popular among Arduino and DIY electronics hobbyists. Let's start with seeing how the 5V relay works, then I'll show you how to set it up on the Arduino and give you some code to get it working.

BONUS: I made a quick start guide for this tutorial that you can download and go back to later if you can't set this up right now. It covers all of the steps, diagrams, and code you need to get started.
Here's the datasheet:

SRD-05VDC-SL-C Datasheet

How the 5V Relay Works

The SRD-05VDC-SL-C relay has three high voltage terminals (NC, C, and NO) which connect to the device you want to control. The other side has three low voltage pins (Ground, Vcc, and Signal) which connect to the Arduino.

5V Relay Terminals and Pins

- NC: Normally closed 120-240V terminal
- NO: Normally open 120-240V terminal
- C: Common terminal
- Ground: Connects to the ground pin on the Arduino
- 5V Vcc: Connects the Arduino's 5V pin
- Signal: Carries the trigger signal from the Arduino that activates the relay

Inside the relay is a 120-240V switch that's connected to an electromagnet. When the relay receives a HIGH signal at the signal pin, the electromagnet becomes charged and moves the contacts of the switch open or closed.

Normally Open vs. Normally Closed

The relay has two different types of electrical contacts inside – normally open (NO) and normally closed (NC). The one you use will depend on whether you want the 5V signal to turn the switch on or turn the switch off. The 120-240V supply current enters the relay at the common (C) terminal in both configurations. To use the normally open contacts, use the NO terminal. To use the normally closed contacts, use the NC terminal.

Normally Open

Normally Open — Signal
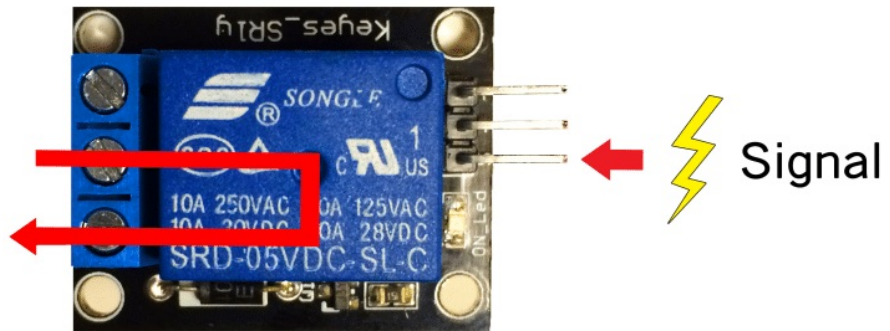
In the normally open configuration, when the relay receives a HIGH signal the 120-240V switch closes and allows current to flow from the C terminal to the NO terminal. A LOW signal deactivates the relay and stops the current. So if you want the HIGH signal to turn ON the relay, use the normally open terminal:

Normally Closed

In the normally closed configuration, a HIGH signal opens the switch and interrupts the 120-240V current. A LOW signal closes the switch and allows current to flow from the C terminal to the NC terminal. Therefore, if you want the HIGH signal to turn OFF the 120-240V current, use the normally closed terminal:

Normally Closed — Signal
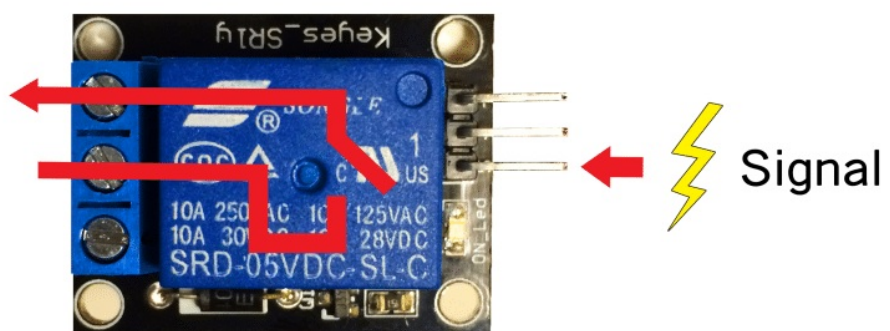
A Temperature Controlled Relay Circuit

To show you how to wire the relay, let's build a temperature controlled relay circuit that will turn off a light bulb when the temperature of a thermistor reaches 150°F. Thermistors are really useful with 5V relays. You can use them to turn off a large motor if gets too hot or turn on a heater if the temperature gets too cold.

WARNING – THIS PROJECT INVOLVES HIGH VOLTAGES THAT CAN CAUSE SERIOUS INJURY OR DEATH. PLEASE TAKE ALL NECESSARY PRECAUTIONS, AND TURN OFF ALL POWER TO A CIRCUIT BEFORE WORKING ON IT.

The setup is fairly simple, just make sure that the high voltage connections to the relay are secure:
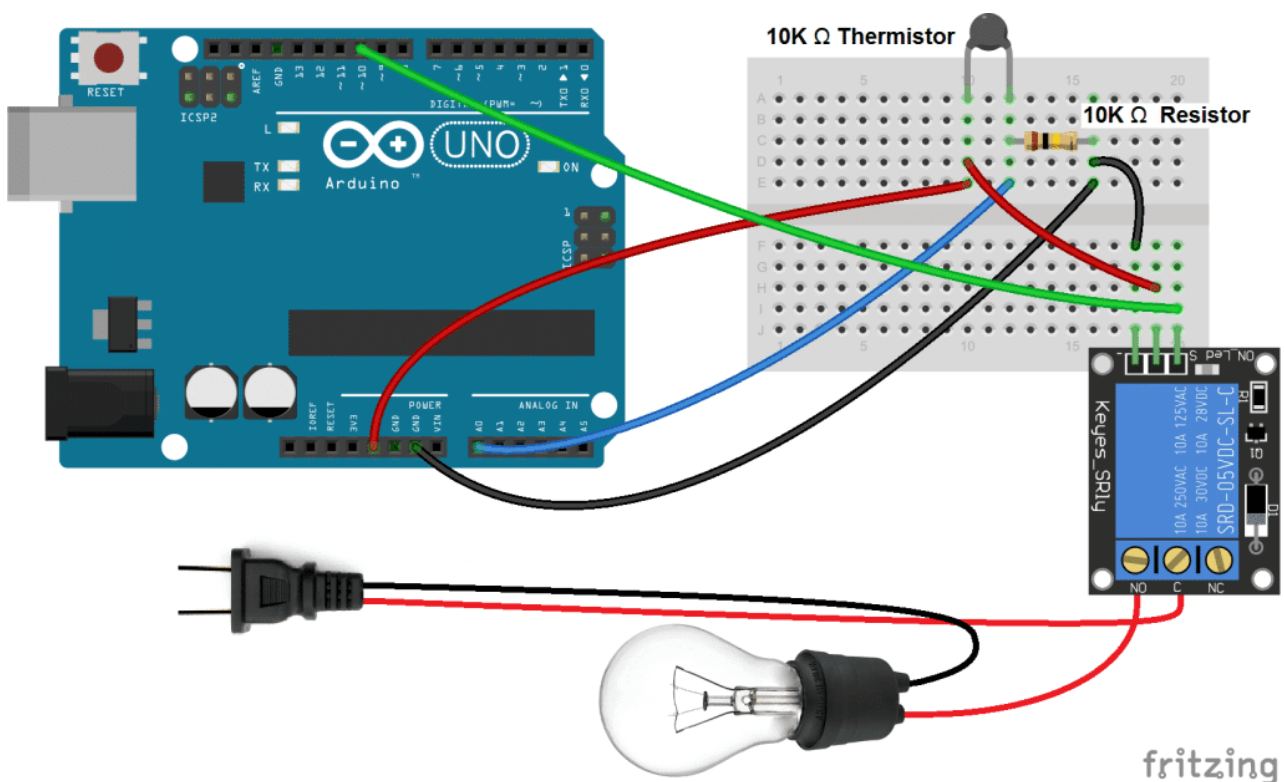
Identify the hot power wire (red wire in the diagram above) in the cord leading to the light bulb and make a cut. Connect the side leading to the light bulb to the NO terminal of the relay, and the side leading to the plug to the C terminal. This way the relay is on the hot side, and current is switched before it reaches the light bulb. It's dangerous to put the relay on the neutral wire, since if the device fails current can still fault to ground when the relay is off.

The thermistor part of the circuit is set up as a voltage divider. The value of the resistor should be the same order of magnitude as the thermistor. For example, I'm using a 10K Ω thermistor, so the resistor should be 10K Ω as well. If you use a 100K Ω thermistor, use a 100K Ω resistor.

If you do use a 100K Ω thermistor, you'll need to change line 7 in the code below to `Temp = log(100000.0*((1024.0/RawADC-1)));` . See our article on Making an Arduino Temperature Sensor for more information.

The Code

After everything is connected, upload this code to the Arduino:

```
#include <math.h>

int pinOut = 10;

double Thermistor(int RawADC) {
 double Temp;
 Temp = log(10000.0*((1024.0/RawADC-1)));
 Temp = 1 / (0.001129148 + (0.000234125 + (0.0000000876741 * Temp * Temp ))* Temp );
 Temp = Temp - 273.15;
 Temp = (Temp * 9.0)/ 5.0 + 32.0;
 return Temp;
}

void setup() {
 Serial.begin(9600);
 pinMode(10, OUTPUT);
}

void loop() {
 int val;
 double temp;
 val=analogRead(0);
 temp=Thermistor(val);
 Serial.print("Temperature = ");
 Serial.print(temp);
 Serial.println(" F");
 if (temp >= 150){
   digitalWrite(pinOut, LOW);
 }
 else {
   digitalWrite(pinOut, HIGH);
 }
 delay(500);
}
```

In this example, the relay will stay activated and let current flow through the light bulb until the temperature of the thermistor reaches 150°F. At 150°F the relay shuts off and the current stops. You can change the temperature in line 27 where it says `if (temp >= 150){` .
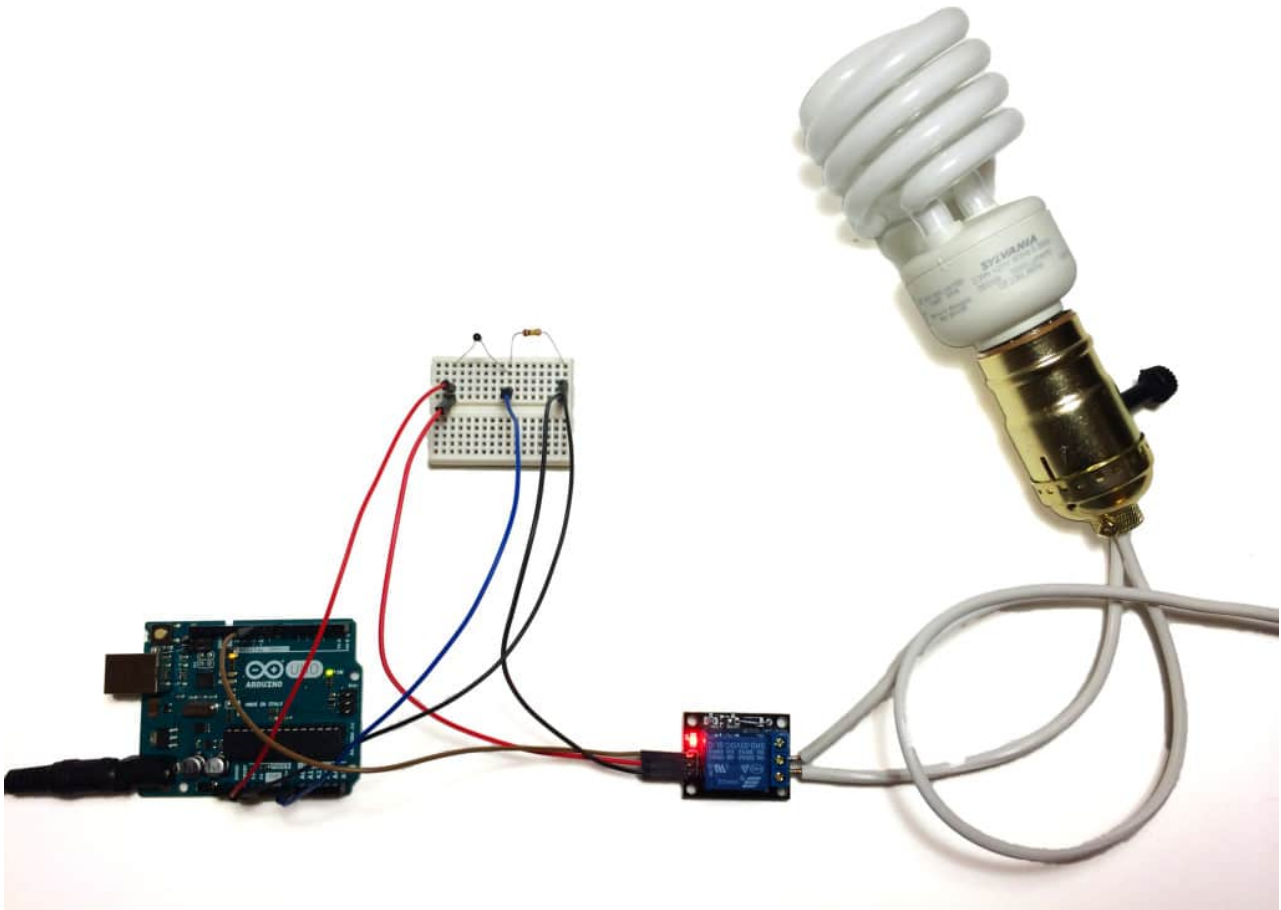
Here's a video you can watch of me wiring up the relay to see it in action:

Watch Video At: https://youtu.be/AHxG5aSWFi0

Another really useful project is a relay controlled power outlet box. This will let you plug any appliance into the outlet and control it with your Arduino without cutting into any power cords. You can also control several devices at the same time. See our tutorial "Turn Any Appliance into a Smart Device with an Arduino Controlled Power Outlet" to see how we built it.

Hope this is useful for you! Leave a comment if you have any questions. If you want us to let you know when we publish more tutorials, be sure to subscribe and share it if you know someone that would find it helpful. Thanks!

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