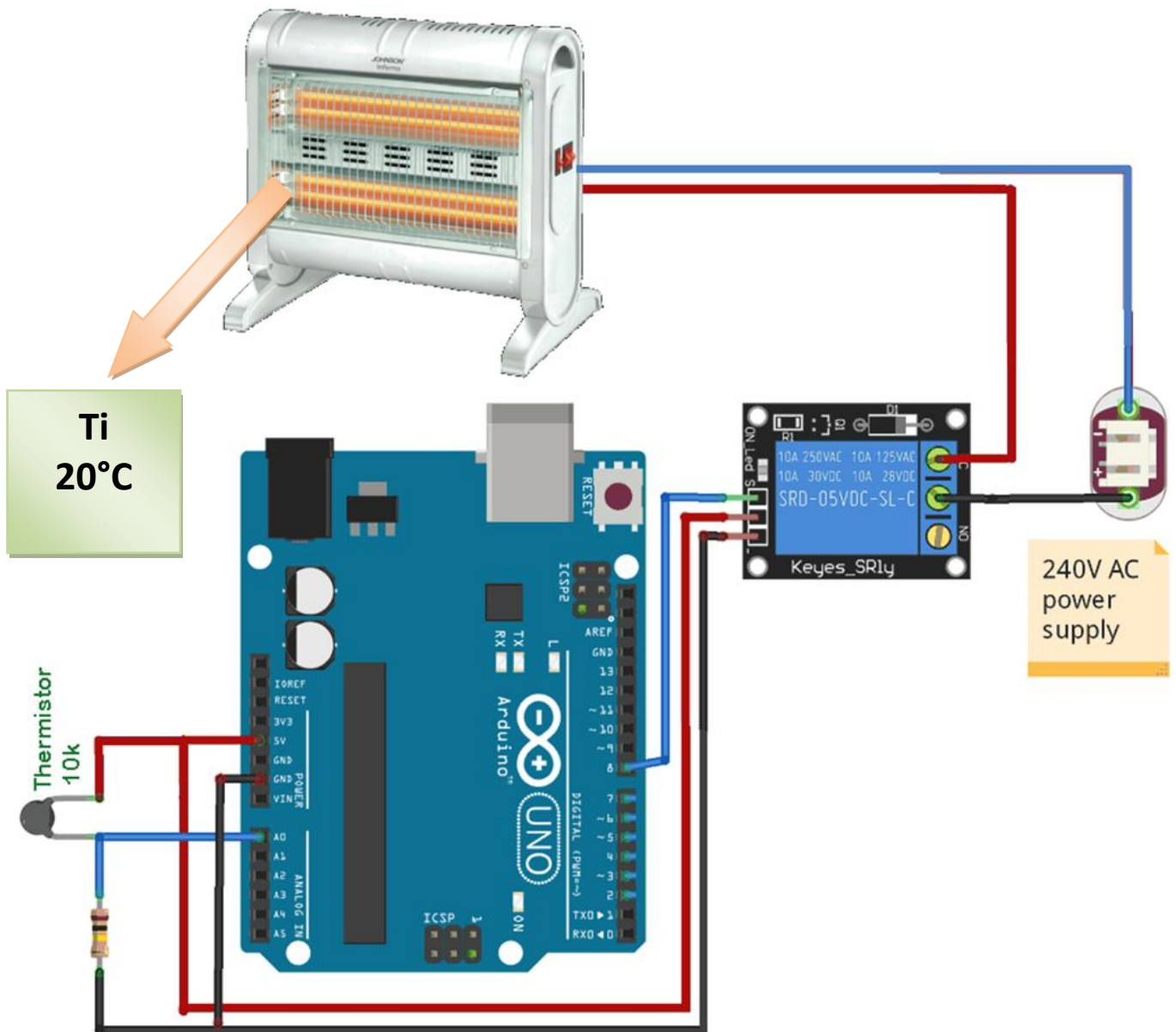


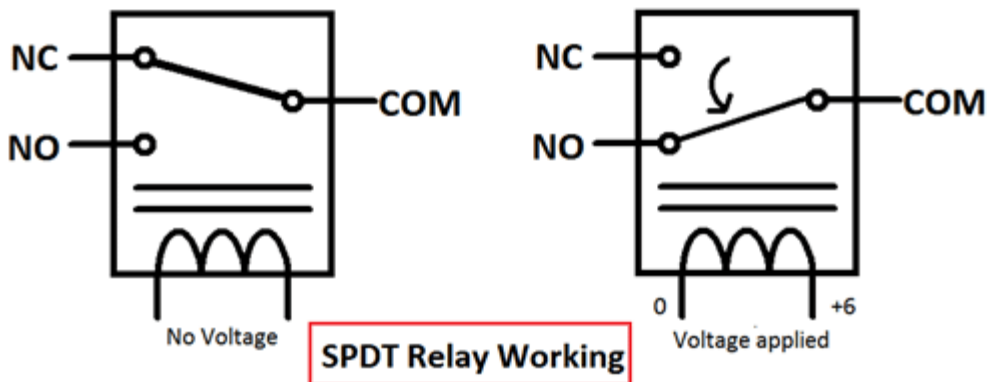
# Temperature automation system controlled by Arduino.

## Circuit Diagram



## Relay

[Relay](#) is an electromagnetic switch, which is controlled by small current, and used to switch ON and OFF relatively much larger current. Means by applying small current we can switch ON the relay which allows much larger current to flow. A relay is a good example of controlling the AC (alternate current) devices, using a much smaller DC current. Commonly used Relay is Single Pole Double Throw (SPDT) Relay, it has five terminals as below:

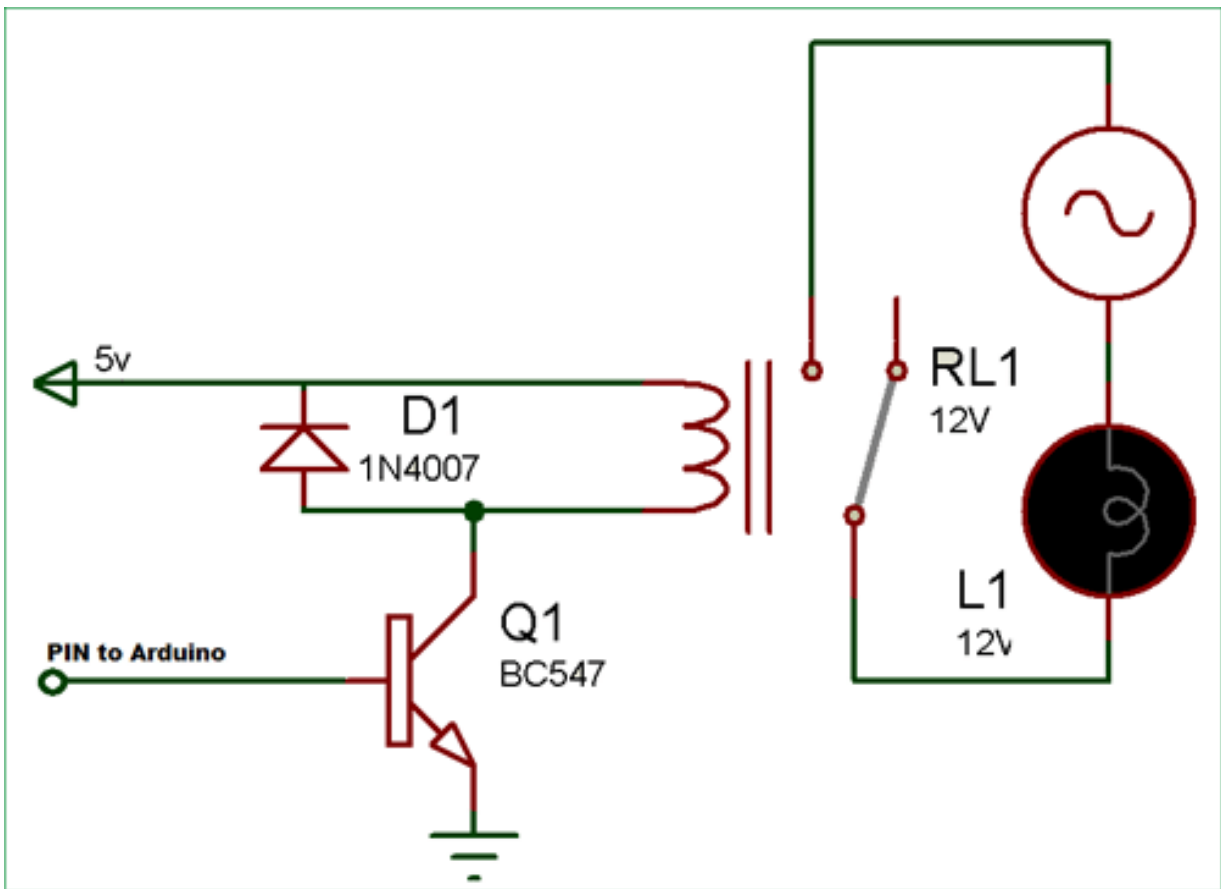


When there is no voltage applied to the coil, COM (common) is connected to NC (normally closed contact). When there is some voltage applied to the coil, the electromagnetic field produced, which attracts the Armature (lever connected to spring), and COM and NO (normally open contact) gets connected, which allow a larger current to flow. Relays are available in many ratings, here we used 5V operating voltage relay, which allows 7A-250VAC current to flow.

The relay is configured by using a small Driver circuit which consists a Transistor, Diode and a resistor. Transistor is used to amplify the current so that full current (from the DC source – 9v battery) can flow through a coil to fully energize it. The resistor is used to provide biasing to the transistor. And Diode is used to prevent reverse current flow, when the transistor is switched OFF. Every Inductor coil produces equal and opposite EMF when switched OFF suddenly, this may cause permanent damage to components, so Diode must be used to prevent reverse current. A Relay module is easily available in the market with all its Driver circuit on the board or you can create it by using above components. Here we have used 5V Relay module



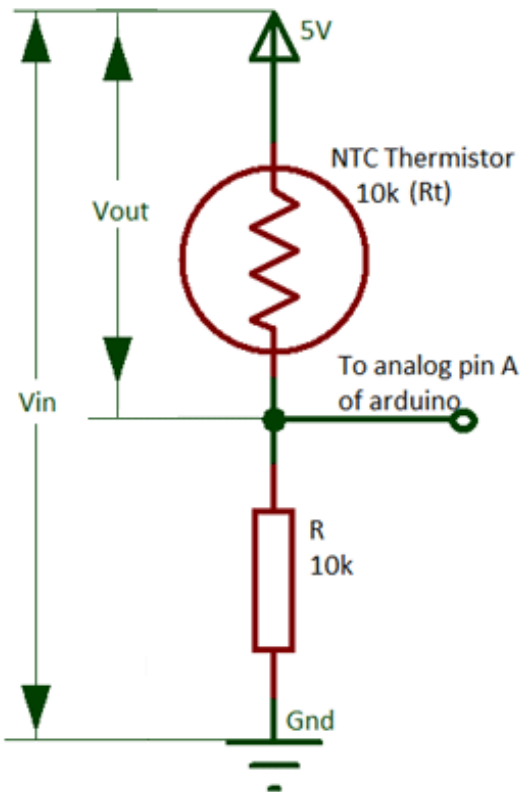
5v Relay Module



Relay Driver Circuit

## Calculating Temperature using Thermistor:

We know from the Voltage divider circuit that:



$$V_{out} = (V_{in} * R_t) / (R + R_t)$$

So the value of  $R_t$  will be:

$$R_t = R (V_{in}/V_{out}) - R$$

Here  $R_t$  will be the resistance of the thermistor ( $R_t$ ) and  $R$  will be 10k ohm resistor.

This equation is used for the calculation of thermistor resistance from the measured value of output voltage  $V_o$ . We can get the value of Voltage  $V_{out}$  from the ADC value at pin A0 of Arduino as shown in the Arduino Code given below.

Calculation of Temperature from the thermistor resistance

Mathematically the thermistor resistance can only be compute with the help of the Stein-Hart equation.

$$T = 1 / (A + B * \ln(R_t) + C * \ln(R_t)^3)$$

Where,  $A$ ,  $B$  and  $C$  are the constants,  $R_t$  is the thermistor resistance and  $\ln$  represents log.

The constant value for the thermistor used in the project is

$$A = 1.009249522 \times 10^{-3}, B = 2.378405444 \times 10^{-4}, C = 2.019202697 \times 10^{-7}.$$

These constant values can be obtained from the [calculator here](#) by entering the three resistance values of the thermistor at three different temperatures. You can either get these constant values directly from the datasheet of the Thermistor or you can get three resistance values at different temperature and get the Constants values using the given calculator.

So, for calculating the temperature we need the value of thermistor resistance only. After getting the value of  $R_t$  from the calculation given above put the values in the Stein-hart equation and we will get the value of temperature in the unit Kelvin. As there is a minor change in the output voltage cause change in the temperature.

## Arduino code

For performing mathematical operation we use Header file `"#include <math.h>"` and `"#define RELAY 8"` is used to assign the input pin for a relay.

```
#include <math.h>

#define RELAY 8
```

For setup the Relay (as an output) at the time of start we have to write code in the *void setup*

```
Void setup(){
    pinMode(RELAY, OUTPUT);
}
```

For the calculation of temperature by Stein-Hart equation using the electrical resistance of thermistor we perform some simple mathematical equation in code as explained in calculation above:

```
float a = 1.009249522e-03, b = 2.378405444e-04, c = 2.019202697e-07;
float T, logRt, Tc;
float Thermistor(int Vo) {
    logRt = log(10000.0*((1024.0/Vo-1)));
    // We get the temperature value in Kelvin from this Stein-Hart equation
    T = (1.0 / (a + b*logRt + c* logRt * logRt * logRt));
    Tc = T - 273.15;    // Convert Kelvin to Celsius
    return T;
}
```

In the below code the function thermistor is reading the value from the analog pin of the Arduino, and **print the temperature value** by performing the mathematical operation

```
serial.println((Thermistor(analogRead(0))));
```

And that value is taken by the *Thermistor* function and then the calculation is start printing

```
float Thermistor(int Vo)
```

We have to write the code for the condition of turning light ON and OFF according to the temperature as we set the temperature value like if the temperature increase more than 20 degree Celsius the lights will turn ON of if less the lights remain off.

So whenever the temperature goes above than 28 degrees, we need to **make the RELAY Pin (PIN 8) high to make the Relay module ON**. And when the temperature goes below 20 degrees, we need to **make the RELAY pin low to turn off the Relay Module**.

```
if (Tc > 20) {  
    digitalWrite(RELAY, HIGH);  
    delay(500);  
}  
else if (Tc < 20) {  
    digitalWrite(RELAY, LOW)  
    delay(500);  
}
```

## Working of Temperature Controlled Home Automation System:

To give the supply to the Arduino you can power it via USB to your laptop or connect 12v adapter. Relay is connected as per circuit diagram. The analog pin (A0) is used to check the voltage of thermistor pin at every moment and after the calculation using Stein-Hart equation through the Arduino code we are able to get the temperature and display it.

As the temperature increases more than 20 degree Celsius Arduino makes the Relay Module Turned On by making the Pin 8 HIGH (where the Relay module is connected) when the temperature goes below 20 Degree Arduino turns off the Relay Module by making the Pin LOW. CFL bulb will also turn On and Off according to Relay module.