Connecting a 12V relay to Arduino

Source: instructables

Components

In order to connect a 12 V relay to an Arduino, you need the following:

- 1 Arduino
- 1 diode (1N4007)
- 1 NPN transistor (BC548)
- 1 relay
- 1 multimeter

Step1 - Mesure the coil resistance

We are going to measure the coil resistance to calculate the current.

First we must find the coil:
On some relays the pins are labeled so you can just measure at pin 2 and 5.

Otherwise you have to measure at every pin:

Between two pins you should have between 100 Ω and 10,000 Ω. Remember that value. Those are the two terminals of the coil. The coil is not polarized so its not important which one goes to V+ or GND.

If you have found those, there are only three left. Between two should be a connection (if you measure a few Ω its okay but everything above 50 Ω is too much). One of them is NC and one is COM. To find out which is which let one probe connected and connect the other to the pin that's left over. If you connect the coil to 12 V DC it should make a clicking noise. If your multimeter now shows a low resistance you have found COM and NO. The one probe you didn't move is COM the other is NO.

On the RT1-1230, the coil resistance can be measured between pins 2 and 4.

Step 2 - Calculate the coil's current

The formula you need is a simple one:

I = V / R

According to the data sheet:

V = 12 V
R = 155 Ω
I = 77.0 mA

Arduino can handle up to 20 mA, but it's better to use a transistor even for currents as low as 15 mA.

Step 3 - Choose a transistor

The transistor should comply to the following:

- It has to be NPN
- I_c should be bigger than the value calculated in step 2
- V_{ceo} should be bigger than the supply voltage

The specifications for the BC548 are:

- NPN
- I_c = 100 mA
- V_{ceo} = 30 V

Step 4 - Calculate R_1

You can find the value of h_{fe} in the transistor's data sheet.
For the BC548, it's 75 at 10mA at 10V. Its not very precise because its very difficult to build a transistor with an accurate h_{fe}.

$I_b = I_c / h_{fe}$
$I_b = 77.0$ mA $/ 75$
$I_b = 1.03$ mA

Considering Arduino's output voltage to be 5 V, due to Ohm's Law:

$R_1 = V / I_b$
$R_1 = 5$ V $/ 1.03$ mA
$R_1 = 4{,}854.37\ \Omega$

This is not very accurate, so we'll use 10 kΩ. If it doesn't work, try using two 10 kΩ resistors in parallel.

Step 5 - Choose a diode

The diode is necessary because a sudden change in the inductor's current (in this case, caused by the relay's operation) will result in sharp rise in it's voltage. The formulae for a inductor's voltage is:

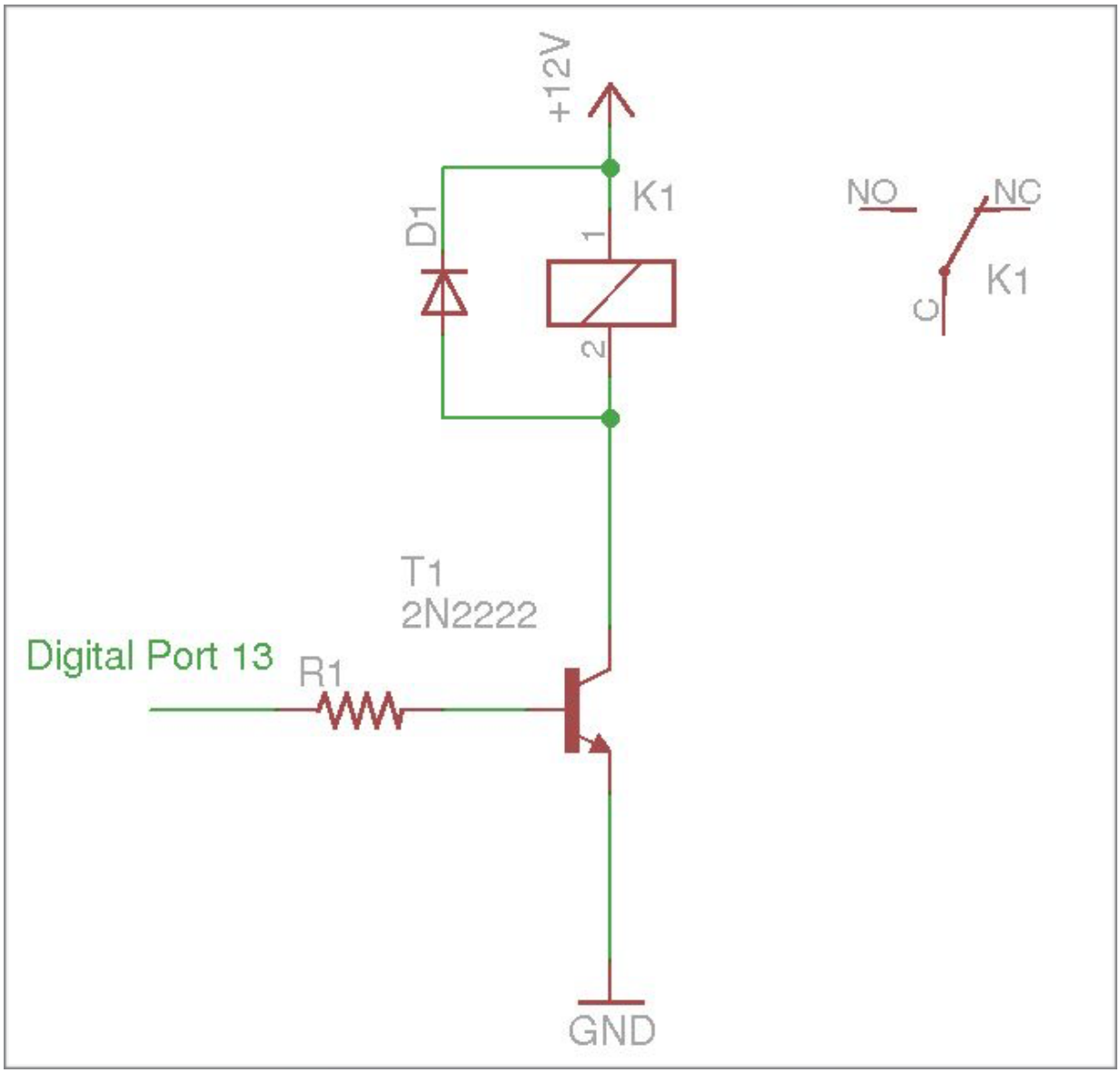
$V_L = - L * (\partial i / \partial t)$

So if ∂t equals zero, V will theoretically be infinite.

But, due to the minus in front, you can add an inverted diode parallel to the relay. This allows the current to flow till it's zero and, therefore, the voltage is also zero.

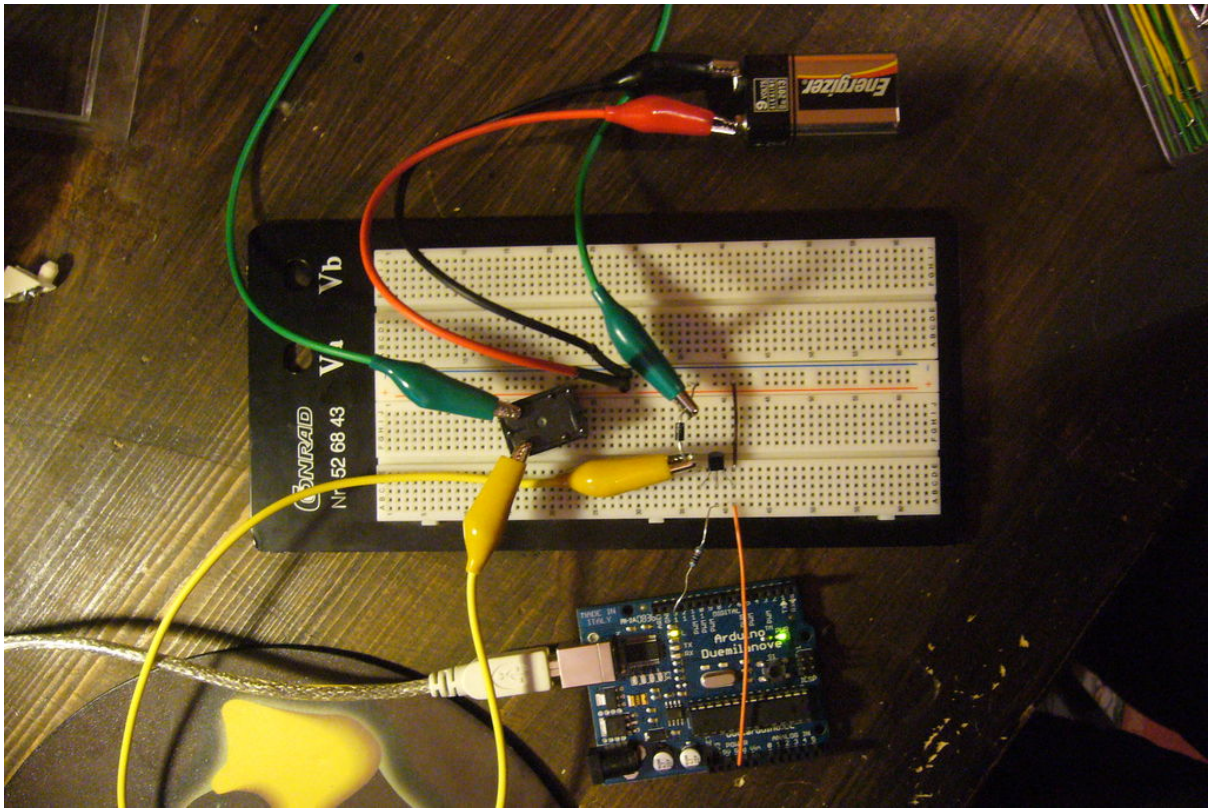
Step 6 - The schematic

Finally, here is the schematic:



Step 7 - Assembling the Circuit

The transistor’s data sheet says which pins are E, B and C.
Before you connect your Arduino, connect a 4.5 V battery’s negative terminal to GND and its positive terminal to R1. The relay should make a clicking noise if not, check your circuit.



Step 8 - The Program

The test program is just an edited version of the "Blink" example:

```
/* ----------------------------------------------------------------------
relayTest.ino
Author: gandalfsz
Date: 18 Jan 2009
Function: Toggles Pin 13 every 10 Seconds
---------------------------------------------------------------------- */

int outPin = 13;

void setup() {
    pinMode(outPin, OUTPUT);
}

void loop() {
    digitalWrite(outPin, HIGH);
    delay(10000);
    digitalWrite(outPin, LOW);
    delay(10000);
}
```