Module 1

Module_01_Potentiometer_0 — Potentiometer basics
In this module we will hook up a potentiometer and read it's voltage using a Arduino Nano.

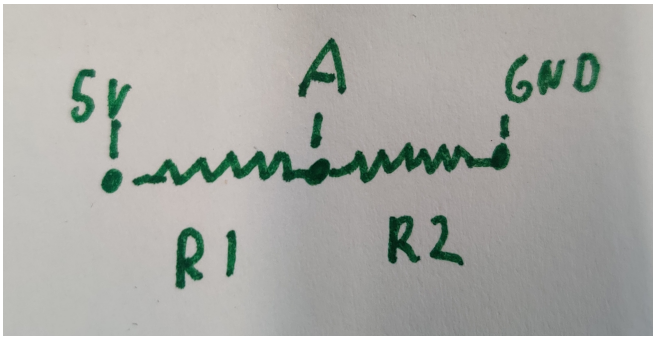
Setup
First install the Arduino IDE. You can download it from the Arduino website —> **https://arduino.cc/**

Now open Module_01_Potentiometer_0.ino

To upload the code you first need to select the **board** and the **serial port**. To to this click **tools->board** and select **Arduino Nano.** The Arduino nano that is in the kit is an old version so we need to select **tools—>processor—>Atmega328P(old bootloader).** Now select the correct serial port. It should be something like /dev/cu.usbserial-xxxx.

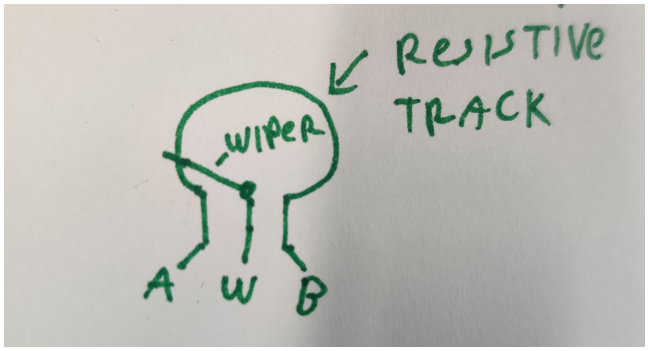
Now upload the software using **cmd+u**.

Before we can read the potentiometer's value we need to connect it to the Arduino. We will use the potentiometer as an **voltage-divider**. A **voltage-divider** is a circuit made from two resistors. The relation between the two resistors (R1 and R2) determines the voltage that is present at the point between the two resistors (A).

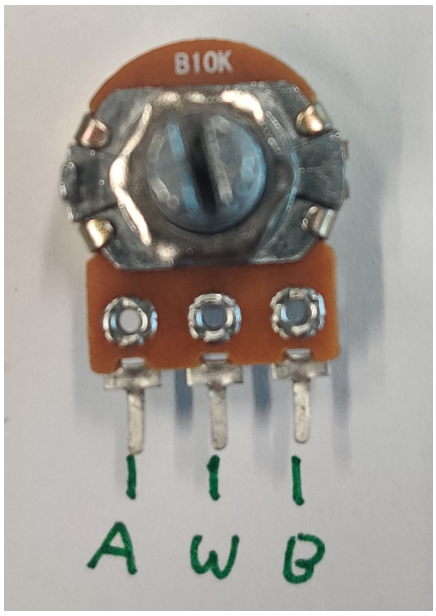


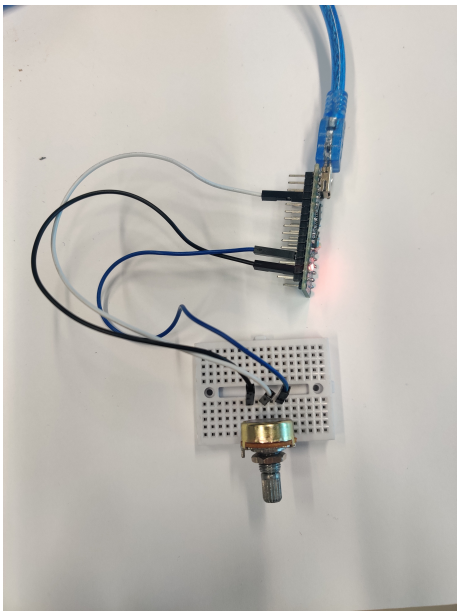
We can calculate the voltage at point A with the following formula:
*Vout = Vin * (R2 / (R1+R2))*
If R1 = 100 and R2 = 100 than Vout = 5 * (100 / (100+100)) = 2.5V
If R1 = 200 and R2 = 100 than Vout = 5 * (200 / (100+200)) = 3.33V

A potentiometer is a variable resistor. It consists of a resistive track and a wiper that makes contact to the resistive track. By moving the wiper across the track the resistance between A-W and W-B changes. If we connect point A to 5V and B to Ground the voltage at point W can be set by moving the wiper.

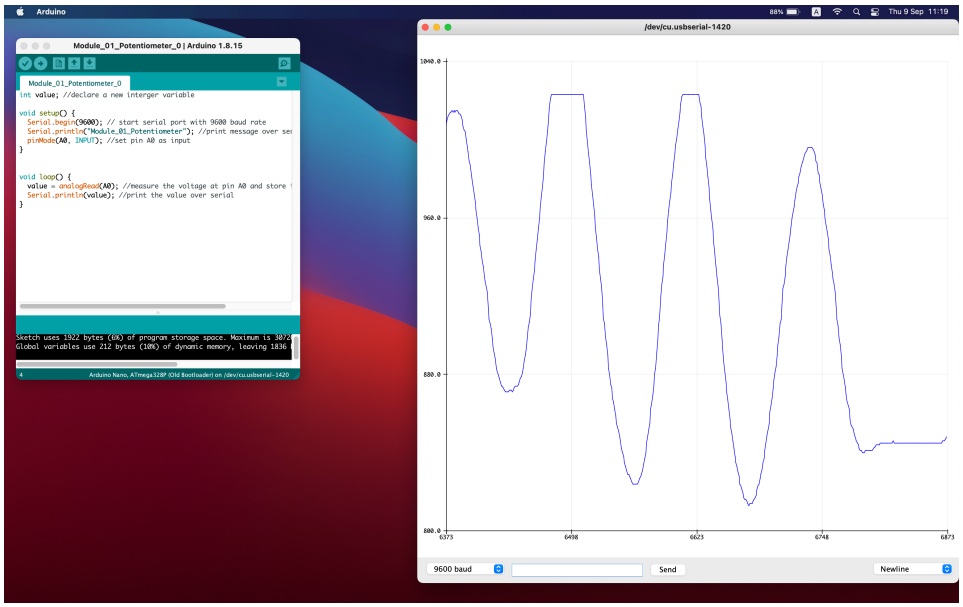


To use the potentiometer with the Arduino you need to connect A to 5V, W to A0 and B to GND.





Now open the serial plotter using **tools—>serial plotter**



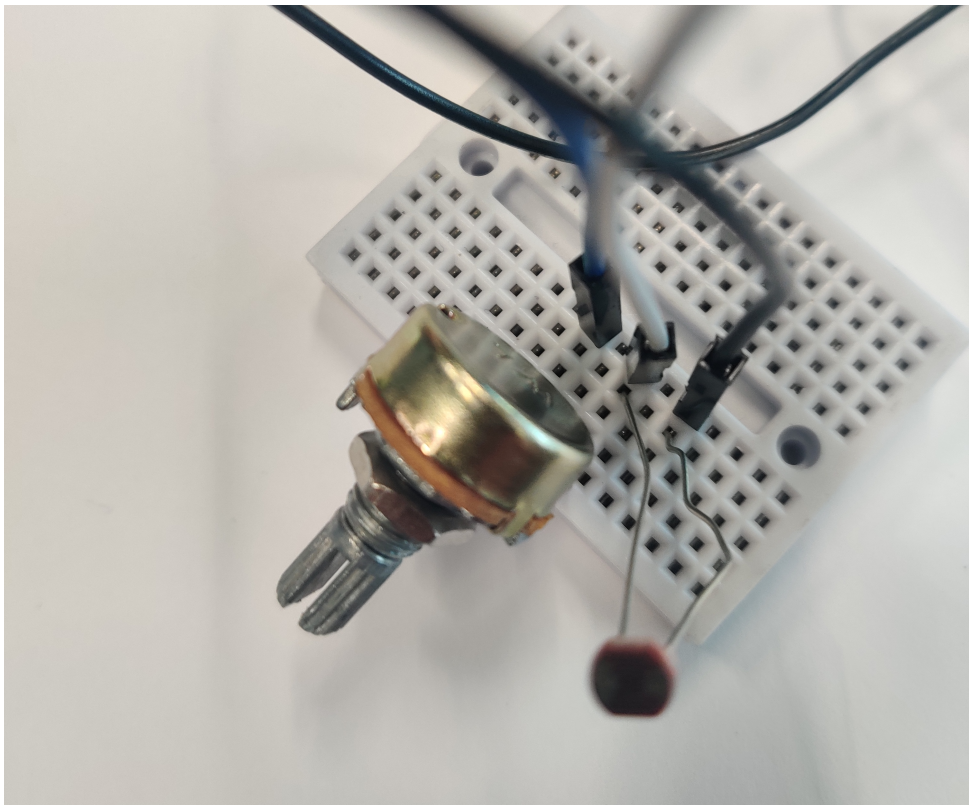
By moving the potentiometer we can see the value change in the serial plotter.

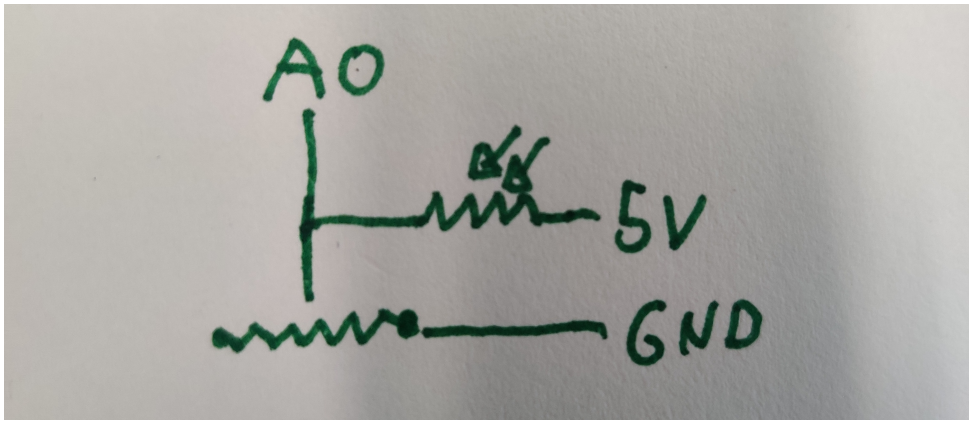
ADC
The Arduino uses a ADC (Analog to digital converter) to measure the voltage at the analog input. The Arduino ADC has a resolution of 10 bits and a voltage range between 0 and 5 volts. If we move the potentiometer from its minimum point to its maximum point we see that the value of the serial plotter goes from 0 to 1023. 1023 in this case means that the voltage is at (measurement/ max value of 10bit)*max voltage we can measure = 1023/1023 * 5 = 5 volts. If we put the wiper somewhere in the middle of the potentiometer we measure 512.

Module_01_Potentiometer_1— Digital filtering
In the previous example we used the analogRead function to measure the voltage from a potentiometer. Depending on the quality of the potentiometer the signal can be noisy. We can use digital filtering to get rid of this noise in exchange for a bit of measuring speed.

Upload Module_01_Potentiomter_1 to the Arduino.
With the function NiceRead we can sample the voltage at pin A0 a x amount of times to decrease the amount of noise. If we open the serial plotter again we can see that the measurement of the pin has less noise.

Module_01_LDR_0 — LDR basics
A LDR is a device that changes it's resistance with the amount of light that hits it. With a LDR and an normal resistor we can make a voltage divider. The voltage of the output of the voltage divider will change with the amount of light that's visible by the LDR. Usually a LDR is combined with a potentiometer to set the sensitivity of the LDR. Use a breadboard to hook up the LDR to the Arduino in the following way:





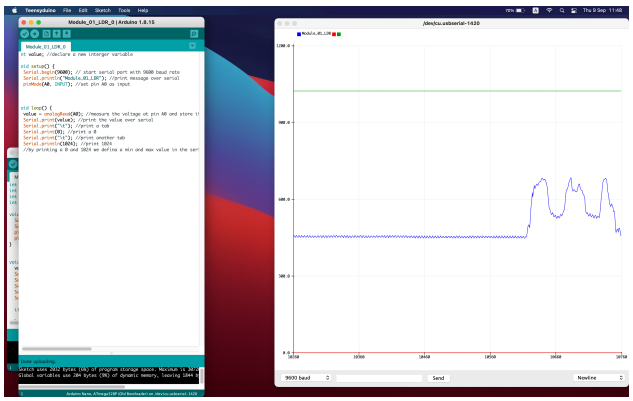
Now if we change the amount of light the resistance of the LDR changes and thus the voltage at A0 changes a well. Upload Module_01_LDR_0 to the Arduino. Now move you hand across the LDR and watch how the measurements change.

Module_01_LDR_1 — Digital Filtering
We can see that the output of the LDR is not very stable. Things like flickering lights etc have an effect on the measured voltage and we can use the same digital filtering as with the potentiometer to get rid of this noise.

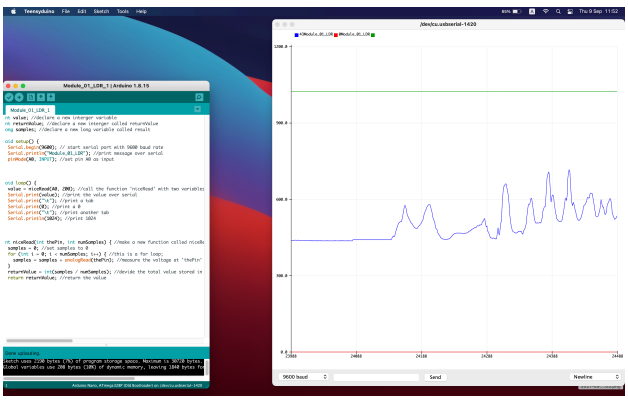
Module_01_LDR_2 — Controlling a LED with a LDR
The Arduino Nano has an onboard LED. We can switch this LED on and off using the measurements of the LDR. Upload Module_01_LDR_2 to the Arduino and watch how the onboard LED switches on and off when you in and decrease the amount of light on the LDR.

Module_01_LDR_3 — Analog Filtering

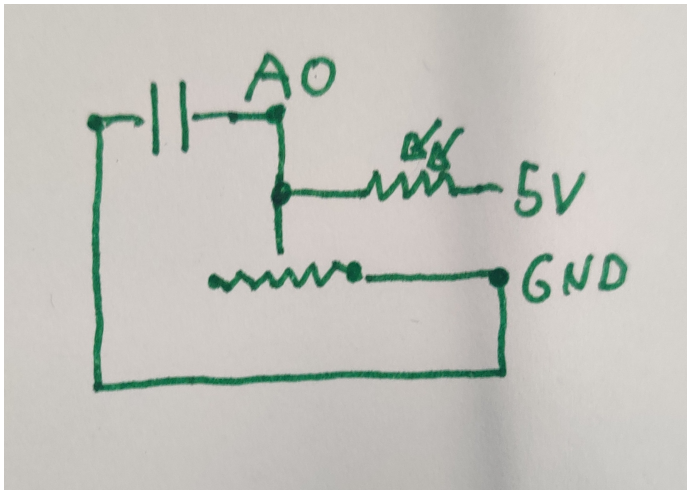
Instead of digital filtering we can do analog filtering on the sensor. We can do this with the help of a capacitor. The advantage of analog filtering is that the measuring speed of the Arduino is not slowed down.

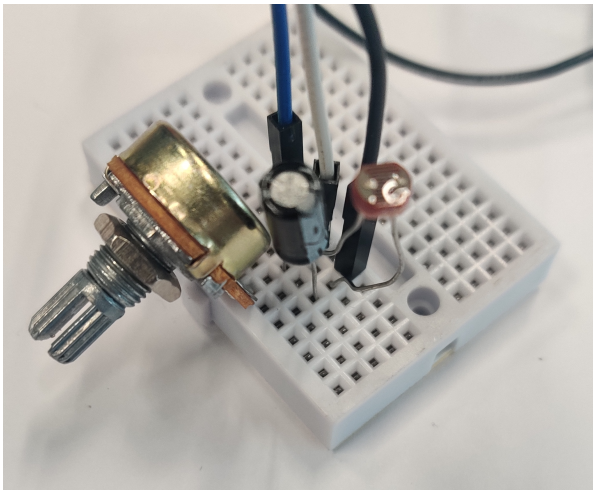


No filtering



Digital filtering





Add the capacitor between A0 and GND

Now if we upload Module_01_LDR_3 and we check the serial plotter we see that the noise from from the sensor is gone. We can adjust the amount of filtering by changing the capacitor's value. If we increase the capacitance the filtering increases but the reaction time of the sensor also decreases so we have to find the right balance.