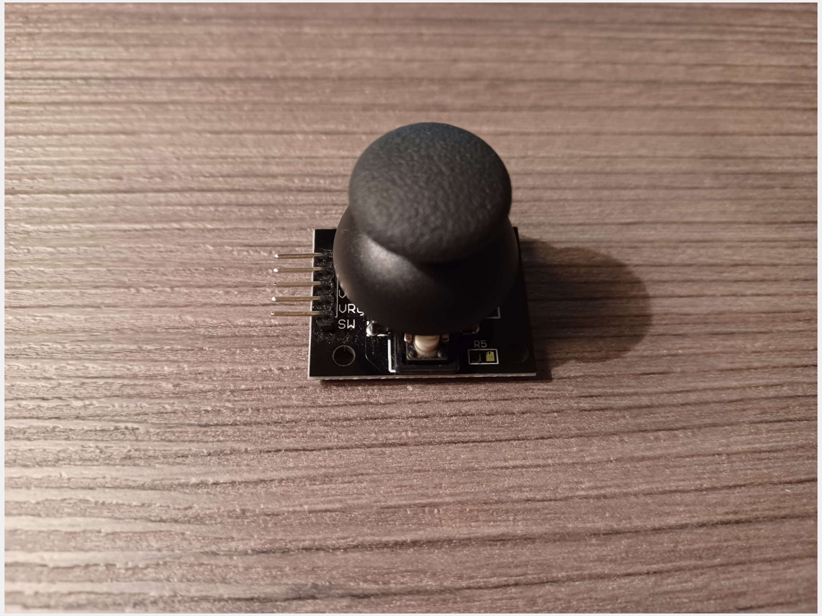
Introduction to Potentiometers and Analog Sticks



Voltage dividers

A **voltage divider** (in this context) is 2 resistors in series which, when measuring between the 2 resistors, can output a fraction of the input voltage.

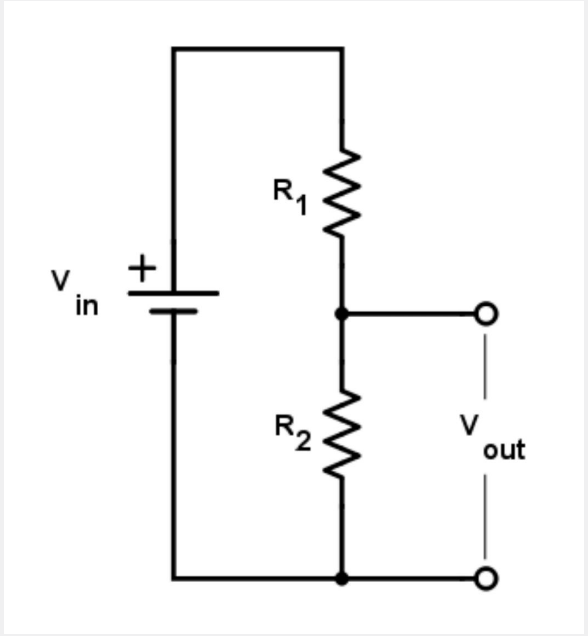
$V_{R1} = (R1 / (R1 + R2)) * V_{in}$

Vin is 5V, R1 is a 5KΩ, R2 is 2KΩ. What is the value of Vout?

$V_{R1} = (5000\Omega / (5000\Omega + 2000\Omega)) * (5V) = 3.57\ V$

If 3.57V is dissipated at R1, then the Vin source between the 2 resistors turns into 5V - 3.57V = 1.43V = Vout.

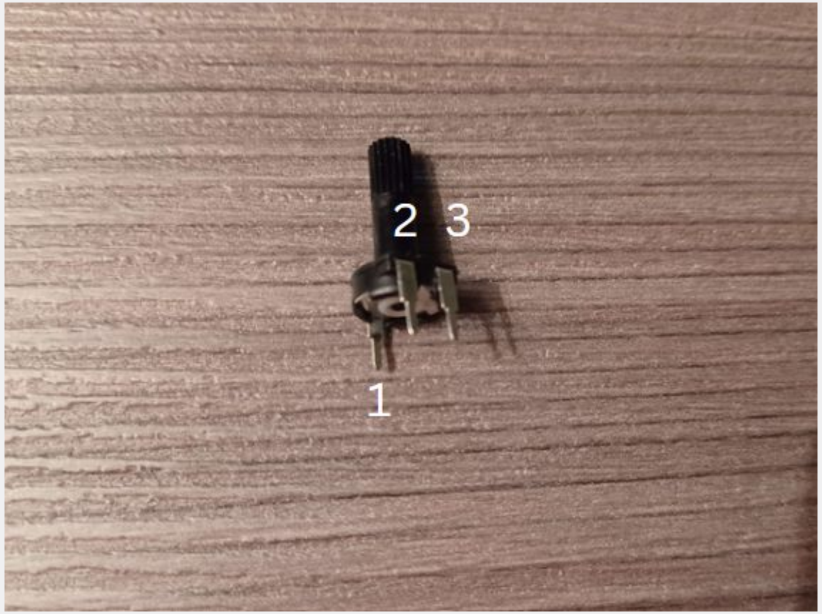
Derivation of voltage divider equation:
https://www.khanacademy.org/science/electrical-engineering/ee-circuit-analysis-topic/ee-resistor-circuits/a/ee-voltage-divider



Introduction to potentiometers

Potentiometers are made with a resistive element connecting 2 and 3, and a “wiper” at 1 that changes the ratio of the resistance on 2 and 3.

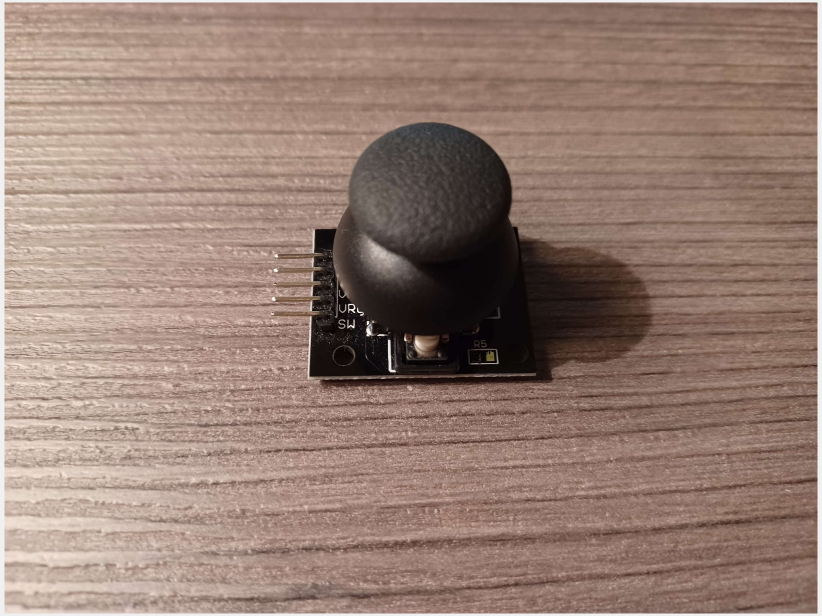
It’s easier to explain it as 2 resistors in series, R1 (at 2) and R2 (at 3). R1 and R2 add up to 10KΩ, and the values of R1 and R2 can change based on a rotating knob. By measuring the voltage in between the 2 resistors, potentiometers function like **voltage dividers**.



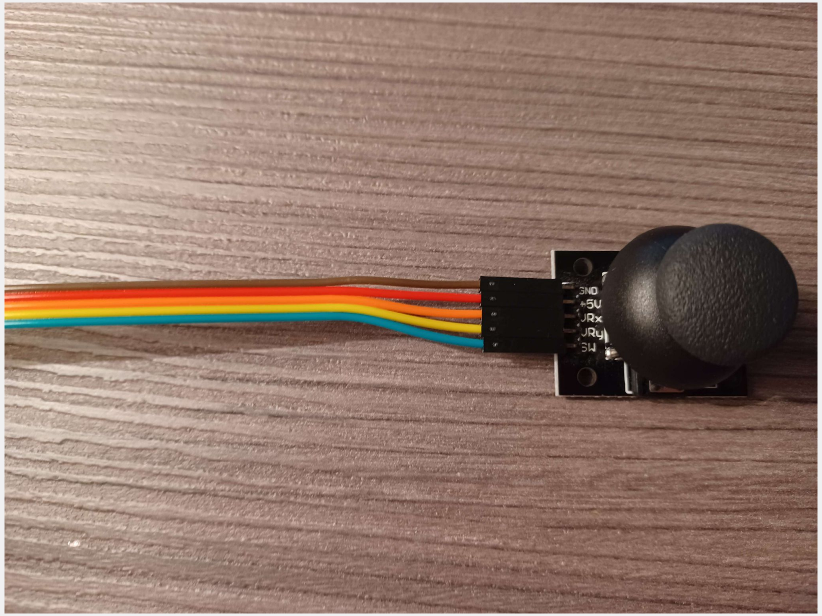
Potentiometer relation to analog sticks

The arduino analog sticks are potentiometer-based.

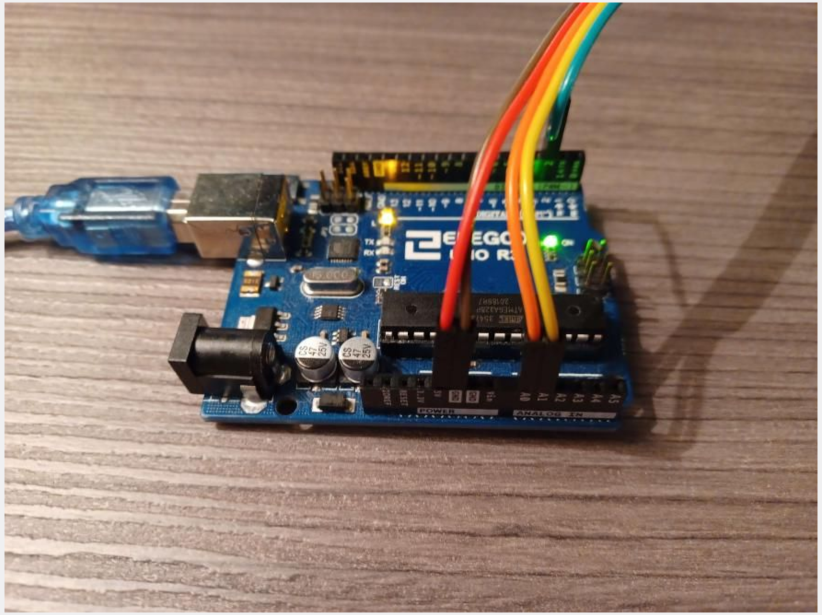
There are 2 potentiometers, controlling either the X or Y direction. The voltage divider output can function as an analog signal, to represent how far the analog stick is moved to the left/right or top/bottom.



Analog stick hardware implementation



Brown: GND, Red: 5V, Orange: VRx, Yellow: VRy, Green: SW

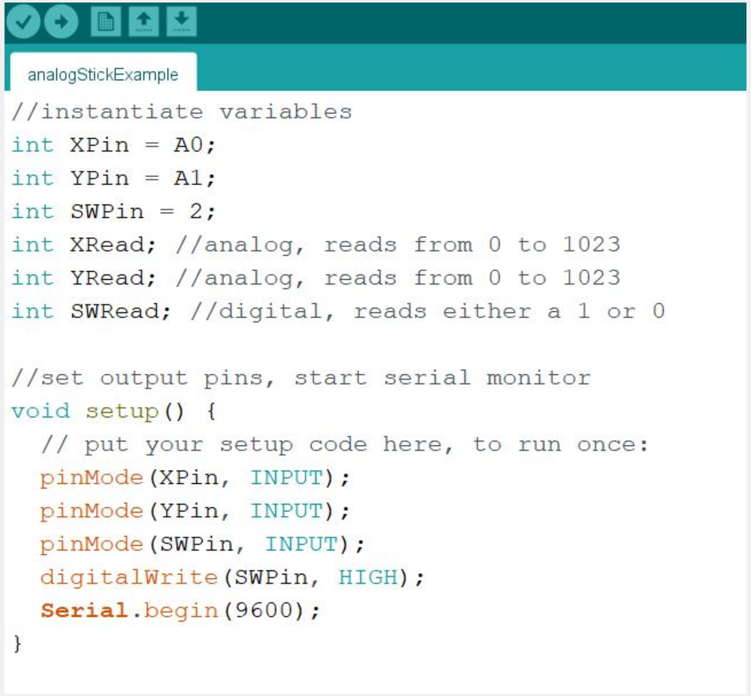

Brown: GND, Red: 5V, Orange/Yellow: Analog, Green: Digital

Analog stick code

The first block of code instantiates the variables to tell the program that VRx is at A0 (the 0th analog pin) and is given the name XPin, and so on.

digitalWrite(SWPin, HIGH); Enables the pull-up resistor for the SWPin. An unpressed button is at 5V (1), a pressed button is at 0V (0).

Serial.begin(9600); Data is sent to the serial port, which acts like a console. 9600 is the baud rate, which specifies that 9600 bits of data are transmitted per second.



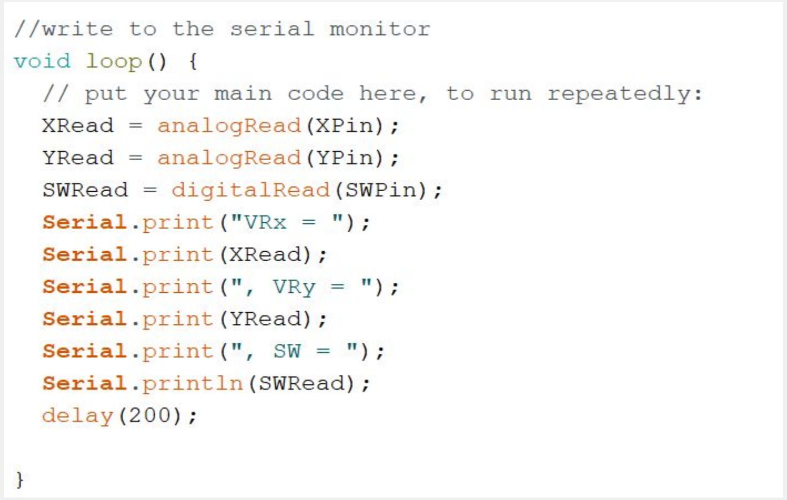
```
//instantiate variables
int XPin = A0;
int YPin = A1;
int SWPin = 2;
int XRead; //analog, reads from 0 to 1023
int YRead; //analog, reads from 0 to 1023
int SWRead; //digital, reads either a 1 or 0

//set output pins, start serial monitor
void setup() {
  // put your setup code here, to run once:
  pinMode(XPin, INPUT);
  pinMode(YPin, INPUT);
  pinMode(SWPin, INPUT);
  digitalWrite(SWPin, HIGH);
  Serial.begin(9600);
}
```

Analog stick code

Every 200ms, the value of VRx, VRy, and SW is read and printed into the serial monitor.

Serial.print(); Print to the serial monitor.

Serial.println(); Print to the serial monitor, then start a new line.



```
//write to the serial monitor
void loop() {
  // put your main code here, to run repeatedly:
  XRead = analogRead(XPin);
  YRead = analogRead(YPin);
  SWRead = digitalRead(SWPin);
  Serial.print("VRx = ");
  Serial.print(XRead);
  Serial.print(", VRy = ");
  Serial.print(YRead);
  Serial.print(", SW = ");
  Serial.println(SWRead);
  delay(200);

}
```

Serial monitor output

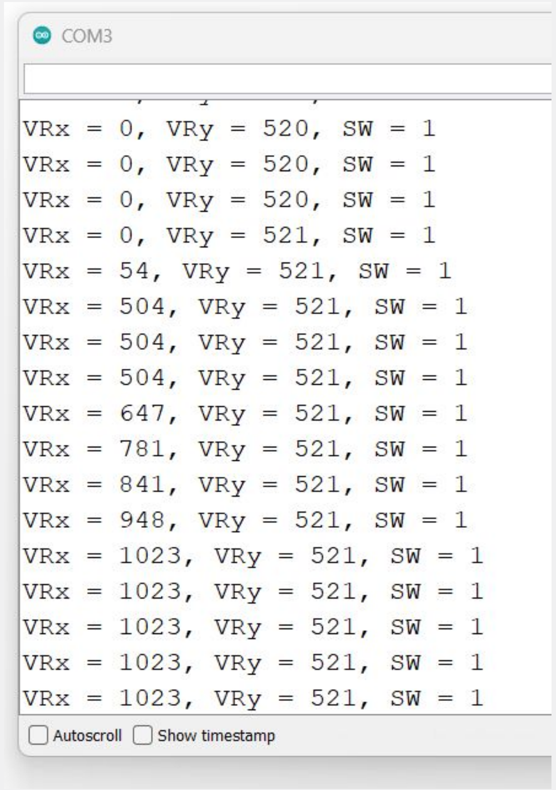
When the analog stick is unpushed, it is in the center of the possible analog values (1023 / 2 = ~512).

For **VRx**, the analog value is 0 at the left and 1023 at the right.

For **VRy**, the analog value is 0 at the top and 1023 at the bottom.

What does the serial monitor output on the right represent?

The analog stick starts at the left (0), is centered in the middle (504), and is slowly pushed to the right (1023). It is not pushed in the y direction, so the value remains at the middle (~521). The button is not pressed, so the SW value remains as 1.



```
VRx = 0, VRy = 520, SW = 1
VRx = 0, VRy = 520, SW = 1
VRx = 0, VRy = 520, SW = 1
VRx = 0, VRy = 521, SW = 1
VRx = 54, VRy = 521, SW = 1
VRx = 504, VRy = 521, SW = 1
VRx = 504, VRy = 521, SW = 1
VRx = 504, VRy = 521, SW = 1
VRx = 647, VRy = 521, SW = 1
VRx = 781, VRy = 521, SW = 1
VRx = 841, VRy = 521, SW = 1
VRx = 948, VRy = 521, SW = 1
VRx = 1023, VRy = 521, SW = 1
VRx = 1023, VRy = 521, SW = 1
VRx = 1023, VRy = 521, SW = 1
VRx = 1023, VRy = 521, SW = 1
VRx = 1023, VRy = 521, SW = 1
```