ADC in Arduino

Introduction

- When we interface sensors to the microcontroller, the output of the sensor many of the times is analog in nature. But microcontroller processes digital signals.
- Hence, we use ADC in between sensor and microcontroller. It converts an analog signal into digital and gives it to the microcontroller.
- There are many applications of ADC like in a biometric application, Environment monitoring, Gas leakage detection etc.
- Arduino Uno has 6 On-board ADC channels which can be used to read analog signal in the range 0-5V.
- It has 10-bit ADC means it will give digital value in the range of 0 – 1023 (2^10). This is called as resolution which indicates the number of discrete values it can produce over the range of analog values.

Digital Output value Calculation

ADC Resolution = Vref / ((2^n) - 1)

Digital Output = Vin / Resolution

Where,

Vref - The reference voltage is the maximum value that the ADC can convert.

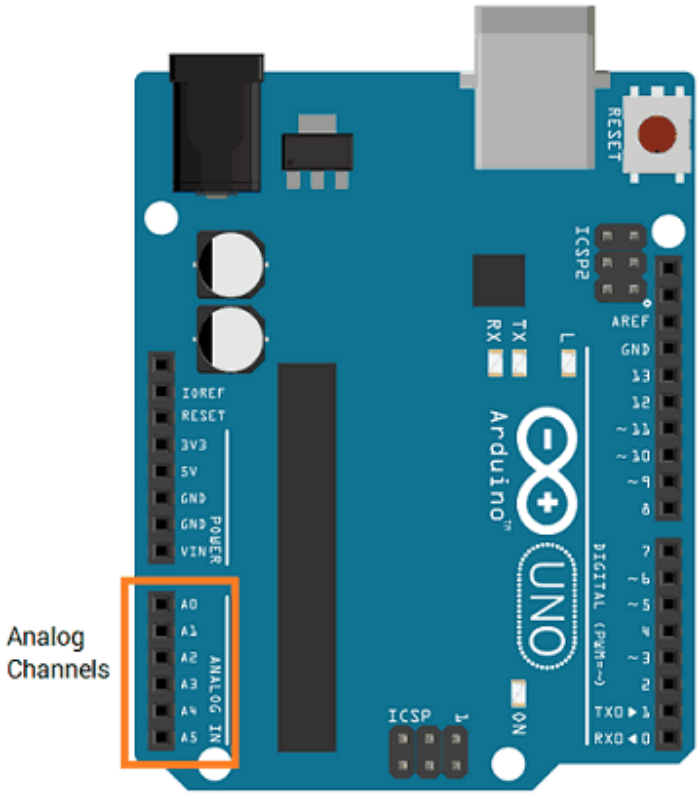
To keep things simple, let us consider that Vref is 5V,

For 0 Vin, digital o/p value = 0

For 5 Vin, digital o/p value = 1023 (10-bit)

For 2.5 Vin, digital o/p value = 512 (10-bit)

ADC Pins of Arduino Uno



Arduino ADC pins

Functions for Arduino ADC

- **analogRead (pin)**

  This function is used to read analog value from specified analog pin.

  pin - number of analog pin which we want to read

  returns - digital value 0 – 1023

  e.g. analogRead(A0) //read analog value at A0 channel

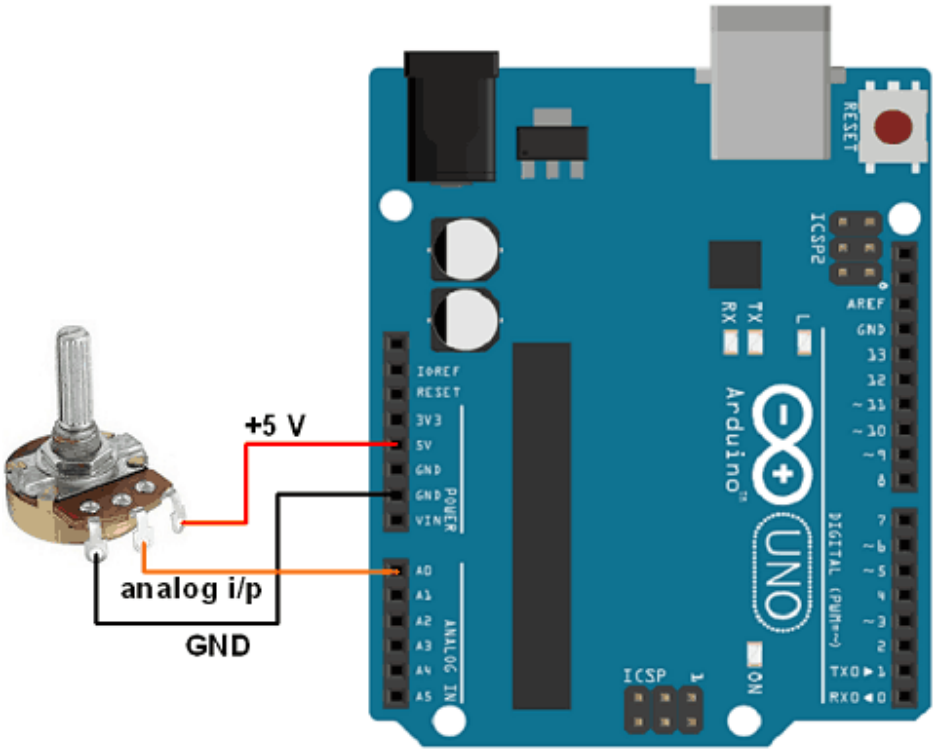
- **analogReference (type)**

  This function is used for configuring the reference voltage used for analog input.

Read Analog value using Arduino

Let's write a program to read varying analog value generated using potentiometer which is connected to A0 analog channel. Display the digital value on Serial monitor which we got from the Arduino ADC.

Interfacing Diagram



Potentiometer connected Arduino ADC Channel

Sketch for reading analog value

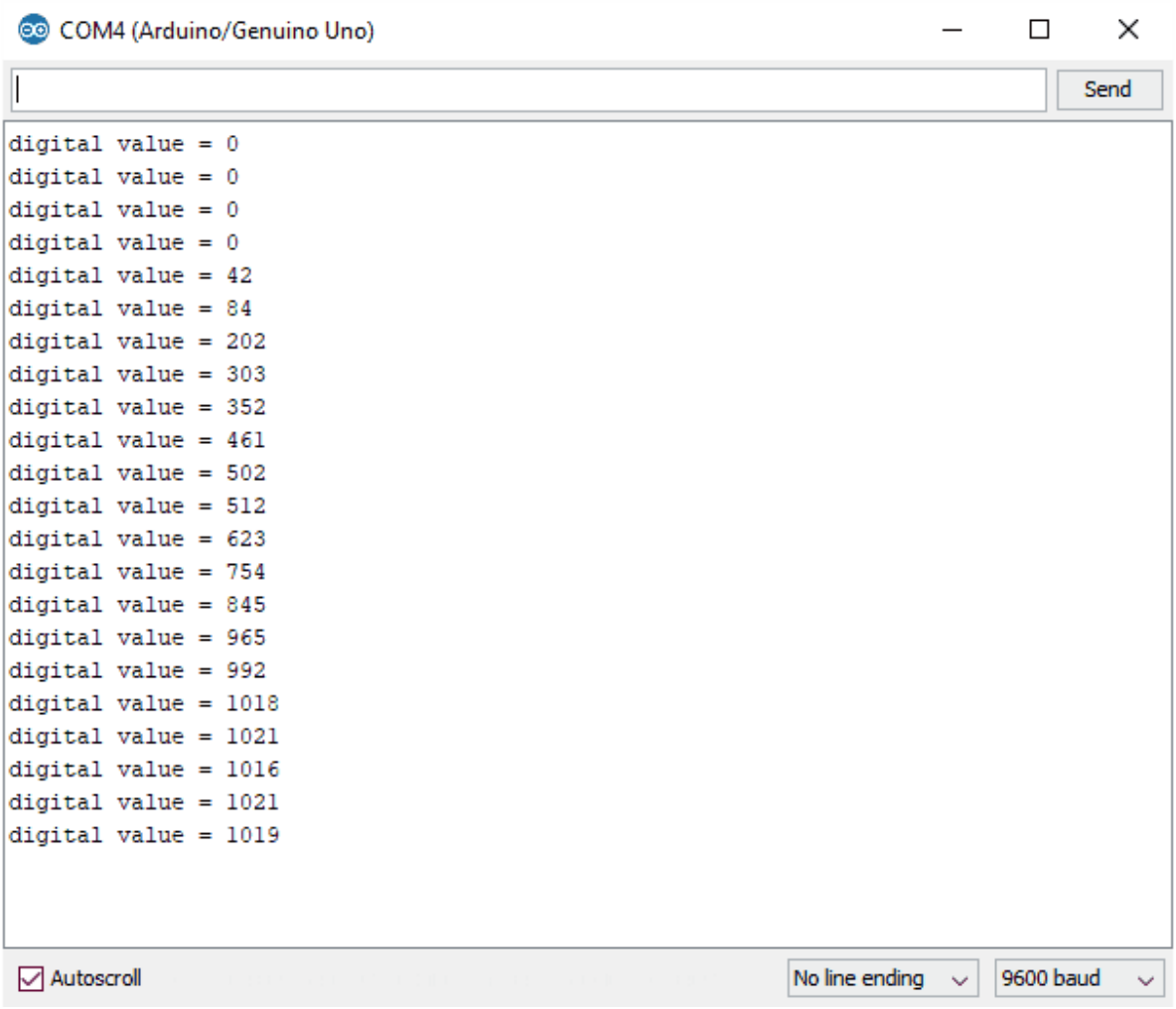
```
int sensorPin = A0;   // input pin for the potentiometer
int digitalValue = 0;// variable to store the value coming from the sensor

void setup() {
  Serial.begin(9600);
}

void loop() {
  digitalValue = analogRead(sensorPin);// read the value from the analog channel
  Serial.print("digital value = ");
  Serial.println(digitalValue);          //print digital value on serial monitor
  delay(1000);
```

```
}
```

Output on Serial Monitor



Note: If nothing is connected to analog input channel then the analogRead () function return the noisy fluctuating value.

Read Analog Voltage using Arduino Uno

As ADC provide digital output which is proportional to analog value. To know what is input analog value, we need to convert this digital value back to analog value through program. To convert this digital value to analog input voltage,

Aout = digital value * (Vref/2^n – 1)

e.g. digital value = 512 and ADC is 10-bit with 5V Vref. But, we want to know that for what analog voltage it is giving respective digital value. Then,

Aout = 512 * (5 V / 1023)

= 2.5 V

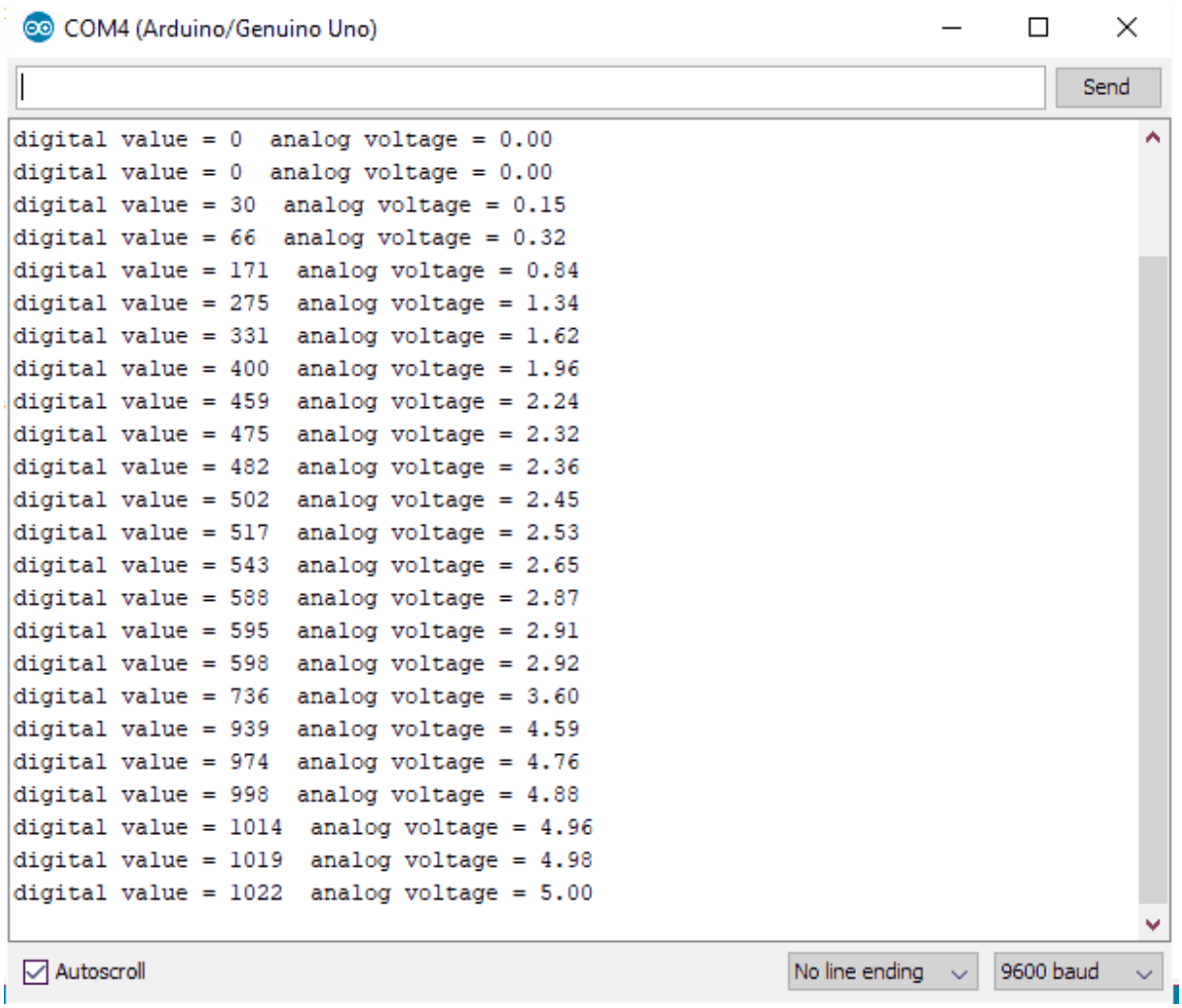
Sketch for reading Analog Voltage using Arduino

```
int sensorPin = A0;    // select the input pin for the potentiometer
int digitalValue = 0;  // variable to store the value coming from the sensor
float analogVoltage = 0.00;

void setup() {
  Serial.begin(9600);
}

void loop() {
  digitalValue = analogRead(sensorPin);// read the value from the analog channel
  Serial.print("digital value = ");
  Serial.print(digitalValue);          //print digital value on serial monitor
  //convert digital value to analog voltage
  analogVoltage = (digitalValue * 5.00)/1023.00;
  Serial.print("  analog voltage = ");
  Serial.println(analogVoltage);
  delay(1000);
}
```

Output on Serial Window


COM4 (Arduino/Genuino Uno)
Send
digital value = 0 analog voltage = 0.00
digital value = 0 analog voltage = 0.00
digital value = 30 analog voltage = 0.15
digital value = 66 analog voltage = 0.32
digital value = 171 analog voltage = 0.84
digital value = 275 analog voltage = 1.34
digital value = 331 analog voltage = 1.62
digital value = 400 analog voltage = 1.96
digital value = 459 analog voltage = 2.24
digital value = 475 analog voltage = 2.32
digital value = 482 analog voltage = 2.36
digital value = 502 analog voltage = 2.45
digital value = 517 analog voltage = 2.53
digital value = 543 analog voltage = 2.65
digital value = 588 analog voltage = 2.87
digital value = 595 analog voltage = 2.91
digital value = 598 analog voltage = 2.92
digital value = 736 analog voltage = 3.60
digital value = 939 analog voltage = 4.59
digital value = 974 analog voltage = 4.76
digital value = 998 analog voltage = 4.88
digital value = 1014 analog voltage = 4.96
digital value = 1019 analog voltage = 4.98
digital value = 1022 analog voltage = 5.00
Autoscroll
No line ending
9600 baud