

Introduction to Soft Robotics

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Part 1: Arduino 101

Arduino Uno and Serial communication



Arduino IDE 1.8.19

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. This software can be used with any Arduino board.

Refer to the [Getting Started](#) page for Installation instructions.

SOURCE CODE

Active development of the Arduino software is [hosted by GitHub](#). See the instructions for [building the code](#). Latest release source code archives are available [here](#). The archives are PGP-signed so they can be verified using [this](#) gpg key.

DOWNLOAD OPTIONS

Windows Win 7 and newer

Windows ZIP file

Windows app Win 8.1 or 10 [Get](#)

Linux 32 bits

Linux 64 bits

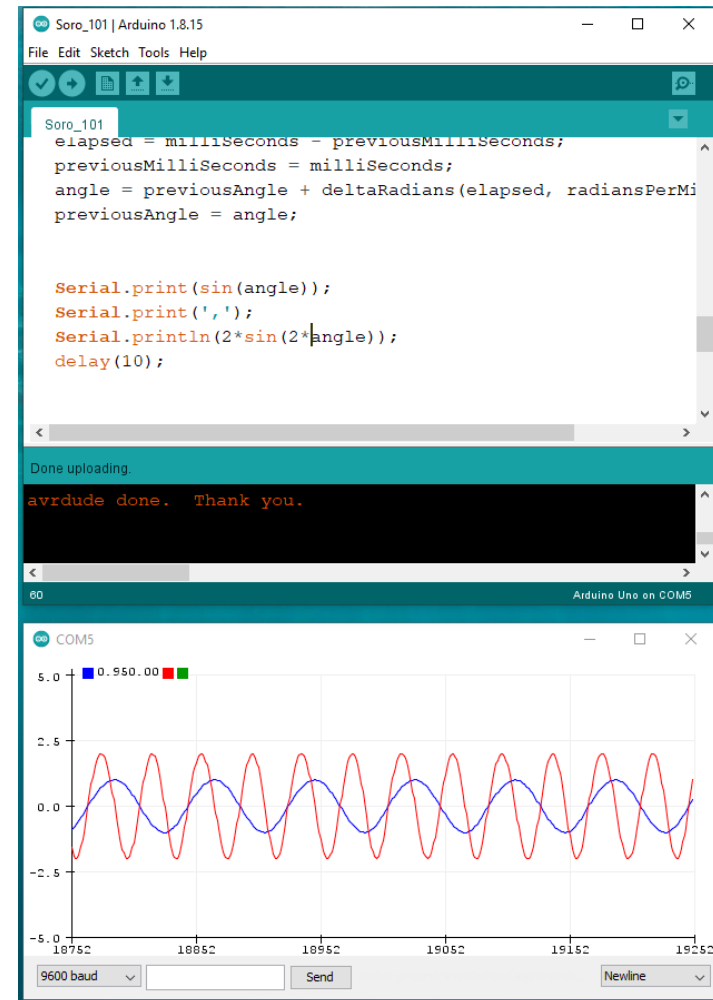
Linux ARM 32 bits

Linux ARM 64 bits

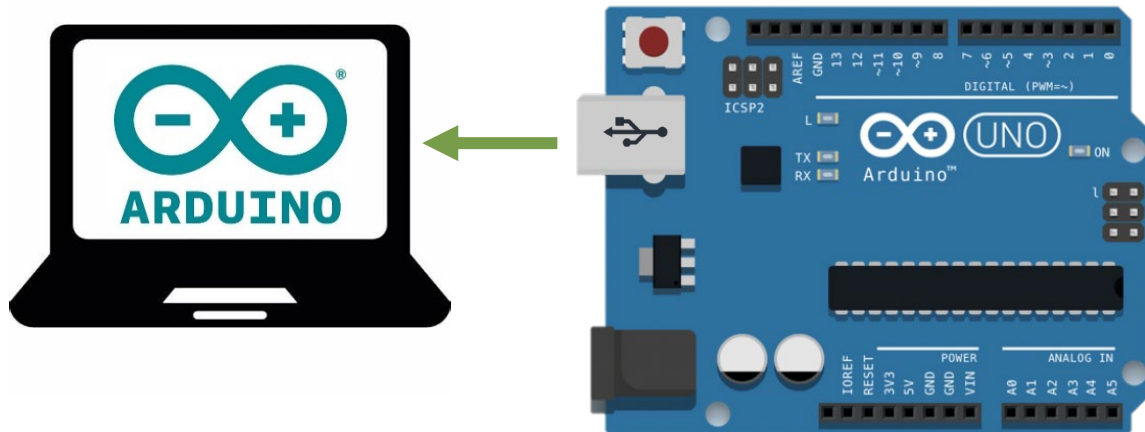
Mac OS X 10.10 or newer

[Release Notes](#)

[Checksums \(sha512\)](#)



SoRo_101 QR code



Part 2: MPX5100 Integrated Silicon Pressure Sensor

MPX5100, 0 to 100 kPa, Differential, Gauge, and Absolute, Integrated, Pressure Sensor

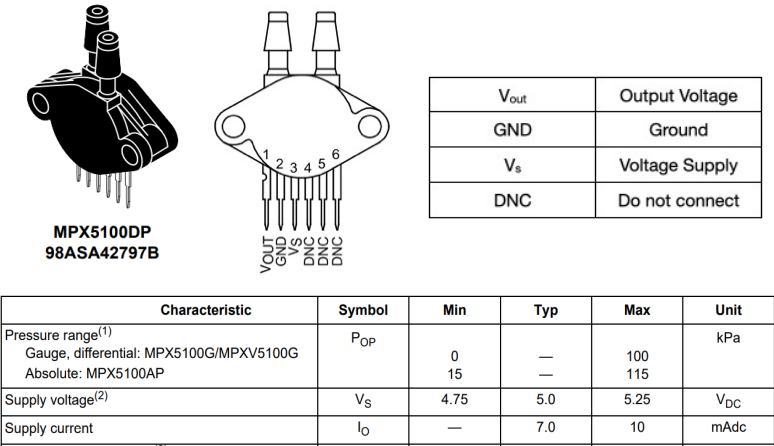


Figure 1. MPX5100DP Pinout (top view), Pin functions, and mechanical and electrical specifications

Nominal Transfer Value:

$$V_{OUT} = V_S (P \times 0.009 + 0.04)$$
$$\pm (\text{Pressure Error} \times \text{Temp. Mult.} \times 0.009 \times V_S)$$

$V_S = 5.0 \text{ V} \pm 0.25 \text{ V}$

Figure 8. Transfer function (MPX5100D, MPX5100G, MPXV5100G)

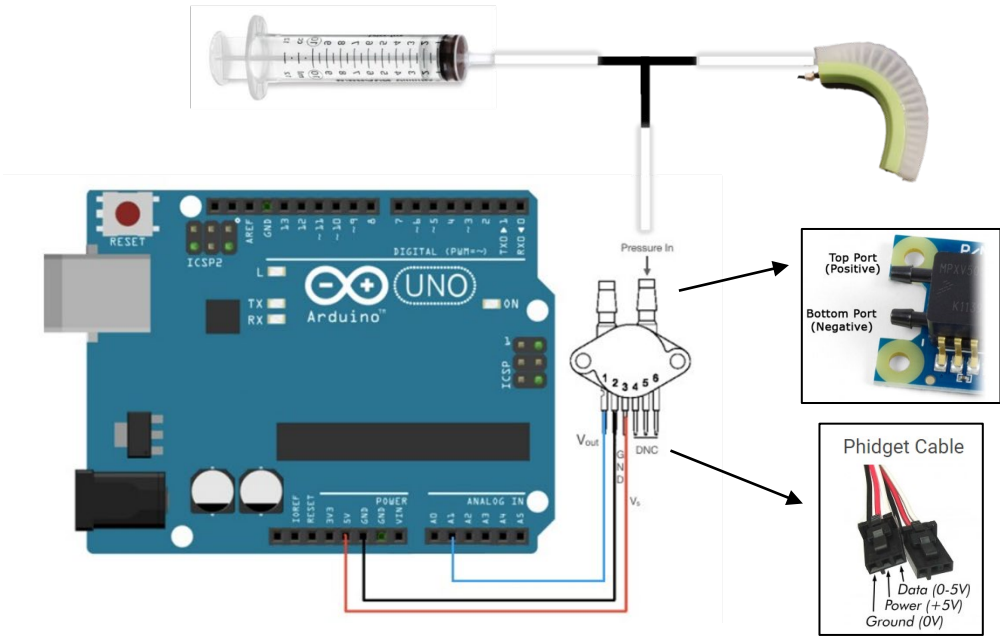


Figure 2. MPX5100DP – Arduino connection diagram

Code Information

Arduino libraries

- Download ads Arduino driver at [GitHub Link](#)
- Copy folder **ads_driver** into **Arduino/Libraries** folder
- Open the **ads.h** file located at **ads_driver** folder
- Change the command **ADS_DFU_CHECK(1)** to **ADS_DFU_CHECK(0)**
- Save the changes
- Download **SoRo_Tutorial_1** sketch at [GitHub Link](#)

Arduino Calibration

- Compile and Upload **SoRo_Tutorial_1** sketch at Arduino Uno Device
- Open the serial monitor
- Put the Bendlabs sensor in the 0° position
- Type **0** and press **Enter**
- Put the Bendlabs sensor in the 90° position
- Type **9** and press **Enter**



Ads_driver QR code



SoRo_Tutorial_1 QR code

Code Information

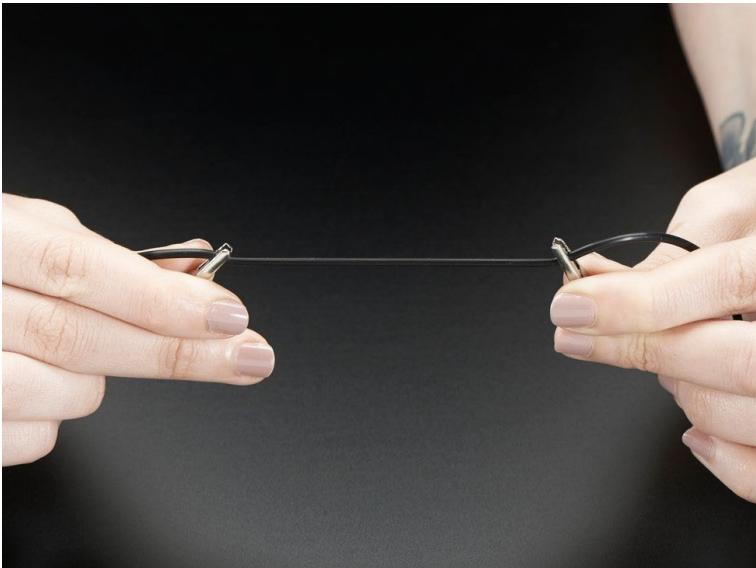
Arduino Calibration and plotting

```
//Pressure sensor calibration factors  MPX5100 Series Integrated Silicon Pressure Sensor analog input (0 to 100 kPa)  Vout=Vs(P * 0.009 + 0.04),  Vs=5V = 1024,  P =  
  
const float SensorOffset = 4.44;  //pressure sensor offset  
const float SensorGain = 0.109;  // pressure sensor proportional relation
```

```
// read the input on analog pin 1:  
float pressure_sensorValue = (analogRead(PRESSURE_SENSOR)*SensorGain-SensorOffset); //Do maths for calibration
```

```
Serial.print(sample[0]);    // Angle data  
Serial.print(",");  
Serial.print(pressure_sensorValue);    // pressure data in kpa  
Serial.print(",");  
Serial.println(resistance_sensorValue);  // Stretch data
```

Part 3: Conductive Rubber Cord Sensor



TECHNICAL DETAILS

Length: approximately 1 meter = 39 inches
Diameter: 2mm
Resistance: 350-400 ohms per inch / 140 - 160 ohms per centimeter

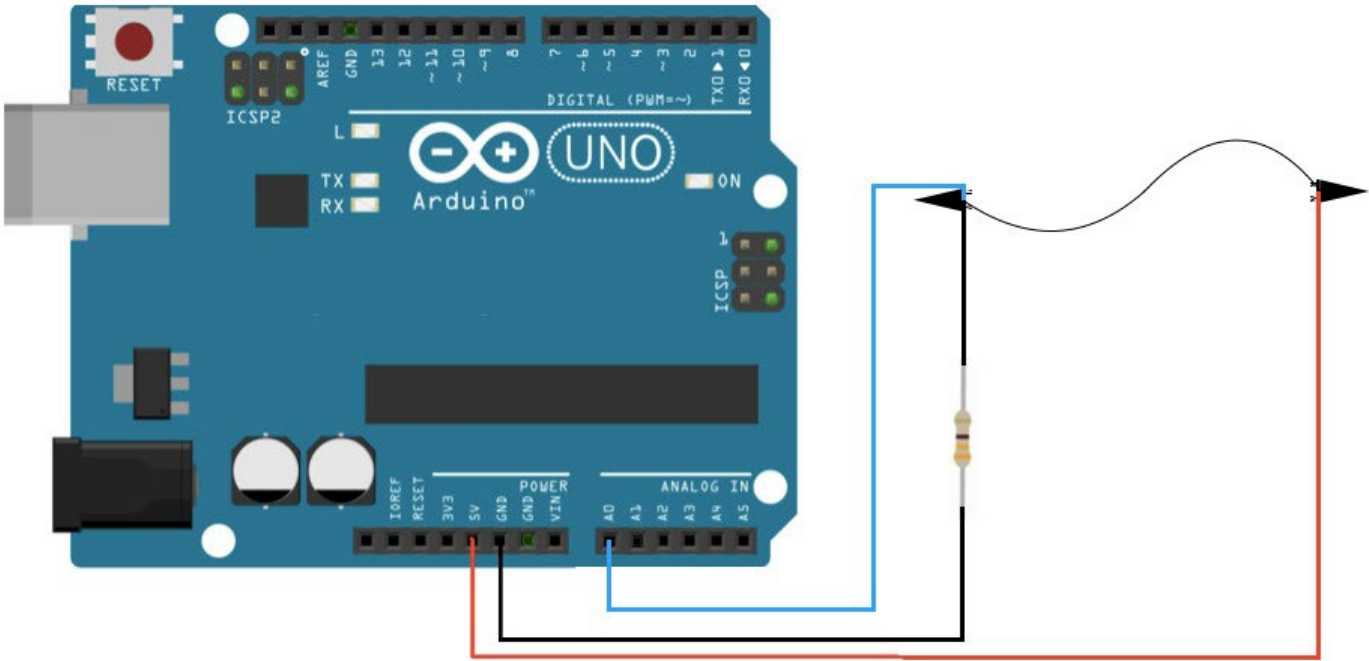


Figure 1. Conductive Rubber Cord Sensor – Arduino connection diagram

Code Information

Arduino Calibration and plotting

```
//Pressure sensor calibration factors |  
  
const float SensorOffset2 = 330; //pressure sensor offset  
const float SensorGain2 = 337590; // pressure sensor proportional relation
```

```
// read the input on analog pin 0:  
float resistance_sensorValue = (SensorGain2/analogRead(RUBBER_SENSOR)-SensorOffset2); //Do maths for calibration
```

```
Serial.print(sample[0]); // Angle data  
Serial.print(",");  
Serial.print(resistance_sensorValue); // pressure data in kpa  
Serial.print(",");  
Serial.println(resistance_sensorValue); // Stretch data
```

Part 4: Bendlabs sensor



bendlabs

One Axis

Sensor Specifications

- Dimensions: 100mm x 7.62mm x 1.27mm (3.94in x 0.30in x 0.05in)
- Average Sensitivity: 0.274 pF/°
- Repeatability: 0.18°
- Life Cycle: >1M cycles

Electrical Specifications

- Sensitivity: 0.016° LSB
- Voltage: 1.62 - 3.63V
- Output: I²C

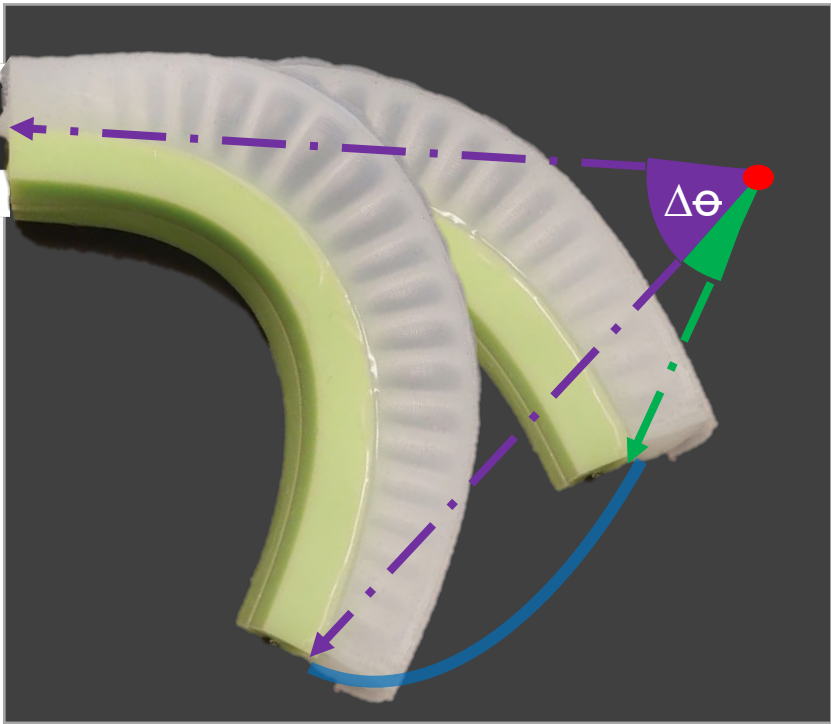
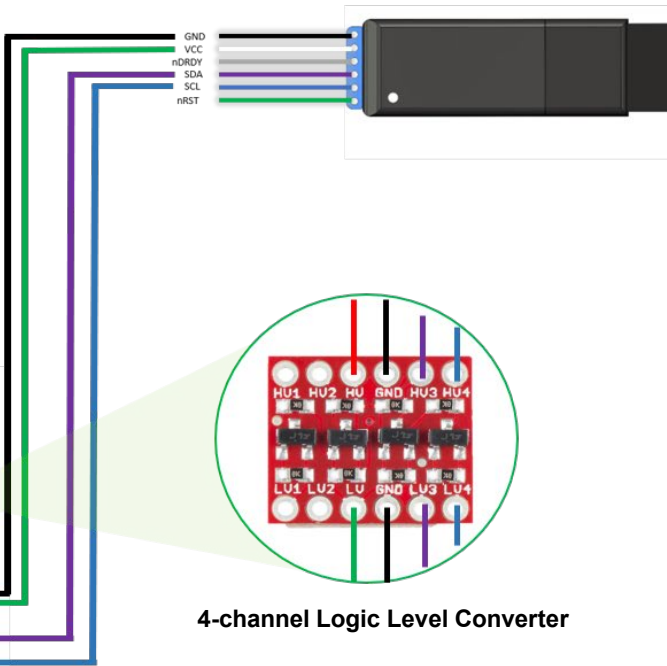
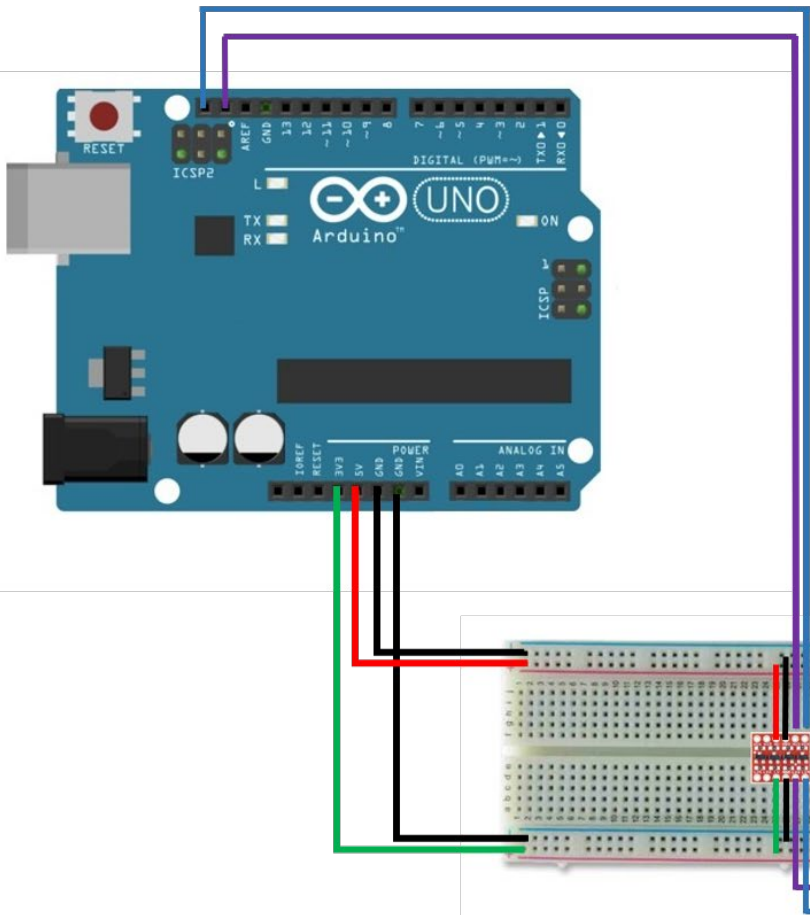


Figure 1. Bendlabs sensor – Logic Level Converter – Arduino connection diagram

Code Information

Arduino Calibration and plotting

```
//BendSensor functions for dataprocessing
```

```
void ads_data_callback(float * sample);
```

```
void deadzone_filter(float * sample);
```

```
void signal_filter(float * sample);
```

```
void parse_com_port(void);
```

```
// Bendlabs sensor information callback
```

```
// Bendlabs sensor Deadzone filter
```

```
// Bendlabs signal filter
```

```
// I2C communication decoding
```

```
//Defining variables for bendlabs sensor data processing
```

```
static float sample[2];
```

```
uint8_t data_type;
```

```
// Read data from the one axis ads sensor
```

```
int ret_val = ads_read_polled(sample, &data_type);
```

```
// Check if read was successful
```

```
if(data_type == ADS_SAMPLE)
```

```
{
```

```
    // Low pass IIR filter
```

```
    signal_filter(sample);
```

```
    // Deadzone filter
```

```
    deadzone_filter(sample);
```

```
}
```

```
case '0':
```

```
    // Take first calibration point at zero degrees
```

```
    ads_calibrate(ADS_CALIBRATE_FIRST, 0);
```

```
    break;
```

```
case '9':
```

```
    // Take second calibration point at ninety degrees
```

```
    ads_calibrate(ADS_CALIBRATE_SECOND, 90);
```

```
    break;
```

Part 5: System integration

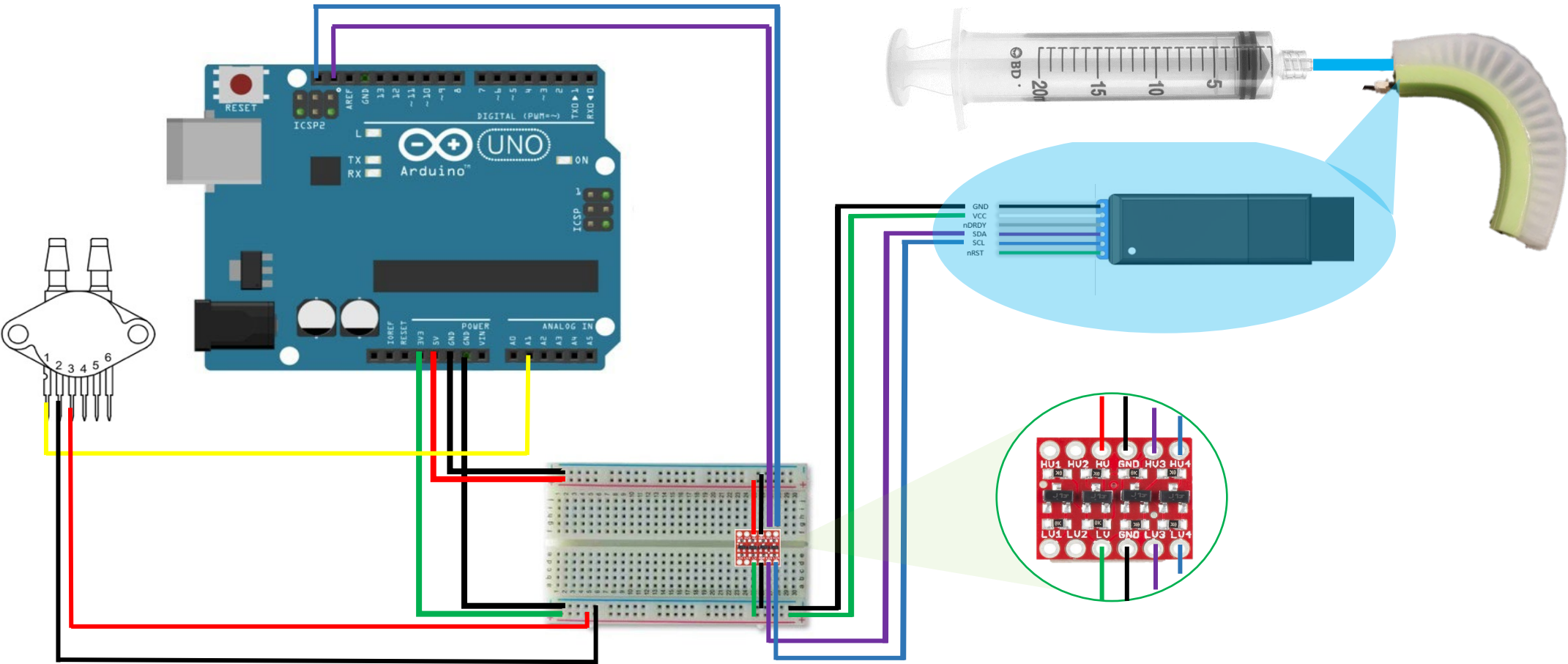


Figure 1. Connection Scheme for a Bendlabs and MPX5100 pressure sensor for Arduino Uno