# Flex Sensor Hookup Guide

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♡ FAVORITE 2

## Introduction

This flex sensor is a variable resistor like no other. The resistance of the flex sensor increases as the body of the component bends. Sensors like these were used in the Nintendo Power Glove. They can also be used as door sensors, robot whisker sensors, or a primary component in creating sentient stuffed animals.

Flex Sensor 2.2"
SEN-10264
**$7.95**
★★★★☆ 10

Flex sensors are available in two sizes: one 2.2" (5.588cm) long and another coming in at 4.5" (11.43cm) long.

Left flat, these sensors will look like a 30kΩ resistor. As it bends, the resistance between the two terminals will increase to as much as 70kΩ at a 90° angle.

By combining the flex sensor with a static resistor to create a voltage divider, you can produce a variable voltage that can be read by a microcontroller's analog-to-digital converter.

### Suggested Materials

This tutorial serves as a quick primer on flex sensor's, and demonstrates how to hook them up and use them. Aside from the sensor, the following materials are recommended:

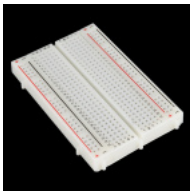
**Arduino Uno** – We'll be using the Arduino's analog-to-digital converter to read in the variable resistance of the sensor. Any Arduino-compatible development platform – be it a RedBoard, Pro or Pro Mini – can substitute.

**Resistor Kit** – To turn the flex sensor's variable resistance into a readable voltage, we'll combine it with a static resistor to create a voltage divider. This resistor kit is handy for some trial-and-error testing to hone in on the most sensitive circuit possible.

**Breadboard and Jumper Wires** – The flex sensor's terminals are breadboard-compatible. We'll stick that and the resistor, then use the jumper wires to connect from breadboard to Arduino.

SparkFun RedBoard - Programmed with Arduino
DEV-13975
**$19.95**
★★★★½ 19

Resistor Kit - 1/4W (500 total)
COM-10969
**$7.95**
★★★★½ 134



Breadboard - Self-Adhesive (White)
PRT-12002
**$4.95**
★★★★½ 34

Jumper Wires Standard 7" M/M - 30 AWG (30 Pack)
PRT-11026
**$1.95**
★★★★½ 20

### Suggested Reading

Analog components, like these flex sensor's, are a great sensor-reading entry-point for beginners, but there are a few electronics concepts you should be familiar with. If any of these tutorial titles sound foreign to you, consider skimming through that content first.

Analog to Digital Conversion
The world is analog. Use analog to digital conversion to help digital devices interpret the world.

Voltage Dividers
Turn a large voltage into a smaller one with voltage dividers.

What is an Arduino?
What is this 'Arduino' thing anyway?

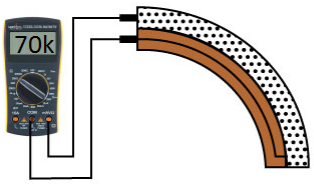
Analog vs. Digital
This tutorial covers the concept of analog and digital signals, as they relate to electronics.

## Flex Sensor Overview

Before we get to circuit-building and Arduino-programming, here's a quick rundown of the flex sensor's important electrical characteristics.

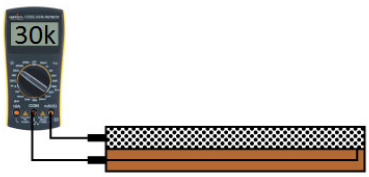
### How it Works

One side of the sensor is printed with a polymer ink that has conductive particles embedded in it. When the sensor is straight, the particles give the ink a resistance of about 30k Ohms. When the sensor is bent away from the ink, the conductive particles move further apart, increasing this resistance (to about 50k-70K Ohms when the sensor is bent to 90°, as in the diagram below).



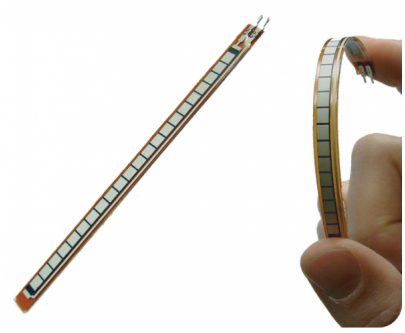

Conductive particles further apart - 70kΩ.

When the sensor straightens out again, the resistance returns to the original value. By measuring the resistance, you can determine how much the sensor is being bent.




Conductive particles close together - 30kΩ.

The flex sensor is designed to be flexed in just one direction – away from the ink – as demonstrated in the image below.



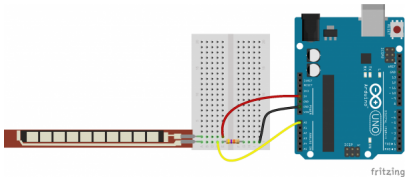
*Flex sensor bend direction (from SpectraSymbol Datasheet).*

Bending the sensor in the other direction will not produce any reliable data, and may damage the sensor. Also take care not to bend the sensor close to the base, as they have a tendency to kink and fail.

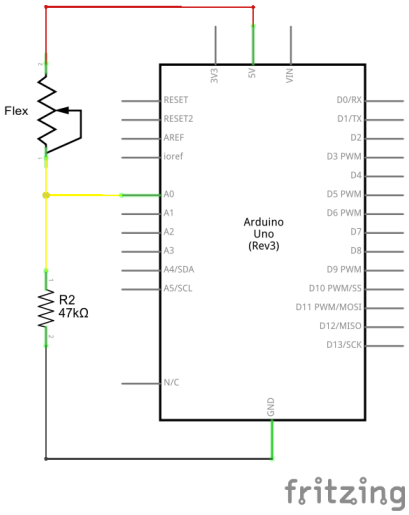
## Example Circuit

The simplest way to incorporate this sensor into your project is by using it in a voltage divider. This circuit requires one resistor. Many values from 10KΩ to 100KΩ will work. If you have a resistor kit, you may want to introduce some trial-and-error to hone in on that perfect static resistance.

A value between the minimum and maximum resistance values is usually a good choice. We'll use a 47kΩ resistor in this example. Here's the hookup:




And a schematic:




The 47kΩ resistor on the ground side, and the flex sensor on the 5V side, means as the flex sensor's resistance increases (meaning the sensor is bending) the voltage on A0 will decrease.

## Example Program

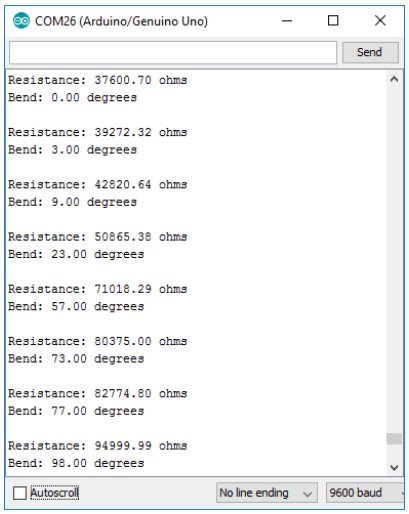
Here is a simple Arduino example based on the circuit above. Copy and paste this into your Arduino IDE, then upload!

**Note:** This example assumes you are using the latest version of the Arduino IDE on your desktop. If this is your first time using Arduino, please review our tutorial on installing the Arduino IDE.
If you have not previously installed an Arduino library, please check out our installation guide.

```
/******************************************************************************
Flex_Sensor_Example.ino
Example sketch for SparkFun's flex sensors
  (https://www.sparkfun.com/products/10264)
Jim Lindblom @ SparkFun Electronics
April 28, 2016

Create a voltage divider circuit combining a flex sensor with a 47k resistor.
- The resistor should connect from A0 to GND.
- The flex sensor should connect from A0 to 3.3V
As the resistance of the flex sensor increases (meaning it's being bent), the
voltage at A0 should decrease.

Development environment specifics:
Arduino 1.6.7
******************************************************************************/
const int FLEX_PIN = A0; // Pin connected to voltage divider output

// Measure the voltage at 5V and the actual resistance of your
// 47k resistor, and enter them below:
const float VCC = 4.98; // Measured voltage of Ardunio 5V line
const float R_DIV = 47500.0; // Measured resistance of 3.3k resistor

// Upload the code, then try to adjust these values to more
// accurately calculate bend degree.
const float STRAIGHT_RESISTANCE = 37300.0; // resistance when straight
const float BEND_RESISTANCE = 90000.0; // resistance at 90 deg

void setup()
{
  Serial.begin(9600);
  pinMode(FLEX_PIN, INPUT);
}

void loop()
{
  // Read the ADC, and calculate voltage and resistance from it
  int flexADC = analogRead(FLEX_PIN);
  float flexV = flexADC * VCC / 1023.0;
  float flexR = R_DIV * (VCC / flexV - 1.0);
  Serial.println("Resistance: " + String(flexR) + " ohms");

  // Use the calculated resistance to estimate the sensor's
  // bend angle:
  float angle = map(flexR, STRAIGHT_RESISTANCE, BEND_RESISTANCE,
                   0, 90.0);
  Serial.println("Bend: " + String(angle) + " degrees");
  Serial.println();

  delay(500);
}
```

After uploading, **open your serial monitor**, and set the baud rate to 9600 bps.

If you bend the flex sensor, you should see resistance and estimated angle calculations change:




If the value's don't seem correct, make sure the constants `VCC` and, more importantly, `R_DIV` are accurate. If you used something other than a 47kΩ resistor, enter that value in for `R_DIV`.

Through trial-and-error, try to hone in on more accurate values for `STRAIGHT_RESISTANCE` and `BEND_RESISTANCE` – your flex sensor's resistance when it's straight and bent at 90°.

## Resources and Going Further

Looking for more flex sensor related documentation? Here are a few sources you may want to consult:

- Datasheet

Need some project inspiration? Want to check out some similar analog sensors? Check out some of these related tutorials:



Getting Started with Load Cells
A tutorial defining what a load cell is and how to use one.



SIK Keyboard Instrument
We can use the parts and concepts in the SparkFun Invetor's Kit to make a primitive keyboard instrument.



Sensor Kit Resource Hub
An overview of each component in the SparkFun Sensor Kit, plus links to tutorials and other resources you'll need to hook them up.



Force Sensitive Resistor Hookup Guide
How to hook a force-sensitive resistor up to an Arduino to measure pressure variances.