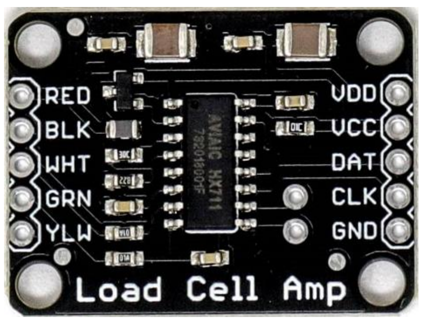
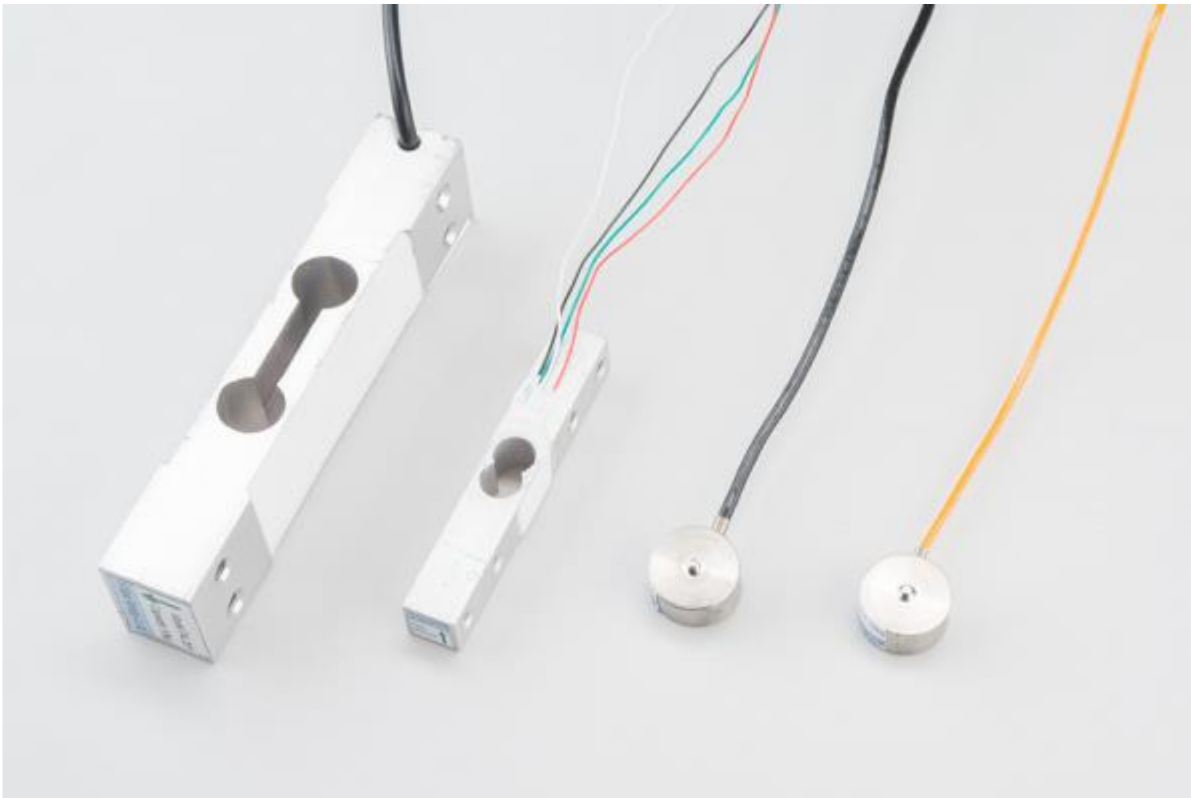
SmartElex Load Cell Amplifier - HX711

The HX711 load cell amplifier is used to get measurable data out from a load cell and strain gauge.



Load Cell Setup

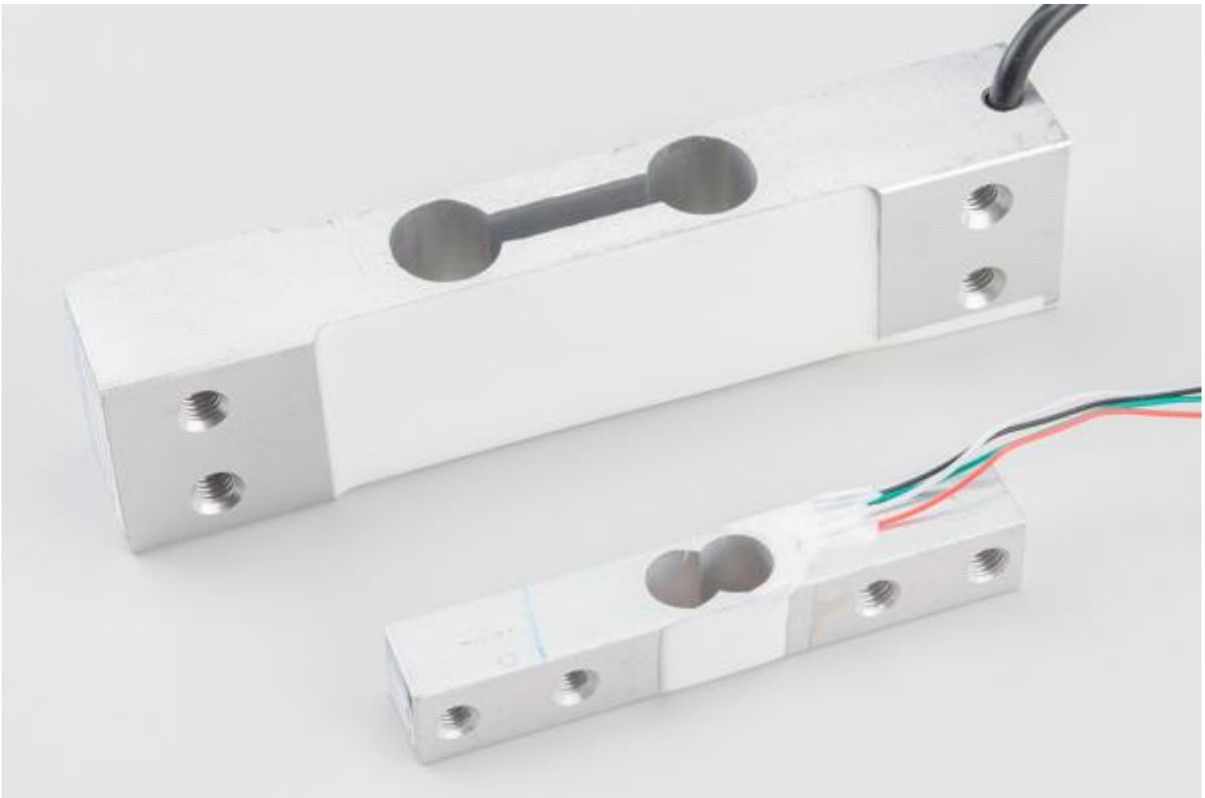
Depending on the type of load cell you are using, the configuration of how it should be hooked up to plates or surfaces will change. We'll list a few different types of setups below.



A selection of different load cells

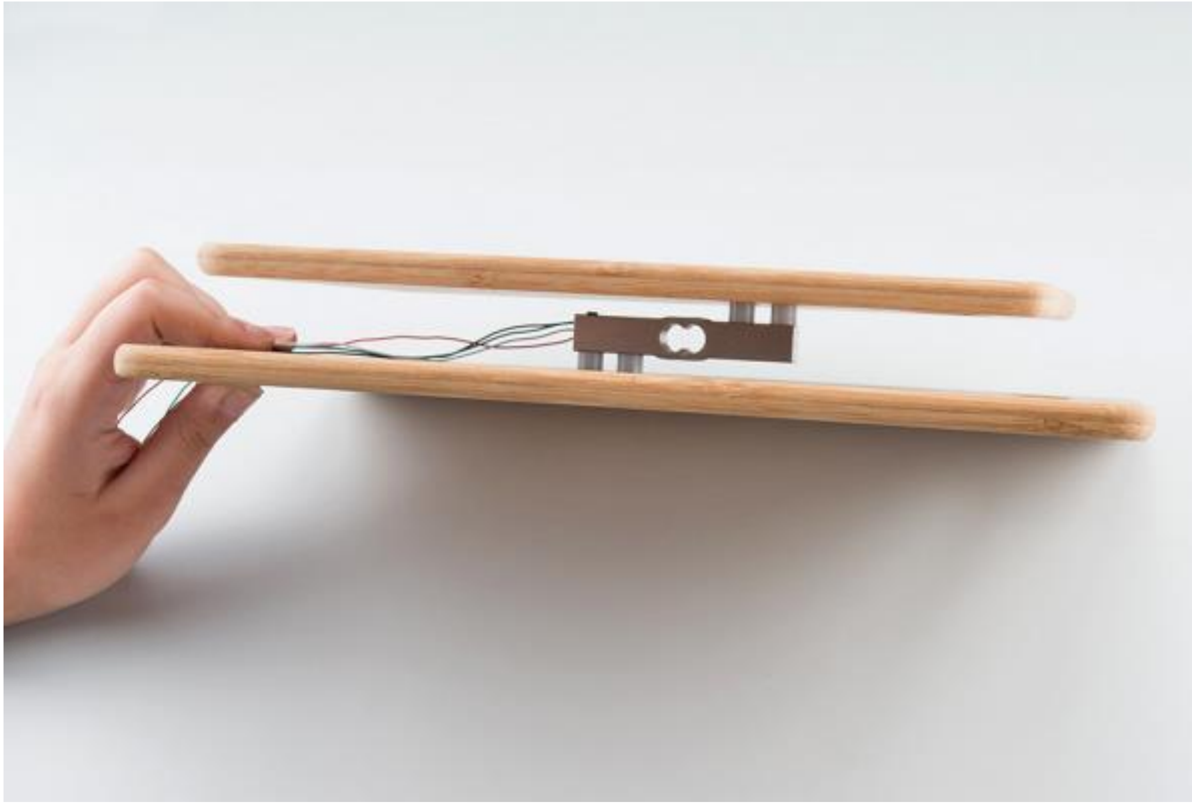
Bar-Type Load Cell

Usually with larger, non-push button bar load cells you will want to hook up the load cell between two plates in a "Z" shape.



Bar strain gauge based load cells

As shown below, the bar-type load cell is mounted with fitting screws and spacers so that the strain can be correctly measured. Note that only one side of the load cell is screwed into each board when a bar-type load cell is placed between two plates. This provides a moment of force, or torque, on the strain gauge rather than just compression force, which is easier to measure and much more accurate.

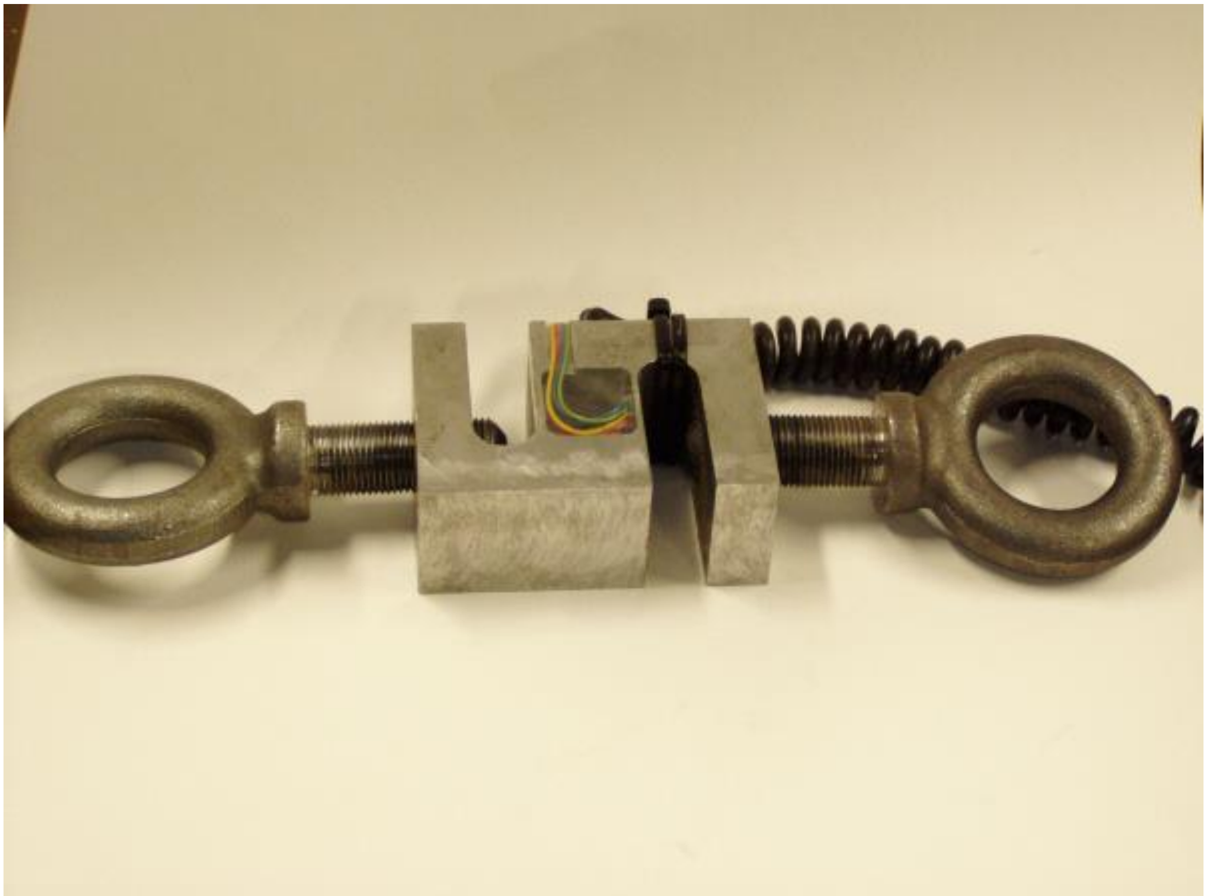


Bar load cell between a two plate configuration

S-Type Load Cell

S-type load cells can measure compression, tension, or both due to its design.

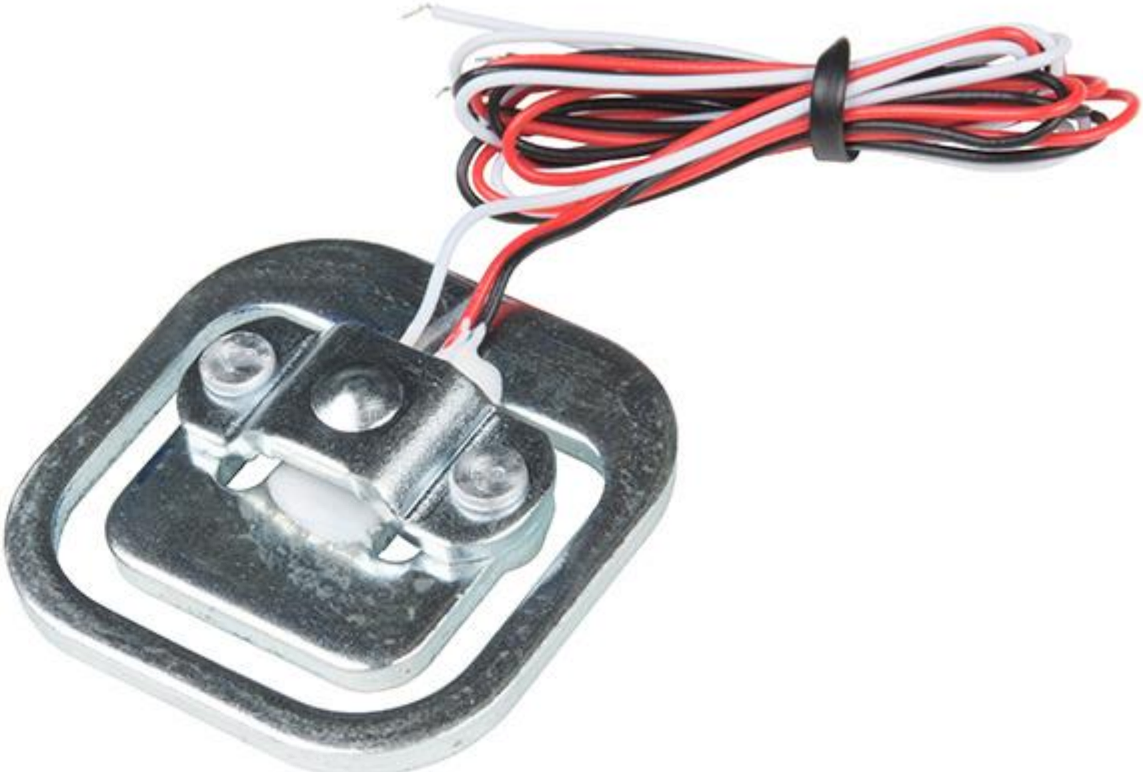
Besides placing the load cell between plates, the s-type can be used to measure suspended tanks or hoppers. You can think of this as a load attached to a crane. Below is an s-type load cell with two threaded, rod end bearings.



S-type load cell configuration

Single, Strain Gauge Load Cells (i.e. Load Sensors)

For single, strain gauge load cells, they can be placed at equal distances with respect to each other underneath a platform.



The image below shows four, single strain gauge (i.e. the load sensor) arranged in a wheatstone bridge configuration. This configuration is also possible with four button-type load cells.

Button/Disk-Type Load Cells

For smaller, push-button or disc load cells, you will want to make sure to screw in the disc to a bottom plate (or surface you are measuring force against), and center the beam, plate, or whatever else you are wishing to measure the force of onto the "button" on the top.

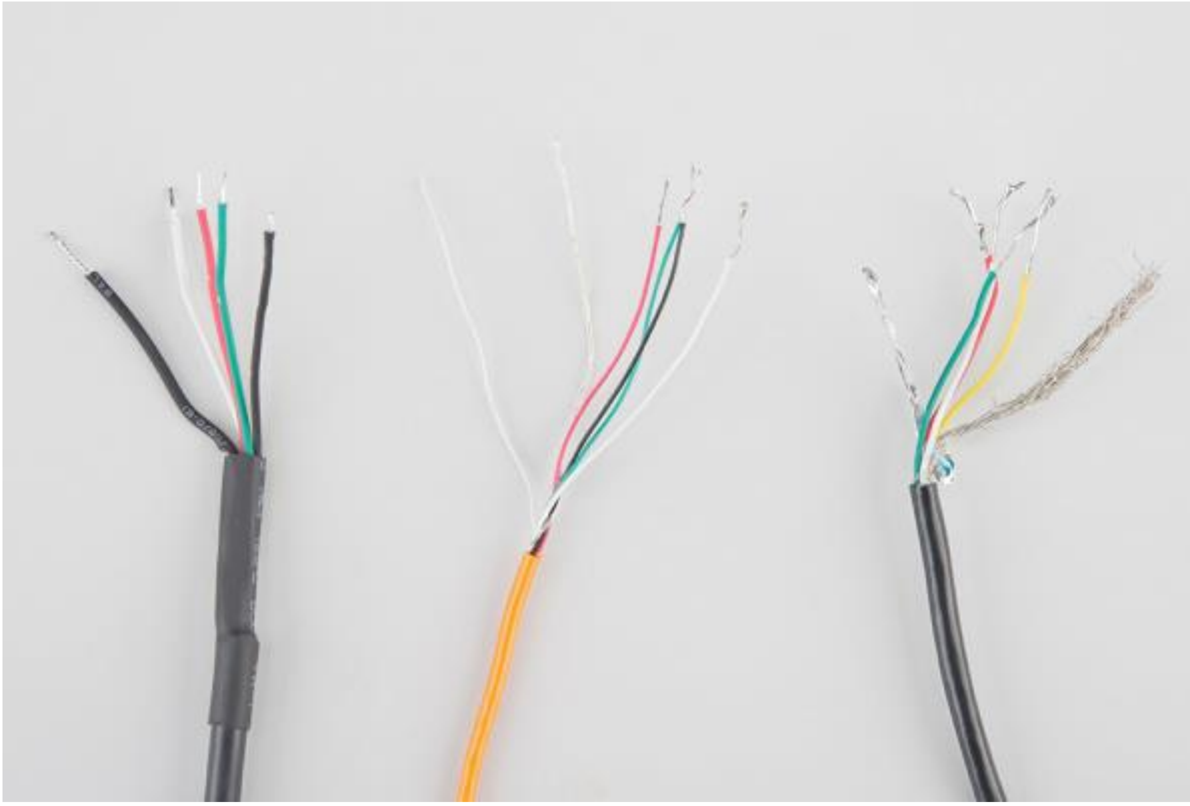
Usually another plate with a hole is used to make sure whatever you are measuring is hitting the same spot on the load cell each time, but it is not necessary. Below are images of four button-type load cells placed at equal distances with respect to each other under a platform. Make sure to read the datasheet for the load cell you are using and get the correct screws to fit into it.

Variances in Measurements

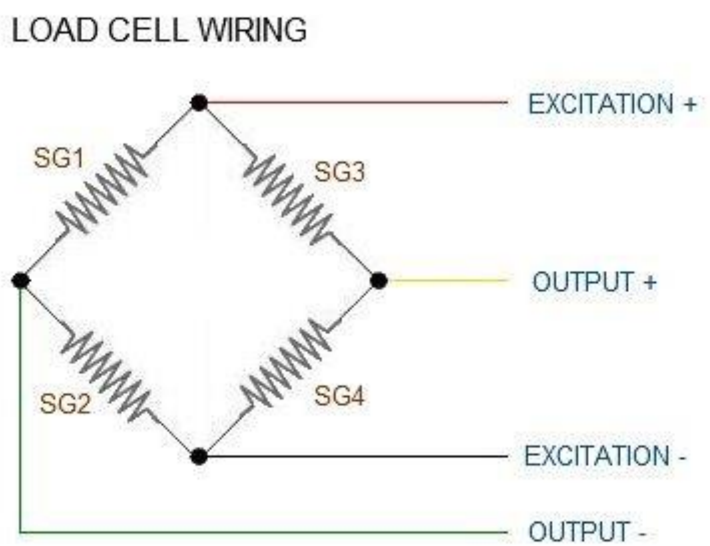
Load cell measurements can be off by +/- 5% due to a range of things including temperature, creep, vibration, drift, and other electrical and mechanical interferences. Before you install your scale, take a moment and design your system to allow for easy calibration or be able to adjust the code parameters to account for these variations.

Wiring

The HX711 Load Cell Amplifier accepts five wires from the load cell. These pins are labeled with colors; **RED, BLK, WHT, GRN, and YLW**. These colors correspond to the conventional color coding of load cells, where red, black, green and white wires come from the strain gauge on the load cell and yellow is an optional ground wire that is not hooked up to the strain gauge but is there to ground any small outside EMI (electromagnetic interference). Sometimes instead of a yellow wire there is a larger black wire, foil, or loose wires to shield the signal wires to lessen EMI.



Here we have a large black wire, some loose wires, and foil and loose wires respectively as EMI buffers In general, each load cell has four strain gauges that are hooked up in a **wheatstone bridge** formation as shown below.



Four strain gauges (SG1 through 4) hooked up in a wheatstone bridge formation

The four wires coming out from the wheatstone bridge on the load cell are "usually":

Wheatstone Bridge Node	**"Typical" Wire Color**

Excitation+ (E+) or VCC	RED
Excitation- (E-) or GND	BLACK or YELLOW
Output- (O-), Signal- (S-), or Amplifier- (A-)	WHITE
O+, S+, or A+	GREEN or BLUE

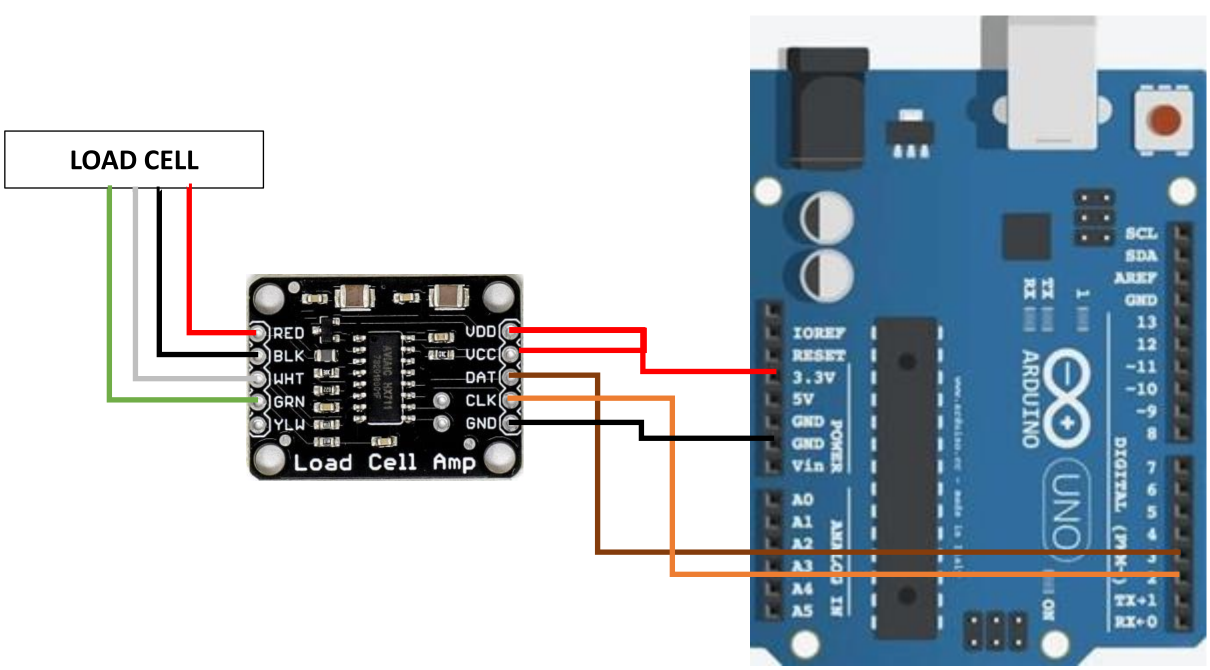
Some load cells might have slight variations in color coding such as blue instead of green or yellow instead of black or white if there are only four wires (meaning no wire used as an EMI buffer). You might have to infer a little from the colors that you have or check the datasheet on the load cell, but in general you will usually see these colors.

If the readings from the HX711 are opposite of what you are expect (for example the values decrease as you increase weight) simply reverse the O+/O- wires.

Note: VCC is the analog voltage to power the load cell. VDD is the digital supply voltage used to set the logic level.

The example code has **DAT and CLK** hooked up to **pin 3 and 2** respectively, but this is easily changed in the code. Any GPIO pin will work for either. Then VCC and VDD just need to be hooked up to **2.7-5V** and GND to ground on your microcontroller.

Wiring:



HX711	Arduino
CLK	D2
DAT	D3
VCC & VDD	3.3V
GND	GND

Arduino Library

Now that you have your load cell, amplifier, and microcontroller hooked up, you can add your code and start calibrating your setup. You will need to download the excellent HX711 library from user **bogde**. As of the writing of this tutorial, the library has been tested on ATmega328P, ESP8266, ESP32, and STM32. Open the Arduino IDE's library manager and search for "**HX711 Arduino Library**".

Examples Code:

The first thing you will want to work with is the calibration code.

```
#include "HX711.h"

#define DOUT  3
#define CLK  2

HX711 scale;

float calibration_factor = -7050; //-7050 worked for my 440lb max scale setup

void setup() {
  Serial.begin(9600);
  Serial.println("HX711 calibration sketch");
  Serial.println("Remove all weight from scale");
  Serial.println("After readings begin, place known weight on scale");
  Serial.println("Press + or a to increase calibration factor");
  Serial.println("Press - or z to decrease calibration factor");
```

```
  scale.begin(DOUT, CLK);
  scale.set_scale();
  scale.tare(); //Reset the scale to 0

  long zero_factor = scale.read_average(); //Get a baseline reading
  Serial.print("Zero factor: "); //This can be used to remove the need to tare the
scale. Useful in permanent scale projects.
  Serial.println(zero_factor);
}

void loop() {

  scale.set_scale(calibration_factor); //Adjust to this calibration factor

  Serial.print("Reading: ");
  Serial.print(scale.get_units(), 1);
  Serial.print(" lbs"); //Change this to kg and re-adjust the calibration factor if
you follow SI units like a sane person
  Serial.print(" calibration_factor: ");
  Serial.print(calibration_factor);
  Serial.println();

  if(Serial.available())
  {
    char temp = Serial.read();
    if(temp == '+' || temp == 'a')
      calibration_factor += 10;
    else if(temp == '-' || temp == 'z')
      calibration_factor -= 10;
  }
}
```

Once you have calculated your calibration factor of your load cell set up, you can move on to other code, such as the simple scale output example code:

```
#include "HX711.h"

#define calibration_factor -7050.0 //This value is obtained using the
SparkFun_HX711_Calibration sketch

#define DOUT  3
#define CLK  2

HX711 scale;

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

```
  Serial.println("HX711 scale demo");

  scale.begin(DOUT, CLK);
  scale.set_scale(calibration_factor); //This value is obtained by using the
SparkFun_HX711_Calibration sketch
  scale.tare(); //Assuming there is no weight on the scale at start up, reset the
scale to 0

  Serial.println("Readings:");
}

void loop() {
  Serial.print("Reading: ");
  Serial.print(scale.get_units(), 1); //scale.get_units() returns a float
  Serial.print(" lbs"); //You can change this to kg but you'll need to refactor the
calibration_factor
  Serial.println();
}
```