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Soil Moisture Sensor Hookup Guide

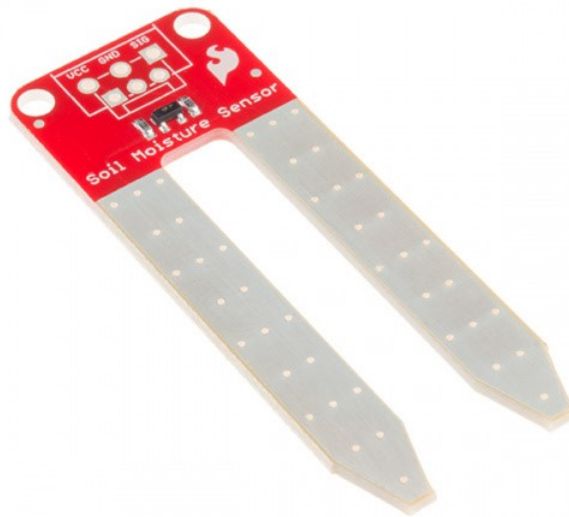
CONTRIBUTORS:  SARAH AL-MUTLAQ,  JOEL_E_B, ELL C

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34

Introduction

Have you ever wanted your plants to tell you when they need watered? Or know how saturated the soil in your garden is? With the SparkFun Soil Moisture Sensor, you can do just that! This tutorial will show you how to get started using the Soil Moisture Sensor as well as how to build your own soil moisture sensing project. If you prefer not to solder, you can purchase the sensor with a 3-pin screw terminal pre-soldered onto the board.

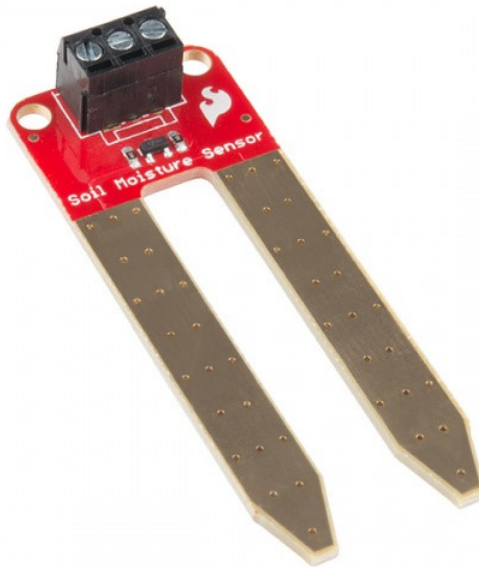


SparkFun Soil Moisture Sensor

● SEN-13322

\$6.50

★★★★☆ 16



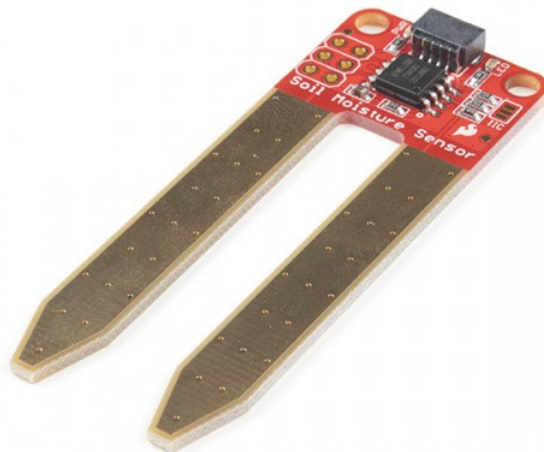
SparkFun Soil Moisture Sensor (with Screw Terminals)

© SEN-13637

\$7.50

★★★★☆ 4

And if you're really in a hurry, use our plug-and-play Qwiic Soil Moisture Sensor!



SparkFun Qwiic Soil Moisture Sensor

© SEN-17731

\$9.50

★★★☆☆ 2

Required Materials

To follow along with the project at the end of this tutorial, you will need the following. You may not need

everything, though, depending on what you already have and which sensor you prefer. Add it all to your cart with the button below and modify as necessary.

Soil Moisture Sensor Wish List SparkFun Wish List



Flexible Qwiic Cable - 100mm
PRT-17259



SparkFun Qwiic Soil Moisture Sensor
SEN-17731

The SparkFun Soil Moisture Sensor is a simple breakout for measuring the moisture in soil and similar material...



Breadboard - Self-Adhesive (White)
PRT-12002

This is your tried and true white solderless breadboard. It has 2 power buses, 10 columns, and 30 rows - a total...



SparkFun USB Mini-B Cable - 6 Foot
CAB-11301

This is a USB 2.0 type A to Mini-B 5-pin cable. You know, the mini-B connector that usually comes with USB Hu...



Jumper Wires Standard 7" M/M - 30 AWG (30 Pack)
PRT-11026

If you need to knock up a quick prototype there's nothing like having a pile of jumper wires to speed things up, a...



SparkFun Soil Moisture Sensor
SEN-13322

The SparkFun Soil Moisture Sensor is a simple breakout for measuring the moisture in soil and similar material...



9V Alkaline Battery
PRT-10218

These are your standard 9 Volt alkaline batteries from Rayovac. Don't even think about trying to recharge these...



9V Battery Holder
PRT-10512

This 9V battery holder allows your battery to snap in tight and holds it in place, which is great in situations wher...



Serial Enabled 16x2 LCD - White on Black 5V
LCD-09395

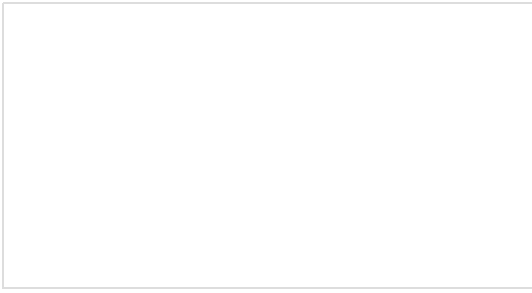
This is the latest evolution of our serial LCD. Included on a single board is a 16x2 LCD and an embedded circui...



SparkFun RedBoard Qwiic
DEV-15123

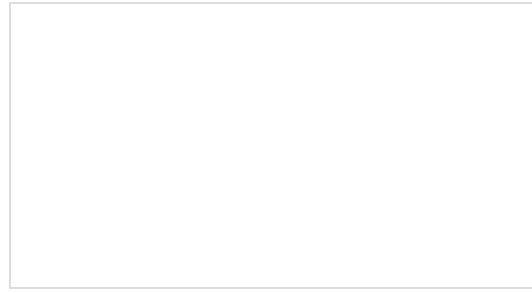
Suggested Readings

There isn't much to learning how to use the Soil Moisture Sensor. However, you may find the following concepts useful along the way.



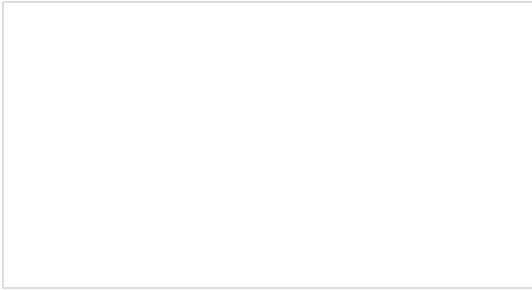
How to Solder: Through-Hole Soldering

This tutorial covers everything you need to know about through-hole soldering.



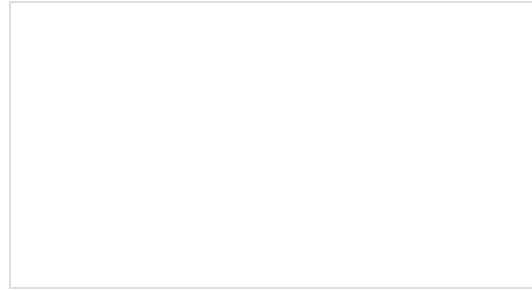
Voltage, Current, Resistance, and Ohm's Law

Learn about Ohm's Law, one of the most fundamental equations in all electrical engineering.



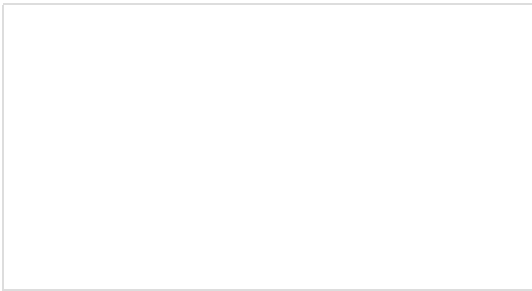
Analog to Digital Conversion

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



Resistors

A tutorial on all things resistors. What is a resistor, how do they behave in parallel/series, decoding the resistor color codes, and resistor applications.



Soil moisture-sensing by hacking a solar light

How to take a solar powered pathway light from a hardware store and make it into a crude soil moisture sensor.

If you aren't familiar with the Qwiic system, we recommend reading [here](#) for an overview should you decide to use the Qwiic version.



Qwiic Connect System

Hardware Overview and Assembly

Our original Soil Moisture Sensor is pretty straightforward when it comes to hookup. There are only three pins to connect: **VCC**, **GND**, and **SIG**.

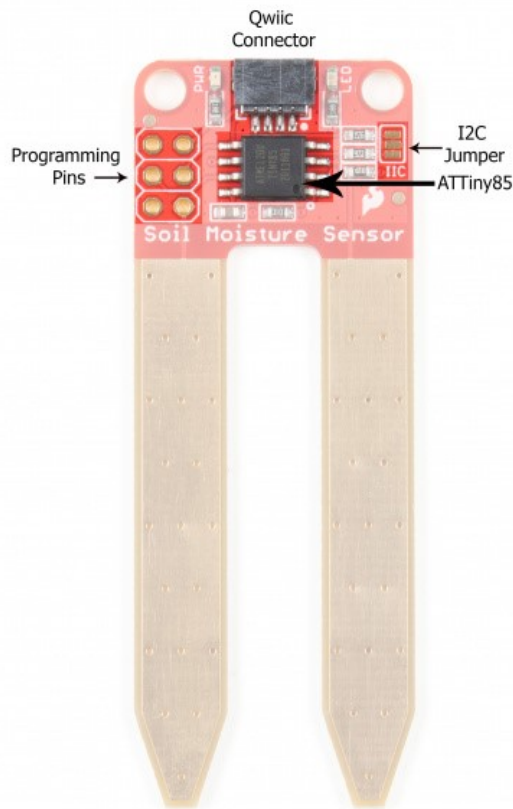


You need to supply power to VCC and GND. We recommend not powering the sensor constantly to prevent corrosion of the probes (more on this in a bit). SIG provides an analog signal out that can be attached to the ADC pin on any microcontroller. The value read on SIG will vary depending on the voltage with which you power the sensor.

Qwiic Enabled Soil Moisture Sensor

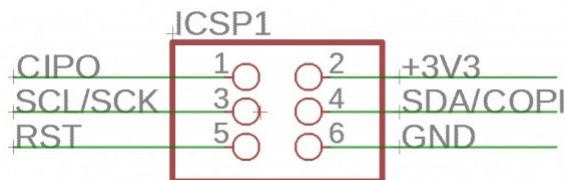
Our Qwiic Soil Moisture Sensor utilizes the I²C protocol with the existing signals and the ATtiny85 MCU as the I²C gateway, which does all the nitty gritty stuff for you. The default I²C address is 0x28. The Qwiic connector should be self-evident, and this board also has pins broken out for SPI programming.

Note: Like our other Qwiic boards, the Qwiic Soil Moisture Sensor comes equipped with pull-up resistors for normal operation. If you are running multiple Qwiic devices on the same circuit, you will want to disable the pull up resistors by using an X-acto knife to cut the joint between the highlighted I²C jumper pads.



Programming Pins

For those of you who are interested in the Qwiic system but aren't quite set up yet, there are pins broken out such that you can use I²C or SPI protocols. See the image below for pin functionality.



Theory of Operation

The two probes are acting as a variable resistor – more water in the soil means better conductivity and results in a lower resistance and a higher SIG out. Your analog readings will vary depending on what voltage you use for Vcc as well as the resolution of your ADC pins.

Powering the Soil Moisture Sensor

If you're using Qwiic to power your board, then you're good to go. Otherwise, we recommend powering the Soil Moisture Sensor with between **3.3V - 5V**. Please note that the analog value returned will vary depending on what voltage is provided for the sensor.

One commonly known issue with soil moisture sensors is their short lifespan when exposed to a moist environment. To combat this, we've had the PCB coated in Gold Finishing (Electroless Nickel Immersion Gold).

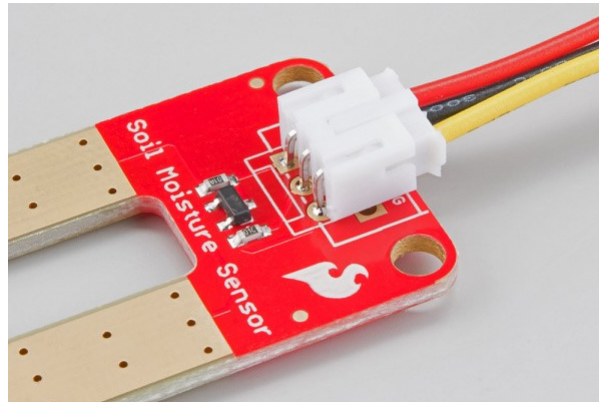
Another way to extend the lifespan of your sensor is to only power it when you take a reading. Using a digital pin set to HIGH on an Arduino, for example, is an easy way to accomplish this. If you wish to power the sensor

with more than a digital pin on your microcontroller can provide, you could always use a transistor.

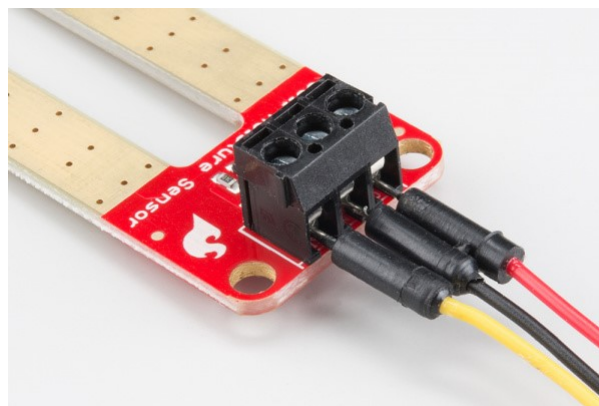
Assembly

If you bought the Soil Moisture Sensor that already has the 3-pin screw terminal attached, you may skip this section. Likewise, if you are using the Qwiic connector!

There are a few different options for connecting the sensor to your circuit. You can solder on a 3-pin JST Jumper Wire Assembly if you need to easily switch sensors on your project. This pairs nicely with our JST to Breadboard Jumper connector.

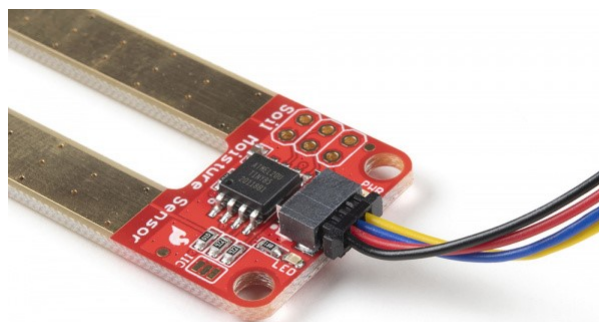


Another option is to solder on a 3-pin 3.5mm Screw Pin Terminal for a slightly more robust connection.



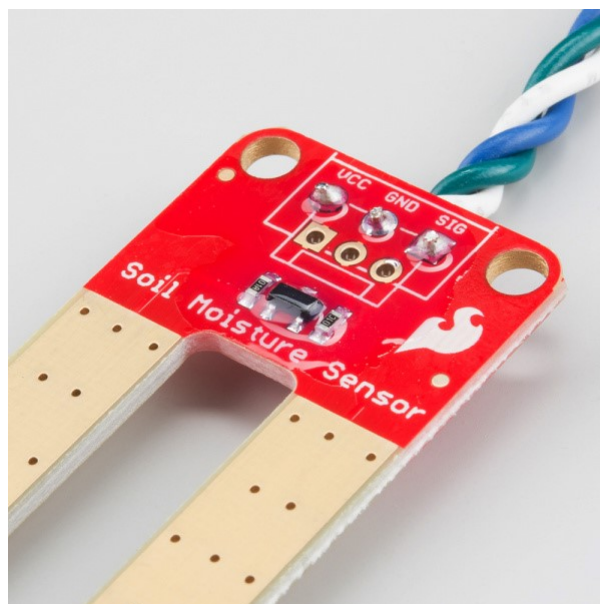
Of course, you can always solder some hookup wire straight to the sensor.

If you've opted for the Qwiic version of this board, assembly is a breeze.



Weatherproofing

If you intend to use this sensor outdoors, we recommend adding a little protection to the PCB to extend its lifespan. You could always use good ol' fashioned hot glue. However, hot glue does not hold up well in the sun and is only recommended for projects that will not be exposed to high temperatures. For projects that need to be able to withstand *all* the elements, you could use a conformal coating to cover the SMD parts on the PCB as well as your solder connections.



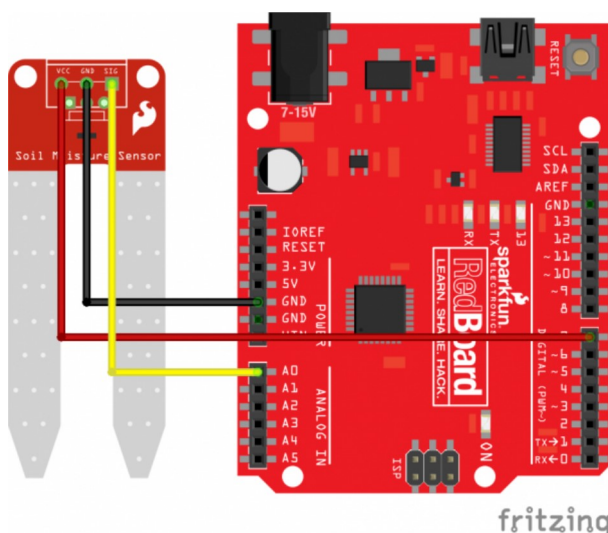
Wires have been soldered to this sensor. All the SMD parts and solder joints have then been covered in conformal coating.

Soil Moisture Sensing Basic Example

Note: 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.

For this first example, we will connect the sensor to a RedBoard or other Arduino-compatible board in a minimalist fashion to show its output over the serial terminal.

Connect your Soil Moisture Sensor to your board as shown in the diagram below.



Once the circuit is built, upload the following code to your RedBoard or Arduino.

```
/* Soil Moisture Basic Example
   This sketch was written by SparkFun Electronics
   Joel Bartlett
   August 31, 2015

   Basic sketch to print out soil moisture values to the Serial Monitor

   Released under the MIT License(http://opensource.org/licenses/MIT)
*/

int val = 0; //value for storing moisture value
int soilPin = A0;//Declare a variable for the soil moisture sensor
int soilPower = 7;//Variable for Soil moisture Power

//Rather than powering the sensor through the 3.3V or 5V pins,
//we'll use a digital pin to power the sensor. This will
//prevent corrosion of the sensor as it sits in the soil.

void setup()
{
  Serial.begin(9600);  // open serial over USB

  pinMode(soilPower, OUTPUT);//Set D7 as an OUTPUT
  digitalWrite(soilPower, LOW);//Set to LOW so no power is flowing through the sensor
}

void loop()
{
  Serial.print("Soil Moisture = ");
  //get soil moisture value from the function below and print it
  Serial.println(readSoil());

  //This 1 second timefrme is used so you can test the sensor and see it change in real-time.
  //For in-plant applications, you will want to take readings much less frequently.
  delay(1000);//take a reading every second
}

//This is a function used to get the soil moisture content
int readSoil()
{
  digitalWrite(soilPower, HIGH);//turn D7 "On"
  delay(10);//wait 10 milliseconds
  val = analogRead(soilPin);//Read the SIG value form sensor
  digitalWrite(soilPower, LOW);//turn D7 "Off"
  return val;//send current moisture value
}
```

Note that in the code, we are powering the soil moisture sensor with a digital pin on the RedBoard, not directly from 3.3V or 5V. Since this is a 5V device, the digital IO pins have a HIGH voltage of ~5V.

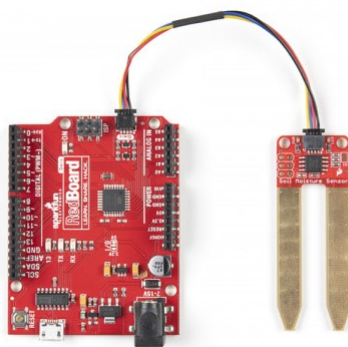
Once the sketch is uploaded, open a Serial Monitor window to see the output from the RedBoard. You should see a value at or close to 0 when the sensor is not touching anything. To see it sense moisture, you can grab both probes with your hand. The moisture from your body will be enough for the sensor to detect.

Further Examples

The Qwiic version of this board was built in cooperation with Zio Smart Prototyping. They've got some great examples in their Qwiic Soil Sensor GitHub Repository, which we've forked [here](#).

QWIIC SOIL MOISTURE SENSOR EXAMPLES

The Qwiic Soil Moisture Sensor can be connected to a Qwiic Redboard as shown here:



Click the image for a larger view

Additional Projects

To connect your plant monitor to the Internet of Things, check out this experiment from our SparkFun Inventor's Kit for Photon. In it, we show how to connect the soil moisture sensor to an Internet connected device such as the Photon or the SparkFun Photon RedBoard.

You can also learn how to use the soil moisture sensor with the Blynk app in the Blynk Experiment Guide. Get plant watering notifications right on your phone or other mobile device!

Check out this great Instructables project from Circuito.io that uses the SparkFun Soil Moisture Sensor:

- Thirsty Flamingo

Calibration

System Calibration

To get any sort of useful data out of your Soil Moisture Sensor, it is advised that you calibrate it to whatever soil you plan to monitor. Different types of soil can affect the sensor, and you may get different readings from one composition to the next. Before you start storing moisture data or triggering events based on that value, you should see what values you are actually getting from your sensor. Using the sketch above, note what values your sensor outputs when the sensor is completely dry vs when the sensor is completely submerged in a shallow cup of water. Depending on what microcontroller you're using, the operating voltage of that microcontroller, and the resolution of its analog-to-digital converter, your results will vary.

For example, using the same circuit above, if I detach the VCC pin from D7 and attach it directly to the 5V supply on the RedBoard, you'll see the close to the following values in the serial monitor when the sensor is dry

(~0) and when it is completely saturated with moisture (~880).

```
Soil Moisture = 0
Soil Moisture = 0
Soil Moisture = 0
Soil Moisture = 0
Soil Moisture = 0
Soil Moisture = 0
Soil Moisture = 0
Soil Moisture = 0
Soil Moisture = 0
Soil Moisture = 883
Soil Moisture = 881
Soil Moisture = 880
Soil Moisture = 879
Soil Moisture = 879
Soil Moisture = 878
Soil Moisture = 877
Soil Moisture = 877
Soil Moisture = 877
Soil Moisture = 876
```

But, if I take the VCC pin and connect it to the 3.3V supply on the RedBoard, the values change. As expected, they get lower since there is less resolution between 0V and 3.3V than there is between 0V and 5V.

```
Soil Moisture = 0
Soil Moisture = 0
Soil Moisture = 0
Soil Moisture = 0
Soil Moisture = 0
Soil Moisture = 0
Soil Moisture = 0
Soil Moisture = 0
Soil Moisture = 0
Soil Moisture = 541
Soil Moisture = 540
Soil Moisture = 539
Soil Moisture = 539
Soil Moisture = 539
Soil Moisture = 539
Soil Moisture = 539
Soil Moisture = 539
Soil Moisture = 539
```

Thus, it is difficult to write an example sketch that works for all platforms. It really depends on the operating voltage and ADC resolution of the board you're using.

Soil Calibration

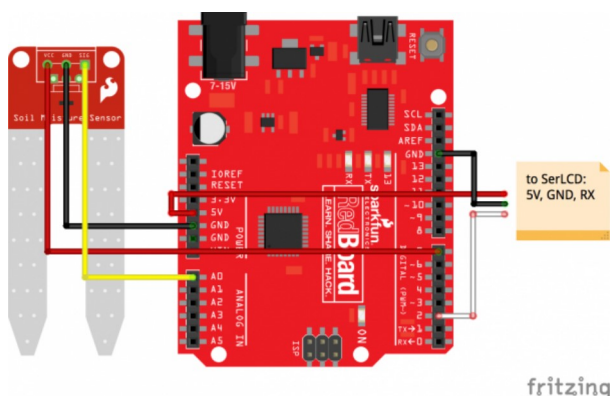
Once you have an idea what values your sensor is outputting in completely dry and completely wet situations, it's time to calibrate your sensor for the specific soil you want to monitor. Do the same test above, only this time test your soil when it is as dry as possible, then measure it when the soil is completely saturated with moisture. Getting these values and comparing them to the ones from the previous calibration will give you the best insight into what values mean for your specific plant and soil. This test may take some trial and error and patience. Be careful not to over-water (or under-water) your plants during these tests.

Once you have a good handle on the values you can expect, you can use the `map()` function to adjust your code accordingly.

Soil Moisture Sensing Project

For this next example, we're going to make a portable soil moisture sensor that will print the current moisture value to an LCD screen. We'll use the circuit from the previous example. This time we just need to add a Serial Enabled LCD Screen and portable power.

Hook up your circuit as pictured below:



Along with the soil moisture sensor, we have connected the LCD screen to 5V, GND, and digital pin 2 (D2) for serial communication (also can be changed in the code).

Feel free to put your circuit in an enclosure of some sort. A SparkFun red box makes for a great project box. For this project, we are powering the ReadBoard with a 9V battery and 9V battery holder to make it portable.



The code for this is fairly straightforward. You will need the Software Serial library to interact with the serial LCD screen. If you do not have this library you can get it from the Arduino GitHub [here](#). If you have never uploaded a library or want a quick refresher on how to do that, check out our tutorial [here](#). Installation should not be necessary, as this library now comes with the Arduino IDE by default.

For more specific information about the code, you can read the comments in the code itself:

```
// SparkFun Soil Moisture Sensor and Serial LCD example 1
// By Sarah Al-Mutlaq 2015
// Sketch reads sensor and displays level and whether soil is wet or dry

// Use the softwareserial library to create a new "soft" serial port
// for the display. This prevents display corruption when uploading code.
#include <SoftwareSerial.h>

// Attach the serial display's RX line to digital pin 2
SoftwareSerial mySerial(3,2); // pin 2 = TX, pin 3 = RX (unused)

// Here we are setting up some water thersholds that we will
// use later. Note that you will need to change these to match
// your soil type and environment.

/*****
 * Change these values based on your calibration values
 *****/
int thresholdUp = 400;
int thresholdDown = 250;

// We are setting up the pin A0 on the redboard to be our sensor
// pin input:

int soilPin = A0;
int soilPower = 7;//Variable for Soil moisture Power

void setup(){
  mySerial.begin(9600); // set up serial port for 9600 baud (speed)
  delay(500); // wait for display to boot up

  pinMode(soilPower, OUTPUT);//Set D7 as an OUTPUT
  digitalWrite(soilPower, LOW);//Set to LOW so no power is flowing through the sensor
}

void loop(){
  // Here we are declaring a string, which are lines of words,
  // and we want DisplayWords to be the words displayed on
  // the LCD screen, which will change based on whether the soil
  // wet or dry based on our threshold values above.
  String DisplayWords;

  // We need to set up a pin to get the value that the soil
  // moisture sensor is outputting, so sensorValue will get the
  // analog value from the sensor pin A0 on the redboard that we
  // set up earlier.

  int sensorValue;
  sensorValue = readSoil();
```

```
// move cursor to beginning of first line on LCD:
mySerial.write(254);
mySerial.write(128);

// clear display:
mySerial.write("          ");
mySerial.write("          ");

// move cursor to beginning of first line of the LCD screen:
mySerial.write(254);
mySerial.write(128);

//Write what we want to display on the screen:
mySerial.write("Water Level: ");
mySerial.print(sensorValue); //Using .print instead of .write for values

// Now we are going to check if the water level is below a
// out thresholdDown value we set earlier, and if it is have
// words "Dry, Water it!" display one column over on the first
// row:

if (sensorValue <= thresholdDown){
  // move cursor to beginning of second line on LCD:
  mySerial.write(254);
  mySerial.write(192);

  DisplayWords = "Dry, Water it!";
  mySerial.print(DisplayWords);

// If the value is not below our thresholdDown value we want to
// check if it is above our thresholdUp value, and if it is
// change the display words to "Wet, Leave it!":

} else if (sensorValue >= thresholdUp){
  // move cursor to beginning of second line on LCD:
  mySerial.write(254);
  mySerial.write(192);

  DisplayWords = "Wet, Leave it!";
  mySerial.print(DisplayWords);

// Otherwise if it is inbetween the two values we want it to
// the display it had, so if our soil was really wet and drying
// the words would only change to "Dry, Water it!" when it got to the lower threshold
// (thresholdDown), but if it was dry and getting wetter the words
// would only change to "Wet, Leave it!" when it got to the upper
// threshold (thresholdUp_):

} else {
```

```
// move cursor to beginning of second line on LCD:
mySerial.write(254);
mySerial.write(192);

mySerial.print(DisplayWords);
}

delay(500); //wait for half a second, so it is easier to read
}

//This is a function used to get the soil moisture content
int readSoil()
{
  digitalWrite(soilPower, HIGH); //turn D7 "On"
  delay(10); //wait 10 milliseconds
  int val = analogRead(soilPin); //Read the SIG value from sensor
  digitalWrite(soilPower, LOW); //turn D7 "Off"
  return val; //send current moisture value
}
```

This code has different values for an upper threshold and a lower one, so you have a middle zone that could either be wet or dry depending on whether the soil is drying out (coming down from being wet) or getting wet (coming up from being dry). If you don't want this middle zone, you can set both thresholds to the same value, but I have found that having this middle area is more similar to how soil actually works; there really isn't a point at which soil goes from being wet to dry. If you are interested in soil and how it reacts to water, you should read up on it; it can be very complicated and interesting.

You will need to adjust the code variables anyway, since this will be unique to your setup, soil type, and how wet you actually want your soil to be. Using the calibration techniques mentioned above, test out the reading and play around with the values until you find some that fit your needs.

Troubleshooting

❓ Not working as expected and need help?

If you need technical assistance and more information on a product that is not working as you expected, we recommend heading on over to the SparkFun Technical Assistance page for some initial troubleshooting.

SPARKFUN TECHNICAL ASSISTANCE PAGE

If you don't find what you need there, the SparkFun Forums are a great place to find and ask for help. If this is your first visit, you'll need to create a Forum Account to search product forums and post questions.

CREATE NEW FORUM ACCOUNT

LOG INTO SPARKFUN FORUMS

Resources and Going Further

For more information, check out the links below:

SparkFun Soil Moisture Sensor (13322):

- [Schematic \(PDF\)](#)
- [Eagle Files \(ZIP\)](#)
- [GitHub](#)

SparkFun Soil Moisture Sensor with Screw Terminals (13637):

- [Schematic](#)
- [Eagle Files](#)
- [GitHub](#)

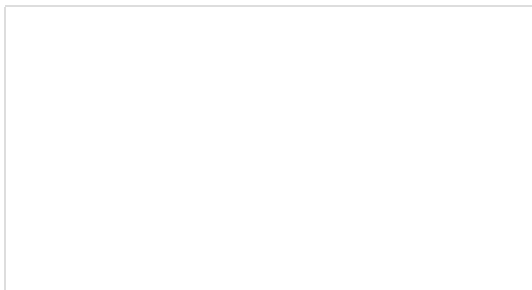
SparkFun Qwiic Soil Moisture Sensor(17731):

- [Schematic \(PDF\)](#)
- [Eagle Files \(ZIP\)](#)
- [Qwiic Soil Moisture Sensor GitHub](#)
- [Atmel ATTiny Datasheet](#)
- [Qwiic Resource Page](#)

Zio:

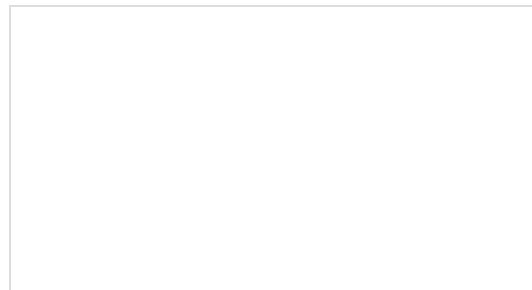
- [Zio's Soil Moisture Sensor](#)
- [Zio's Soil Moisture Sensor GitHub Link](#)

Still want more? Check out these other great SparkFun tutorials for more soil moisture sensing fun!



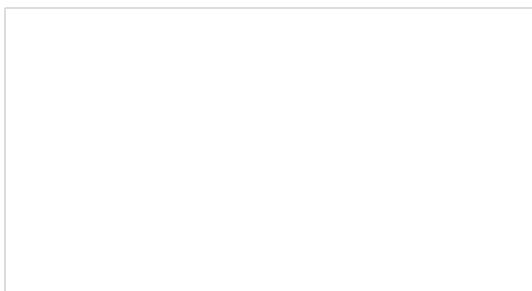
SparkFun Inventor's Kit for Photon Experiment Guide

Dive into the world of the Internet of Things with the SparkFun Inventor's Kit for Photon.



Photon Weather Shield Hookup Guide V11

Create Internet-connected weather projects with the SparkFun Weather Shield for the Photon.



ESP32 Environment Sensor Shield Hookup

Guide

SparkFun's ESP32 Environment Sensor Shield provides sensors and hookups for monitoring environmental conditions. This tutorial will show you how to connect your sensor suite to the Internet and post weather data online.