Plant Watering System (Capacitive)

Use a micro:bit with a Bit Board to check if your plant needs water, and then water it using a pump.

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INTRODUCTION

Use a micro:bit with a Bit Board to check if your plant needs water, and then water it using a pump activated by a Relay Module connected to the Bit Board.

This is an updated version of our older guide which used a resistive sensor: Plant Watering System (Resistive)

We recommend you use this guide which uses a **Capacitive Sensor** which is much more up-to-date

TOOLS:

- Computer (1)
- Phillips Screwdriver (1)

PARTS:

- Crazy Circuits Bit Board (1)
- micro:bit (1)

V2

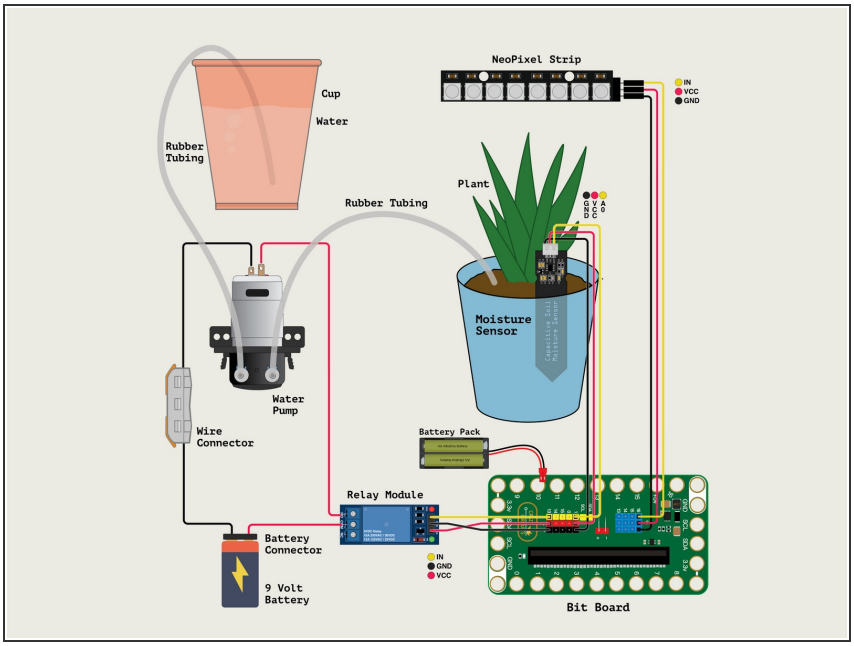
- Capacitive Moisture Sensor (1)
- Crazy Circuits Ribbon Cable (2)
- Addressable RGB LED Strip (1)
- DC Water Pump (1)
- Relay Module (1)
- 9 Volt Battery Connector (1)
- Wire Connector (1)
- LEGO Baseplate (1)
- Misc LEGO Parts (1)

Step 1 — What is a Capacitive Moisture Sensor?



- In our original Moisture Sensor guide we uses a *Resistive* Moisture Sensor. They work okay, but are prone to corrosion with extended use.
- The **Capacitive Moisture Sensor** we'll use in this guide should last much longer and will not corrode over time.
- ⓘ If you want a deeper explanation of how a Capacitive Moisture Sensor works check out these blog posts from Biomaker or Maker Portal.

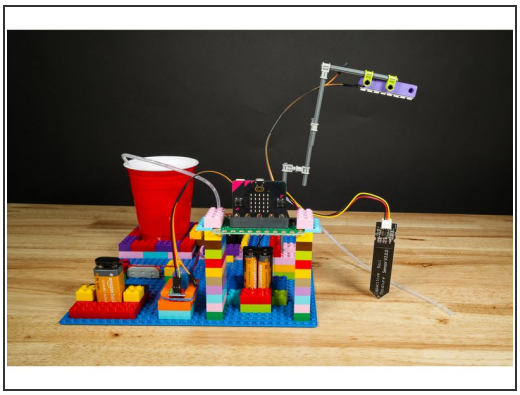
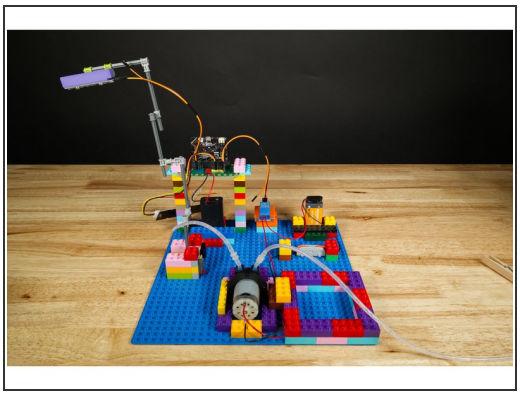
Step 2 — The System Layout



- Here's the basic layout of all of the parts of our Plant Watering System. Basically, we have a plant and a container of water. There's a pump that will send water to the soil from the cup when needed.
- We've got our **Moisture Sensor** stuck into the dirt of our plant. It can read how wet (or dry) the soil is.

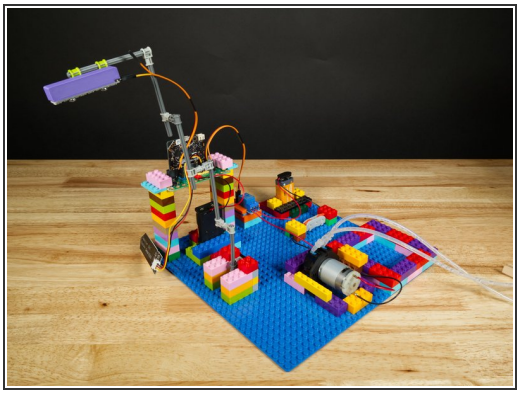
- The Moisture Sensor is connected to the **Bit Board** so the micro:bit can get a reading on the soil.
- When water is needed the **Relay Module** will be triggered by the micro:bit so that it turns on the **Water Pump**.
- We power the pump with a **9 Volt Battery**. One wire goes directly to the pump using a **Wire Connector**, and the other goes to the Relay Module which acts as a switch.
- We also have a **Addressable RGB LED Strip** (often called a "NeoPixel Strip") that can work as a light source for the plant.
  - Note: We've attached it with a NeoPixel Beam Holder
- Finally, we can power the Bit Board with an AA **Battery Pack**. *Note that the 9 Volt Battery is only used to power the pump.*

Step 3 — Build with LEGO

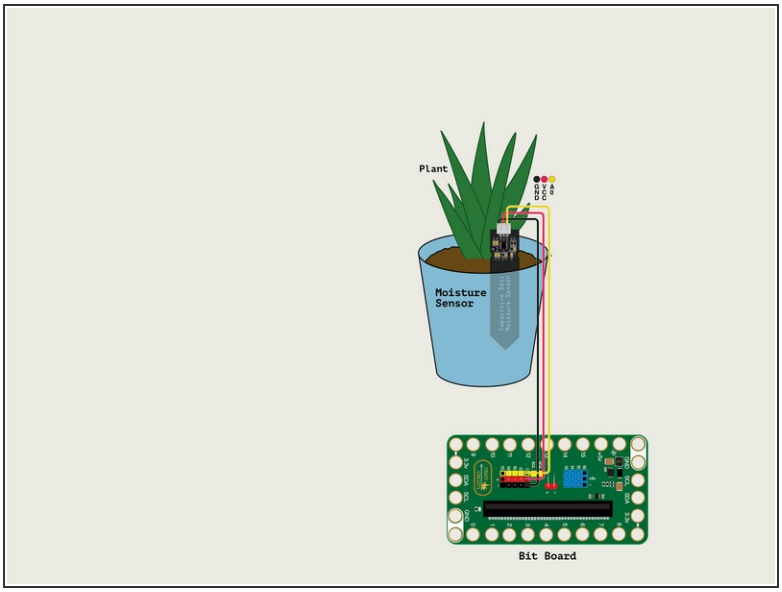

- We used a large LEGO Baseplate to build our project.
- Most of the build is just plain bricks, though we did use one of our [3D Printed Component Holders] you can instead use LEGO bricks with rubber bands or tape to hold the Relay Module.
- The **Addressable RGB LED Strip** is probably the trickiest part of this, so we used a bunch of random LEGO Technic axles we had lying around. *(Parts list to come!)*
- We've raised the Bit Board up on two towers of bricks so that the moisture sensor can reach our plant.

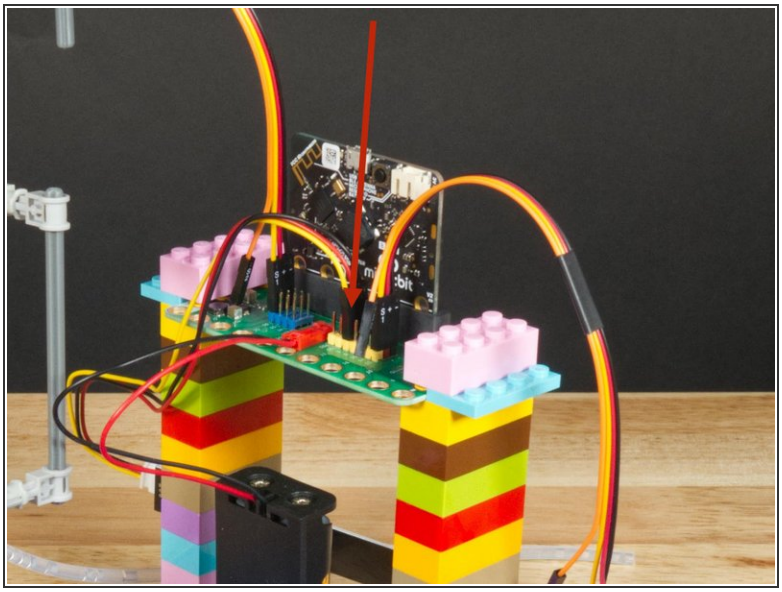
Step 4 — Build with LEGO


- The building with LEGO is the main challenge with this project. Of course you don't have to exclusively build with LEGO.
- You can incorporate cardboard, wooden dowels, popsicle sticks, or any other common crafting/building materials.
- The photos of our build are mainly for reference and to provide some tips on your own build.

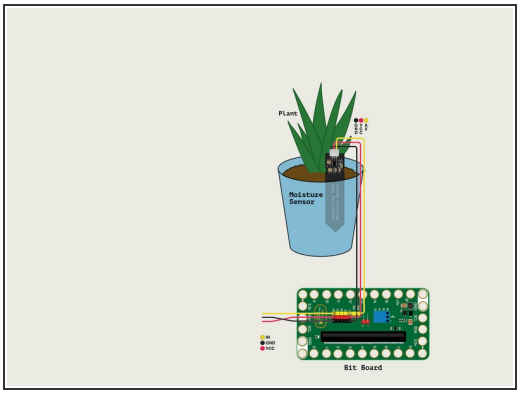
Step 5 — Add the Moisture Sensor

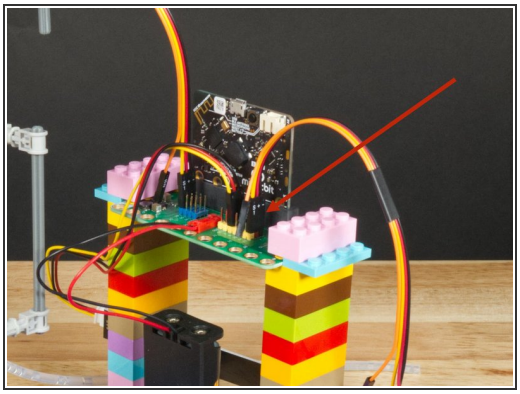


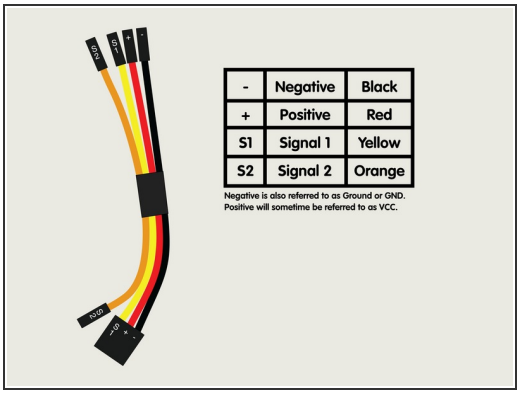


- Plug the **Moisture Sensor** into **Pin 1**.
- The **Yellow** wire will go into **Pin 1**.
- The **Red** wire will go into the **+** (Positive) Pin.
- The **Black** wire will go into the **-** (Negative) Pin.
- We've also placed the Moisture Sensor into the dirt of our plant.

Step 6 — Add the Ribbon Cable







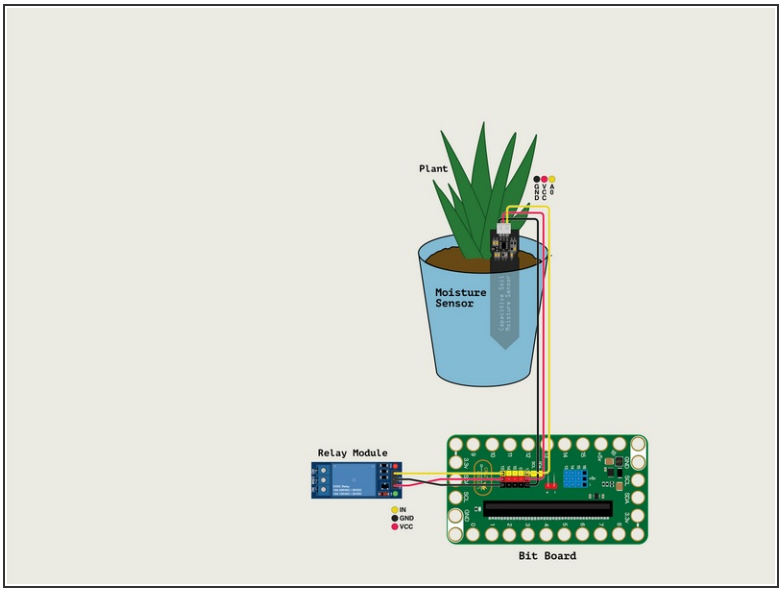
-	Negative	Black
+	Positive	Red
S1	Signal 1	Yellow
S2	Signal 2	Orange

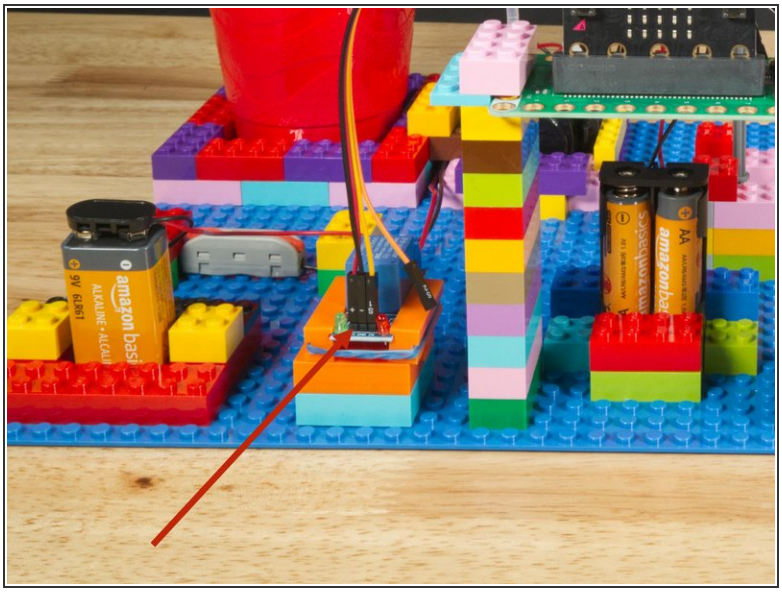
Negative is also referred to as Ground or GND.
Positive will sometime be referred to as VCC.

- Before we add the **Relay Module** we'll start by plugging a Crazy Circuits Ribbon Cable into **Pin 13**.
- Since the **Crazy Circuits Ribbon Cable** has a connector on one end that combines three wires together you'll want to plug that end into the **Bit Board**. The **Yellow** wire will get plugged in and the **Orange** wire will be dangling on its own.

Note: You don't have to use a **Crazy Circuits Ribbon Cable** and can certainly use any F/F Jumper Wires but the color-coded Crazy Circuits Ribbon Cable with the end connector makes things a little easier for beginners.

Step 7 — Add the Relay Module



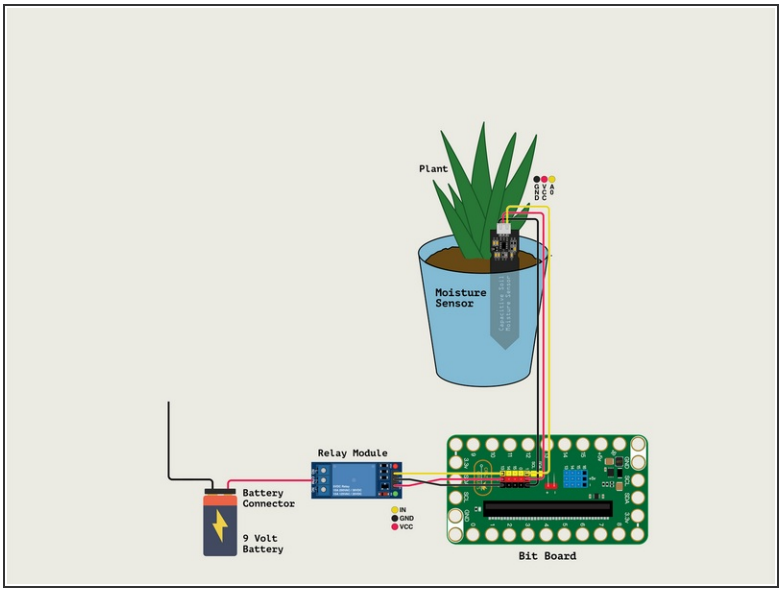


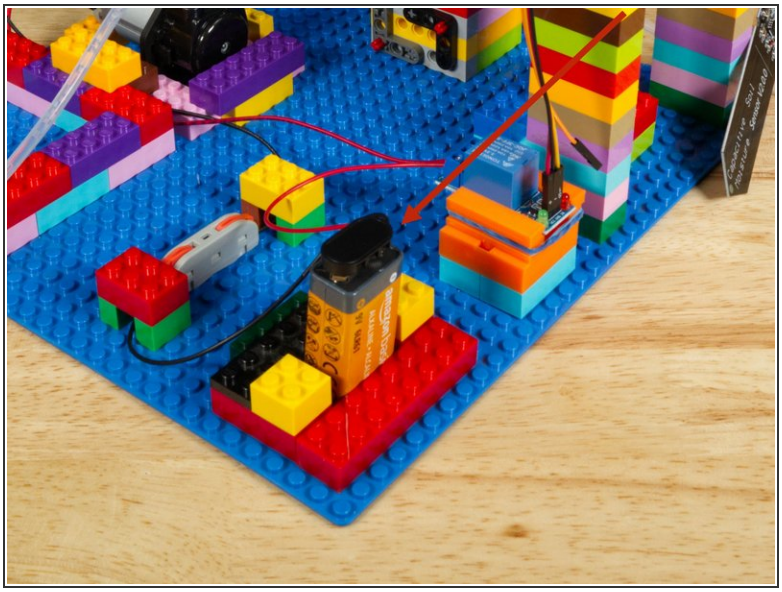
- Let's plug in the Relay Module! (Again, if you're using the **Crazy Circuits Ribbon Cable** it makes things a little easier, but any F/F Jumper Wires will work fine.)
- The **Red** wire will go into the **VCC** Pin.
- The **Black** wire will go into the **GND** Pin
- The **Yellow** wire will go to the **IN** Pin.

ⓘ **VCC** stands for **Voltage Common Collector** and is often used to indicate where Positive power is applied in a circuit.

ⓘ **IN** is often used to indicate an **IN**PUT and it is how we control the circuit using the micro:bit

Step 8 — Add the 9 Volt Battery

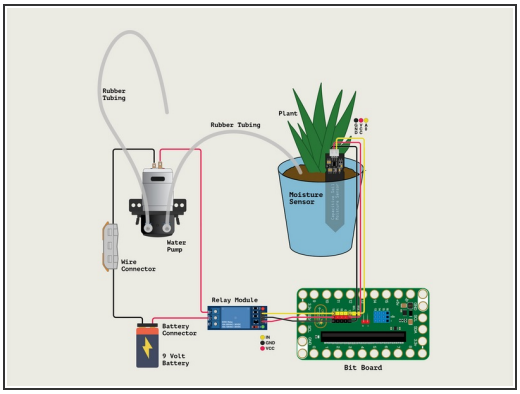


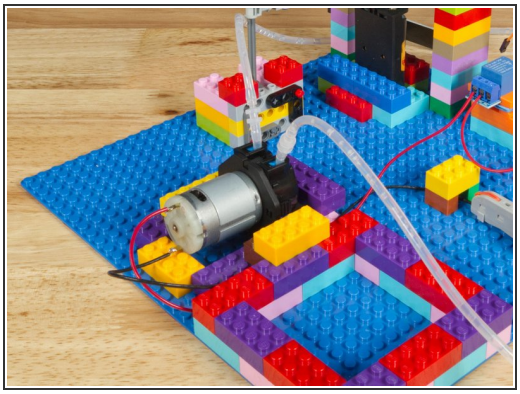


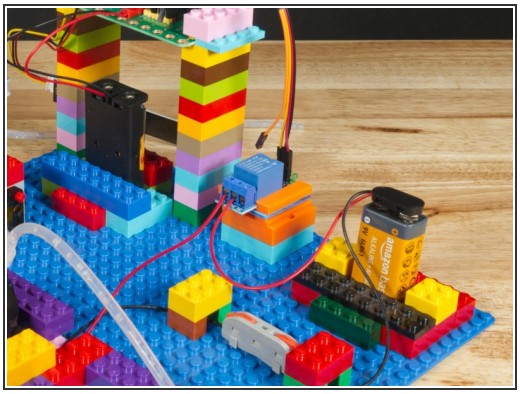
- Attach the **9 Volt Battery Connector** to the 9 Volt Battery.

ⓘ We built a little LEGO brick "pocket" to fit the battery into, but you can attach it in any way you like.

Step 9 — Add the Pump

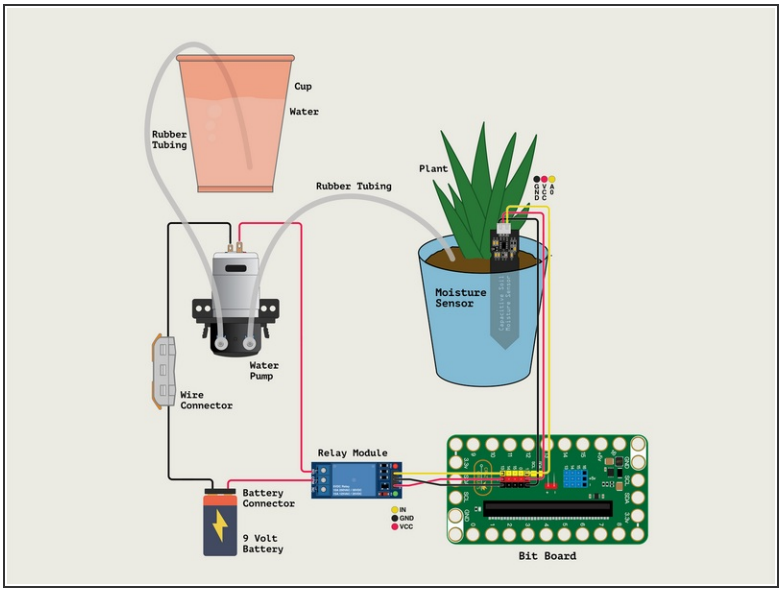


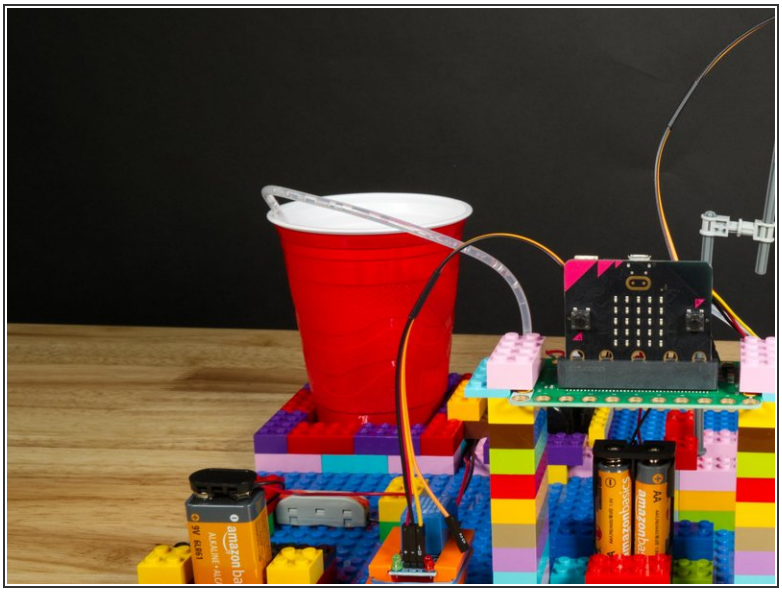




- We'll add the **Water Pump** next. The pump needs to be connected to the **9 Volt Battery** for power.
  - ⓘ The **Relay Module** sits between the Battery and the Pump and acts as a "Smart Switch" to turn on the pump by closing the circuit when the micro:bit tells it to.
- The **Red** (Positive) wire from the battery connector will go to the **COM** (Common) Screw Terminal on the Relay Module.
- The **Red** (Positive) wire from the Pump will go to the **NO** (Normally Open) Screw Terminal on the Relay.
- We will then run the **Black** (Negative) wire from the battery connector to the **Black** (Negative) wire of the Pump. We're going to use a **Wire Connector** to make the connection.
  - If you don't have a Wire Connector you can twist the bare wires together and cover with a small piece of masking tape or other non-conductive tape.

Step 10 — Add a Water Container

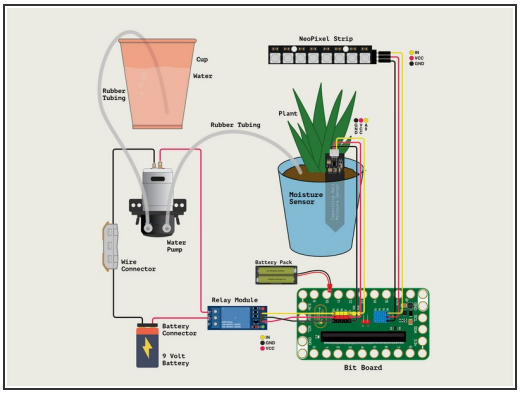


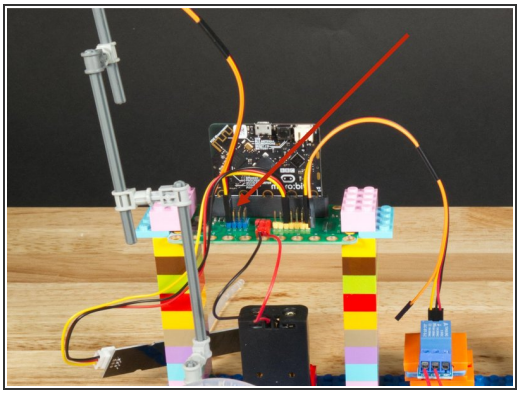


- Once we have the **Water Pump** connected we can place the feed hose into our water container.
- We used a red plastic cup for our demo, and we built up a little wall of LEGO bricks around it to help hold it in place.
- You may want a more stable water container. An old food container with a lid you can cut notches out of for the wire and tubing would be ideal.

⚠ **Warning!** Water and electronics do not mix! While the Moisture Sensor is meant to be in wet soil, water should not touch other parts of your electronics. Be careful around the wires, battery, relay, Bit Board, and any other components.

Step 11 — Add an Addressable RGB LED Strip

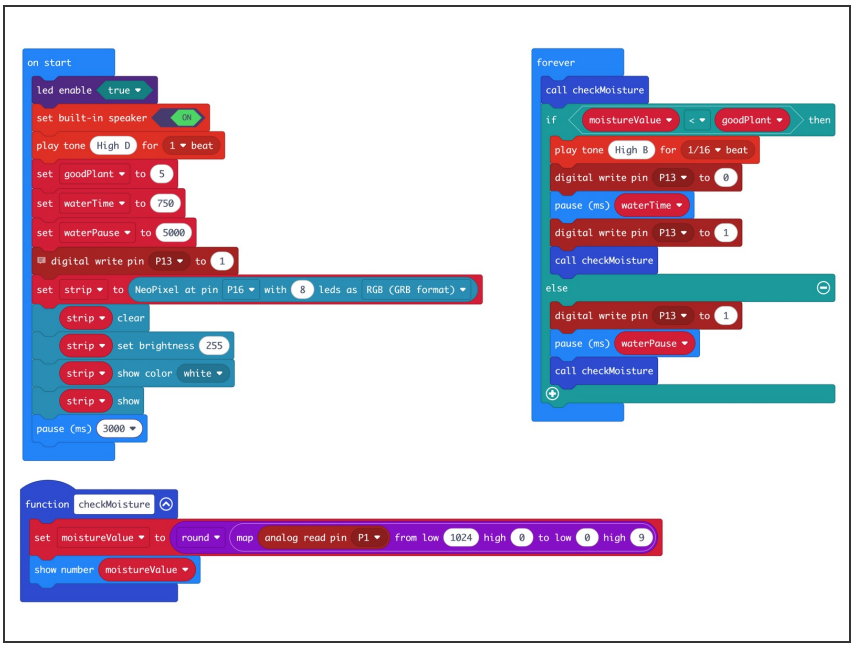






- Let's plug in the Addressable RGB LED Strip! (Again, if you're using the **Crazy Circuits Ribbon Cable** it makes things a little easier, but any F/F Jumper Wires will work fine.)
- The **Red** wire will go into the **VCC** Pin.
- The **Black** wire will go into the **GND** Pin
- The **Yellow** wire will go to the **IN** Pin.
- Plug the other end of the Crazy Circuits Ribbon Cable into **Pin 16** of the **Blue Pins**.

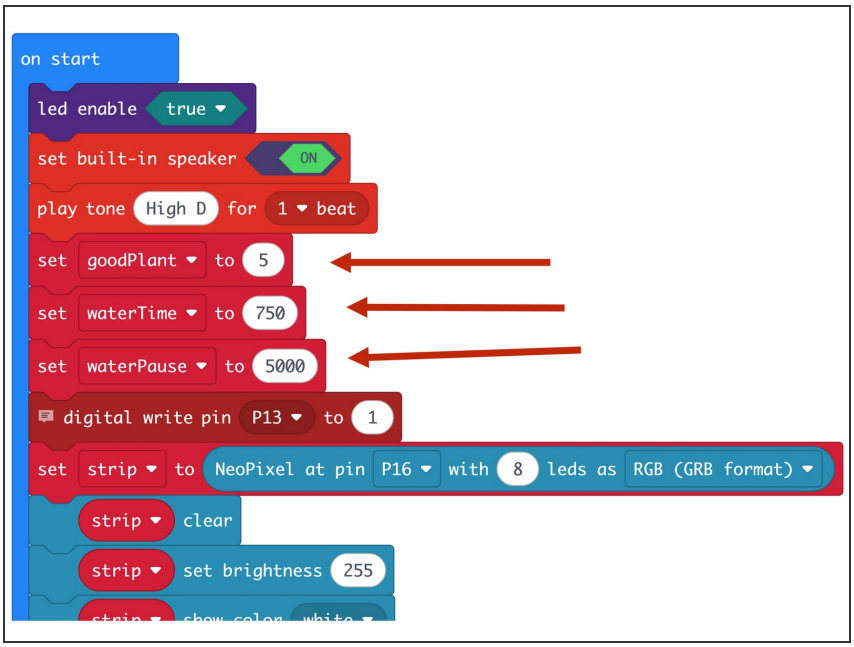
Step 12 — Load the Code



- If you've never used a micro:bit before you'll want to check out this guide: Bit Board V2 Setup and Use
- We're going to load the following code for our **Plant Watering System V3** program: https://makecode.microbit.org/_XxXCfDAme...

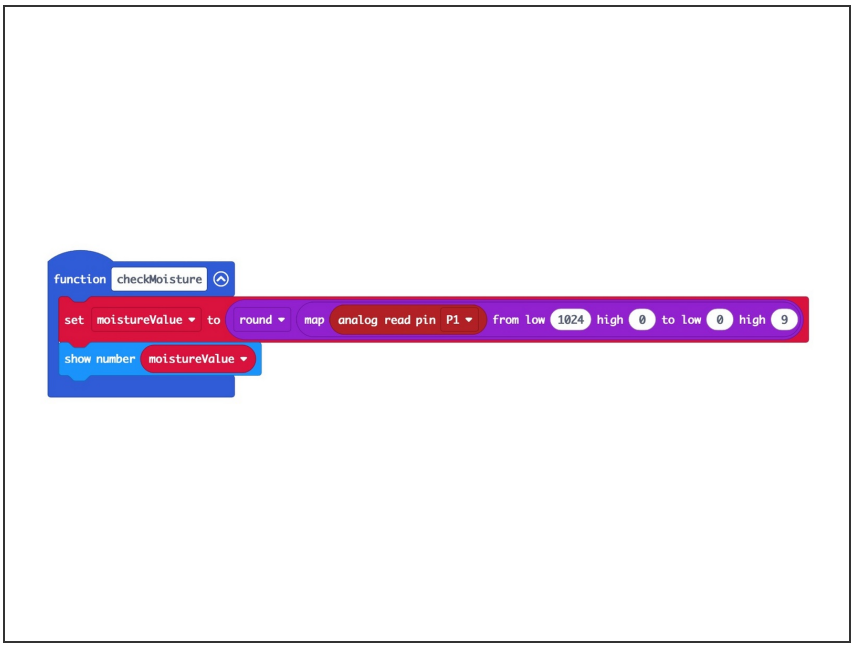
⚠ **Don't run the code immediately!** It's best to disconnect the 9 Volt Battery so we don't start pumping water until after we calibrate the system.

Step 13 — The Variables



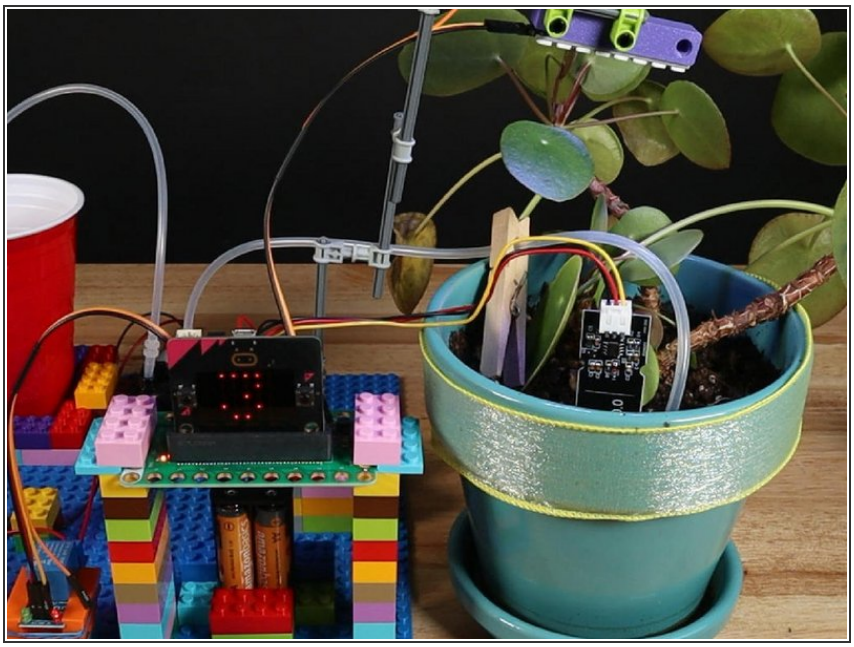
- There are two variables you can adjust in the **on start** section of the code.
- The **goodPlant** variable is the number the Moisture Sensor will read from the soil. The scale goes from 0 to 9 and for our plant 5 or 6 was properly moist soil.
- The **waterTime** is the amount of time the pump will run to put water into the soil. 1000 milliseconds = 1 second, so this will run for 1 second, then check the sensor again, and add more water if still needed.
  - We'd recommend starting with the **waterTime** variable set to 1000 or lower, as we don't want to overdo it and add **too much** water.
- Finally, the **waterPause** is the amount of time between water being pumped to the plant.

Step 14 — The Math



- We use a function named **checkMoisture** to read the Moisture Sensor connected to **Pin 1** and determine the value. (We also display the value on the micro:bit)
- The value will be between **0** and **1024** with **0** being wet and **1024** being dry.
- Since we want to use a scale of **0** to **9** take make it easy to display (with **0** being dry and **9** being wet) we'll use the **map** function to **remap** the scale of the values and to **reverse** it.
- So if the sensor reads a value of **1024** we'll map that to **0** and if the sensor reads a value of **0** we'll map that to **9**.
- If our sensor reads a value near **512** that will map to either **4** or **5** on our scale.
- We've also added the **round** function so if we get a decimal reading such as **4.3** it will display as **4** on the micro:bit's built-in LED matrix. Otherwise it would scroll **4.3** across the display, making it much more difficult to read the value quickly.

Step 15 — Calibrate the Sensor



- We are ready to calibrate!
- ⚠ First, disconnect the 9 Volt Battery to prevent the pump from running while we get some measurements.
- If you've got the code loaded, and the sensor in the soil, power up the Bit Board with the battery pack and after a few seconds you should see a value on the LED matrix.
- We got a value of 3 which means our soil is a bit dry!
- We added what we thought was the correct amount of water and the value went to **5**. This is how we got the value we set the variable **goodPlant** to, which you can see in Step 13.

Step 16 — Test it Out!



- If everything seems to work so far you can reconnect the **9 Volt Battery** and test the whole system.
- If you want to "trick" your probe into thinking the soil is dry just pull it out of the soil and the value should go low enough to cause the pump to run.
- Remember! You will need to experiment to determine how much water your plant needs, how often you should check the soil, etc. Gather information and make decisions based on what you've learned.

Step 17 — Take it Further



- Like many of our projects, we are working with a cause and effect, and we're using a sensor to collect data and do something based on that input.
- You might want to experiment with placing the probe in different places to see what readings you get.
- You can also change the code to do other things or alter the behavior of the system. Anything goes!

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