runlinc Project : Monitoring NPK (E32W Version)

Contents

Introduction

Problem

Can we monitor the soil using sensors and STEMSEL board? How to do that? What sensor can we use? What kind of communication does the sensor use?

Background

NPK sensors are a type of sensor that can be used to detect the amount of Nitrogen (N), Phosphorus (P) and Potassium (K) inside the soil, which are crucial nutrients for various of plant processes. Farmers use these data to monitor the soil. Different amount of N, P and K will significantly influence the health of the plants. Most NPK sensors on the market use metal probe heads, to use it you just simply insert the metal probe head into the soil, and the microcontroller will read and process the signal from the probe (the probe need to be powered with electricity), and output the digital number of the amount of N, P and K on a screen.

The NPK sensor probe we use will output a certain signal (using the Modbus communication protocol), which cannot be read directly by normal digital devices and human. To convert the signal to digital data through a microcontroller, a Modbus Module called ‘MAX485 TTL to RS-485 Interface Module’ is being used. The module will concert the Modbus data into the data which our microcontroller can read, then the microcontroller will use its communication protocol with a screen to output the data on the screen, then you can read it.

Ideas

We have an NPK sensor which uses Modbus data port to output signal, so we can use a microcontroller with a Modbus module to read the signal and output the NPK data on a screen. Our microcontroller (STEMSEL board) can output data directly through the webpage we made, so we already have the device to display data and the microcontroller if we have the board, the Modbus module and a PC or a smart phone. We can read NPK data using

this!

Plan

We have a STEMSEL board, a Modbus module and an NPK sensor. We will connect them together, and use the system we build to monitor the NPK data in the soil.

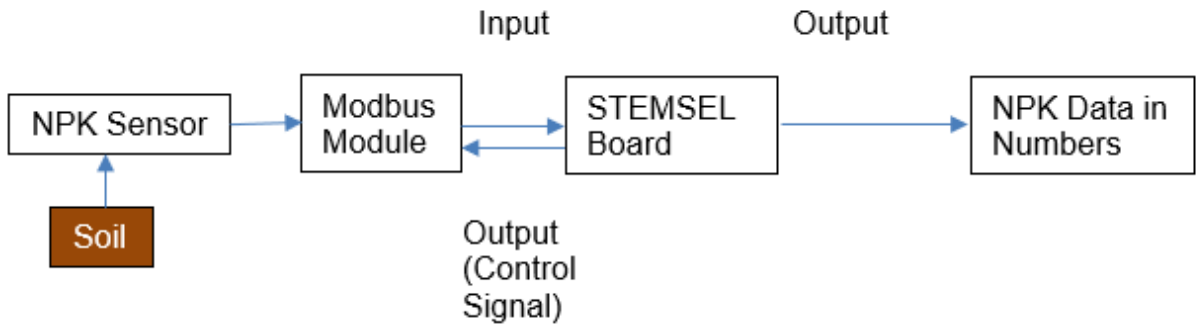

Figure 1: Block diagram of Microchip inputs and outputs

runlinc Background

runlinc is a web page inside a Wi-Fi chip. The programming is done inside the browsers compared to programming inside a chip. The runlinc web page inside the Wi-Fi chip will command the microchips to do sensing, control, and data logging Internet of Things (IoT). It can predict and command.

Part A: Design the Circuit on runlinc

Note: Refer to runlinc Wi-Fi Setup Guide document to connect to runlinc

Use the left side of the runlinc web page to construct an input/output (I/O).

The Modbus module we use has 8 pins. In these pins, 3 of them are for receiving control signal from the microcontroller (Driver in, Driver Enable and Receiver Enable, DI, DE and RE). Another one, Receiver Out (RO), is for output data to the microcontroller, these are all the pins that you need to set up on the microcontroller.

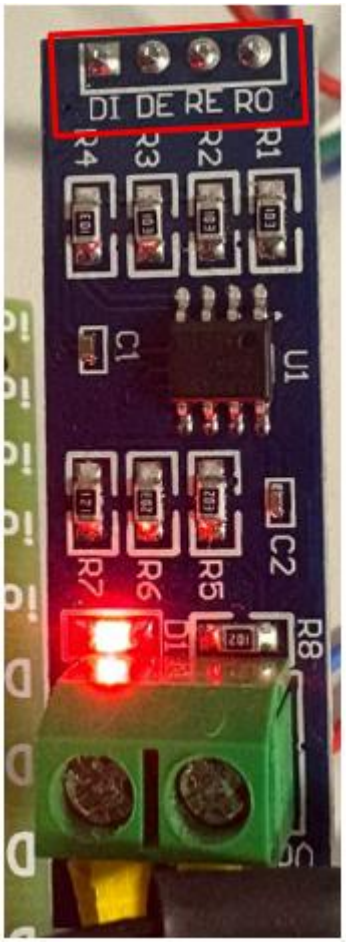

Figure 2: 4 pins that need to be set up on STEMSEL board on the Modbus board

For port D15 name it NPKControl and set it as DIGITAL_OUT.

For port RX2 name it NPKSensor and set it as NPK_IN.

For port TX2 set it as NPK_IN.

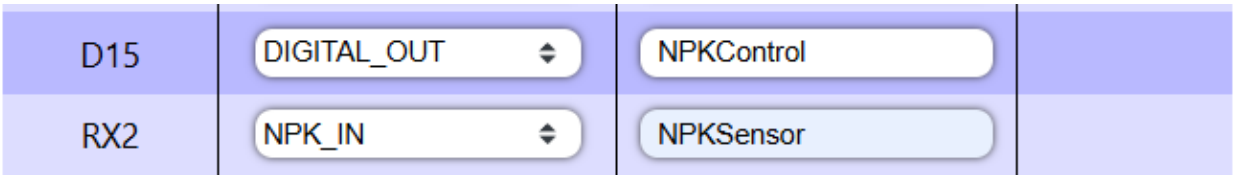

Figure 3: I/O configurations connections

Part B: Build the Circuit

Use the STEMSEL E32W board to connect the hardware. For this project, we are using both the left and right I/O ports, with **negative port (-ve)** on the outer side, **positive port (+ve)** on the middle and **signal port (s)** on the inner side (as shown below).

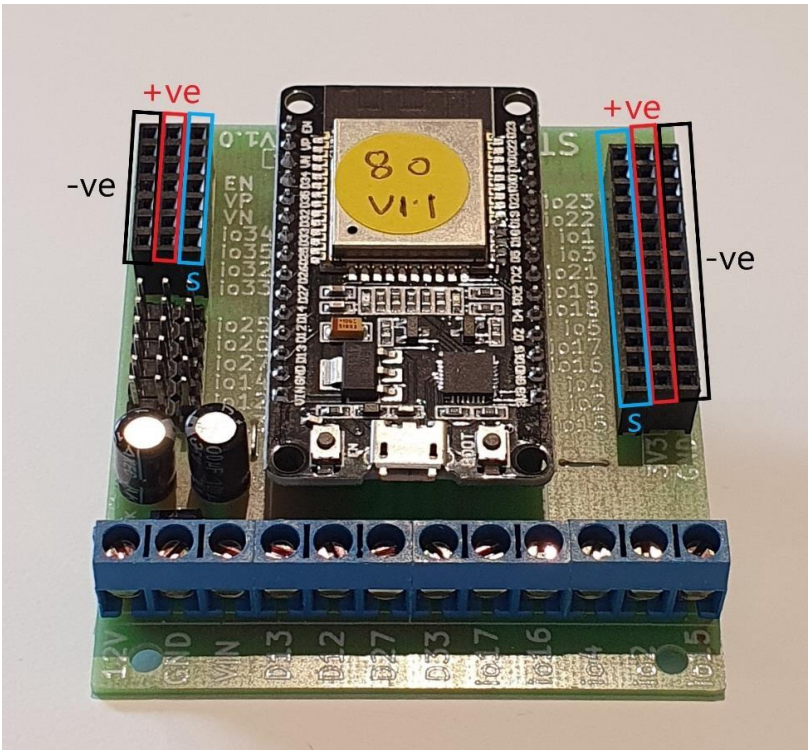

Figure 4: Negative, Positive and Signal port on the E32W board

The NPK sensor we use has 4 wires, the manufacturer uses different colors to indicate different wires. We need to connect different wires to their corresponding places. The name and usage of the wires is shown in the picture below.

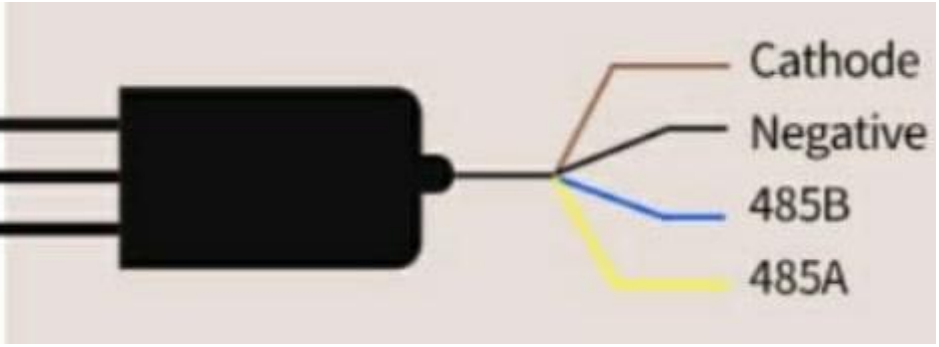

Figure 5: 4 wires on the NPK sensor port

First, loosen the 2 screw terminals' screw, and insert the yellow wire (485A) to the screw terminal A (right) and insert the blue wire (485B) into the screw terminal B (left) then fasten the screws, as shown in the picture below.

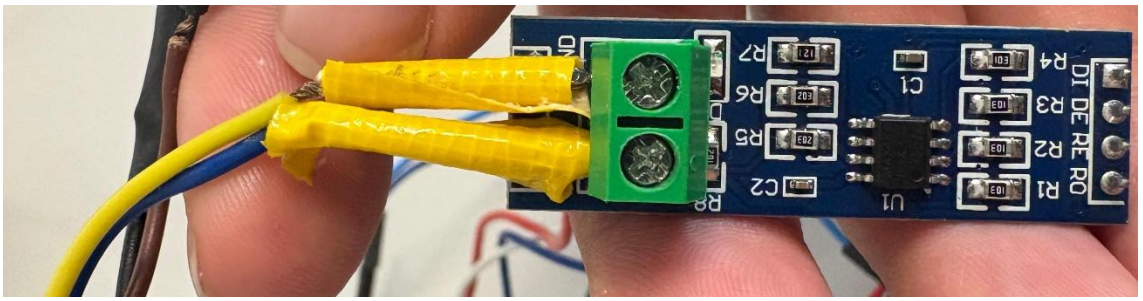

Figure 6: connection of 485A and 485B

Next, Connect Negative into a GND port on the STEMSEL board, and the Cathode into the 12V terminal.

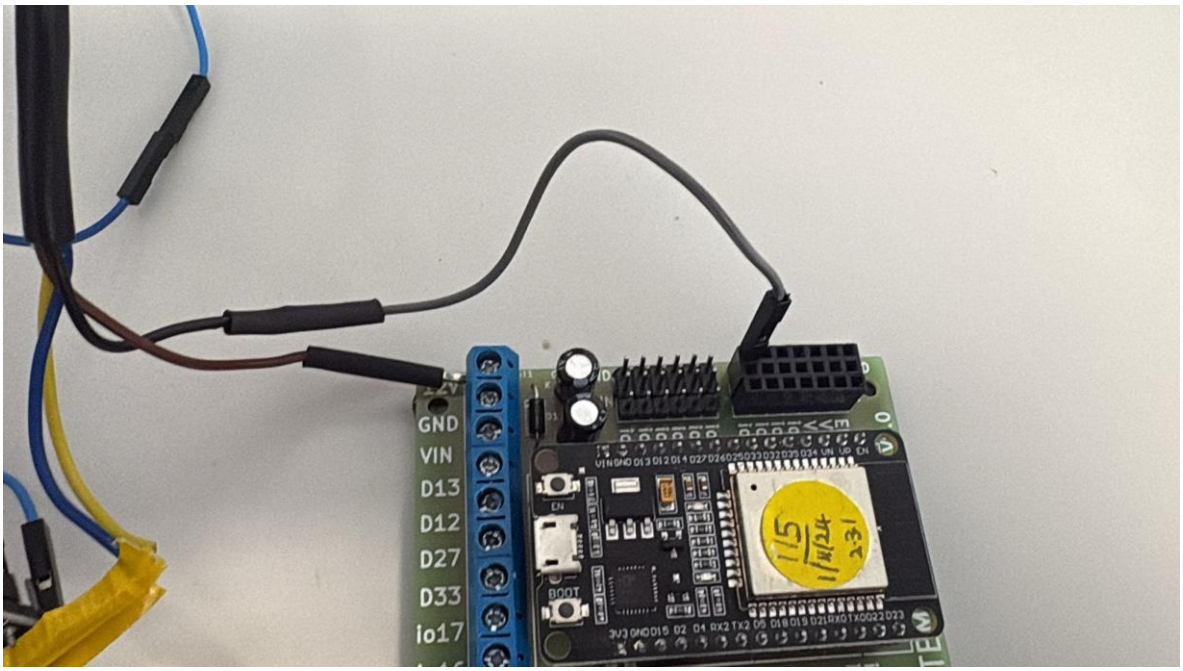

Figure 7: connection of Cathode and Negative

Next, Connect a wire to GND (blue in picture) and another wire to VIN (red in the picture).

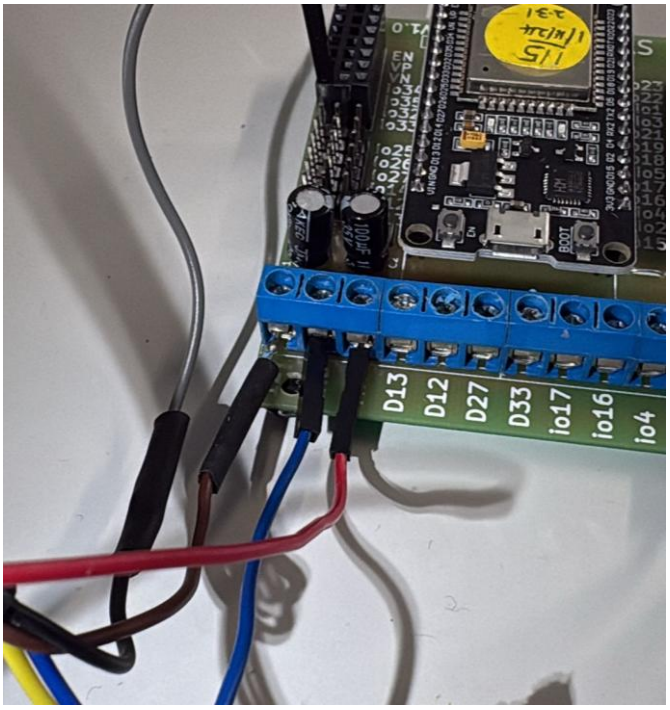

Figure 8: two cables on GND and VIN

Next, Connect the GND wire (blue in picture) to GND on the Modbus module, and the VIN wire (red in the picture) to VCC on the Modbus module. **Note** that this VCC accepts **5V** input. Note 2: Don't make the side window of the connector head facing an adjacent pin. If they touch with each other it might cause a damage to the chip or a dangerous situation.

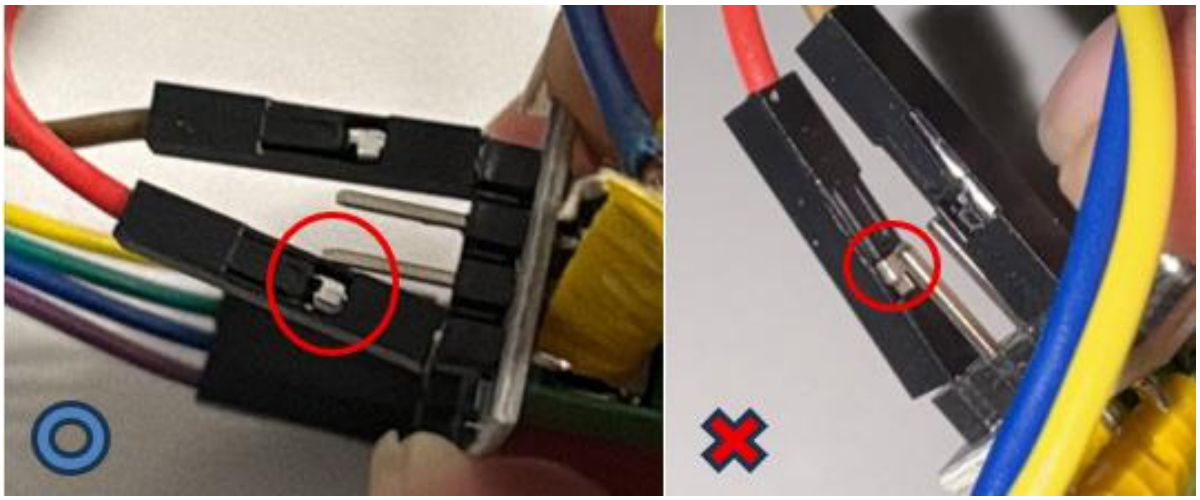

Figure 9: right way to connect cable(left) and wrong way to connect cable(right)

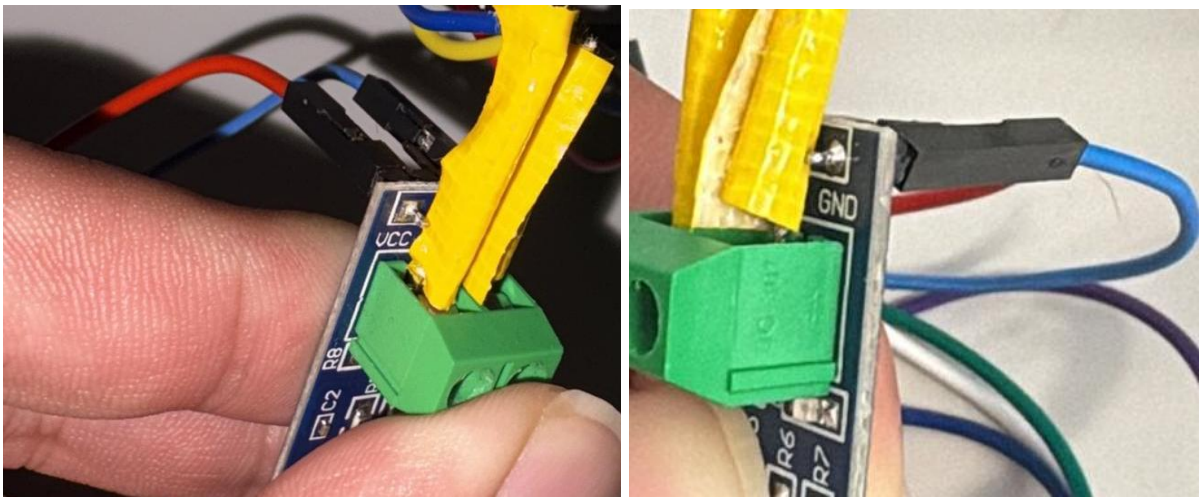

Figure 10: two cables to GND and VCC on Modbus module

Next, connect the DI port on the Modbus module (purple wire here) to TX2 (io17) on the STEMSEL board, and the RO port on the Modbus module (blue wire here) to RX2 (io16) on the STEMSEL board. Then connect the DE and RE pins (white and green pins) to io15. These are the pins for controlling the receiver, they should be jumped together, because one pin is on when it's being powered, and another on is on when it's connected to the ground, and we should always turn on one of them (one is for receiver and another is for transmitter).

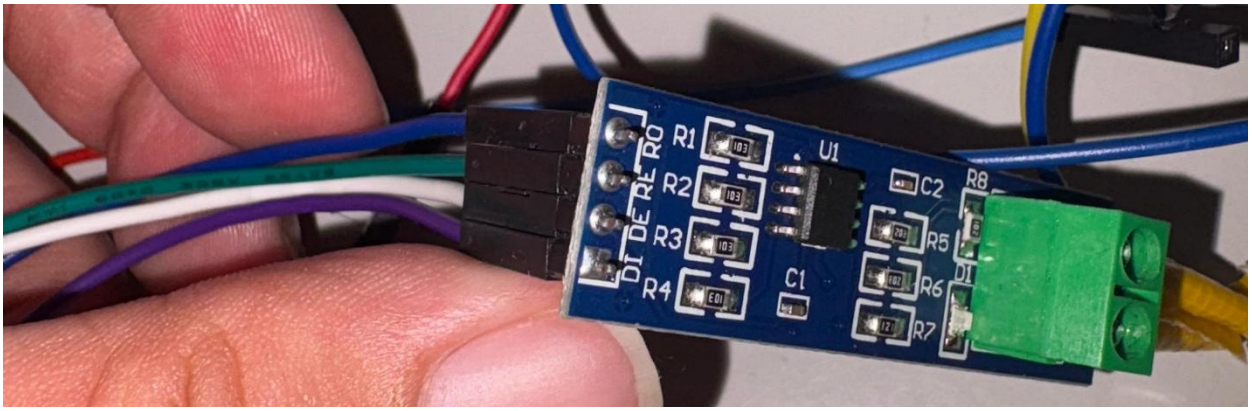

Figure 11: 4 pins on the Modbus module connected with wires

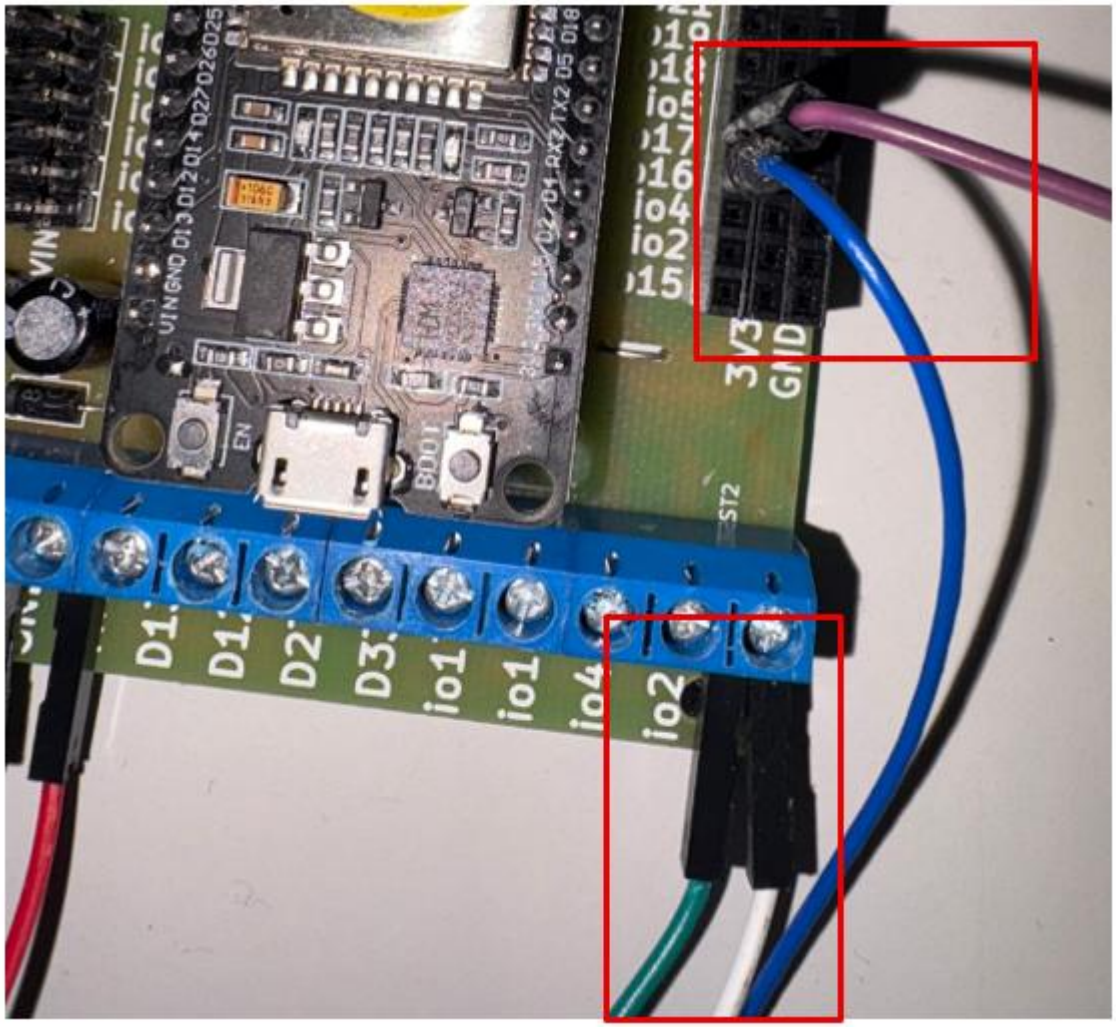

Figure 12: 4 pins on the Modbus module connected to io15, 16 & 17

At last, use a 12V~20V Direct Current power source (a power adapter here) and connect the positive pin to 12V on the STEMSEL board, and negative pin to GND on the STEMSEL board.
Note: We are using a 12V power supply so we don't need to use the micro USB connector port to power up the board.

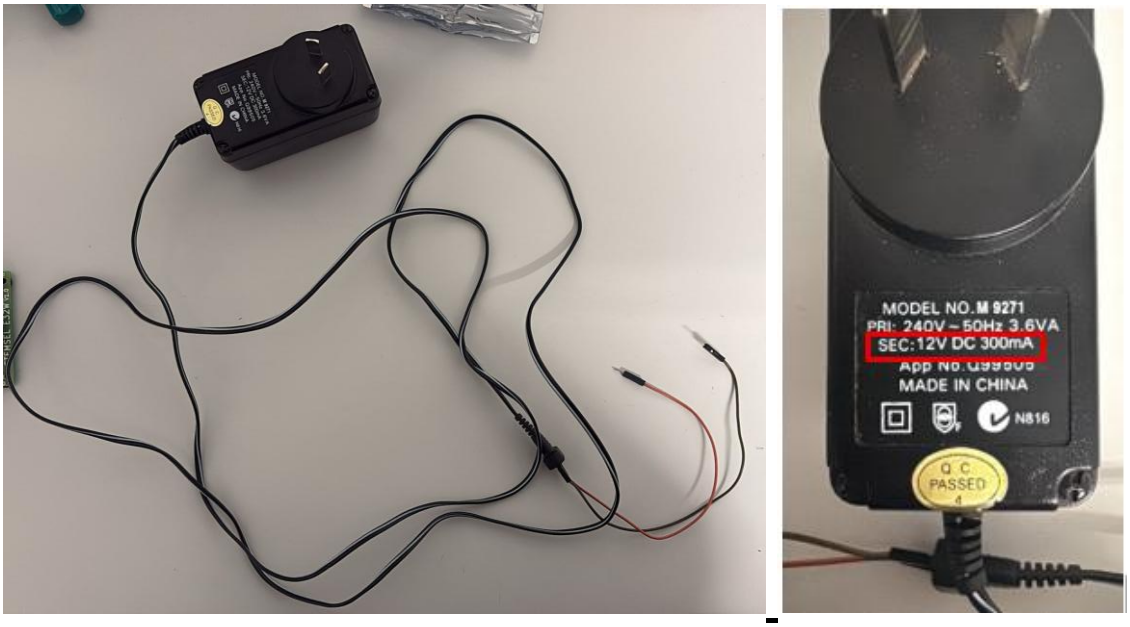

Figure 13: Power Adapter

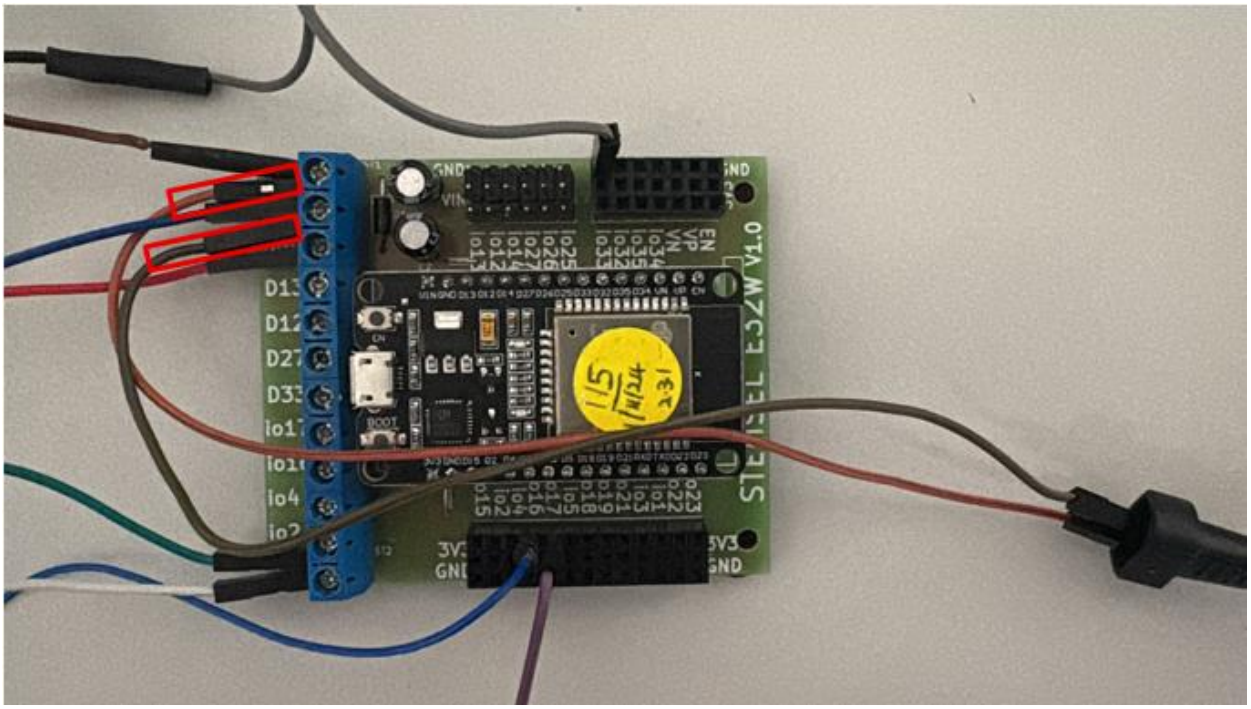

Figure 14: Power Adapter's pins connected to STEMSEL board's VIN and GND

You should see the red LEDs on STEMSEL board and Modbus module turn on after you've powered the system on.

Part C: Program the Test Circuit

Now, we can start programming the functions of the sensor.

The final code in HTML box should look like this:

```
<h2>NPK Monitoring Web Page</h2>

NPK Raw Data: <font id="NPK_Message"></font><br>
Nitrogen: <font id="Nitrogen_Message"></font><br>
Phosphorus: <font id="Phosphorus_Message"></font><br>
Potassium: <font id="Potassium_Message"></font>
<br><br>
```

The final code in JavaScript Loop should look like this:

```
// Get Data from Sensors
RawNPK = NPKIn( NPKSensor );

// Display NPK Sensor Data
const NPKArray = RawNPK.split(",");
Nitrogen = NPKArray[0]
Phosphorus = NPKArray[1]
Potassium = NPKArray[2]

document.getElementById("NPK_Message").innerHTML = RawNPK;
document.getElementById("Nitrogen_Message").innerHTML = Nitrogen + " mg/Kg";
document.getElementById("Phosphorus_Message").innerHTML = Phosphorus + "
mg/Kg";
document.getElementById("Potassium_Message").innerHTML = Potassium + " mg/Kg";

// 1 Second Delay to get readings before display update
await mSec( 1000 );
```

The final runlinc webpage should look like this:

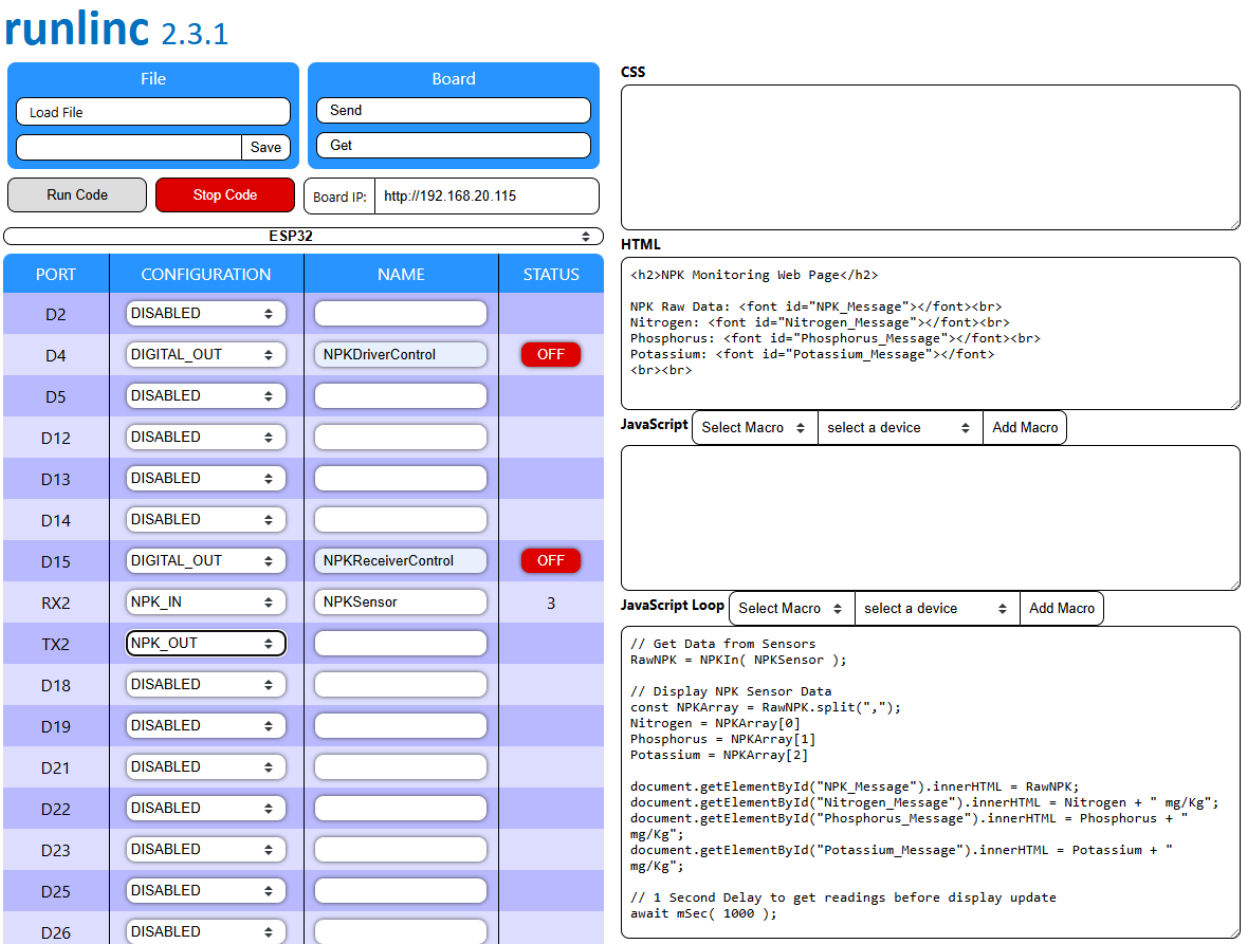

Figure 15: runlinc webpage screenshot

Part D: The Working Project

Now, turn on the device and insert the probe head into any soil with moisture (a watered pot of plant here), then click on the “Run Code” button on the control page.

Figure 16: NPK sensor with soil

When the project is running successfully, this page will show up, at first, it will show “No data on NPK sensor”, then after a while, there will be 3 stable numbers showing up after “NPK Raw Data” separated with comma, corresponding to the 3 readings below. If you move the NPK sensor a bit with your hand, the number will change.

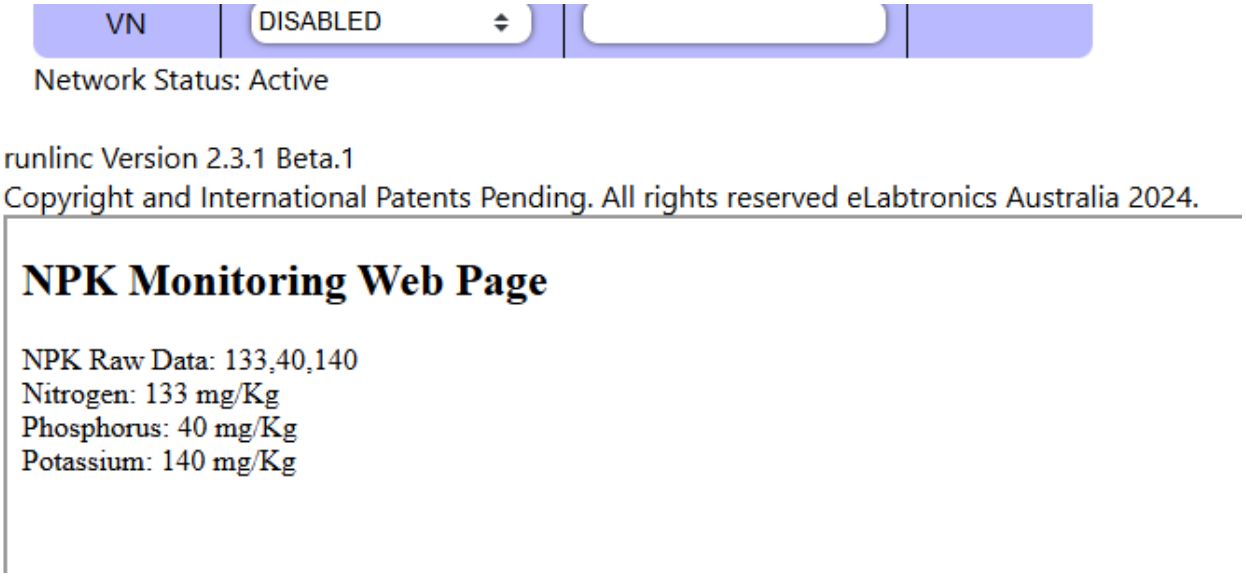

Figure 17: working state web page

Summary

NPK sensors are quite easy to use, we can insert it directly into the soil, power it up and it will give out data. And we can read it’s data through a STEMSEL board with some way of connection and coding. Now we can monitor the state of the soil for the plants we grow and give plants a better environment! Can we do that in a better way, e.g. make it a battery powered device or monitor the soil remotely with it?