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Measure Soil Nutrient using Arduino & Soil NPK Sensor

Mr. Alam — November 21, 2020 4 comments

(Last Updated On: December 21, 2020)

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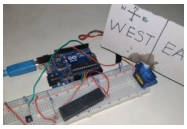

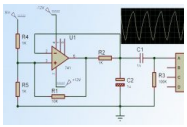

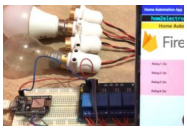

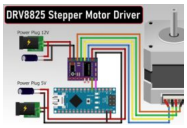

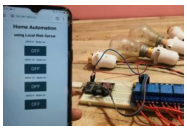

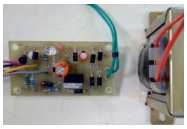

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Overview

In this article, we will learn about the **interfacing of Soil NPK Sensor with Arduino**. The **soil nutrient** content can be easily measured using NPK Soil Sensor & Arduino. Measurement of soil content **N (nitrogen)**, **P (phosphorus)**, and **K (potassium)** is necessary to determine how much additional nutrient content is to be added to soil to increase crop fertility.

The **soil fertility** is detected using NPK sensors. A major component of **soil fertilizer** is nitrogen, phosphorus, and potassium. The knowledge of the soil nutrient concentration can help us to learn about **nutritional deficiency** or abundance in soils used to endorse plant production. Apart from measuring Soil NPK, you can also measure Soil Moisture Content using **Soil Moisture Sensor**, which is explained in my one the previous post.

There are multiple methods of measuring the soil nutrient content like using some **optical sensors** or using the **spectrometer**. But the **spectral analysis method** of determining the nutrient content is not convenient and the drawback is the data are only **60-70%** correct. While comparing the spectral analysis method with traditional wet chemistry methods, the accuracy of the products is yet to be fully resolved, given the paucity of data in that regard.

So, here we will use a **JXCTIOT Soil NPK Sensor** to detect the soil nitrogen, phosphorous & Potassium in a soil. The JXCT Soil NPK sensor is a **low cost, quick responsive, high precision & portable** Soil NPK Sensor that works with **Modbus RS485**. The advantage of this sensor over a traditional detection method is that it gives very **fast measurement** & data are **highly accurate**. All you need is to insert its probe in soil and get the reading using Arduino. So, let's learn in detail about the interfacing of Soil Nutrient Sensor or NPK Sensor with Arduino.

Bill of Materials

The components required for making a device that can help you in studying the Soil Nutrient Content is given below. You can purchase almost all the components from the Amazon.

S.N.	Components Name	Description	Quantity	
1	Arduino Board	Arduino Nano	1	https://amzn.to/2tsBbp1
2	NPK Sensor	JXCTIOT Soil NPK Sensor	1	https://amzn.to/38kHbAH
3	OLED Display	0.96" I2C OLED Display	1	https://amzn.to/2XaQ5uz
4	Modbus Module	MAX485 Modbus	1	https://amzn.to/36PM2JG

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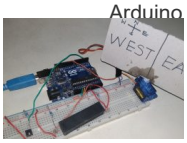

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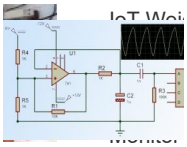

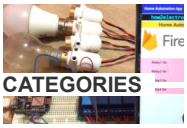

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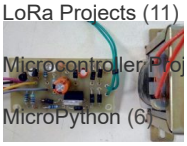

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5	Power Supply	9V - 12V DC Supply	1	https://amzn.to/3fhi057
6	Connecting Wires	Jumper Wires	10	https://amzn.to/2L8Xc1p
7	Breadboard	-	1	https://amzn.to/2YM6YyS

Soil NPK Sensor

The **soil NPK sensor** is suitable for detecting the content of **nitrogen, phosphorus,** and **potassium** in the soil. It helps in determining the fertility of the soil thereby facilitating the systematic assessment of the soil condition. The sensor can be buried in the soil for a long time. It has a **High-quality probe**, **rust resistance**, **electrolytic resistance**, **salt & alkali corrosion resistance**, to ensure the long-term operation of the probe part. Therefore, it is suitable for all kinds of soil. It is suitable for the **detection** of alkaline soil, acid soil, substrate soil, seedling bed soil & coconut bran soil.

The sensor doesn't require any **chemical reagent**. Since it has High measurement accuracy, fast response speed, and good interchangeability, it can be used with any **microcontroller**. You cannot use the sensor directly with the microcontroller as it has a Modbus Communication port. Hence you need any Modbus Module like **RS485/MAX485** and connect the sensor to the microcontroller.

The sensor operates on **9-24V** & power consumption is very low. While talking about the accuracy of the sensor, it is up to within **2%**. The nitrogen, phosphorous & potassium measuring resolution is up to **1mg/kg (mg/l)**.

Specifications

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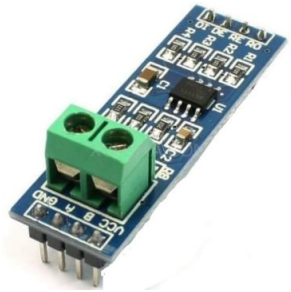
2. Measuring Range: 0-1999 mg/kg (mg/l)
3. Operating Temperature: 5-45 °C
4. Resolution: 1mg/kg
5. Precision: ±2% F.S.
6. Output Signal: RS485
7. Baud Rate: 2400/4800/9600
8. Protection Class: IP68

MAX485 TTL to RS-485 Interface Module

The **MAX485 TTL to RS-485 Interface Module** allows us to use the RS-485 differential signaling for robust long-distance serial communications up to **1200 meters** or in electrically noisy environments and is commonly used in industrial environments. It supports up to **2.5MBit/Sec** data rates, but as distance goes up, the maximum data rate that can be supported comes down.



The data starts out as a typical **TTL level** serial as far as the microcontroller is concerned while the **RS-485 module** takes care of converting the electrical signals between TTL and the differential signaling used by RS-485. A significant benefit of RS-485 is that it supports multiple devices **(up to 32)** on the same cable, commonly referred to as 'multi-drop'.

Specifications

1. Use MAX485 Interface chip
2. Uses differential signaling for noise immunity
3. Distances up to **1200 meters**
4. Speeds up to **2.5Mbit/Sec**
5. Multi-drop supports up to **32 devices** on same bus
6. Red power LED
7. **5V** operation

Pinout & Module Connection

The module has two **4-pin headers** on the assembly.

1 x 4 Header (Data side)

RO = Receiver Output. Connects to a serial RX pin on the microcontroller
RE = Receiver Enable. Active LOW. Connects to a digital output pin on a microcontroller. Drive LOW to enable receiver, HIGH to enable Driver

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DI = Driver Input. Connects to serial TX pin on the microcontroller.

1 x 4 Header (Output side)

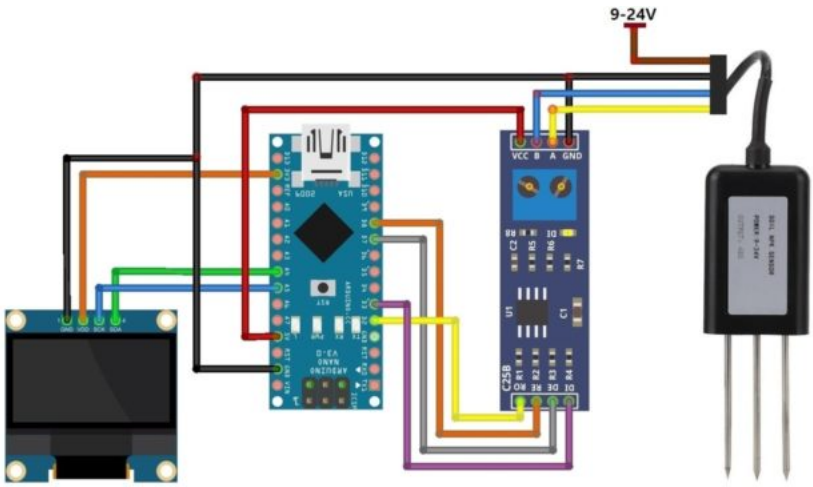
VCC = 5V
B = Data 'B' Inverted Line. Common with the B
A = Data 'A' Non-Inverted Line. Connects to A on far end module
GND = Ground

1 x 2 Screw Terminal Block (Output side)

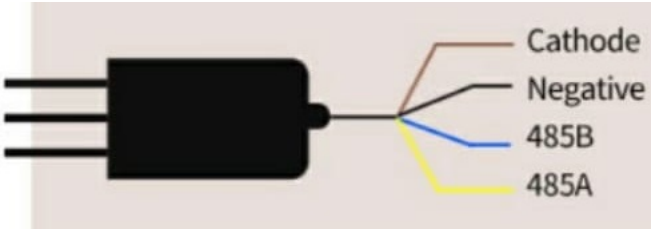
B = Data 'B' Inverted Line. Connects to B on far end module
A = Data 'A' Non-Inverted Line. Connects to A on far end module

Interfacing Soil NPK Sensor with Arduino

Now, let us **interface the Soil NPK Sensor with the Arduino** Nano Board using the **MAX485 Modbus Module**. The connection diagram is given below.



The **R0 & DI** pin of from the Modbus is connected to **D2 & D3** of Arduino using Software Serial. Similarly, we have to enable **DE & RE** high which is done by connecting them to the **D7 & D8** pin of Arduino. The NPK Sensor has 4 wires. The **brown** one is VCC which needs a **9V-24V Power Supply**. The GND pin which is **black** in color needs to be connected to the GND of Arduino. The **Blue wire** which is the B pin is connected to the B pin of MAX485 & the **Yellow Wire** which is the A pin is connected to the A pin of MAX485.



The **0.96" SSD1306 OLED Display** is an I2C Module. The OLED Display VCC & GND are connected to **3.3V** & GND of Arduino. Similarly, its **SDA & SCL** pins are connected to the A4 & A5 of Arduino. You can follow the circuit diagram & assemble the circuit on a breadboard or make a custom design PCB.

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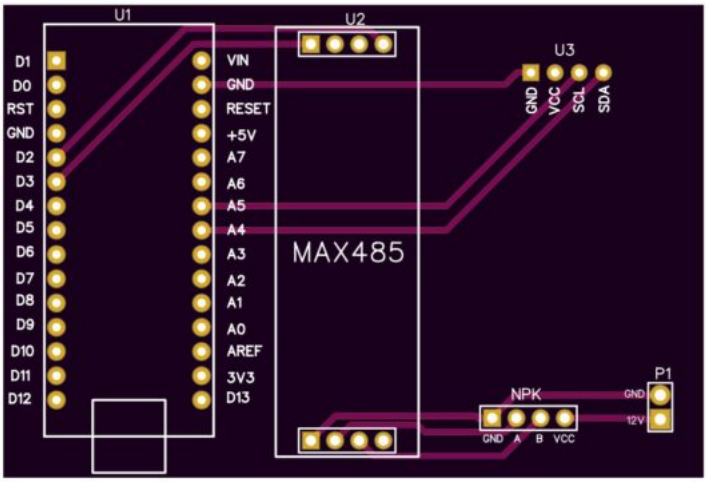
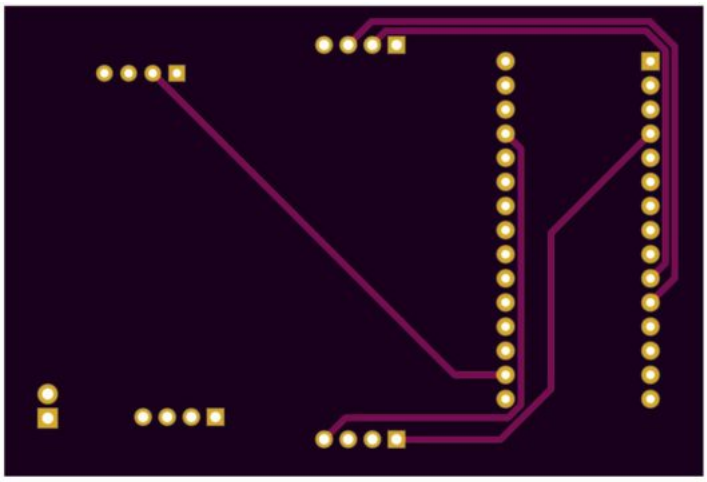
Project PCB Gerber File & PCB Ordering Online

If you don't want to assemble the circuit on breadboard and you want PCB for the project, then here is the PCB for you. The PCB Board for the NPK Meter is designed using **EasyEDA** online Circuit Schematics & PCB designing tool. The front side and back side of the PCB is given below.





Download Gerber File: **NPK Meter PCB**

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You can now upload the Gerber File to the Website and place an order. The PCB quality are clean and brilliant. That is why most of the people trust NextPCB for **PCB** & **PCBA Services**.

Modbus Command for NPK Sensor

Modbus commands can instruct a Modbus Device to:
1. change the value in one of its registers, which is written to Coil and Holding registers
2. read an I/O port: Read data from Discrete and Coil ports,
3. command the device to send back one or more values contained in its Coil and Holding register

A Modbus command contains the Modbus address of the device it is intended for (**1 to 247**). Only the addressed device will respond and act on the command, even though other devices might receive it.

The NPK Sensor has 3 different for reading the value of **Nitrogen (N), Phosphorous (P) & Potassium (K)**. The address is provided along with the instruction manual. The sensor that I received has the following address:
1. Nitrogen: ***{0x01,0x03, 0x00, 0x1e, 0x00, 0x01, 0xe4, 0x0c}***
2. Phosphorous: ***{0x01,0x03, 0x00, 0x1f, 0x00, 0x01, 0xb5, 0xcc}***
3. Potassium: ***{0x01,0x03, 0x00, 0x20, 0x00, 0x01, 0x85, 0xc0}***

Source Code/Program

The source code for interfacing Soil NPK Sensor with Arduino & retrieving Soil Nutrient value from the Sensor via Modbus command is given below. You can send the command and retrieve the value in HEX Code. The HEX code needs to be converted into Decimal to get the Measured Soil Nutrient content data.

Since we are using OLED Display to display the Soil Nutrient values (Nitrogen, Phosphorous & Potassium) in mg/kg, you will need OLED Library. Download the following OLED Library and add it to the Arduino IDE.
1. **Adafruit SSD1306 Library**: Download
2. **Adafruit GFX Library**: Download

Here is the complete source code. Compile & upload it to the Arduino Nano Board.

```
#include <SoftwareSerial.h>
#include <Wire.h>
#include <Adafruit_GFX.h>
#include <Adafruit_SSD1306.h>
```

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```
#define SCREEN_HEIGHT 64    // OLED display height, in pixels
#define OLED_RESET -1       // Reset pin # (or -1 if sharing Arduino reset pin)
Adafruit_SSD1306 display(SCREEN_WIDTH, SCREEN_HEIGHT, &Wire, OLED_RESET);

#define RE 8
#define DE 7

//const byte code[]= {0x01, 0x03, 0x00, 0x1e, 0x00, 0x03, 0x65, 0xCD};
const byte nitro[] = {0x01,0x03, 0x00, 0x1e, 0x00, 0x01, 0xe4, 0x0c};
const byte phos[] = {0x01,0x03, 0x00, 0x1f, 0x00, 0x01, 0xb5, 0xcc};
const byte pota[] = {0x01,0x03, 0x00, 0x20, 0x00, 0x01, 0x85, 0xc0};

byte values[11];
SoftwareSerial mod(2,3);

void setup() {
  Serial.begin(9600);
  mod.begin(9600);
  pinMode(RE, OUTPUT);
  pinMode(DE, OUTPUT);

  display.begin(SSD1306_SWITCHCAPVCC, 0x3C); //initialize with the I2C addr 0x3C (128x64)
  delay(500);
  display.clearDisplay();
  display.setCursor(25, 15);
  display.setTextSize(1);
  display.setTextColor(WHITE);
  display.println(" NPK Sensor");
  display.setCursor(25, 35);
  display.setTextSize(1);
  display.print("Initializing");
  display.display();
  delay(3000);
}

void loop() {
  byte val1,val2,val3;
  val1 = nitrogen();
  delay(250);
  val2 = phosphorous();
  delay(250);
  val3 = potassium();
  delay(250);


  Serial.print("Nitrogen: ");
  Serial.print(val1);
  Serial.println(" mg/kg");
  Serial.print("Phosphorous: ");
  Serial.print(val2);
  Serial.println(" mg/kg");
  Serial.print("Potassium: ");
  Serial.print(val3);
  Serial.println(" mg/kg");
  delay(2000);

  display.clearDisplay();


  display.setTextSize(2);
  display.setCursor(0, 5);
  display.print("N: ");
  display.print(val1);
  display.setTextSize(1);
```

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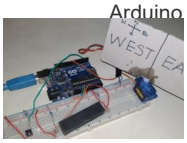

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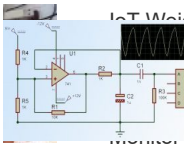

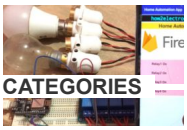

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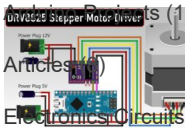

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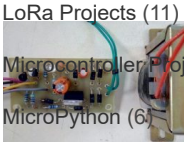

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```
  display.setTextSize(2);
  display.setCursor(0, 25);
  display.print("P: ");
  display.print(val2);
  display.setTextSize(1);
  display.print(" mg/kg");

  display.setTextSize(2);
  display.setCursor(0, 45);
  display.print("K: ");
  display.print(val3);
  display.setTextSize(1);
  display.print(" mg/kg");

  display.display();
}

byte nitrogen(){
  digitalWrite(DE,HIGH);
  digitalWrite(RE,HIGH);
  delay(10);
  if(mod.write(nitro,sizeof(nitro))==8){
    digitalWrite(DE,LOW);
    digitalWrite(RE,LOW);
    for(byte i=0;i<7;i++){
    //Serial.print(mod.read(),HEX);
    values[i] = mod.read();
    Serial.print(values[i],HEX);
    }
    Serial.println();
  }
  return values[4];
}

byte phosphorous(){
  digitalWrite(DE,HIGH);
  digitalWrite(RE,HIGH);
  delay(10);
  if(mod.write(phos,sizeof(phos))==8){
    digitalWrite(DE,LOW);
    digitalWrite(RE,LOW);
    for(byte i=0;i<7;i++){
    //Serial.print(mod.read(),HEX);
    values[i] = mod.read();
    Serial.print(values[i],HEX);
    }
    Serial.println();
  }
  return values[4];
}

byte potassium(){
  digitalWrite(DE,HIGH);
  digitalWrite(RE,HIGH);
  delay(10);
  if(mod.write(pota,sizeof(pota))==8){
    digitalWrite(DE,LOW);
    digitalWrite(RE,LOW);
    for(byte i=0;i<7;i++){
    //Serial.print(mod.read(),HEX);
    values[i] = mod.read();
    Serial.print(values[i],HEX);
    }
    Serial.println();
```

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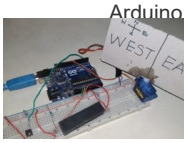

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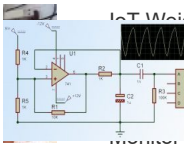

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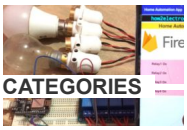

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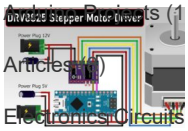

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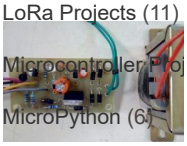

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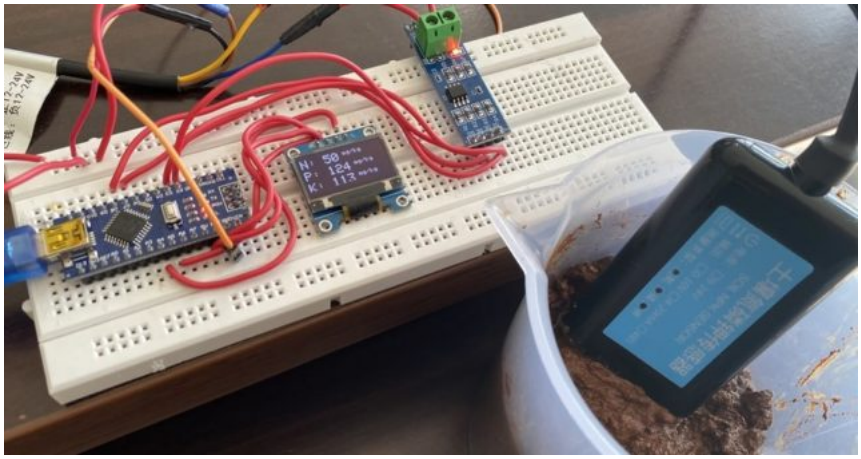
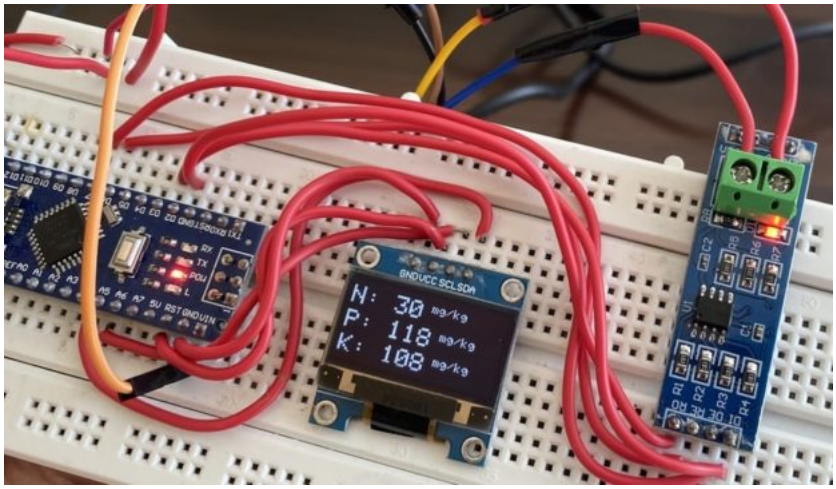
Monitoring Soil NPK Data on OLED Display

Once the code is uploaded, the OLED will initialize along with the sensor. The sensor will take some time to get stabilized and the reading may be incorrect for few seconds initially.

Once the sensor gets stabilized, you can dip the sensor in the soil to get the NPK Reading. The volume of Nitrogen, Phosphorous & Potassium which are the Ammonium content in the soil will be displayed as mg/Kg.



So this is how you interface Soil Nutrient Sensor Arduino & get the NPK Readings. Similarly, put the sensor in different samples of soil. You will see a variation in the volume of NPK depending upon the type of soil.



Video Tutorial & Guide

Follow the following video to learn about the entire project & code information.

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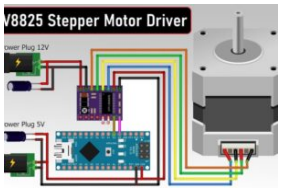
Watch this video on YouTube.

You can also check the advanced version of this project that is combined with Soil NPK Sensor & Soil Temperature Sensor: **IoT Based Soil Nutrient Monitoring**.

Recommended For You



How to Control Stepper Motor with DRV8825 Driver & Arduino

IoT Based Soil Nutrient Monitoring with Arduino & ESP32

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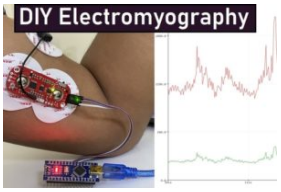

Electromyography(EMG) with MyoWare Muscle Sensor & Arduino

4 Comments

Hussnain Uz Zaman December 26, 2020 at 2:39 AM

i created this same project a year ago. this sensor has pc software where you can configure everything of modbus. even address of you sensor and baund rate also.

Reply

Myo min hyet December 3, 2020 at 4:46 PM

Yeah i can but i cant even know what the values are and there is some chinese words.I used CAS modbus scanner. Does the npk values show on serail montior coz i cant read the values thanks

Reply

myominhtet December 1, 2020 at 10:59 AM

can u read the npk modbus sepcification on the modbus scanner

Reply

★ **Mr. Alam** December 1, 2020 at 11:07 AM

Maybe.
I haven't tried it. You can try and let us know.
Thanks.

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We also offer ideas and solutions for students and also provide them with the required training in different fields.

Share the joy of learning with us.

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