Day 2: Sensors and Communication

Welcome to day two of our IoT workshop series! Today we will read a value from a soil moisture sensor, see it in the Serial Monitor, connect our board to WiFi, and finally send a message to an MQTT broker.

We are using the **Arduino framework inside PlatformIO** throughout this workshop.

1. How a Capacitive Soil Moisture Sensor Works

A capacitive soil moisture sensor measures how much water is in the soil by detecting changes in **capacitance** around its probe. Water and dry soil store electrical charge differently, so as the soil gets wetter, the capacitance the sensor measures changes. The sensor turns this into an **analog voltage**: drier soil and wetter soil produce different voltage levels, which our ESP32 can read.

Unlike older resistive sensors, the capacitive type has **no exposed metal electrodes** touching the soil. This means it does not corrode nearly as quickly, making it much better suited for long-term use.

We are using the **DFRobot Analog Capacitive Soil Moisture Sensor**.

2. Connecting the Sensor to the DOIT ESP32

The sensor has three wires:

Sensor Pin	Connects to ESP32	Purpose
VCC (red)	VIN (5V) or 3V3	Power
GND (black)	GND	Ground
AOUT (blue)	An analog-capable GPIO (e.g. GPIO34)	Analog signal out

A few notes:

- The signal wire goes to an **analog input pin**. On the DOIT ESP32 DevKit, pins like **GPIO34, GPIO35, GPIO32, GPIO33** work well for analog reading.
- The sensor can run on either **3V3** or **5V**. The **VIN** pin on the DOIT ESP32 provides 5V (when the board is powered over USB).
- **Important:** the ESP32's analog pins can only safely read up to ~3.3V. If you power the sensor from 5V, its output range is higher, so be aware the readings will scale differently — and never feed more than 3.3V into a GPIO pin.
- Double-check GND is shared between the sensor and the board.

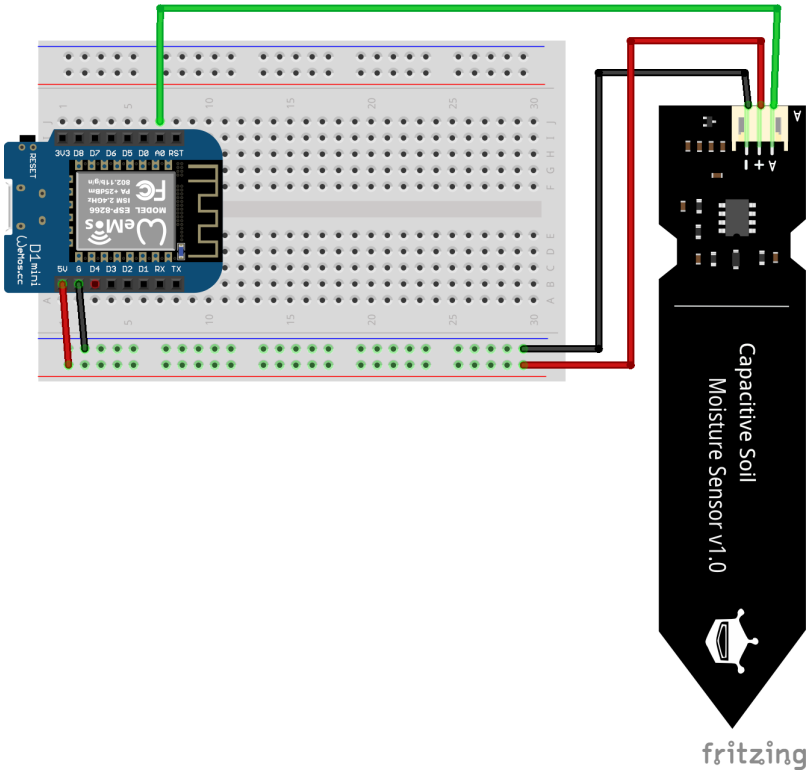


Fig. 1: Wiring of the analog sensor

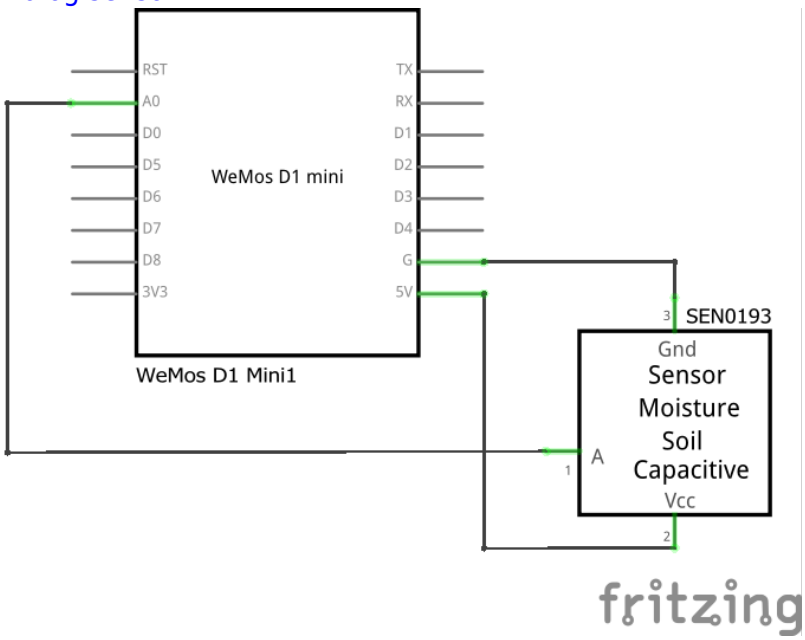


Fig. 2: Schematic

3. Reading the Sensor with the Serial Monitor

Before we send data anywhere, we want to **see** it. The easiest way is the **Serial Monitor**.

Serial is a way for the ESP32 to send text back to your computer over the USB cable. By calling `Serial.begin()` once at startup and then `Serial.println()` whenever we have something to show, we can print our sensor readings to the screen in real time. This is incredibly useful for checking that everything is wired correctly and that the numbers change when you touch the sensor or place it in soil.

Open the Serial Monitor in PlatformIO and make sure the **baud rate matches** the value you set in

`Serial.begin()` (commonly 115200).

```
// PLACEHOLDER — Sensor reading code
// This should:
//   - start Serial at the chosen baud rate in setup()
//   - read the analog value from the sensor pin
//   - print the value to the Serial Monitor in loop()
//   - add a short delay so the output is readable
```

Once uploaded, you should see numbers scrolling in the Serial Monitor. Try touching the sensor or dipping it into soil/water — the value should change.

4. Connecting to WiFi

Now that the board works on its own, let's get it online. The ESP32 has built-in WiFi, so we just need to give it the **network name (SSID)** and **password** of our workshop access point.

In `setup()` we tell the ESP32 to connect, then wait in a short loop until the connection succeeds. We can print the status to Serial so we know when we're online.

```
// PLACEHOLDER — WiFi connection code
// This should:
//   - include the WiFi library
//   - store the SSID and password
//   - start the connection in setup()
//   - wait until connected, printing progress to Serial
//   - print the assigned IP address once connected
```

When it works, the Serial Monitor will show that the ESP32 has joined the network and received an IP address.

5. Introducing MQTT

MQTT is a lightweight messaging protocol that is very popular in IoT. The idea is simple: devices send ("**publish**") messages to a central server (the "**broker**"), and other devices can listen ("**subscribe**") for them. Today we will only **publish** — sending messages out. We will not subscribe.

6. Publishing a Message to the Broker

For our final step, we connect to the **MQTT broker** and send a single message of **your choosing** — any text string you like, for example "`hello from my esp32`".

- This is **not** the soil moisture value. That's a separate exercise. Here we are just proving we can talk to the broker by sending a simple string.

- We connect to the broker, then publish our chosen string to a **topic**.

```
// PLACEHOLDER — MQTT publish code
// This should:
//   - include the MQTT client library
//   - set the broker address and port
//   - connect to the broker in setup() (after WiFi is connected)
//   - publish a single text string of your choosing to a topic
//   - print confirmation to Serial
```

Pick any message you want and send it.

Recap

By the end of today you have:

- Learned how a capacitive soil moisture sensor works
- Wired it to the DOIT ESP32
- Read its value in the Serial Monitor
- Connected the ESP32 to WiFi
- Learned the basics of MQTT
- Published your own message to the MQTT broker

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