Aqua Track: Complete Hardware Implementation Guide

Role: IoT Systems Integrator **Project:** ESP32 Water Level Monitor **Goal:** Build, code, and calibrate the physical device.

Part 1: The Hardware Setup

1. Bill of Materials (BOM)

Component	Description
ESP32 Dev Board	The "Brain" (DOIT DEVKIT V1 recommended).
JSN-SR04T	**Waterproof** Ultrasonic Sensor (comes with a small green PCB).
5V Power Adapter	Standard Micro-USB phone charger (1A or higher).
Jumper Wires	4x Female-to-Female wires.
Waterproof Box	IP65 Junction box to house the electronics outside the tank.

2. Wiring Diagram

You need to connect the **Sensor Board** (Green PCB) to the **ESP32**.

- **VCC** (Sensor) ➔ **VIN** (ESP32) *(Note: Must be 5V. Do not use 3.3V)*
- **GND** (Sensor) ➔ **GND** (ESP32)
- **TRIG** (Sensor) ➔ **GPIO 5** (D5)
- **ECHO** (Sensor) ➔ **GPIO 18** (D18)

3. Power Supply

- **Primary Method:** Simply plug the Micro-USB charger into the ESP32.
- **Alternative (Direct 5V):** If you are using a custom power supply, connect Positive to **VIN** and Negative to **GND**.
- **Warning:** Never power the board via USB and VIN at the same time.

Part 2: Firmware & Code

1. Install Arduino IDE

Download and install from arduino.cc.

2. Install ESP32 Board Manager

1. Open IDE. Go to **File** > **Preferences**.
2. In "Additional Boards Manager URLs", paste: `https://raw.githubusercontent.com/espressif/arduino-esp32/gh-pages/package_esp32_index.json`
3. Go to **Tools** > **Board** > **Boards Manager**.
4. Search for `esp32` and install the package by **Espressif Systems**.

3. Install Required Library

1. Go to **Sketch** > **Include Library** > **Manage Libraries**.
2. Search for **"Firebase Arduino Client"**.
3. Install the one by **Mobizt**.

4. Flash the Code

Use the `esp32_firmware.ino` provided previously. Select **DOIT ESP32 DEVKIT V1** as your board and click Upload.

Part 3: Configuration & Calibration

This is the critical step to ensure your phone shows "100%" when the tank is actually full.

Step A: Wi-Fi & Cloud (Lines 22-27 in code)

- `WIFI_SSID`: Your exact Wi-Fi name (Case sensitive!).
- `WIFI_PASSWORD`: Your Wi-Fi password.
- `API_KEY`: Found in Firebase Console > Project Settings.
- `FIREBASE_PROJECT_ID`: Found in Firebase Console (e.g., `aqua-track-123`).

Step B: Tank Physics (Lines 30-31 in code)

Variable 1: `TANK_HEIGHT_CM` (Total Depth)

- **Definition:** The distance from the sensor lens to the bottom of the empty tank.
- **Action:** Measure this with a tape measure.
- *Example:* `200.0` (for a 2-meter deep tank).

Variable 2: `SENSOR_GAP_CM` (The Blind Zone)

- **Definition:** The distance from the sensor lens to the maximum water level.
- **Why?** The JSN-SR04T cannot see anything closer than 20cm. You MUST leave a gap.
- **Action:** Decide that "100% Full" is 25cm below the lid.
- *Standard Value:* `25.0`

Visual Calibration Logic:

```
[ LID / SENSOR ]
      |
      |   <-- SENSOR_GAP_CM (e.g., 25cm of Air)
      v       (This is "100% Full" on the App)
~~~~~~~~~~~~~~
      |
      |
      |   <-- Water Depth
      |
______|_______ (Bottom)
```

- **Total Height:** 200cm
- **Usable Water Range:** 175cm (200 - 25)

Part 4: Testing & Troubleshooting

Serial Monitor Checklist

Open **Tools > Serial Monitor** (Set baud rate to **115200**).

1. **"Connected to Wi-Fi"**:
   - *If failed:* Check SSID spelling. Ensure you are using 2.4GHz Wi-Fi (ESP32 cannot see 5GHz).
2. **"Firebase Auth Success"**:
   - *If failed:* Check API Key. Ensure "Anonymous Auth" is enabled in Firebase Console.
3. **"Distance: X cm | Level: Y %"**:
   - *Test:* Point the sensor at a wall. Move it closer and further.
   - *Issue (Reading 0):* Check wiring. Ensure VCC is connected to 5V (VIN), not 3.3V.
   - *Issue (Reading stuck):* Unplug power and replug. JSN-SR04T sometimes freezes if powered before the ESP32 logic starts.
4. **"Success! / Uploading..."**:
   - Check your phone App. The water level should animate immediately