

Petra Aquaponics LoRaWAN Sensor

User Manual & Technical Report

Model: AQ-L1

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Abstract

This document provides a comprehensive overview, operational instructions, and technical specifications for the Petra Aquaponics LoRaWAN Sensor (Model: AQ-L1). This device is a multi-parameter monitoring solution designed for modern aquaponics systems. It integrates dissolved oxygen, water temperature, ambient air quality, and system voltage sensors with both LoRaWAN and Wi-Fi connectivity, providing users with robust local and remote monitoring capabilities.

Chapter 1: System Overview

1.1 Introduction

The AQ-L1 is an advanced environmental sensor node engineered for the specific demands of aquaponics. By providing real-time data on critical water and air parameters, it empowers growers to maintain optimal conditions, improve system health, and increase yields. The device features a durable, 3D-printed ABS enclosure with passive ventilation and active cooling, making it suitable for installation in outdoor or greenhouse environments.

1.2 Key Features

- **Multi-Sensor Integration:** Measures Dissolved Oxygen (DO), Water Temperature, Ambient Air Quality (PPM), and Battery/System Voltage. It also includes an internal sensor

for enclosure temperature and humidity.

- **Dual-Connectivity:** Utilizes a LoRa-E5 module for long-range, low-power data transmission to a LoRaWAN gateway and an integrated ESP32C3 for local configuration and control via a Wi-Fi web interface.
- **Onboard Display:** A crisp OLED screen provides at-a-glance status updates, current sensor readings, and network information directly on the device.
- **Web-Based Configuration:** A user-friendly web portal, accessible via any Wi-Fi-enabled device, allows for easy setup, calibration, and control without requiring specialized software.
- **Persistent Settings:** User configurations, such as calibration values, display titles, and transmission intervals, are saved to non-volatile memory and retained through power cycles.
- **Flexible Powering:** The device can be powered via a USB-C connection and includes circuitry for monitoring a connected 18650 Li-ion battery, automatically reporting its power source.
- **Active Enclosure Cooling:** An integrated 5V fan helps regulate internal temperature, protecting the electronics from overheating in direct sunlight or high-temperature environments.

Chapter 2: Initial Setup and Configuration

2.1 Unboxing and Powering On

1. Unpack the AQ-L1 sensor unit and its associated probes (Dissolved Oxygen and NTC Thermistor for water temperature).
2. Connect the probes to their respective waterproof connectors on the main unit.
3. Power the device by connecting a 5V USB-C power source or by ensuring a charged 18650 battery is installed. The onboard OLED display will illuminate and begin the initialization sequence.

2.2 Connecting to the Web Interface

The AQ-L1 creates its own Wi-Fi network (Access Point) for initial configuration.

1. On a smartphone, tablet, or computer, open your Wi-Fi settings.

2. Search for a network named **XIAO-ESP32C3-AP**.
3. Connect to this network using the password: **Access@Sensor**
4. Once connected, open a web browser and navigate to the IP address: **http://192.168.4.1**
5. The Petra Aquaponics Sensor web interface will load.

Chapter 3: Web Interface and Usage

The web interface is the primary control center for configuring the AQ-L1. It is divided into several functional sections.

3.1 LoRa Message Sender

This feature allows for sending custom text messages over the LoRaWAN network for testing or command purposes.

- **Usage:** Enter a message into the text field and click "**Send Message**".
- **Feedback:** The status field below the button will update in real-time.

3.2 Update Display Title

This allows you to customize the name displayed on the device's OLED screen.

- **Usage:** Enter a new title (max 20 characters) and click "**Update Title**".

3.3 Advanced Settings

This collapsible section contains critical calibration and operational parameters.

- **DO Temperature Compensation Mode:** Controls whether the Dissolved Oxygen calculation uses the live water temperature reading or a fixed default value.
- **Update Uplink Interval:** Sets the time in seconds between automatic LoRaWAN data transmissions (min 90s).
- **Update Gas Sensor Ro:** Allows for calibration of the air quality sensor's baseline resistance for accurate PPM readings.

Chapter 4: On-Device Display

The integrated OLED screen provides a real-time dashboard of the sensor's status.

- **Line 1:** Custom Device Title
- **Line 2:** Wi-Fi SSID
- **Line 3:** IP Address
- **Line 4:** Air Quality (PPM)
- **Line 5:** Dissolved Oxygen (mg/L)
- **Line 6:** Water Temperature (°C)
- **Line 7:** Power status ("Power: Mains" or "Battery: XX.X %")

Chapter 5: LoRaWAN Integration

The AQ-L1 transmits its sensor data using the efficient **Cayenne Low Power Payload (LPP)** format.

Channel	Data Type	Unit
1	Dissolved Oxygen	mg/L
2	Air Quality	PPM
3	Water Temperature	°C
4	Battery Level	%
5	Enclosure Temperature	°C
6	Enclosure Humidity	% RH
7	VUSB Sense (Power)	Digital

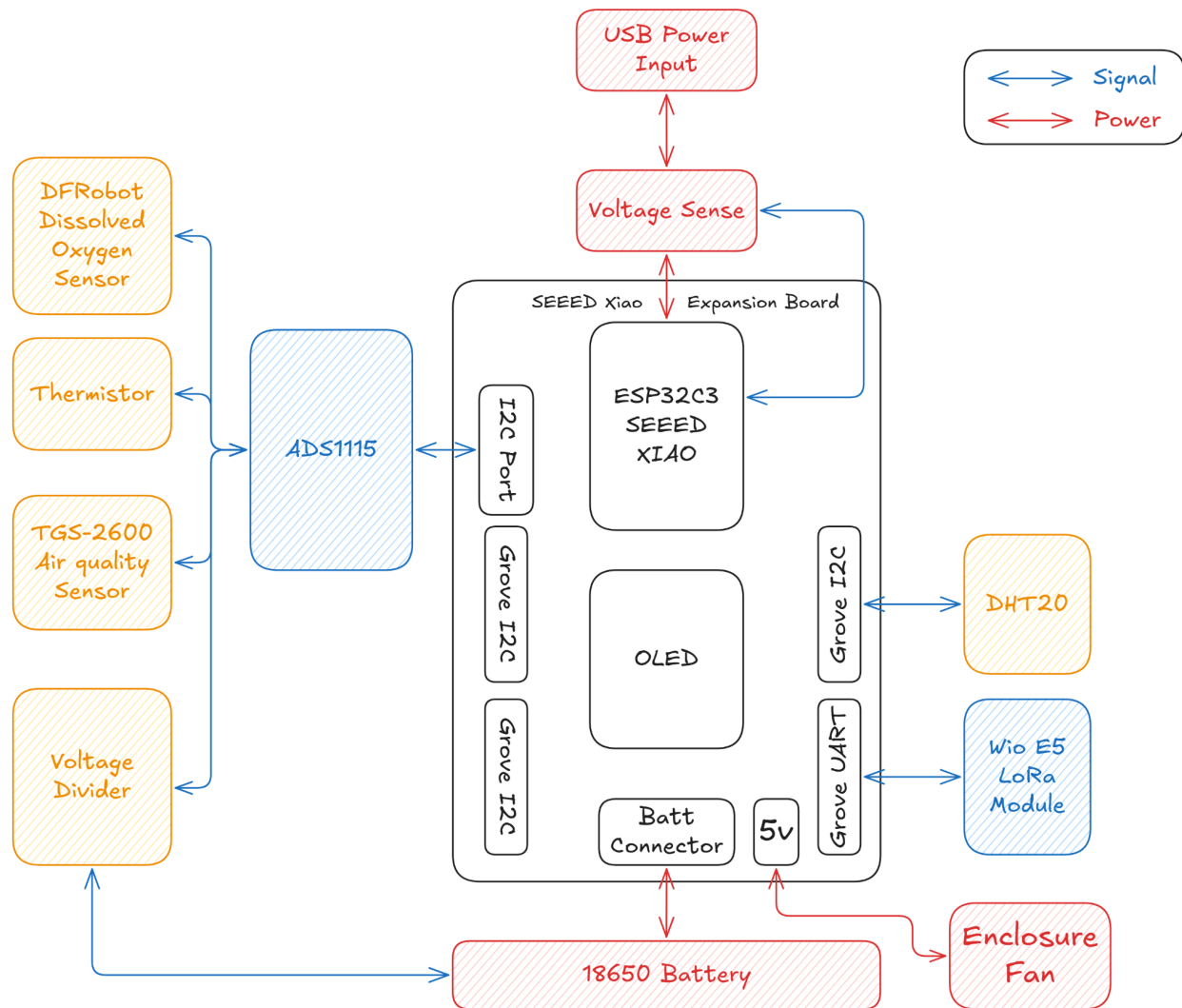
*On channel 7, a value of **1** indicates mains (USB) power; **0** indicates battery power.

Chapter 6: Hardware Specifications

6.1 System Block Diagram

The following diagram illustrates the architecture of the AQ-L1 sensor module, showing the relationships between the microcontroller, sensors, and communication modules.

Petra LoRaWAN Aquaponics Dissolved Oxygen Sensor Module



6.2 Components Breakdown

Component	Model / Type	Function
Microcontroller	SEEED XIAO ESP32C3	Main processing unit, Wi-Fi connectivity, and system control.
Expansion Board	SEEED XIAO Expansion Board	Provides Grove connectors, battery management, and OLED interface.
Analog-to-Digital Converter	ADS1115	Converts analog sensor signals to digital data for the MCU.
Dissolved Oxygen Sensor	DFRobot Analog DO Sensor	Measures the concentration of dissolved oxygen in water.
Water Temperature Sensor	NTC Thermistor	Measures water temperature for DO compensation and monitoring.
Air Quality Sensor	TGS-2600	Detects various air contaminants, reported in PPM.
Enclosure Sensor	DHT20	Measures the internal temperature and humidity of the device housing.
LoRaWAN Module	Wio E5	Handles long-range, low-power data

		transmission.
Display	0.96" I2C OLED	Provides a real-time visual display of data and status.
Power Sources	USB-C / 18650 Li-ion Battery	Offers flexible power options for deployment.
Cooling System	5V Enclosure Fan	Provides active cooling to protect electronics from overheating.