# Automated Quality & Utility Assistant (AQUA)Requirements Document

## 1. Introduction

AQUA is an open-source aquarium controller designed to automate and monitor key aspects of a reef tank. This document outlines the hardware, software, and functional requirements necessary to build a custom AQUA setup.

## 2. System Overview

The AQUA system will integrate multiple sensors and actuators with a processing unit to monitor and control the aquarium environment. Key features include temperature monitoring, pH control, lighting automation, water level management, dosing, and power usage monitoring.

## 3. Hardware Requirements

### 3.1. Core Components

* **Processing Unit** (Raspberry Pi, Arduino, or other microcontroller with sufficient capability)
* **MicroSD Card** (Minimum 16GB, Class 10, if applicable)
* **Power Supply** (Appropriate voltage and current rating for the chosen processing unit)
* **Protective Case** (Optional but recommended for protection)
* **DC Power Bus** (Shared power bus for all of the digital components)
* **AC Power Bus** (Shared power bus for all of the AC components)

### 3.2. Sensors & Probes

* **Temperature Sensor:** DS18B20 (Digital)
* **pH Sensor:** Atlas Scientific pH probe with EZO-pH circuit
* **Water Level Sensors:**
  + Optical water level sensors OR
  + Mechanical float switches
* **Total Dissolved Solids (TDS) Sensor:** Atlas Scientific TDS probe (Optional)
* **Oxidation-Reduction Potential (ORP) Sensor:** Atlas Scientific ORP probe (Optional)
* **Dissolved Oxygen Sensor:** Atlas Scientific dissolved oxygen probe (Optional)
* **Light Sensor:** BH1750 (Optional for ambient light monitoring)

### 3.3. Actuators & Peripherals

* **Relay Module:** 4/8-channel relay board for controlling pumps, lights, heaters, etc.
* **Dosing Pumps:** Peristaltic pumps for automatic dosing
* **Power Strip:** Smart or mechanical power strip for relay control
* **Cooling Fans:** DC or AC fans for temperature regulation
* **Heater:** Aquarium heater controlled via relay
* **Lighting System:** LED lights with PWM control (Optional)
* **Auto Top-Off (ATO) System:** Pump and water reservoir for evaporation replacement

### 3.4. Connectivity & Expansion

* **I2C ADC Module (ADS1115):** Required for reading analog sensors
* **I2C Multiplexer (Optional):** If multiple I2C sensors are used
* **GPIO Breakout Board:** For easier wiring
* **Jumper Wires, Resistors, and Breadboard:** For prototyping

## 4. Software Requirements

This architecture leverages the Reef-Pi project as it’s inspiration

* **Operating System:** Linux-based OS (if applicable)
* **Reef-Pi Software:** Latest version from [Reef-Pi GitHub](https://github.com/reef-pi/reef-pi)
* **Web Interface:** Web-based dashboard accessible via browser
* **Dependencies:**
  + Python 3
  + Node.js & npm
  + InfluxDB & Grafana (Optional for advanced logging & monitoring)

## 5. Functional Requirements

### 5.1. Monitoring

* Temperature readings with high/low threshold alerts
* pH level readings with logging & alerts
* Water level detection with automated refill capability
* Total Dissolved Solids Sensing (optional)
* Salinity Sensor (optional)
* Dissolved Oxygen Sensor (optional)
* Light intensity monitoring (optional)
* Ability to add in a video stream for live monitoring with a IP based camera
* Monitor the power usage of the power strip once “hacked” to provide power control

### 5.2. Automation & Control

* Automatic heater and fan control based on temperature readings
* pH control via CO2 dosing or chemical addition
* Auto top-off system to replace evaporated water
* Scheduled lighting control for day/night cycles
* Dosing pump scheduling for adding supplements

### 5.3. Alerts & Notifications

* Email or SMS alerts for critical conditions (high temperature, low water level, etc.)
* Logging of sensor data for historical tracking

### 5.4. User Interface

* Web-based control dashboard for settings and manual overrides
* Mobile compatibility for remote monitoring
* Graphical data representation (optional with Grafana)

## 6. System Constraints

* Requires continuous internet access for remote monitoring (if applicable)
* Electrical safety precautions needed when dealing with AC-powered components
* Regular maintenance required for sensor calibration and cleaning

## 7. Future Enhancements

* AI-based predictive analytics for water chemistry trends
* Integration with smart home systems (Home Assistant, Alexa, etc.)
* Additional sensor support (e.g., nitrate, ammonia sensors)

## 8. Conclusion

This requirements document outlines the necessary components and functionalities to build a reliable AQUA system for automating reef aquarium maintenance. By following these specifications, users can create a scalable and efficient aquarium monitoring solution.