Water Level Detector Proof of Concept (PoC)

Submitted to Aliaxis

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Abstract

This project, commissioned by Aliaxis, involves an analogue system designed to detect water level in a water tank. The system consists of a vertical probe, a transmitter and a receiver. The transmitter transmits a signal to the receiver using red light. The report comprehensively elaborates the water level probe and the designs of both the transmitter and the receiver. This report also outlines the evaluation of the prototype, its range, stability, and accuracy.

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1. Introduction  
   Our client, Aliaxis, requested for an analogue system designed for detecting the water level of the water tank. Our goal for this project is to maximise the range of the transmission between the transmitter and the receiver and minimise the signal loss during the transmission. For this project, there is no constraints in size and budget of the analogue system design, however, there are requirements that were requested by the client.
   1. Client requirements  
      Our team has asked for a few requirements for the design of the project. This involves accuracy, compliance, system stability, transmission (Tx) range and battery life.  
      Accuracy: We conducted an analysis to determine the accuracy needed by the system sensor converting the water level values into electronic measurements.  
      Compliance: Device must transmit data without RF emissions to avoid the system needing to meet and be tested to the international standards.  
      System stability: We are expecting that the system measurement is stable enough to be used as an input.  
      Transmission (Tx) Range: We expect that the transmission range can be as far as possible to transmit the signal from the transmitter to the receiver.  
      Battery life: We will determine the power requirements for a solar charged battery.
   2. Design tools and methodology  
      In this project, our team used software for designing and simulating. FEMM was used to simulate the dielectric material of the water level probe, we compared the accuracy of the probe using 2 different materials. In addition of using software for design tools, we used LTSpice to simulate the circuit for the transmitter and receiver of the project, observing the waveforms of the signal and the frequency of the waveform.   
        
      We used a top-down design, where we broke the system into different phases. The first phase would be about the water level probe, the second phase is the transmitter, and the last phase is the receiver. We conducted prototyping on the breadboard for testing with electrical components, before soldering the components onto the PCB board.
2. Water Level Probe
   1. Operation principles
   2. Optimised configuration  
      We were given 2 options for the dielectric material of the probe, silicone rubber and polyvinyl chloride (PVC) from the design meeting. After conducting simulation in FEMM, we have observed that polyvinyl chloride has a more accurate water level detection, in comparison with silicone rubber.
   3. Accuracy  
      We’ve calculated the volume of water when the water tank is full, and calculated the theoretical volume of water when the water tank is at 20% water level. Then we calculated a theoretical accuracy using the theoretical volume of water when the water level is at 20%. The result from our theoretical accuracy shows that with the smallest detectable capacitance of 1pF, the theoretical change in volume
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Appendices

Appendix A – Calculation in Water Level Probe

We used