

# Implementation Of Water Level Conditioning System Using Wireless Multi-Point Communication

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**Abstract:** Wireless communication is the most popular in these days. Recently, people are trying to use the wireless communication systems in home appliances. In this system that is designed and development of a water level conditioning system using wireless, which is being used to control the water distribution system. The development system based on the wireless RF (Radio Frequency) technology which can be installed in industries, departments, domestics and so on. The level controller is used with ultrasonic sensors to sense the level of water in the tanks and a reservoir. The system used microcontrollers, these controllers have the ability to detect the level of water in a Tank1, Tank2 and a Reservoir, and then display the status of water on LCD screen, and moreover the buzzer will be work depending on the condition of water level in a reservoir. The main objectives of this paper are to design and develop a wireless water level conditioning system using point-to-multi-point RF communication technology. It is reliable because it has no problems arising after installation such as a breakage of wire.

**Keywords:** Radio Frequency (RF), ultrasonic sensor, microcontroller

## I. INTRODUCTION

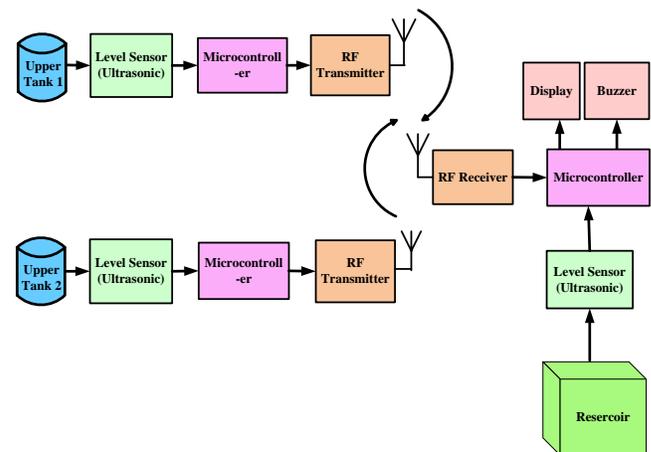
Sustainability of available water resource in many regions of the world is now a dominant issue. The problem is related to poor water allocation, inefficient use, lack of adequate and integrated water management. Water is commonly used for agriculture, industries and domestic consumption. This paper is discussed about water level conditioning system using water level sensors with wireless communication between controllers placed at the overhead tanks and the sump. So the system basically operated with three controllers and RF transceiver modules. This system is composed of ultrasonic sensor, two microcontrollers, LCD display and RF modules for wireless communication. NRF24L01 RF module is used for wireless communication system. Data transmission is used with SPI (Serial Peripheral Interface) for point-to-multipoint communication. SPI is a synchronous protocol; the data is clocked along with a clock signal (SCK). The clock signal controls when data is changed and when it should be read. Since SPI is synchronous, the clock rate can vary, unlike RS-232 style communication. SPI is a data exchange protocol. As data is being clock out, new data is being clock in. Data is always exchange between devices. No device can just be a transmitter or just a receiver in SPI. However, each device has two data lines, one for input and one for output. These data exchange are controlled by the clock line, SCK, which is controlled by the master device. More and more tanks can be connected to this system because of multi-point communication system. The following are the objectives of the research project to ensure it meets the aim:

- ❖ To know the sensing equipment for measuring water level.
- ❖ To know the usage of motor as a valve controller.
- ❖ To analyze RF technology applied in this application.

## II. DESIGN OF WIRELESS DATA COMMUNICATION SYSTEM

In this system, it uses three Radio Frequency (RF) transceivers along with a microcontroller each installed at the overhead tank and a reservoir. Addition, it uses PIC18F4550 which receives signals from the transmitters and send these data to master microcontroller. In receiver unit section, PIC18F4550 microcontroller which interprets and effectively

communicates the status of the water overhead tanks via an integrated LCD display. The water level indicators shows the water level of tank1, tank2 and in reservoir as high or low level using ultrasonic sensors. RF transmitters send these signals to RF receiver at the reservoir using SPI interfacing protocol. Moreover, it interprets a buzzer that beeps briefly when there is no water in a reservoir or there is something circuit errors and loss of data transmission. Suppose an error or loss of data occurs during transmission, then the system is programmed to retransmit the data. The block diagram of Water Level Conditioning System using Multi-point RF Communication is shown in Figure 1.



**Figure 1.** Block Diagram of Water Level Conditioning System Using Multi-point RF Communication

## III. SYSTEM DESIGN AND IMPLEMENTATION

This system consists of two main parts: interfacing with PIC microcontrollers with RF module and wireless point-to-multipoint communication. The following are the main components and the operations of theirs are used in this application.

### A. Objectives

The main aim of the system is to design wireless water level conditioning system for users who lives in departments or

industries. The wireless communication system used in water distribution system is rarely used in these days. This system can provide many benefits to the users.

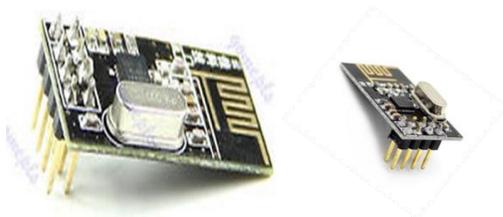
**B. System Benefits**

- i. System is low cost and easy to install of wireless communication.
- ii. The system was success to transfer data at the short-range using wireless communication network and flexible to apply.
- iii. The water level indication sensor is the most popular electric components in these days that can shows the level of water simply and easy to implement.

**(1) RF (Radio Frequency) Module**

An RF module (radio frequency module) is a usually small electronics device used to transmit and /or receive radio signals between two devices. The specifications of the nRF24L01 are;

- i. Frequency range – 2.4 to 2.5 GHz
- ii. Maximum data rate is 1000 kbps
- iii. Minimum supply voltage – 1.9 V to 3.6 V
- iv. Multi-channel operation - 125 channels
- v. Distance travel – 10m to 150m



**Figure 2. nRF24L01 Module**

nRF24L01 is a single-chip radio transceiver for the worldwide 2.4-2.5GHz ISM band. The transceiver consists of a fully integrated frequency synthesizer, a power amplifier, a crystal oscillator and a modulator. Output power and frequency channels are easily programmable by use of the 3-wire serial interface. Current consumption is very low, only 10.5mA at an output power of -5dBm and 18mA in receive mode. Built-in power Down modes makes power saving easily reliable.

**(1).1 Mode of operation**

The nRF24L01 can be set in the following main depending on three control pins:

**Table I**  
*nRF24L01 main modes*

Mode	PWR_UP	CE	CS
Active(RX/TX)	1	1	0
Configuration	1	0	1
Stand by	1	0	0
Power down	0	X	X

The nRF24L01 has two active (RX/TX) modes:

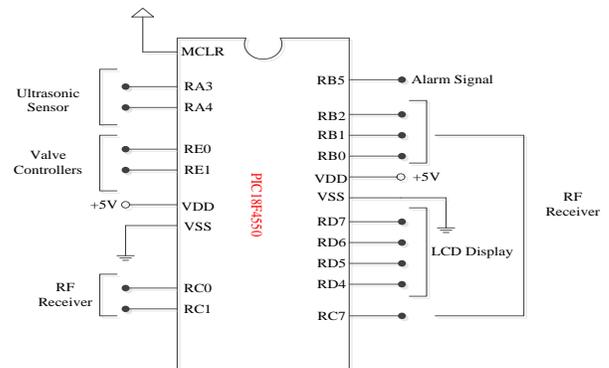
- i. ShockBurst
- ii. Direct Mode

The device functionally in these modes is decided by the content of a configuration word. The nRF2401 can be programmed using a 3-wire interface where the data rate is decided by the speed of the microcontroller. By allowing the digital part of the application to run at low speed while maximizing the data rate on the RF link, the nRFShockBurst mode reduces the average current consumption in applications considerably. The shockBurst technology used on-chip FIFO to clock in data at a low data rate and transmit at a very high rate thus enabling extremely power reduction. When operating th nRF2401 in ShockBurst, we gain access to the high data rated (1 Mbps) offered by the 2.4 GHz band without the need of costly, high-speed microcontroller (MCU) for data processing. By putting all high signal processing related to RF protocol on-chip, the nRF201 offers the following benefits:

- i. Highly reduced current consumption
- ii. Lower system cost ( facilitates use of less expensive microcontroller)
- iii. Greatly reduced risk of ‘on-air’ collisions due to short transmission time

**(2) Microcontroller**

PIC 18F4550 microcontroller is used as the main processor of this system.



**Figure 3. PIC 18F4550 Microcontroller Pins Assign**

This processor was chosen because of its good features and integrated peripherals. Its portability and low-power consumption design can satisfy the prolonged outdoor work. Three ultrasonic sensors are used in this system so that this controller is the most suitable to use to interface three sensors and wireless communication.

**(3) Ultrasonic sensor**

Ultrasonic sensor is a non-contact measurement function which is used to detect the water level, then the data will go to transmit and receive through the RF module and the whole procedure is going control by the microcontroller. Figure.4 shows the workings principle of ultrasonic sensor. Ultrasonic sensor generates high frequency sound waves and evaluates the echo from the water level of the overhead tank and reservoir which is received back by the sensor. This module includes ultrasonic transmitter, receiver and its control circuit. That is able to measure from 2cm to 400cm with an accuracy of about 3mm. And also it has 4-pins: Vcc (5V, +ive of power supply), TRIG (Trigger pin), ECHO (Echo pin) and GND (ive of power supply).Figure 4 shows ultrasonic sensor which is using

for water level indication. Basic steps of Programming for Ultrasonic Distance Measurement:

- i. Provide TRIGGER to ultrasonic module
- ii. Listen for Echo
- iii. Start Timer when Echo High is received
- iv. Stop Timer when Echo goes low
- v. Convert it to Distance
- vi. Display the Distance measurement

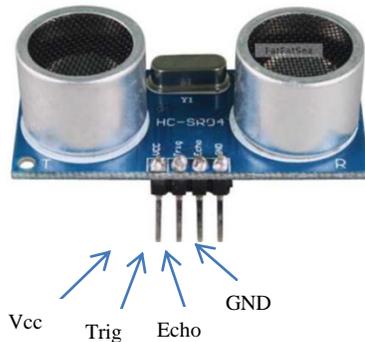


Figure 4. Ultrasonic HC-SR04 sensor

#### (4) SPI(Serial Peripheral Interface) Interfacing Protocol

SPI stands for Serial Peripheral Interface. SPI is synchronous protocol that allows a master device to initialize communication with a slave device. Data is exchange between these devices. SPI is implemented in the PICmicro MCU by a hardware module called the synchronous serial port or the Master synchronous serial port. This module is built into many different PICmicro devices. It allows serial communication between two or more devices at a high speed and is reasonably easy to implement. SPI is a serial interface using these signals;

- i. SS: Slave Select or Slave Select; when this signal goes low, the slave will listen for SPI clock and data signals.
- ii. SCK: Serial Clock; this controls when data is sent and when it is read.
- iii. SDO: Serial Data Output; this signal carries the data sent out of the device.
- iv. SDI: Serial Data Input; this signals carries the data into the device.

#### IV. SOFTWARE IMPLEMENTATION

The system flowchart of wireless water level conditioning system is shown in figure 5. After turning on the device, it automatically initializes the hardware, RF module and SPI interfacing protocol. Then it gets the water level data from water level sensors and then sending these signals to nRF24L01 receiver. Firstly, we have to initialize nodes, master and data communication before starting system. Secondly, check there is error in communication or not. If there are any errors in data transmission system, then the sensors are checking the water level of tank1 and tank2. After sensing these signals, has sent to the RF receiver which is the main MCU. Thirdly, check the water level of main reservoir. The ON/OFF conditions of buzzer are depending on the signals. Finally, if the transmitting is being texted, go back to second state, if not, the system will be stopped.

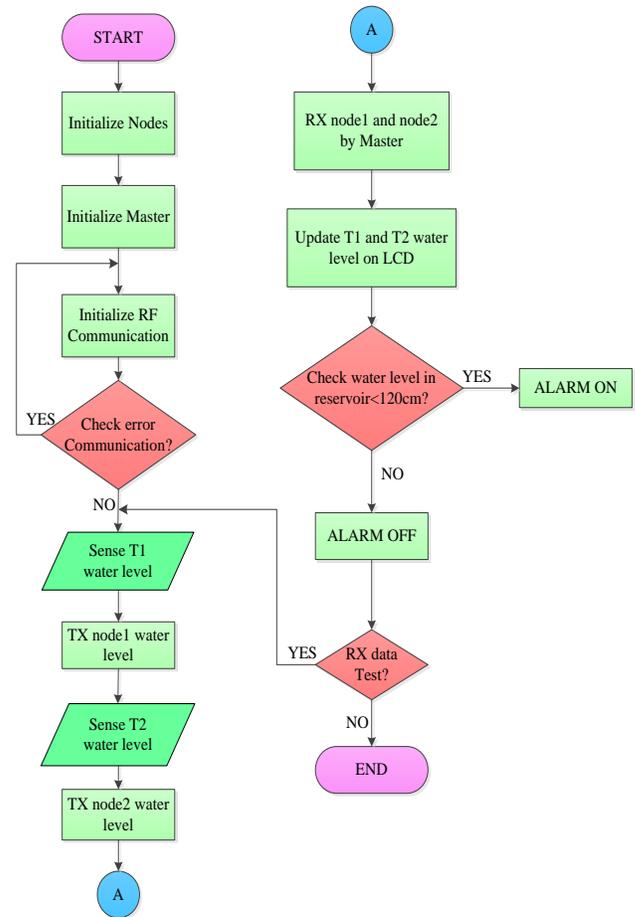


Figure 5. System flowchart of wireless water level conditioning system

The conditions of water level are shown on Liquid Crystal Display (LCD). To define the water level of Tank1 and Tank2, (1feet, 23cm, 20cm) water storage is chosen. For (1 feet, 1 feet, 22cm) water storage reservoir, 15cm is defined as a low level. For the real time condition, we can define any value to show the value of water level for any size of overhead Tanks and a reservoir.

#### V. HARDWARE TEST RESULTS

The connection of Tank1, Tank2 and reservoir are connected using SPI network protocol. NRF24L01 RF module is using for this application because of the device is the most suitable for point-to-multipoint communication system. Moreover, the important thing is to choose the brain of this system, PIC18F4550 is chosen due to simulating of three of ultrasonic sensors and multi-point communication system. For sensing the level of water, ultrasonic (HC-SR04) sensor is used. And also, 4x20 LCD display is used to show the conditions of water levels for overheads Tanks, reservoir and other conditions. Figure 6. shows the sensing of water level in reservoir using ultrasonic module.

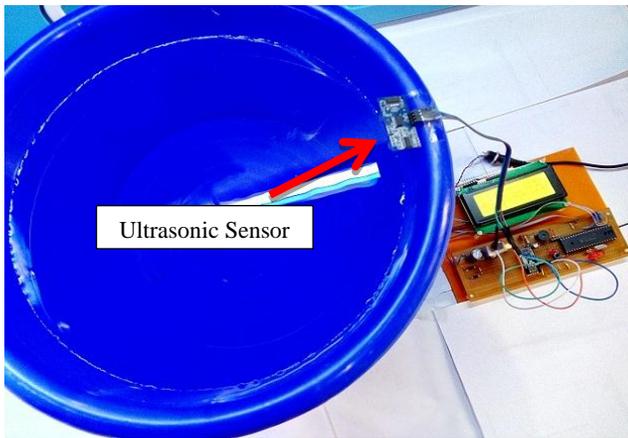


Figure 6. The sensing of water level in reservoir using ultrasonic module

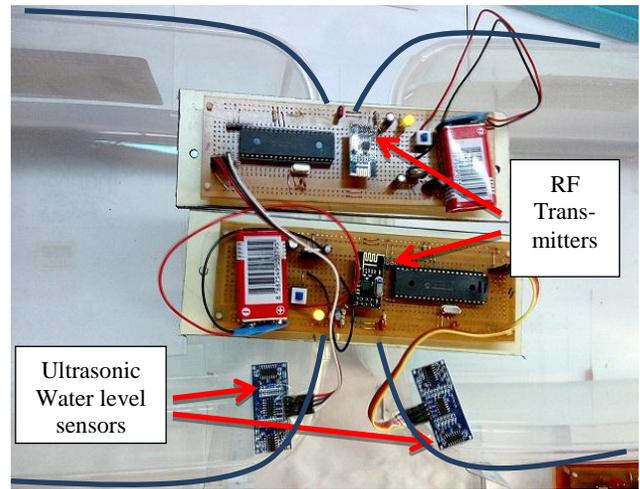


Figure 9. shows the overview of Tank1 and Tank2

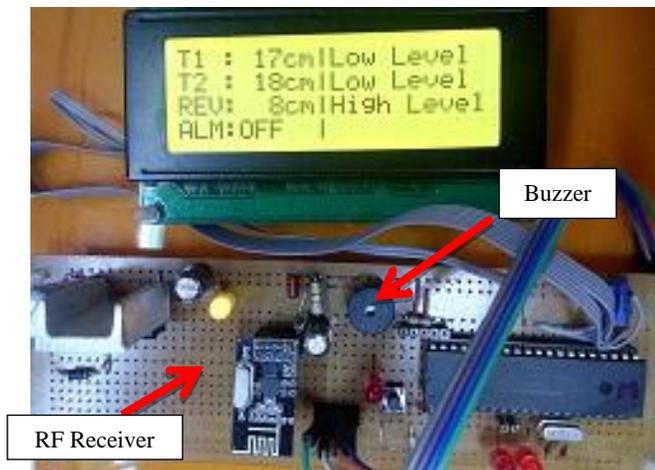


Figure 7. The water levels of Tank1, Tank2 and reservoir on LCD

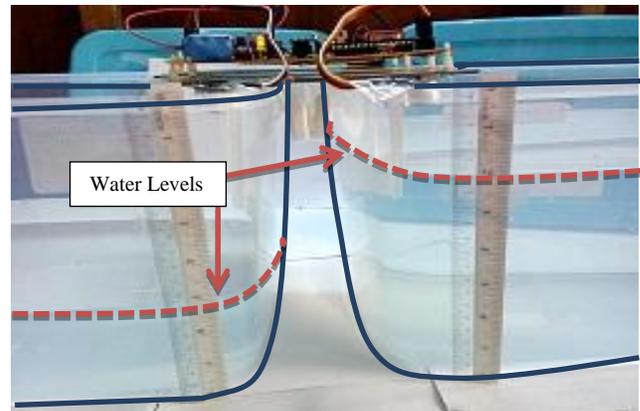


Figure 10. shows the water level of Tank2 is reached low level

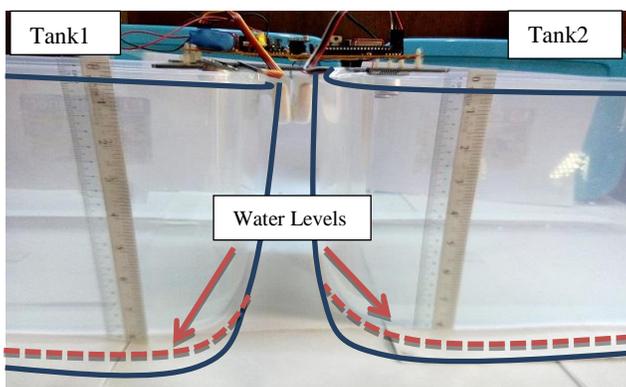


Figure 8. Tank1 and Tank2 water levels are reached low level

According to the usage of water from Tank1 and Tank2, unfortunately the water level of tank1 also reached low level whereas the level of Tank2 is reached high level (4cm) which is shown figure 11. From these results, the water level of Tank1 and Tank2 is defined as high level (5cm) and low level (18cm) from water level sensor to the surface of water. And then the water level in reservoir is reached above 15cm, the buzzer is used as an alarm signal, if not, which is increased to high level below 15cm so that no need to work buzzer.



Figure 11. The water level of Tank2 is reached high level (4cm)

## VII. APPLICATION AND ADVANTAGES

### A. Applications

The water level conditioning system using wireless communication is one of the most important systems. It is necessary due to the many of applications and wide usage of them by millions of throughout the world. Some applications in wireless data communication are;

- i. Alarm and security system
- ii. Home automation
- iii. Surveillance
- iv. Automotive
- v. Intelligent sports equipment
- vi. Industrial applications and
- vii. Toys

### B. Advantages

The design of this system offers many advantages.

- i. It is reliable because it has no problem arising after installation such as breakage of wire.
- ii. Installation design does not complicate due to wireless system.
- iii. Real time signal information can get by the user in control system by using sensors.

## VIII. CONCLUSION

In this paper, the system explained about the design of Wireless Water Level Conditioning System that is great accuracy, compact and elegant design than conventional system. That kind of wireless systems are popular in these modernize days. Because of this system is fully wireless communication, with its precise working saves water and the human energy. This design is implementable for houses, offices and other industries applications. RF transceiver can be used for long distance communication between overhead tanks and a reservoir. The range coverable is only up to domestic and office areas. It is observed that domestic and offices are one of the major areas of water polling. There are many kinds of water level sensors to institute for Ultrasonic level sensors. Wireless Water Level Conditioning System has a rising demand and it is a good performance from the electronics perspective.

## VI. FURTHER EXTENSION

After showing the wireless communication of the water levels of Tank1, Tank2 and Reservoir, more and more tanks will attached this system according to the module of RF communication. Actually, automated water level control system should do later. Motor control system and other sensors can be used in this application.

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