

# ULTRASONIC FLOW METER

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## ABSTRACT

An ultrasonic flow meter is a type of flow meter in which two ultrasonic water coupled piezoelectric transducers are mounted on the pipe, that measures the frequency shift caused by the liquid flow. These transducers emit the ultrasound pulses and by averaging the time difference between the pulses of ultrasound measures the frequency shift from the Doppler's shift effect [1]. The time difference is calculated by GP22ASIC and generated digital signal is processed by microcontroller and flow rate is being displayed on the LCD. For liquid applications the design and manufacture of the sensor housing is particularly important to ensure the sensor is able to operate reliable under high pressure and within a wide range of temperatures [3]. These water coupled sensor is ideally suited for ultrasonic water flow meter, there are two ultrasonic water coupled sensor are used for the calibration purpose, extended memory is also available for data logging. The main thing in this ultrasonic flow meter is that the GSM communication is possible so human interruption is avoided, so that this ultrasonic flow meter full fill the all government as well as domestic requirement like marriage party, playground etc. Total system requires only 700ua current so it is one of the most power efficient and reliable system. The only authorize person can make changes in this ultrasonic flow meter by using the security keyword through keypad. There is LCD display for displaying the information like time, flow rate, amount of volume used by the customer. i.e. the system is familiar with user, these all are the advantages of ultrasonic flow meter [7].

**Keyword :-** GSM Communication, Ultrasonic sensor, GP22, PIC microcontroller, Time of flight, Doppler's effect, Transit time, flow measurement.

## 1. INTRODUCTION

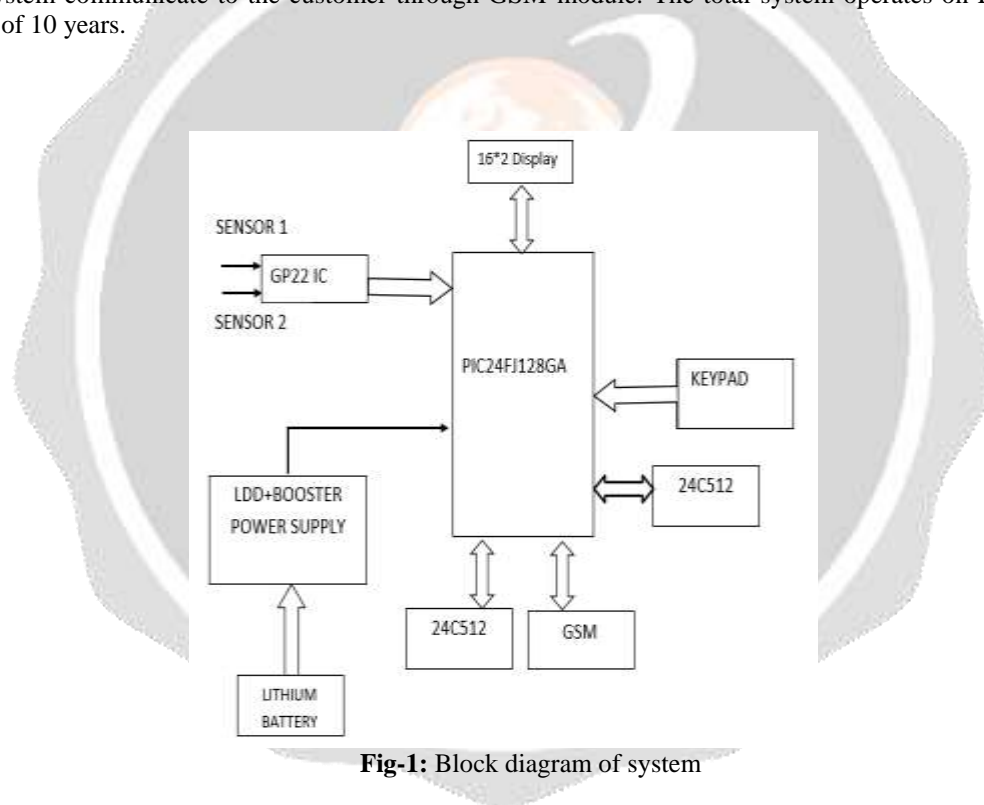
Ultrasonic flow meters are one of the most popular types of meters used to measure liquid flow in pipes. The most common variety has both transducers can send and receive the ultrasonic beam. Figure 1 shows the block diagram of UFM. Both the transducers are mounted on either side of the flow meter, or the pipe wall [2]. The sending transducer sends an ultrasonic pulse at an angle from one side of the pipe which is received by the receiving transducer. The flow meter measures the time that the ultrasonic beam takes to travel across the pipe in forward and reverse direction. When the signal travels along the direction of the flow, it travels more quickly compared to the condition of no flow in pipe [1]. On the other hand, when the signal travels in opposite direction of flow, it slows down. Other than the ultrasonic sensor there are so many advantages and application of ultrasonic flow meter. By using the extended EEPROM in our system it is possible to store the data for long time and automatic billing is generated according to volume of water used by customer. All these information is directly send to the customer through the GSM communication. Over all the ultrasonic flow meter fulfill the current requirement.

## 2. OVERVIEW OF THE SYSTEM

An ultrasonic flow meter is one of the fully equipped system that fulfill the all current requirement. It is completely battery operated system. Total system requires only 700 $\mu$ a current, so the power consumption in system is reduced by using the power efficient component and supervisory circuit. There is LCD display for displaying the information like time, flow rate, amount of volume used by the customer. i.e. the system is familiar with user. There are two ultrasonic water coupled sensor are used for the calibration purpose, extended memory is also available for data logging. The main important point is security is achieved by using of keypad and human interruption towards the system is avoided by make use of the GSM Module.

### 3. SYSTEM ARCHITECTURE

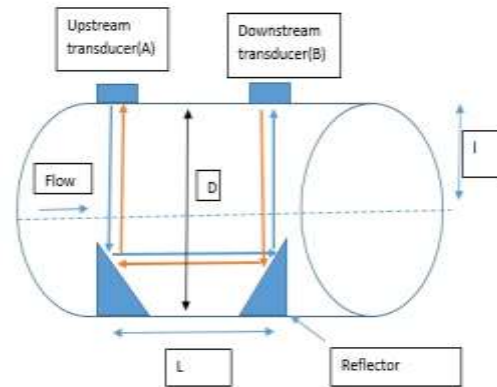
Figure 1 shows the block diagram of the ultrasonic water flow meter. There are two sensor used, one for inlet and another for outlet, the time difference between the two sensors is directly proportional to the flow rate. GP22ASIC IC is used to convert the time difference into the digital value and it is given to controller [6]. The role of microcontroller in ultrasonic flow meter is very important. The keypad is interfaced with microcontroller for making any changes in the system and this is done by only the authorized person. There is also supervisory circuit that reduce the power consumption and it will make power efficient system. 24LC512 are the EEPROM used for the data logging. System communicate to the customer through GSM module. The total system operates on Li-ion battery having life of 10 years.



**Fig-1:** Block diagram of system

### 4. WORKING OF THE SYSTEM

In Figure 2, ultrasonic water coupled flow sensor is shown. The flow sensor consists of a pipe with a diameter “D” and two piezoelectric water coupled transducers placed at fixed distance “L” from each other. The ultrasonic transducers are mounted in a protective housing. The housing and the transducers are inserted into slots in the pipe, exposing inner covers of the transducers to the fluid in the pipe.



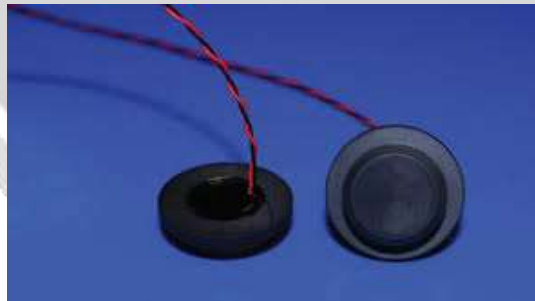
**Fig- 2.** Ultrasonic Water Flow-meter Pipe

Two reflectors in the pipe direct the ultrasonic signals from one transducer to the other, as shown in Figure 2. The path between two transducers via reflectors (as shown in Figure 2, for example) is referred to herein as a single path, the single path sensor of Figure 2 is used for flow applications where the diameter of the pipe is either small or large [7]. For larger diameter pipes, transducers with multiple paths are used. In addition to the integrated transducer style of ultrasonic flow sensor (as illustrated in Figure 2, for example), other types of ultrasonic liquid flow sensors are available with clamped-on transducers. However, this mechanism is limited to reflective-type single path sensors such as shown in Figure 2 for example.

## 5. SYSTEM COMPONENT

### 5.1 Water Coupled Ultrasonic sensor

For liquid applications the design and manufacture of the sensor housing is particularly important to ensure the sensor is able to operate reliable under high pressure and within a wide range of temperatures. These water coupled sensor is ideally suited for ultrasonic water flow meter..



**Fig- 3.** Ultrasonic sensor

### 5.2 PIC24FJ128GA308:

In our system we have used PIC24FJ128GA308 microcontroller for monitoring the various operation like GSM communication, data logging, receiving information from ultrasonic sensor. This microcontroller having multiple i/o port, 128byte program memory, 8K data memory, operating frequency 32Mhz.

### 5.3 GP22:

The GP22 is time to digital converter IC and it is standard device for precision time interval measurement in industrial applications. With single shot of 22ps resolution and 4ms counting range, the GP22(time to digital

converter) is best for ultrasonic sensors, spectroscopic applications and test equipment. In our system GP22 is used for calculating the time difference between the sensors and convert it into digital and this digital output given to the microcontroller. The GP22 measure mode 2 offers ultra-low power operation with 3-fold multi-hit capability.

#### 5.4 24LC512(EEPROM):

EEPROM stands for electrically erasable programmable read only memory and it is extended memory for our system, it is preferred for low-power applications for personal communications or data monitoring. This device has both byte and page write ability of up to 128 bytes of data. In our system EEPROM is used for data logging it stores the data like flow rate amount volume used by user.

#### 5.5 GSM Module:

GSM(Global system for mobile) is used in our ultrasonic flow meter for sending the billing related information to customer and it avoid human interface to the system.

### 6. EXPERIMENTAL RESULT

Figure 4 shows the graph of experimental result. In that experiment we have monitored 5 days of data logging i.e. how much of water used by customer in 5 days and graph for the same. we have observed system accuracy practically.



Fig- 4. Data collection of 5 days.

### 7. CONCLUSION

Our system works on Doppler's effect that states that when a wave travels through a moving medium then it's frequency varies with respect to direction of flow of medium. We can calculate the time difference by taking inverse of the frequency. From this time difference the velocity of medium can be calculated. Thus, flow rate can be measured.

### 8. REFERENCES

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