

A POSSIBLE WATER DEPTH MEASURING SYSTEM USING ULTRASONIC WAVE

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Abstract-To measure the depth of water or detection of obstacle present inside the water, a simple technical method is used. In this method, transducer of both transmitter and receiver are placed just below the surface of water. Ultrasonic wave are generated by the generator using piezoelectric crystal as transducer. This ultrasonic sound vibration is transmitted for few microseconds into water. The transmitted pulses are either reflected from the bottom surface of water or reflection due to any obstacle present inside the water. The reflected pulses are received introducing some time delay, by using the same transducer. By measuring the time delay between transmitted and received pulse, we can decide the depth of water by using the formula-

$$\text{Speed} = \text{Distance} / \text{time (m/s)}$$

$$\text{Distance (depth) in meter} = 1480 * \text{time in second (ultrasonic velocity in water is 1480 m/s.)}$$

Introduction

Ultrasonic has become increasingly importance in various field such as in biomedical field, communication system industries etc. One of the most importances of ultrasonic wave in SONAR based communication system.

SONAR stands for sound navigation and ranging in which pulse ultrasound is used. Sonar is used in navigation, forecasting, submarines, and missiles, ship etc. In SONAR system ultrasonic wave used for detection of submarines and other underwater object by reflection of the ultrasonic wave. SONAR unit consist of ultrasonic transmitter and receiver. To measure the water depth, for instance the, transmitter send out a short pulse of sound and later the pick up the reflected sound wove. The water depth is determine from the time elapsed between the emission of ultrasonic sound and reception of its reflection off the sea-floor. The time difference is measured between the transmitted pulses and received pulse with the help of suitable

measuring system such as CRO. The speed of the ultrasonic wave is 1480 m/s and in air 330 m/s i.e. attenuation to the ultrasonic wave in water is minimum.

Experimental Work

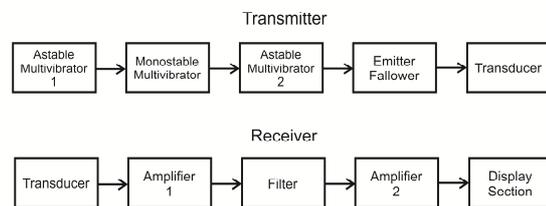


Fig 1: Block diagram of Experimental work

The circuit diagram of the SONAR system is shown in figure. It consists of ultrasonic wave transmitter and receiver.

Transmitter Section:

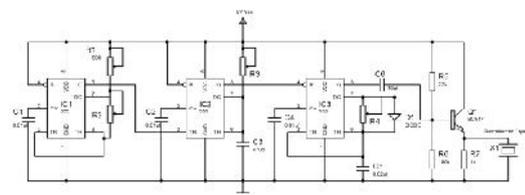


Fig 2: Circuit diagram for Transmitter section

As shown in transmitter circuit, the astable multivibrator 1 using IC 555 is generated a frequency 80 KHz .The 80 KHz frequency is generated by proper designing of timing component resistance R1 and R2 and capacitor C. The frequency generated by a astable multivibrator 1 is only used for triggering the monostable multivibrator. Therefore output of astable multivibrator 1 is given to the triggering input of monostable multivibrator.

By giving a triggering pulse to the monostable multivibrator, it produces a pulse which has a minimum on time, i.e. width of positive pulse is minimum and width of negative pulse is comparatively large i.e. off time is greater. The width of positive pulse and negative

is determined by a resistor R capacitor C which is externally connected to 555. In this circuit R is generally variable resistor is used.

The output of monostable multivibrator is given to the astable multivibrator 2 using 555 at pin4 which is a reset pin of IC555. Astable multivibrator 2 generate a pulse only for time period of positive pulse which is produced by monostable multivibrator and during the negative pulse of monostable multivibrator, is remained off i.e. it does not produce the oscillation. It means that astable multivibrator produces oscillation at the time of positive pulse at pin 4 of 555 (astable multivibrator 2).

Astable multivibrator generates oscillation of high frequency. This frequency is set at resonance frequency of piezo-electric crystal (i.e. transducer). The resonant frequency of piezo electric crystal is near about 80 kHz. The frequency generated, by astable multivibrator 2, which to be transmitted in terms of mechanical vibration (ultrasonic wave) with the transducer as piezo electric crystal. The frequency is determined by the resistor RA' and RB' and capacitor C. The output of the astable multivibrator 2 is not given directly to the piezo electric crystal because of impedance matching between output of astable multivibrator and crystal. If there are mismatching of the impedance, loading effect are arises, which is unwanted things. Therefore emitter follower is placed between output of the astable multivibrator 2 and piezo electric crystal. Emitter follower helps to match the impedance of output of astable multivibrator and crystal. It also increases the current gain which helps in increasing power gain. Due to increase in power gain, powerful mechanical vibration are obtained from the crystal which to be transmitted in water.

Piezo electric crystal has a property to convert the electrical signal into mechanical vibration and vice versa.

Receiver section:

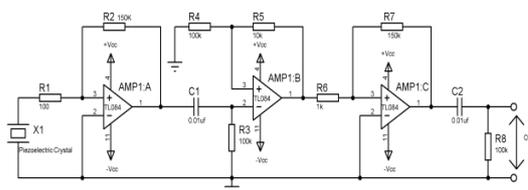


Fig 3: Circuit diagram for Receiver section

As shown in receiving section, peizo electric crystal picks up the mechanical vibration (ultrasonic

wave) through the water. This mechanical vibration is converted into electrical signal whose amplitude or strength is very poor i.e. amplitude of the signal generated by the piezo electrical crystal is at microvolt level. The weak from the crystal is given to the high gain amplifier 1. This amplifier is nothing but the operational amplifier which is in inverting mode. The inverting op amp is designed for high gain nearly about 1500. The inverting op amp amplifies the signal from piezo electric crystal and the output of the op amp, the amplitude of the signal is about few milivolts.

The output of the op amp is given to the filter. This filter is a active high pass filter, which are used because the piezo electric connected at the receiver pick up the mechanical vibration which is transmitted by the transmitter, but it also pick up the surrounding mechanical vibration, due to this frequency of different signal are produced which is unwanted frequency or it is also called noise. The unwanted frequency is either low or high. Therefore high pass filter is used for rejecting the frequency which is less than resonant frequency. The designing of active high pass filter is done by considering the desirable gain and lower cut off frequency. The gain of this filter is 2 and lower cut off frequency is 75 KHz. All frequency is rejected below 75 KHz and passes the frequency above 75 KHz.

The filter output from the high pass filter is again amplified by amplifier 2. This amplifier is also a high gain amplifier and it is used in inverting mode. The amplified output of this amplifier is at few milivolts level and gain of this amplifier is 150 i.e. it amplifies the signal to 150 times. The amplified output signal of amplifier 2 is then passed through passive high pass filter. It rejects the frequency below the cut off frequency. The output of the passive filter is the output of the receiver circuit which given to the display system such as CRO.

Result and discussion

The circuit of the sonar is working properly. The range of this instrument i.e. distance from the transmitter is about the 1 meter because range depends upon the power received by the transducer. It means that power is proportional to the range i.e. power increase, the range is also increases. In transmitter only resonant frequency of transducer to be transmitted. It should be noted that the transducer i.e. piezoelectric crystal must have same resonant frequency. If receiving crystal and transmitter crystal have different resonant frequency, transmitter resonant frequency of crystal that

receiver crystal does not pick up the transmitted wave which is mechanical vibration. Receiver pick up the leakage frequency present surrounding the crystal which is unwanted frequency is also called harmonics. Unwanted frequencies are filter out by using electronic filter.

Discussion:

For constructing of transmitter, only IC 555 is used which has low cost compact size and require minimum power supply. IC 555 used for making the astable multivibrator and monostable multivibrator and minimum passive component such as resistor, capacitor are required. The construction and designing of both the multivibrator are easy. Simple emitter follower is used for impedance matching and increasing current using transistor BC547 and piezo electric crystal are used for converting the electrical signal into mechanical vibration and also in received same piezo electric crystal is used which has same resonant frequency. IC TL084 is used receiver circuit which is operational

amplifier (op amp). It consists of four op amp and requires dual power supply. The op amp is used inverting high gain amplifier and filter with minimum passive component is used in receiver circuit which is externally connected to op amp. In this circuit the crystal is water proof because of to avoiding the shorting of signal terminal to ground.

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