Ultrasonic Based Distance Measurement System

Some basic question:

- **What is “Ultrasonic”?**
- **Its existence?**
- **Is it really possible to use it for distance measurement?**

Introduction

Ultrasonic is the application of ultrasound.

Now What are the ultra sounds?

Ultrasound is an oscillating sound pressure wave with a frequency greater than the upper limit of the human hearing range .

Ultrasound is thus not separated from 'normal' (audible) sound based on differences in physical properties, only the fact that humans cannot hear it.

Some Basic Properties

The term *sonic* is applied to ultrasound waves of very high amplitudes

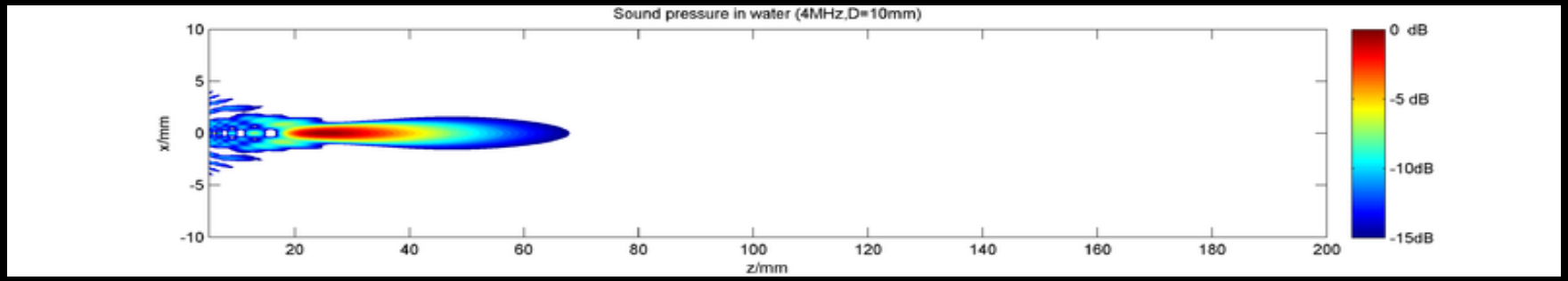
Ultrasound devices operate with frequencies from 20 kHz up to several gigahertz.

the molecules of the material in which the waves are traveling cannot pass the vibration along rapidly enough.

Ultrasonic as distance sensor

Ultrasonic sensors work on a principle similar to radar or sonar **which** evaluate attributes of a target by interpreting the echoes from radio or sound waves respectively.

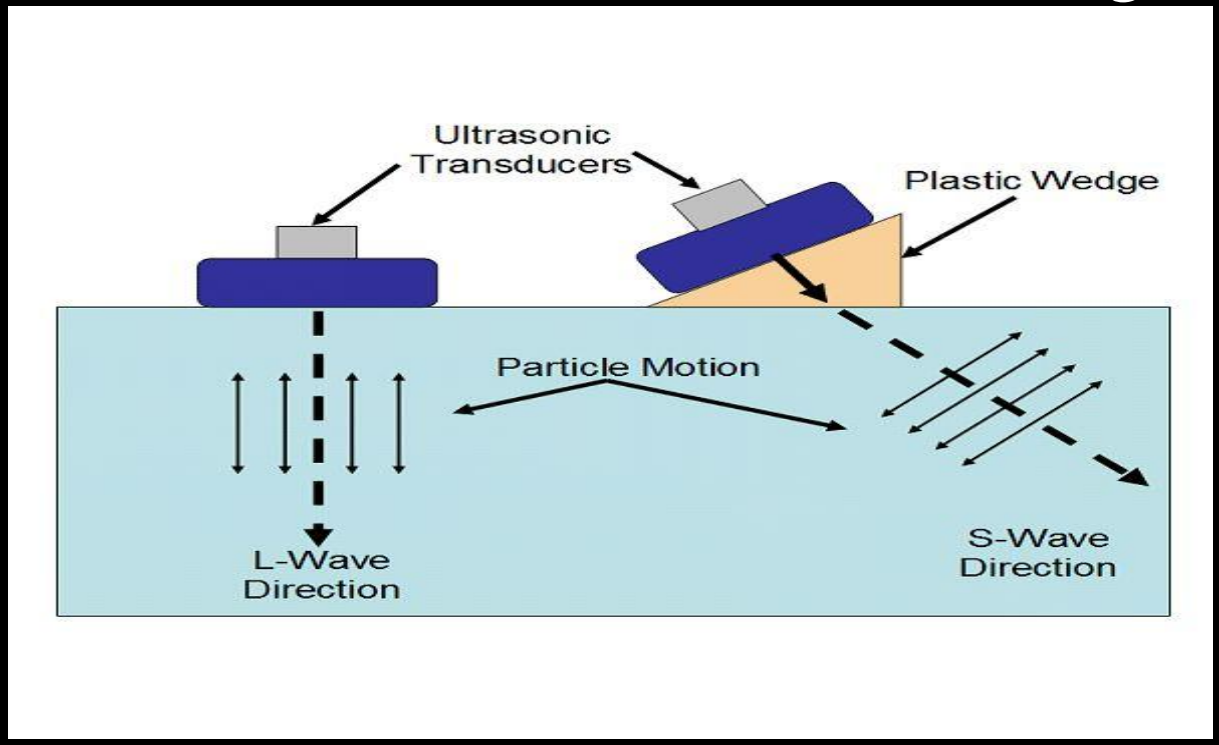
Ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensor.



Sound field of a non focusing 4 MHz ultrasonic transducer with the transducer surface having a spherical curvature

Ultrasonic Transducers

An ultrasonic transducer is a device that converts energy into ultrasound, or sound waves above the normal range of human hearing.

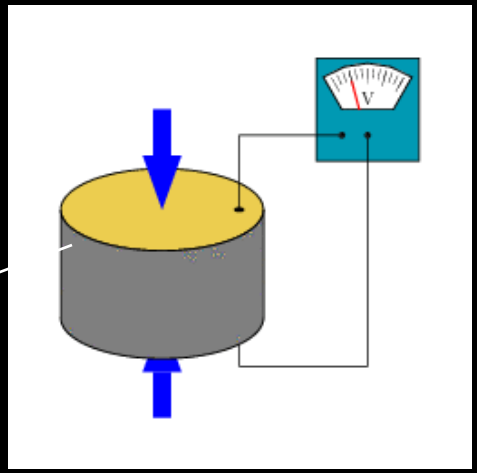


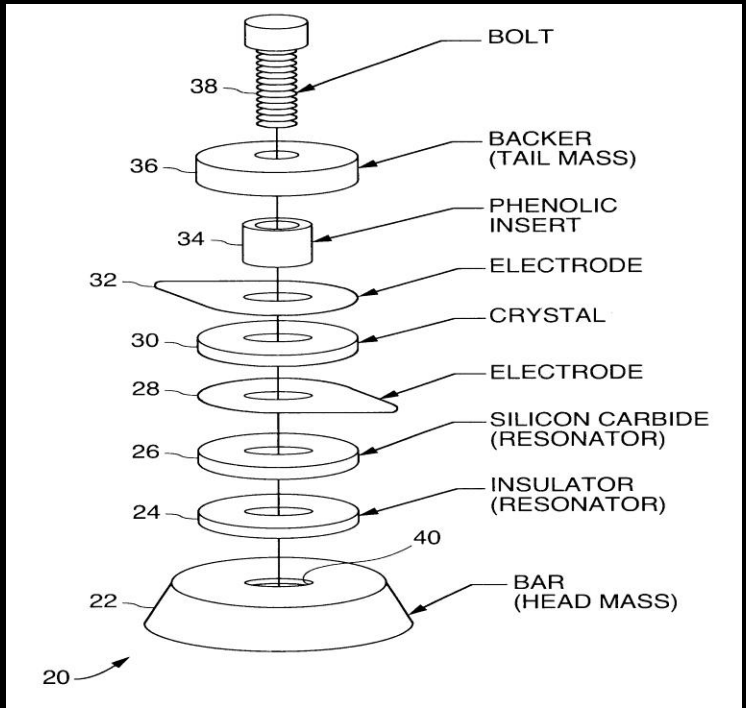
The ultrasonic transducers are used commonly for the measurement of flow rates of the fluids, the level of the liquid, displacement of the object etc

Piezoelectric Crystal: An Important Ultrasonic Transducer Element

The piezoelectric crystal is one of the most commonly used elements in the ultrasonic transducers. It can be used as the both, transmitting as well as the receiving device, in the transducers. It is enclosed within the casing so that it can work efficiently and securely.

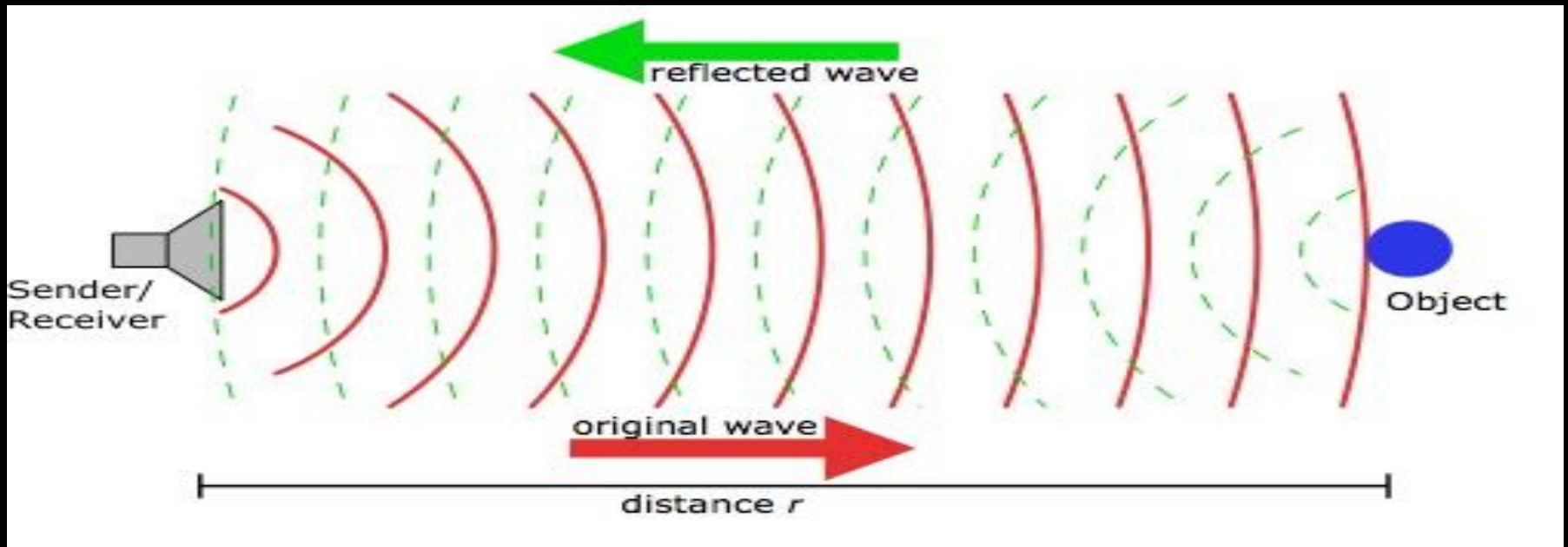
The piezoelectric crystals can work in the frequencies ranging from 20 KHz to 15 MHz. The voltage passed through these devices generates the ultrasonic waves.



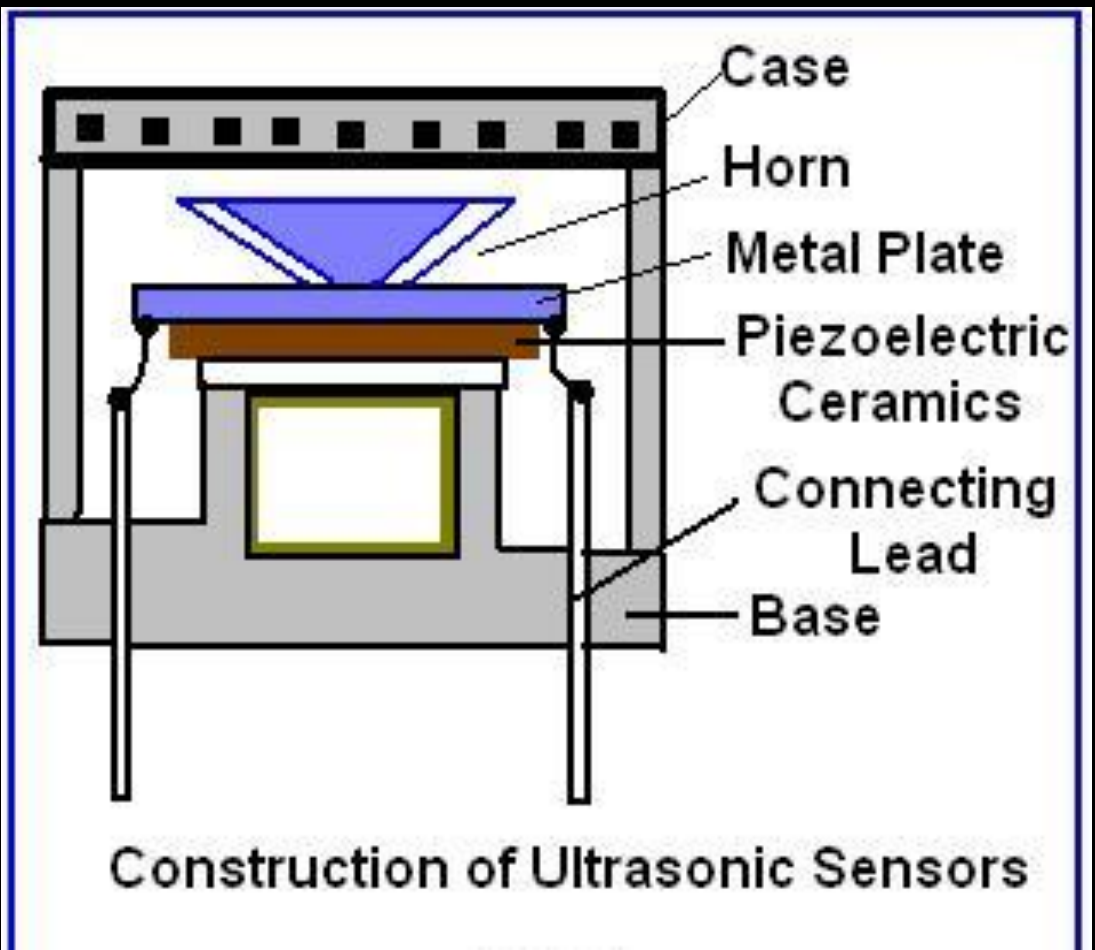


So at a glance

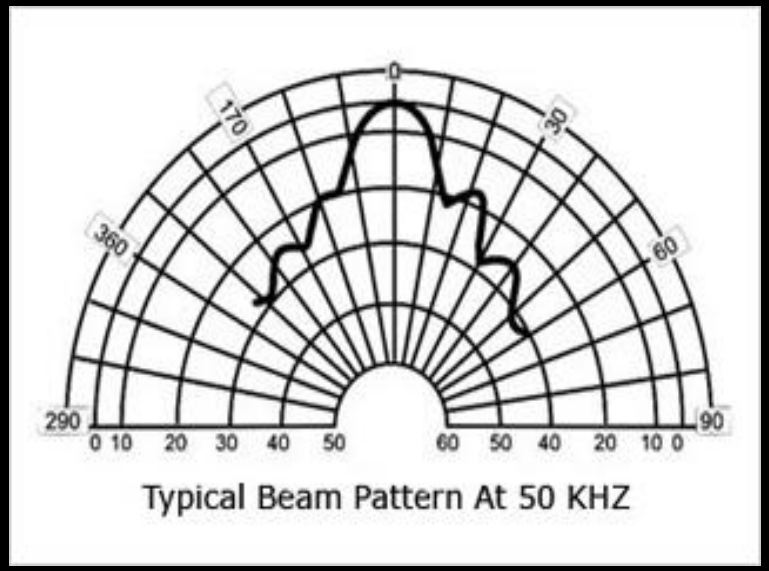
Ultrasonic waves are the waves with a frequency greater than the upper limit of human hearing (greater than 20 kHz). Ultrasonic waves Send into(onto) a body which are reflected at the interfaces and Return time of the waves tells us of the depth(Distance) of the reflecting surface. The time taken for the pulse to propagate from transmitter to receiver is proportional to the distance of object.



This distance measurement done by ultrasonic transducers(send and receive the sound waves)

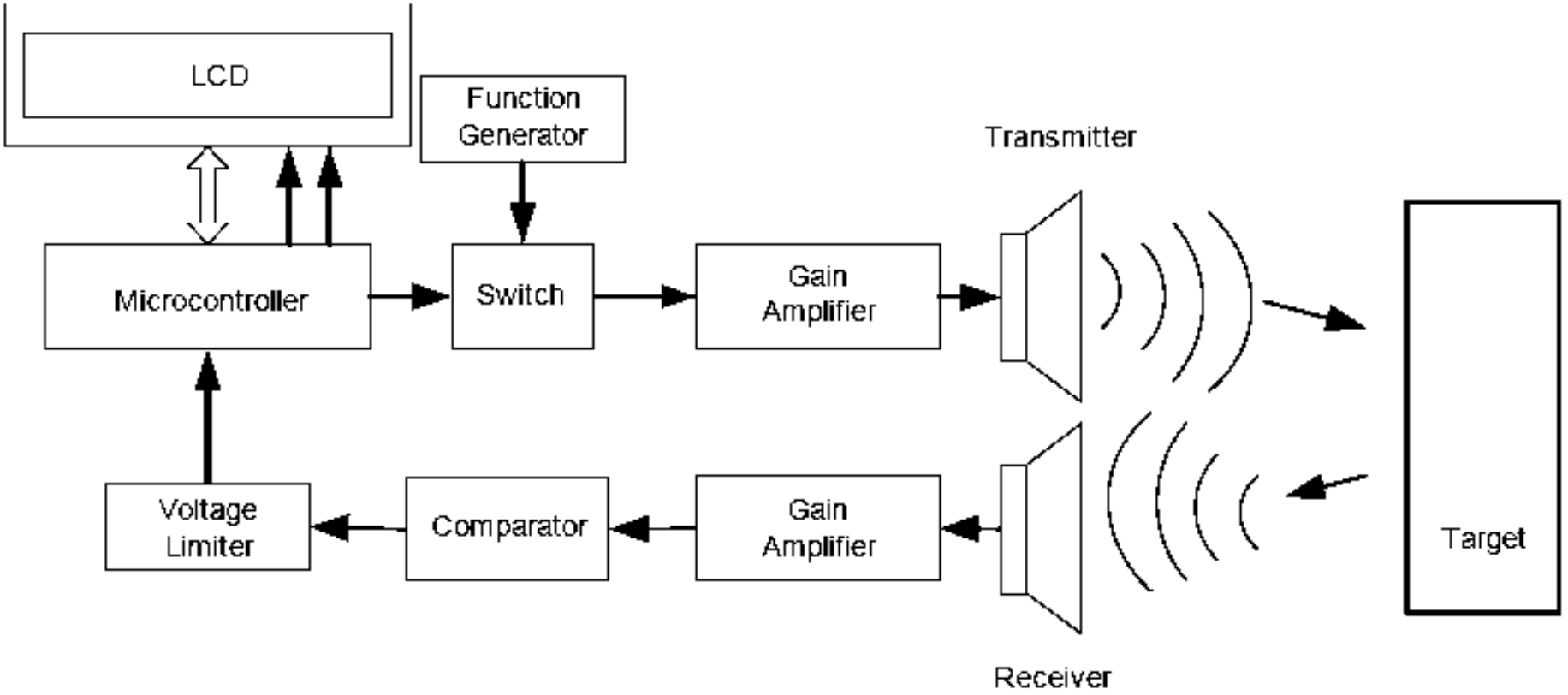


Construction of Ultrasonic Sensors

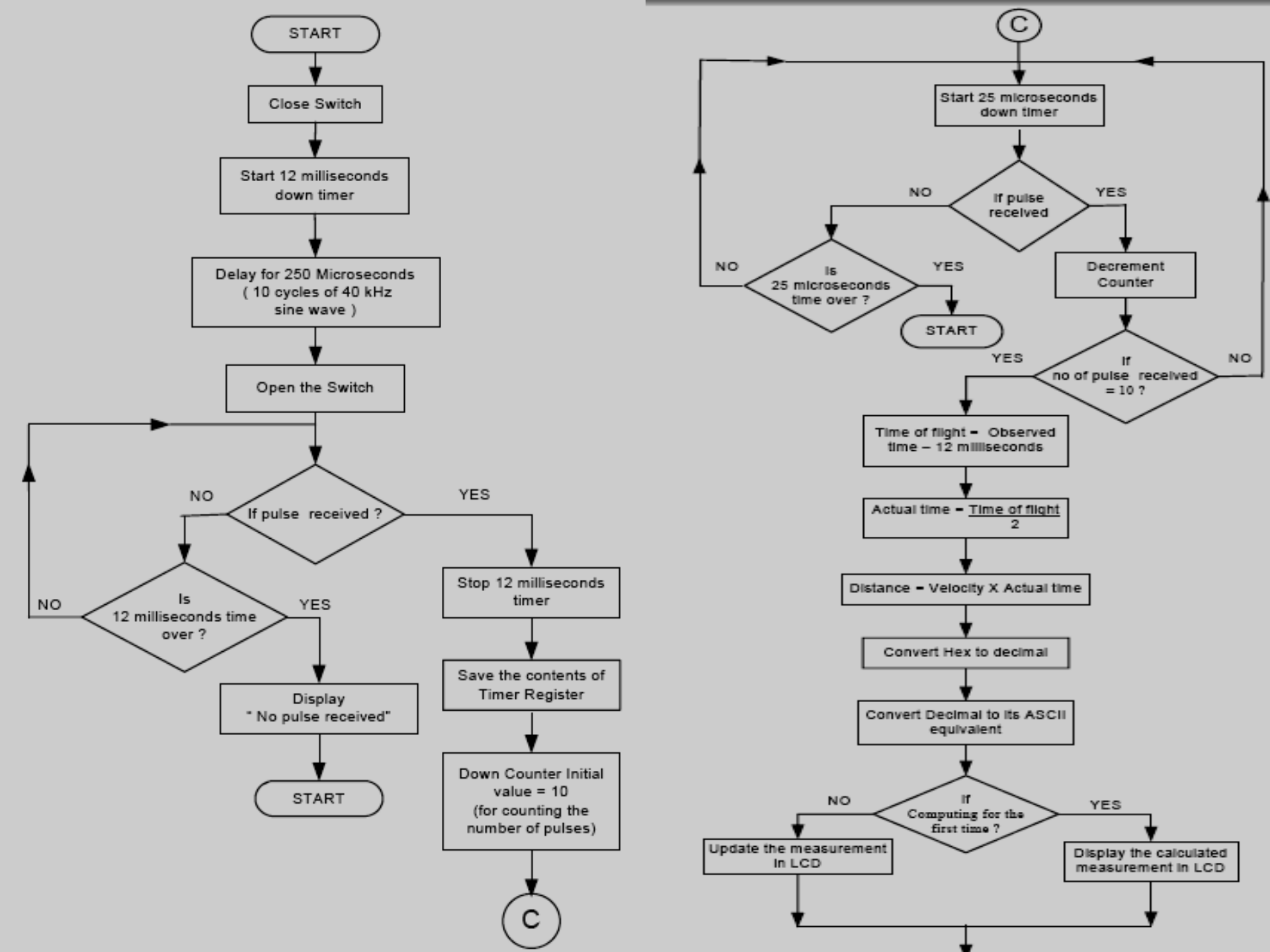


Typical Beam Pattern At 50 KHZ

Block Diagram for *Ultrasonic Based Distance Measurement System*



- 12 milliseconds is the time taken for the ultrasound waves to travel a maximum distance of 4 meters (time of flight gives twice the time taken to traverse a unit distance).
- This system of distance measurement does not require large amount of memory hence a 20 pin 8051 based microcontroller AT89C2051, is chosen as the controller with 12MHz clock.
- It performs the operation of giving the switching signal, computing the distance, converting the hex value to decimal and then to ASCII to be displayed in the LCD.


START
Close Switch
Start 12 milliseconds down timer
Delay for 250 Microseconds (10 cycles of 40 kHz sine wave)
Open the Switch
If pulse received ?
NO
YES
Is 12 milliseconds time over ?
NO
YES
Display " No pulse received"
START
Stop 12 milliseconds timer
Save the contents of Timer Register
Down Counter Initial value = 10 (for counting the number of pulses)
C
C
Start 25 microseconds down timer
If pulse received
NO
YES
Is 25 microseconds time over ?
NO
YES
START
Decrement Counter
If no of pulse received = 10 ?
YES
NO
Time of flight = Observed time – 12 milliseconds
Actual time = Time of flight / 2
Distance = Velocity X Actual time
Convert Hex to decimal
Convert Decimal to its ASCII equivalent
If Computing for the first time ?
NO
YES
Update the measurement in LCD
Display the calculated measurement in LCD

Conclusion

- The microcontroller with LCD makes it user friendly.
- The circuit can easily been implemented on bread board and tested for its functionality by varying the distance between the transducer and the target.
- The target surface needs to be perpendicular to the impinging ultrasound waves.
- The power level of the signal is too low for long range measurement.
- Less hardware are used so smaller in size.
- Inexpensive components used so that reduces the cost per unit .

Outcomes

•We have found that this project is effectively useful in research and development area as well as in Army and civil area.

• Major outcome is that this project can replaced too many costly types of equipment which we have to bought from foreign countries.

• Product is also eco friendly because it does not harm Earth's environment.

•Project is less complicated than other, so analysis and replacement of components is easy.

Thank You