Experiment #5

ULTRASONIC REMOTE CONTROL SYSTEM

INTRODUCTION:

Low frequencies in the range 20-100 KHz can not be heard by human being. Therefore, they are described as ultrasonic. They propagate in the air at a much lower speed than light. This property can be used to advantage in many industrial applications. For example the measurements of the change of the propagation time of an ultrasonic wave in a solid or liquid medium can help it detecting variations in the thickness or the density of the medium. Ultrasonic systems are, therefore, widely used in industry for monitoring and/or measuring thickness and density. By the same principle, they can be used in detecting cavities and inclusions in castings, abrupt variations in composition of alkloys and many other similar applications. Ultrasonic systems can be also used in constructing home security systems as well as in remote control of TV sets or toys.

TRANSMITTER CIRCUIT:

From your lecture notes you know that an ultrasonic transmitting unit is no more than a crystal of a piezoelectric material sandwiched between two metal plates; see Fig. 1. The same crystal can be used for receiving ultrasonic transmissions. This is attributed to the characteristics of the crystal which converts mechanical vibrations into electrical voltages and vice versa. In an electronic transmitting circuit the crystal electrical equivalent circuit is a parallel resonance circuit. Thus in an LC sinusoidal oscillator circuit rather than using discrete capacitors and inductors a crystal can be used. The frequency of oscillation will be decided by the crystal resonance frequency. If oscillations are successfully generated an alternating voltage will appear across the terminals of the crystal. This, in turn, will result in crystal vibrations and consequently air vibrations. This establishes an ultrasonic wave. This is the idea of an ultrasonic transmitter. Note that the crystal is used to generate the alternating voltage and also to initiate air vibrations. Fig. 2 shows a possible ultrasonic transmitter circuit based on this idea. Other possible ways of thinking are also possible. Try to develop an alternative ultrasonic transmitter circuit.

RECEIVER CIRCUIT:

If the path between the transmitter and the receiver is clear, the ultrasonic emission from the sending end is received and detected by the receiver which converts the air vibrations hitting the crystal into electrical signal. Otherwise, if the path between the transmitter and the receiver is not clear, the ultrasonic wave is blocked and the receiver detects nothing. Usually a detected signal is too small and, thus, required voltage amplification. This can be achieved using a voltage amplifier. The output of the amplifier is expected to operate a transducer which may convert the electrical signal into sound, light, or any appropriate output for further processing. A possible ultrasonic receiver is shown in Fig. 3. The circuit is very similar to the one discussed in the lecture except that a LED now replaces the relay coil.

EXPERIMENTAL WORK:

During the experiment you are requested to construct the circuits shown in Figs. 2 and 3. Check the operation of the transistors under DC conditions. Make sure that this agrees with your theoretical hand calculations. Then check the waveforms at the testing points given. Verify the operation of the circuit and find the useful range of its operation. Try to think what measures can be taken to increase its useful operating range. Submit a report including your findings.

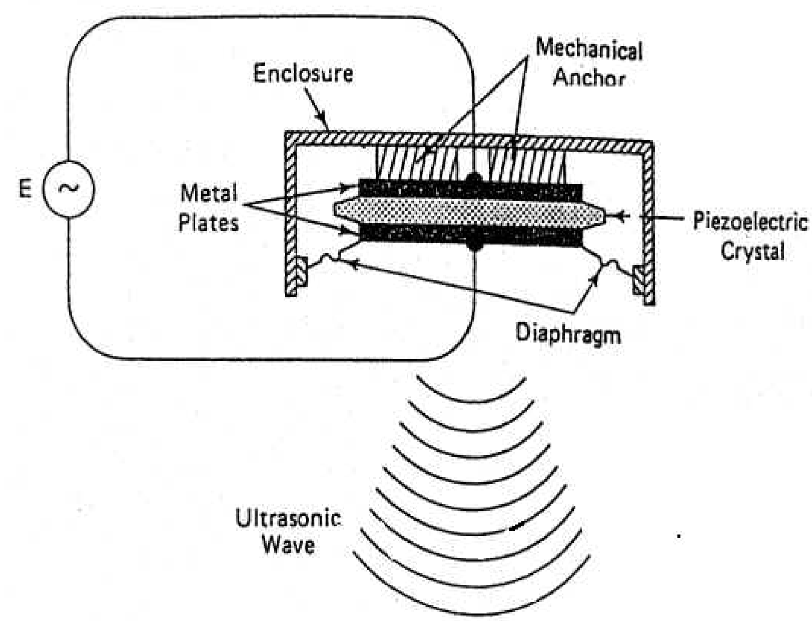

Fig.1: Ultrasound Transmission (Schematic Diagram)

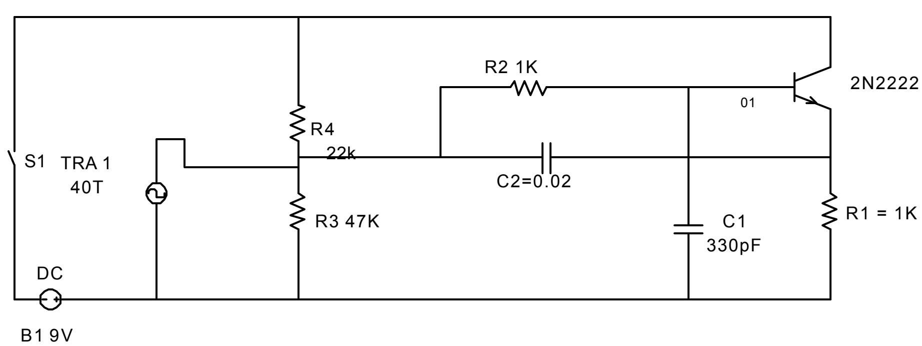

Fig 2: Ultrasound Transmission (Circuit Diagram)

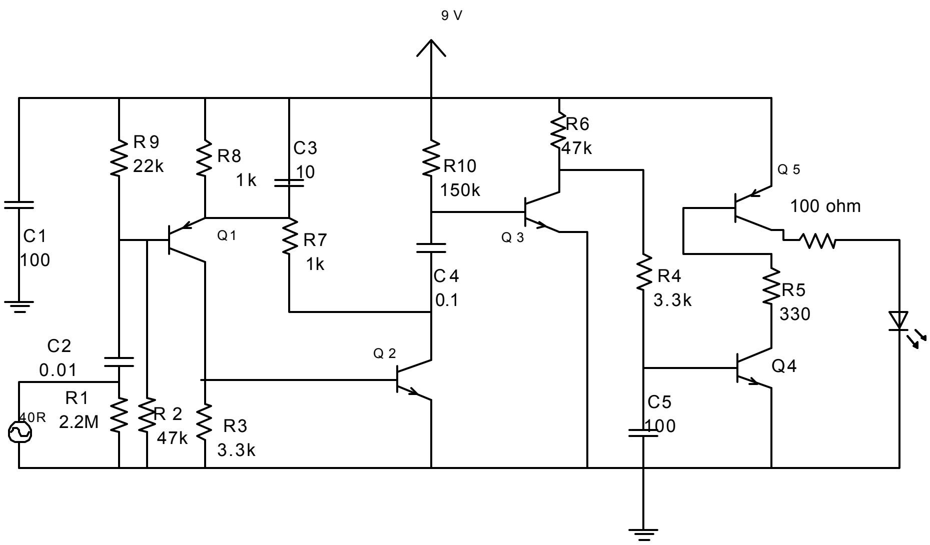

Fig 3: Ultrasound Receiver Circuit