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Electronic Buzzer for Blind

Group no. B08

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Problem Statement: The aim of the project is to build an Electronic Buzzer for blind people. This product will detect any obstacle in the path of the person and if its distance is less than 1m, it will alert the person by buzzing the buzzer.

Design Approach:

1. Issues

1.1 Conditions on the target

For contact less detection of obstacle, we have to rely on the target to reflect the pulse back to itself. The target needs to have a proper orientation that is it needs to be perpendicular to the direction of propagation of the pulses. Also if the reflectivity of the target is low, the signal received by the device may not be detectable. For example we cannot expect the device to work on a sound absorbing target.
Hence the target needs to be oriented perpendicularly and it should have high enough reflectivity.

1.2 Power and beam width

The power in the ultrasonic waves reduces exponentially with distance in the medium it travels. We used 40 kHz ultrasonic because of the easy availability of the corresponding transducers.
Secondly, the beam width of typical ultrasonic sources is high, so that the waves diffuse in space. These two considerations greatly limit the range achievable by ultrasonic methods. We can do our best by transmitting pulses of high power, so that even after attenuation the signal is strong enough for detection. This would mean the use of a good drive circuit for the transducer.
To avoid the beam from spreading, we can enclose the transmitter and receiver in a sound absorbing material.

1.3 Resonance of transducer

The transducer resonates at 40khz.(It has a narrow bandwidth of about 4khz centered at 40kHz).The transmitted signal must hence be a pulse train of 40kHz, consisting of enough cycles to allow the transients to die down.

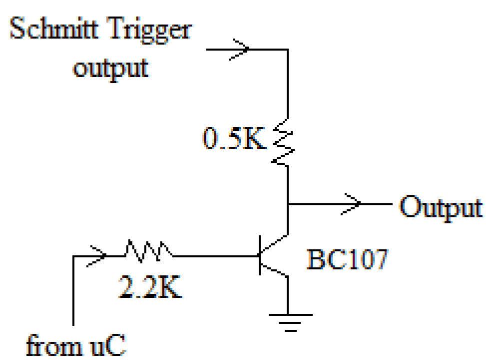
Two Design approaches were tried to transmit a train of 40Khz pulses

Design A

The very narrow bandwidth of the transducer requires us to generate 40 kHz pulse train of adequate number of cycles accurately and reliably. Rather than generating this pulse using hardware, for example by using the 555 timer, we would like to generate this pulse train using a microcontroller (software).Since it operates from a crystal, the microcontroller is accurate and reliable. In this case micro controller will generate pulses by setting a particular bit high and low. After generating fixed number of pulses, it waits for some time and then again re-transmits the pulses.

Design B

Using a Schmidt trigger to generate pulses of 40 khz and controlling it using a micro controller. Schmidt trigger continuously generates pulses of 40Khz frequency. But since we need bursts of such pulses at regular intervals, we made a switch using BJT and connected the microcontroller's terminal to its base.



BJT Switch which controls the pulses generated by Schmitt Trigger

Detection

Received signal is very low in amplitude. So, an amplifier circuit is used to amplify the received signal. Because of the resonance, the receiver must give a voltage of frequency 40 kHz across its terminals. But a lot of other noisy waveforms were also detected. For example when the transmitter was idle, some high frequency noise (in MHz) was detected at the receiver terminals. Also some noise in 80-90 KHz range was present when the receiver was operating. Since we need to detect the 40 kHz waveform, we must be frequency selective in our detection, and not send out false detections coming from the noisy range to the measuring circuit. For this a tone decoder is used which was tuned to detect signal in the frequency range 38-42 Khz.

Polling mechnaism in Design A: After sending a train of 40Khz pulses, microcontroller will wait for some time so as not to detect the transmitted signal and then polling will start so as to detect refected pulses. Duration of this polling is set in such a way that signal is detected only if the obstacle is in the range of 1m.

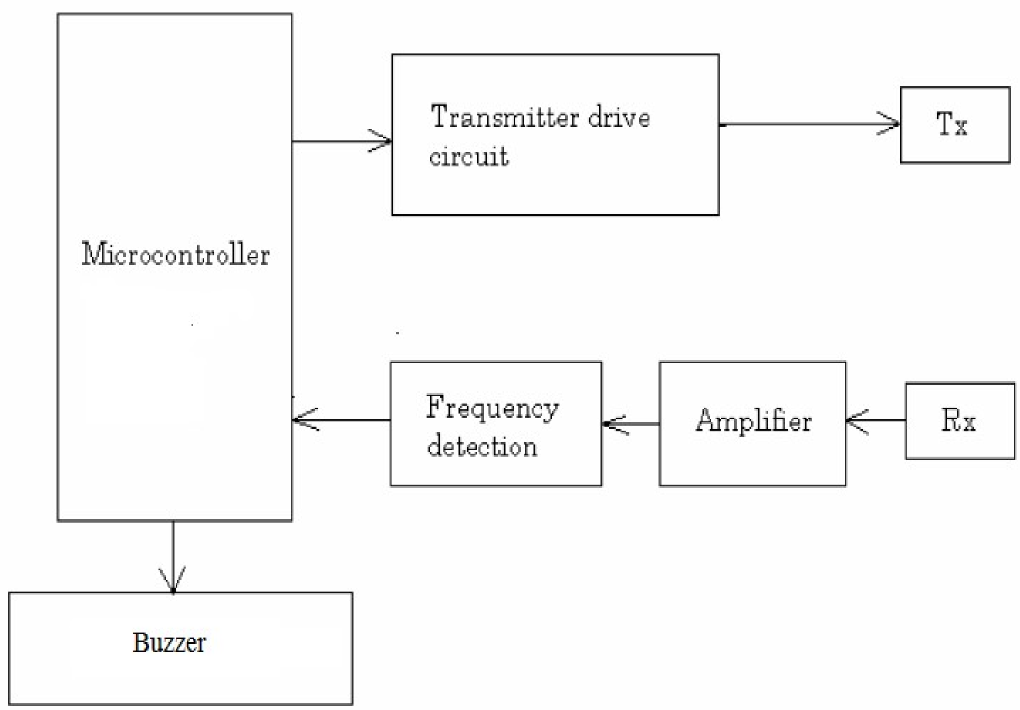
Polling Mechanism in case of Design B: In this case, in order to reduce the flicker just due to reception of pulses just for a moment, micro controller will poll the output of tone detection for a fixed duration. If output of tone detector is low for this full duration, then only it will sound the buzzer.
And if it is high even once the counter will reset and the buzzer wont sound.

1.5 Atmospheric Influences
The velocity of sound is dependent on temperature. The variation is about 1% every 6° C around 20° C. Whether this is a critical problem or not depends on the accuracy the device achieves. For accurate measurements, or if the device requires to operate under diverse environments with similar results, then this must be taken into consideration. If not, it must be possible to include this later without too much change in the design and the components.

1.6 Hardware and Software
Considering all the issues, the hardware should consist of
1. The drive circuit and
2. The circuit for detecting the 40kHz received wave

And the software consists of
1. Generation of pulses
2 .Detection of received signal and sounding of buzzer.

Block Diagram: Design A

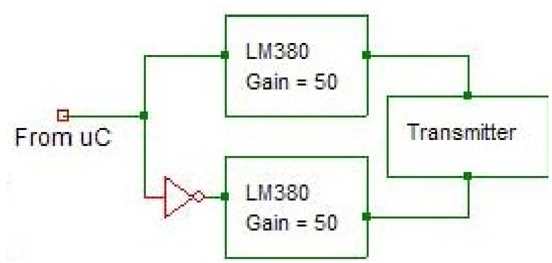


Circuit Design:

Choice of Components:
Design A:
Transmitter:

Micro Controller: In order to generate a 40 kHz pulse train, the microcontroller needs to act (say toggle a port pin) every 12.5 µs. Hence a microcontroller with speed and instructions adequate enough to switch every 12.5 µs had to be chosen. These requirements are satisfied by 89c51. It has an instruction speed of 250 ns, which is adequate to generate 40 KHz.

Drive Circuit:
The 40 kHz waveform is generated by the microcontroller. This cannot be given directly to the transducer because then the current being less, we wouldn't give enough power to the transducer. We need to use a power amplifier to drive the transducer.
Since 40 kHz is just outside the range of audio frequency, we can use an audio power amplifier to drive the ultrasonic transducer. We chose LM380 audio power amplifier. To quadruple the power given to the transducer two LM380 audio power amplifiers have been used in bridge configuration.



Amplifier at the Detector:
Because 40kz is near audio, an audio amplifier can be used at the receiver. We are using an LM386 audio amplifier. The gain of the amplifier is set to be 100.A gain of 100 is sufficient as the tone decoder detects signals as small as 0.1 V.

Detection of the 40 KHz waveform:
We need to look for the narrow band of signals in 38-42 KHz range. If any signal is detected in this band, the microcontroller needs to be reported to. A tone decoder is ideally suited for this. Its detection bandwidth is 10-20% of center frequency (which would be set to 40 KHz).There is no need for a rectifier (which would be required, for example if we use a notch pass filter).The microcontroller only needs to monitor the logic level of the tone detector output. We have used an LM 567 tone decoder.

a) Amplification:

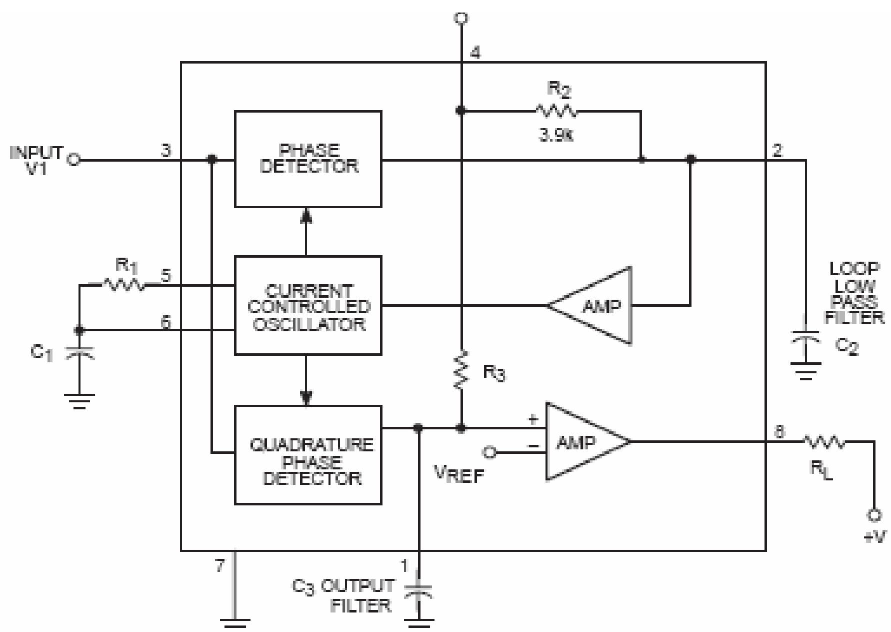
First the sensor's output goes through the amplifier block which is a 2-stage opamp circuit. Because 40kz is near audio, an audio amplifier can be used at the receiver. We are using an LM358 audio amplifier. The overall gain of the amplifier is set to 200.

b) Detection:

We need to look for the narrow band of signals in 38-42 KHz range. If any signal is detected in this band, the microcontroller needs to be reported to. A tone detector is ideally suited for this. Its detection bandwidth is 10-20% of center frequency (which would be set to 40 KHz).There is no need for a rectifier (which would be required, for example if we use a notch pass filter).The microcontroller only needs to monitor the logic level of the tone detector output. We have used an LM 567 tone decoder. Hence the amplified signal goes into the tone decoder whose output goes low when its input falls in its passband range which is 37kHz-42kHz.

Tone decoder settings:
The LM567 being an important component of the receiver circuitry, we put down the components used in the LM567.

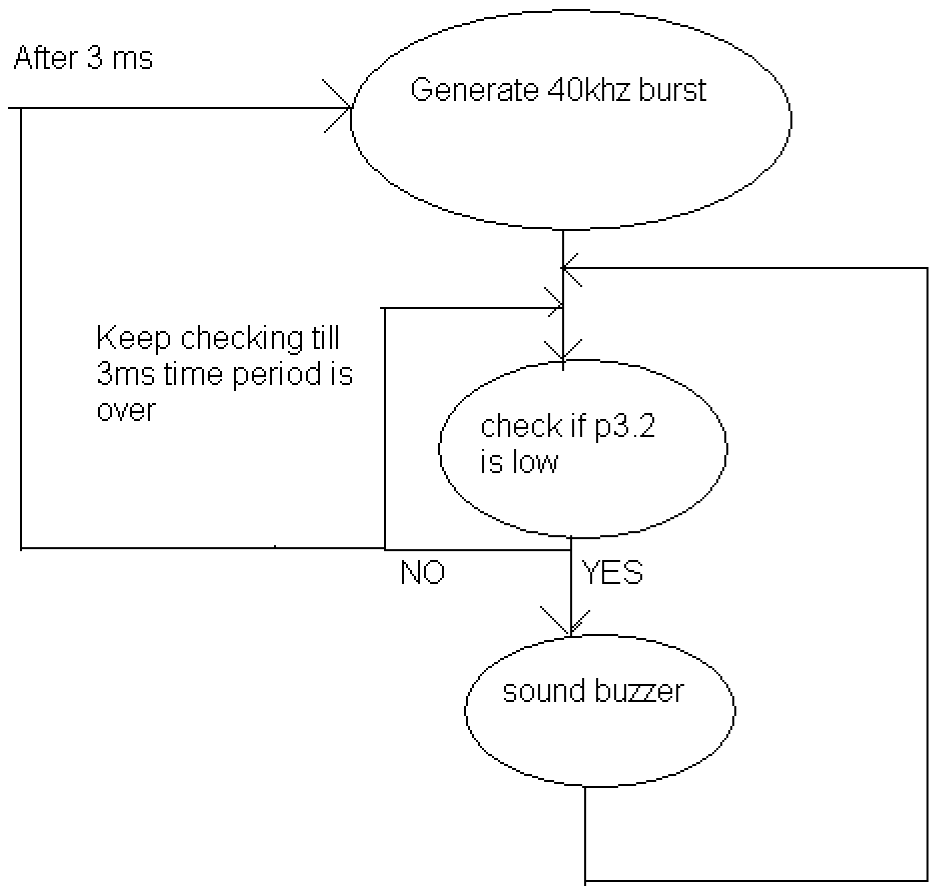
The circuit diagram of this is given:



The block diagram of LM567 tone decoder

a) R1 and C1 have been selected to be 2.53k and 10nF for the desired center frequency of 40 kHz.
b) The loop filter C2 would decide the detection bandwidth, and more importantly, the speed of operation. For the optimum speed, a value of 3.3nF has been chosen.
c) The output filter C3 (to avoid out of band transitions) has been chosen to be 10nF.Smaller values were required to speed up the turn on time.

d) In order to decrease the sensitivity of the output stage, a resistor (100k) has been introduced from pin 1 to pin 4 (reference no 4).



DESIGN A CODE FLOW CHART

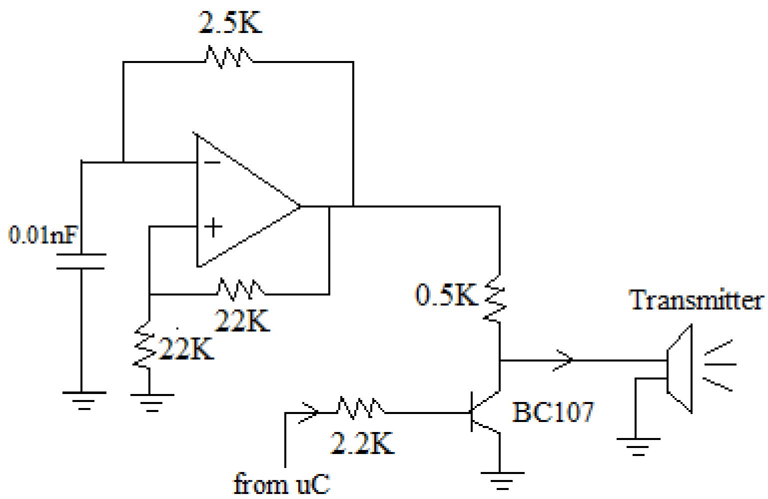
Design B:

Schmidt Trigger: We choose appropriate values of Resistors and capacitances in order to generate pulses of 40khz. Circuit diagram and calculations are given below.

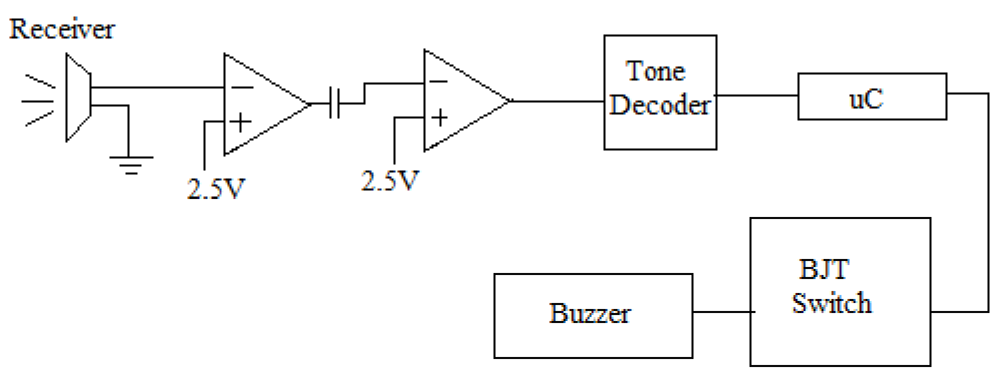
freq = 1.1*R*C= 40*1000 which gives R= 2.5K, C = 0.01nF

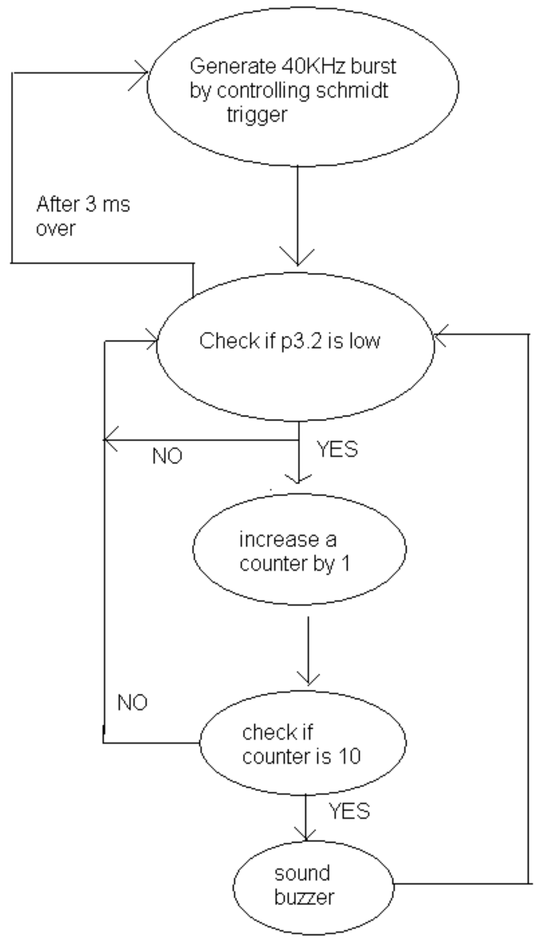
Switch: Since we need only burst of pulses at different times we have to use a switch which was made using a BJT and latter being controlled with micro controller.

Circuit Diagram:



Receiver Side: Same as Design A





Design B code Flow Chart

Explanation of Micro Controller code:

Design A:
Connections: A train of pulses (40khz) is generated by toggling the bit p3.1 at the frequency of 40khz. Output of the tone decoder is checked at p3.2 and if it is low, output to the buzzer is send from p3.3

Software: It generates a train of 70 pulses and then wait for some time before starting polling for the received signal. Now the polling is done for that much duration so that only pulses reflected from obstacles in the range of 1m are detected.

Design B:
Connections: Input from the micro controller and Schmidt trigger is given to BJT. Output of BJT is given to transmit and received signal goes to tone decoder after being amplified. The output of the tone decoder also goes to micro controller and if it is low , signal to buzzer is also given from micro controller.

Software:
To generate a burst of 40, 40kHz pulses, micro controller sets the control signal to BJT switch high for a period of 1000 micro seconds. After that it starts polling the output of Tone Decoder and sounds the Buzzer in the case when output is low. After the obstacle is detected in the polling duration or if the time is out, it will restart the process.

Test Procedure:
The receiver and transmitter were mounted on a general purpose board. They were padded with cotton so as to avoid any interference.
To test the circuit we took an obstacle and brought it in front of the transducer pair and check for any sound that the buzzer is producing.

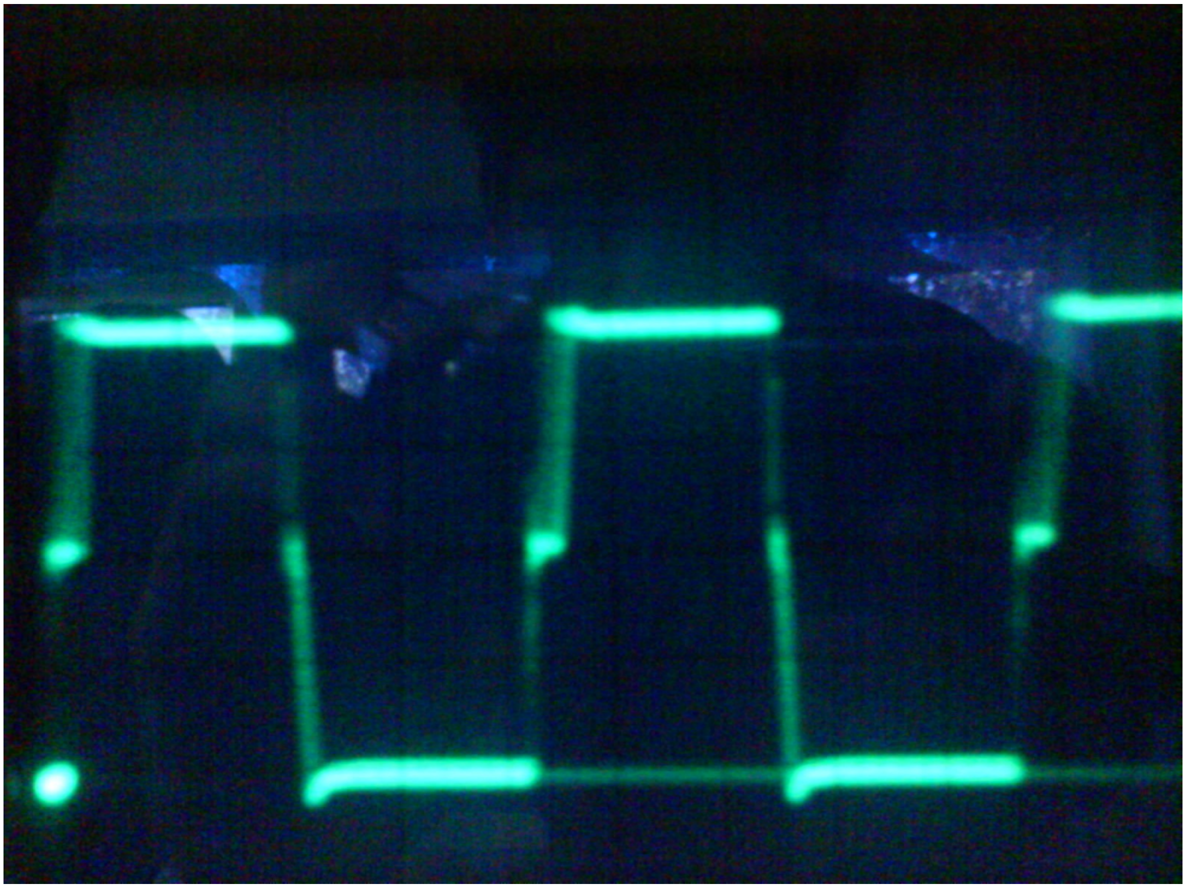
Test Results and Conclusions:

Design A:
When the circuit was tested on Bread Board that is Micro Controller giving Signal to NAND gate and then bridge amplifier, output at the receiver was very much distorted. Even after passing the output through a filter, it was not good. So the possible reason may be that power supplied by micro controller is not enough. But since we are using power amplifiers, it adds up to the noise. Now if signal to NAND gate is given from a signal generator, output is very good and is detected at the receiver end even for very low input. So the possible reason may be very less slew rate of Micro Controller as compared to Signal Generator.

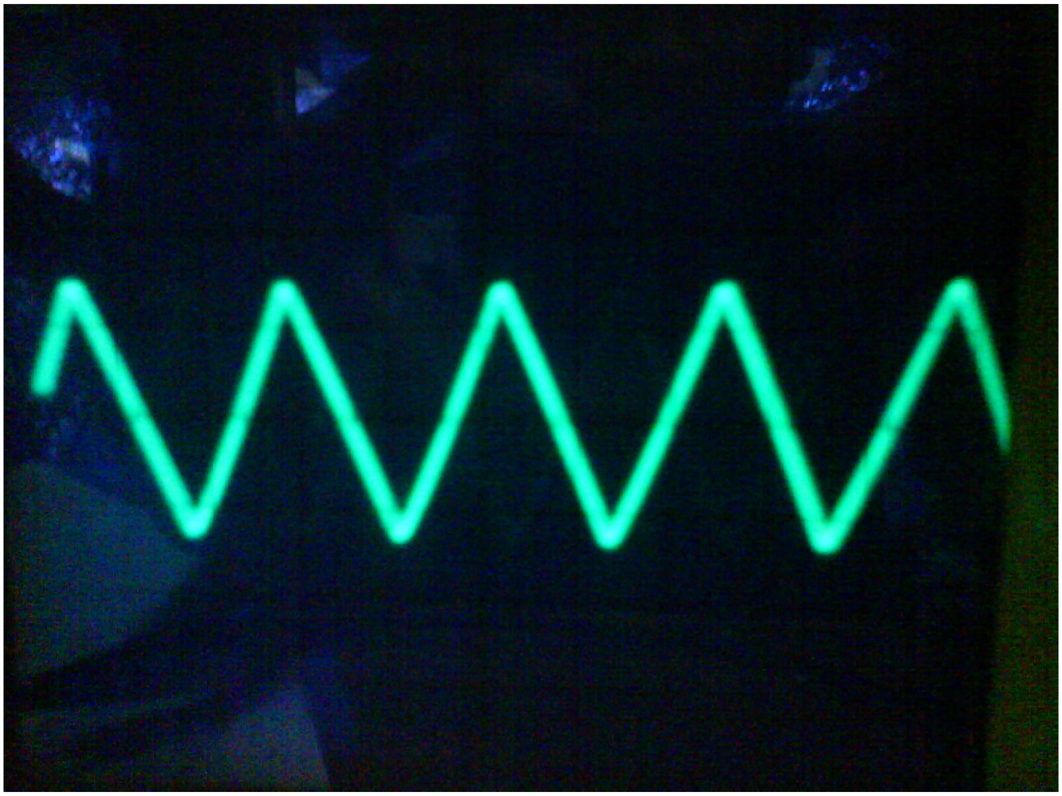
At the receiver, good signal is detected if the transmitter works properly that is the transmitter is driven by signal generator.

Conclusions: A micro controller with more driving capability should have been chosen.

The output waveform of the power amplifier is:



Design B:
We face the same problem in this case too, the microcontroller is not able to provide enough current for the BJT. So we put a NAND gate in between and use it as a NOT gate.
It does successfully control the output of the Schmidt trigger, but in the process the voltage falls a little and the range of the transducer greatly reduces.
Still this design was more successful and we could demonstrate the working of the project though for a very short range of about 60cm.



The output waveform of the Schmitt Trigger is:

The waveform on receiver terminals is: