

DESIGN AND CONSTRUCTION OF AN AUDIENCE RESPONSE SYSTEM

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DEDICATION


This project is dedicated to my beloved parents late Alhaji Dauda Usman and Hajiya Hadiza Dauda Usman and also to my dear husband Mallam Alhassan Hussein and finally to my precious baby, Amatulah Hannan.

DECLARATION

I Usman Mairo declare that this work was done by me and to the best of my knowledge has never been presented elsewhere for the award of a degree. I also hereby relinquish the copyright to the Federal University of Technology Minna

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ABSTRACT

In this project we constructed a device that will enable easier means of question and answer session between students and lecturers in lecture hall. This is achieved by the student transmitting to the lecturer when seeking his attention, and the lecturer transmitting back, giving him a go ahead. This is due to the fact that question and answer sessions tends to be rowdy when other means like raising or waving of hands, clapping, whistling e.t.c are employed thereby distracting the attention of the other students. This device enables the smooth running of lectures/discussion by reducing the distraction caused by hand raising. This device transmit at a frequency of 100KHz and 200KHz while it receives at 1KHz and 50KHz respectively using infrared (IR) techniques. A prototype was built and tested within an IR range of four meter. The Audience Response System (ARS) is constructed in such a way that its base station can be suitably fixed on the lecturer's desk with its hand held pads made available to students during lectures. It is wireless and so is convenient to install and operate.

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CHAPTER ONE

INTRODUCTION

1.1 Preamble

Change they say is the only thing that is constant in life, and as humans, we need advancement in every aspect of our lives. Our contributions to the society we belong are most times fuelled by personal experiences complemented by the knowledge of a particular field of study.

The revitalization of undergraduates lecture environment by involving the students more in the lecture itself began several years ago. It is belief that lecture presentation in the classical way were ineffective. This was Largely due to the size of the classes, rarely fewer than forty students and in some cases as many as several hundreds. The financial problems in both private and public universities made it safe to predict that the class size problem would only get worse.[1]

Hewitt and Seymour studied the dropout rate among students and noted that this is about 50% across all disciplines.[1] Blame for this unfortunate loss of students was most often attributed to the large, impersonal lecture format rather than to the subject being taught. Reasons for the reluctance of students to respond in a large lecture were understandable. Ways of improving the lecture by actively involving the students more in the lecture itself were thought of.[2]

Recent articles by Hake and Poulis furnished data to support this approach and have established the value of modifying the passive lectures with interactive "engagement".

Although many suggestions and innovations have been proposed and tried, there had not been a solution to the large passive lectures proven to be successful, flexible and cost effective for a wide range of students than the "audience response system" [3],[2]

The audience response system was first tried out as an interactive educational tool at the Illinois institute of Technology (IIT) eleven years ago to enhance the participation of students in their physics lectures. They used a commercial 2-way wireless (RF) keypad that the students can hold in their hand and enter responses upon request during lectures. The responses are picked up by an RF receiver and input to a personal computer program. Results appear within seconds by a projecting a histogram of the class responses which were saved on spread sheets for grading purposes.[4]

A typical audience response system is comprised of the following components.

- Base station
- Wireless keypads (one for each participant)
- Audience response system software

The merits of using the audience response system can't be over emphasized, as it makes students alert with their minds on the lecture. In effect, attendance and attention can be monitored using this system. This enables the lecturer to extend, repeat or modify previous lecture topic discussions. Questions that could be answered by "yes/no" or multiple choice were woven into the lecture.

It also test students if they actually read the text before the lecture as good preparation prior to lectures has produced improved students performances [4]

Being wireless gives the system a great amount of flexibility, portability, functionality and mobility. Using wireless keypads instead of a show of hands allows a smooth running of the class without distracting the attention of both the lecturer and students [5]

It has changed the one-way interaction between lecturers and students as it enables the lecturer to know the effectiveness of the lecture as well as livening up the lecture environment.

When incorporated with a projector device driven by a computer software, the responsesystem can be used for research purposes, polling votes, quiz competition, group interviews and lots more.

1.2 Objective

The main objective of this project is to construct a device aimed at providing a response system to aid interaction between students and lecturers in the lecture

1.3 Methodology

This project is carried out by first conceptualizing the idea, then constructing the device block by block, ensuring that each block has operated as conceived before proceeding to the next block. Most of the references of this project are from the Internet due to its nature though many books and articles were also consulted, but notably, some individuals that are specialized in electronics were contacted for advice and correction in some instances.

CHAPTER TWO

LITERATURE REVIEW / THEORETICAL BACKGROUND

2.1 Literature Review

In general, any device or process that elicits feedback from a targeted audience can be considered an audience response system. This might include paper and pencil questionnaires, raised hands or even air horns and lit matches [6].

Since the 1960's, a number of companies have offered audience/personal response systems, several of whom are now defunct or changed their business model.

Circa 1966, Audience Studies Institute (ASI) of Hollywood, California developed a proprietary analog ARS system for evaluating the response of a theater audience to unreleased motion pictures, television shows and commercials. This early ARS was used by ASI's clients to evaluate the effectiveness of whatever it was they wanted to accomplish.

ASI would give out free tickets on the street to bring people into the theatre called the "Preview House", for particular showings where each attendee would fill out a questionnaire and then be placed in a seat with a "dial" handset outfitted with a single knob that each attendee would turn to a position to indicate his or her level of interest, turning the knob all the way left for "dull" to turning all the way to right for "great". ASI upgraded their system in 1976 to become fully digital, have Yes/No buttons and in some cases numeric keys for entering in numbers, choices and monetary amount.

The technologies employed for the transmission of data from the keypads to the base stations includes, Radio Frequency(RF), Infra-Red(IR) and browser-based software.

Radio frequency (RF): Ideal for large group environments as it does not require line of sight to operate and can accommodate hundreds of people on a single base station. This is because the data transmitted travels via radio frequency and as such, participants only need to be within the range of the base station (300-500 feet). Due to cost and complexity, its usage has been limited.

Infra-red (IR): IR audience response systems are better suited for smaller groups. It requires line-of-sight between the keypads and the base station. They are typically more portable and affordable than RF systems.

Browser-Based: Browser-based audience response systems are still in their early stages of development. They are software-only systems, intended to work with the participant's existing wireless devices, such as cell phones, laptops, notebook computers, or PDA.

Because browser-based routes data via an IP address, proximity to a base station is avoided. It was designed to be easy to use, to be standard compliant, but not cost-effective[7].

The aim of this project is to improve on the infra-red (IR) audience response system by adding a feedback from the base station back to the participant's keypad, hence making the infra-red ARS a two-way communication system, which is an advancement over its traditional one-way feature.

Although the projector driven by a software program has been excluded from this project, its base station has been modified into a transceiver rather than just a transmitter.

2.2 Theoretical Background

The purpose of the Audience Response System is to create a device that aids in

question/ answer session in the classrooms. To achieve this, wireless communication techniques were employed by using a 2-way infrared (IR) transmission unit.

The photodiode whose resistance is low when it senses infra-red rays, is Connected to the non-inverting input of the comparator while the inverting input is biased to give a low output when it(photodiode) senses the infra-red rays

The output of the comparator is fed to the input of a 567tone decoder which gives a low output when the frequency at its input equals the frequency of its voltage controlled oscillator (VCO). The frequency of the VCO is set to 1KHz for the first transceiver and 30KHz for the second transceiver.

The output of the tone detector is fed to the clock input of a 7474 D-type flip flop which lights an LED indicating that transmission has taken place. The LED remains on until the flip flop is reset.

The system which has an alternative power supply has a supply voltage of +9 V dc is used to power the circuit.

For simplicity and better understanding, this project is grouped into four stages They are;

- Power Supply unit
- Frequency Generator
- Transmitter stage
- Receiver stage

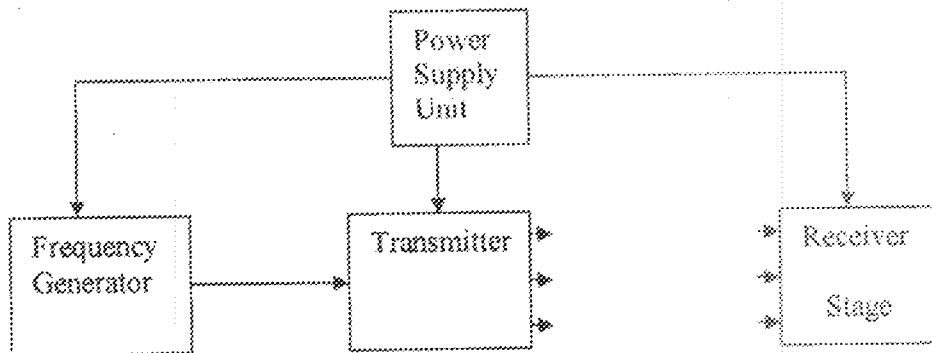


Fig 2.1 Block Diagram Of An Audience Response System (ARS)

2.2.1 Power supply unit

The power supply needed for this device is 9 volts. This is meant to supply power to the other stages of the device.

2.2.2 Frequency Generator

This generates the frequency of transmission. It comprises of a 555 timer IC configured in the astable mode. All IC timers rely upon an external capacitor to determine the off-on time intervals of the output pulses [15]. As we can recall from our study of basic electronics, it takes a finite period of time for a capacitor (C) to charge or discharge through a resistor(R). Those times are clearly defined and can be calculated given the values of resistance and capacitance. Below is the pin configuration of the 555 timer IC.

- 1. Ground
- 2. Trigger
- 3. Output
- 4. Reset
- 5. Control Voltage
- 6. Threshold
- 7. Discharge
- 8. Vcc (+)

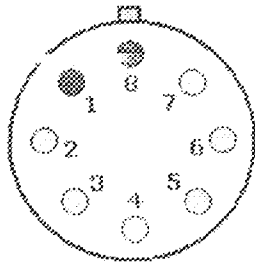


fig. 1. 9-pin T package

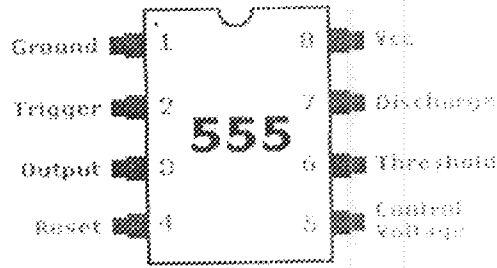


fig. 2. 8-pin V package

Fig 2.2 Pin Configuration Of 555 Timer IC

Both the trigger and threshold inputs (pins 2 and 6) of the two comparators are connected together and then to the external capacitor. The capacitor charges toward the supply voltage through the two resistors, R1 and R2. The discharge pin (7) connected to the internal transistor is connected to the junction of those two resistors. Assuming the capacitor is initially discharge, both the trigger and threshold inputs will be near zero volts when the switch is closed. The lower comparator sets the control flip-flop causing the output to switch high, turning off transistor T1 hence the capacitor begins to charge through resistors R1 and R2. The voltage across the capacitor rises from zero to the value of the applied DC voltage. When the charge on the capacitor reaches $\frac{2}{3}$ of the supply voltage, the upper comparator will trigger causing the flip-flop to reset. This causes the output to switch low thereby causing Transistor T1 to conducts. As T1 conducts, R2 is connected across the external capacitor and the capacitor starts to discharge through it. When the voltage across the capacitor reaches $\frac{1}{3}$ of the supply voltage, the lower comparator is triggered, causing the control flip-flop to set and the output to go high. Once the output is high, Transistor T1 cuts off and the capacitor begins to charge. This process continues with the capacitor alternating between charging

and discharging, causing the output to be a continuous stream of symmetrical rectangular pulses.

The frequency of operation of the astable circuit is dependent upon the values of R1, R2, and C. The frequency can be calculated with the formula:

$$F = 1.44 / (R1 + 2R2)C$$

The time intervals for the on and off portions of the output depend upon the values of R1 and R2.

2.2.3 Transmitter

An infrared emitter (LED) was used for transmission. This LED is a junction diode made from semiconductor material, gallium arsenide phosphide. Its action and type of rays is dependent on the type of semi conductor doping used. [9]

When furnished with appropriate voltage and current (which could be gotten from data sheets), the infrared emitter emits infrared rays at a given wavelength. Once, forward biased the transmitter emits infrared rays projected at an angle of about 60° from the current surface[9].

2.2.4 Receiver Stage

The receiver stage comprises of a photodiode, a voltage comparator, a phase lock loop and a flip-flop.

The photodiode is used to sense the infrared rays, its resistance decreases as it senses the infrared rays. It is made up of a normal P-N junction with a transparent window through which light can enter. It is usually operated in the reverse bias mode and

leakage current tends to increase in proportion to the amount of light falling on the junction.

The photodiode is connected to the non-inverting input of the comparator while the inverting input is biased to give a low output when it (photodiode) senses the infra-red rays.

Basically, a comparator is a differential operational amplifier without a feedback. Hence it is controlled by the open loop voltage gain [10]. It has 2 inputs, the inverting input and the non-inverting input. If the output of the non-inverting input is greater than the inverting input, the output is high else it is low. The output of the comparator is fed to the input of a phase lock loop.

A phase lock loop (PLL) is a closed loop frequency control system, which functioning is based on the phase sensitive detection of phase difference between the input and output signals of the controlled oscillator (CO). It contains a phase detector, amplifier, and VCO. The phase detector compares the two input frequencies, generating an output that is a measure of their phase difference. If f_{IN} doesn't equal f_{VCO} the phase-error signal, after being filtered and amplified, causes the VCO frequency to deviate in the direction of f_{IN} . If the conditions are right, the VCO will quickly lock to f_{IN} maintaining a fixed relationship with the input signal [17].

The output of the PLL is fed to the clock input of a 7474 D-type flip flop which lights an LED indicating that transmission has taken place. The LED remains on until the flip flop is reset.

CHAPTER THREE

DESIGN AND IMPLEMENTATIONS

3.1 Design Specification

Input voltage:	220V ac mains
Supply voltage:	+9 V dc
Infra-red range:	4 M (approx)

3.2 Power supply unit.

The power supply unit (PSU) is meant to provide electrical power to every other unit in the system. It is a linear type that comprises of the following:-

- Transformer
- Rectifier Diodes
- Voltage Regulators
- Filter Capacitor

Hence $dv = (20/100) \times 15.56V$

$$dv = 3.11V$$

And

$$dt = \frac{1}{2} T$$

$$dt = \frac{1}{2} \times \frac{1}{F} \quad \text{where frequency } F = 50$$

$$dt = \frac{1}{2} \times \frac{1}{50}$$

$$dt = 0.01s$$

$$C = I dt/dv$$

$$C = 1 \times (0.01/3.11)$$

$$C = 3.215 \times 10^{-3} F$$

$$C = 3215\mu F$$

A preferred value of 3.300 μ f was employed for the power supply unit.

3.2.5 Alternative power supply

It comprises of an electro-magnetic relay which is used for automatic switching between power from the mains and the back-up battery.

Power from the mains is connected to the normally open terminal (NO) while the battery is connected to the normally closed terminal (NC). In the case of power outage, the NC terminal energizes the coil which creates a magnetic field and attracts the common armature thereby closing the circuit thus current flows in the circuit.

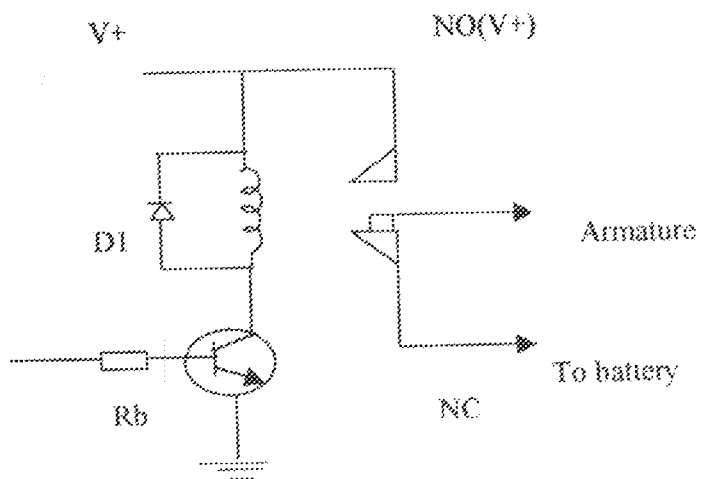


Fig 3.4 Circuit diagram of a relay switch

CALCULATIONS

From the circuit diagram,

$$V+ = I_c R_c + V_{CE}$$

$V_{CE} = 0$ since a transistor was used as a switch.

$$I_c = V+ / R_c$$

Where $R_c =$ coil resistance = 175Ω

$$V+ = \text{supply voltage} = 9\text{v}$$

$$I_c = 9\text{v} / 175\Omega$$

$$I_c = 0.00693\text{A}$$

From

$$h_{fe} = I_c / I_b$$

And $h_{fe} = 412$ for a BC337 transistor

$$I_b = I_c / h_{fe}$$

$$I_b = 0.00693 / 412$$

$$I_B = 1.682 \times 10^{-5} \text{ A}$$

From the formular

$$V_B = I_B R_B + V_{BE}$$

$$R_B = \frac{V_B - V_{BE}}{I_B}$$

$$V_{BE} = 0.6 \text{ v (diode voltage)}$$

$$R_B = \frac{9 - 0.6}{1.682 \times 10^{-5}}$$

$$R_B = 4.9 \times 10^5 \Omega$$

$$R_B = 490 \text{ K}\Omega$$

A preset value of $500 \text{ K}\Omega$ was employed.

3.3 Frequency Generator

A 555 timer IC configured in the astable mode was used to generate frequency.

The astable mode has no stable state, its output is continuously changing between "low"

and "high". For the frequency generated to be symmetric, $R_2 \gg R_1$.

For the transceiver transmitting at 100 KHz , using the formular

$$F = \frac{1.44}{(R_1 + 2R_2)C}$$

$$\text{Assuming } C = 0.1 \mu\text{F} = 100 \text{ nF}$$

$$R_1 = 1 \text{ K}\Omega$$

$$F = \frac{1.44}{(R_1 + 2R_2)C}$$

$$R_2 = \frac{1.44 - R_1}{2FC}$$

$$R_2 = \frac{1.44}{(2 \times 100 \times 0.1 \times 10^{-6})} = \frac{1 \times 10^3}{2}$$

$$R_2 = (72,000 - 500)$$

$$R_2 = 72K\Omega$$

A variable resistor of 100K Ω was used.

For the second pad transmitting at 200KHz

Assuming $R_1 = 1K\Omega$

$$C = 0.1\mu F$$

$$R_2 = ?$$

Using the formula

$$R_2 = \frac{1.44}{2FC} - \frac{R_1}{2}$$

$$R_2 = \frac{1.44}{(2 \times 200 \times 10^3 \times 0.1 \times 10^{-6})} - \frac{1 \times 10^3}{2}$$

$$R_2 = (36,000 - 500)\Omega$$

$$R_2 = 35,500\Omega$$

$$R_2 = 35.5K\Omega$$

A preset value of 47K Ω was used.

For the base station,

At 50 KHz

Assume $R_1 = 1K$

$$C = 0.1\mu F$$

$$R_2 = ?$$

$$R_2 = \frac{1.44}{2FC} - \frac{R_1}{2}$$

$$R_2 = \frac{1.44}{(2 \times 50 \times 0.1 \times 10^{-6})} - \frac{1000}{2}$$

$$R_2 = (144,000 - 500)\Omega$$

$$R_2 = 143,500\Omega$$

$$R_2 = 143.5K\Omega$$

A preset of 200K was used.

For 1Hz

Assume $R_1 = 1K$

$$C = 1\mu F$$

$$R_2 = ?$$

$$R_2 = \frac{1.44}{2FC} - \frac{R_1}{2}$$

$$R_2 = (720,000 - 500)$$

$$R_2 = 719,500\Omega$$

$$R_2 = 719.5K\Omega$$

A preset of 1M Ω was employed.

3.4 Transmitter

The transmitter is not too complex since no coding is involved. An infrared emitter was used to for transmission. The infrared is forward biased to meet the electrical conditions on which it operates. The typical 5mm LED emits infra red current of about 150mA at a voltage of about 1.7V. An infra-red transmitter is as shown below in fig 3.7

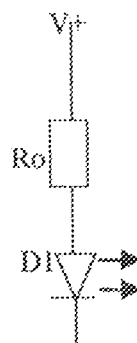


Fig 3.5 An infra-red emitter

DI is the infra red diode while Ro is the limiting resistor. V+ is gotten from the power supply.

CALCULATIONS

For the diode to be forward biased, $V_f = 1.7V$ ($V_f = \text{max forward voltage}$)

$I_f = 150mA$ ($I_f = \text{max forward current}$)

The resistor R is given as,

$$R_o = \frac{V_+ - V_f}{I_f}$$

$$R_o = \frac{5 - 1.7}{150mA}$$

$$R = 22\Omega$$

$$R = 22\Omega$$

3.5 Receiver Unit

The receiver is shown below in fig 3.8. It employs the use of a photodiode receiver, a voltage comparator, a phase lock loop and a dual flip flop.

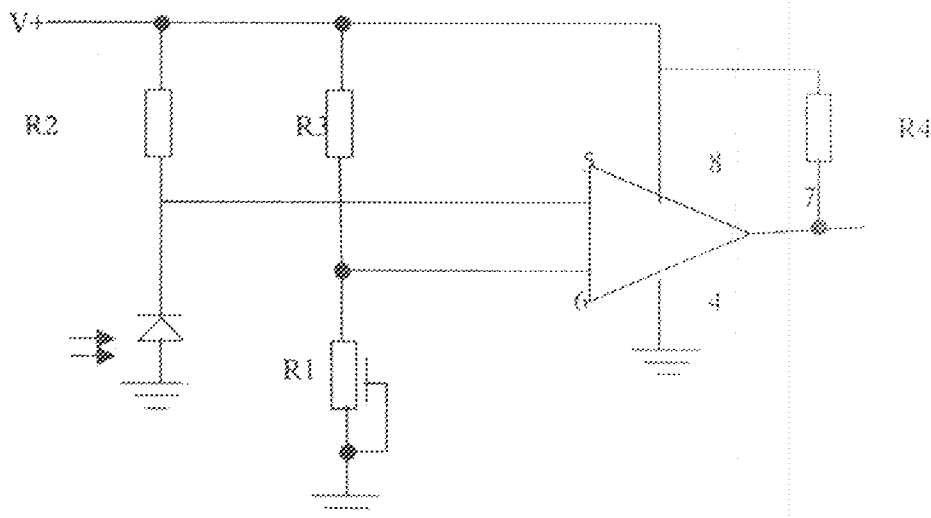


Fig 3.8 Circuit diagram the Receiver stage

3.5.1 Photo diode

The photo diode was used as the main opto sensor due to its ability to resist day light interference better than the other optical devices. It is operated in the reverse biased condition. In darkness the photodiode has a high resistance hence a low voltage [5]. The resistance measured from the photodiode when there is no transmission is approximately 1 M Ω . Fig 3.9 shows the potential divider network formed using the photodiode and the resistors R1 and R2

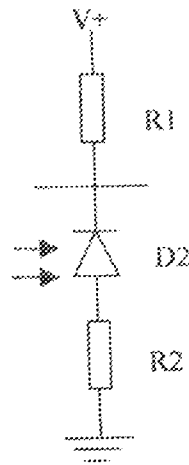


Fig 3.7 A Potential Divider Network

3.5.2 Voltage comparator

The photodiode is connected to the non-inverting input of the comparator while its inverting input is biased to give a low output when it senses the infra red rays. The LM 393 dual differential comparator was used. It consists of two independent precision voltages with an offset voltage specification as low as 2.0mV designed to operate from a single power supply over a wide range of voltages. Operation from dual supplies also is possible as long as the difference between the two supplies is 2V to 36 V, and Vcc is at least 1.5V more positive than the input common-mode voltage. Current drain is

independent of the supply voltage. The outputs can be connected to other open-collector outputs to achieve wired-AND relationship [20].

CALCULATION

For the non inverting input

R2 is set at 1M Ω (to allow an appreciable drop)

At $V^+ = 9V$, the drop across R2 will be

$$\frac{R2 \times V}{R1 + R2}$$

If V_{R2} is the drop across R2

$$V_{R2} = \frac{1M\Omega \times 9V}{1M\Omega + 1M\Omega}$$

$$V_{R2} = 9/2$$

$$V_{R2} = 4.5V$$

R4 is a resistor of 1K Ω whose resistance is required from the data sheet because the output is an open collector output. Hence R1 is preferred to as the resistance of the diode.

For the inverting input,

Assuming $V = 3v$, by voltage divider

$$V = \frac{R1 \times 9v}{R1 + 1K}$$

$$3v = \frac{R1 \times 9v}{R1 + 1K}$$

$$9R1 = 3R1 + 3K$$

$$3K = 6R1$$

$$R1 = 500\Omega$$

A preset value of 10K was used. This is to allow variation of resistance, which will give room for sensitivity of range.

3.5.3 Phase lock loop

The phase lock loop(PLL) used is 567 tone decoder. It is a highly stable phase lock loop with synchronous AM lock detection and power output circuitry. Its primary function is to drive a load whenever a sustained frequency within its detection band is present at the self-biased input. The bandwidth, center frequency and output delay are independently determined by means of external components. The center frequency of the VCO is set by a timing capacitor C_t and timing resistor R_t . [11][16].

$$f_o = 1/(1.1R_tC_t)$$

The output of the comparator is fed to the input of the tone decoder which gives a low output when the frequency at its input equals the frequency of its voltage controlled oscillator (VCO). The frequency of the VCO is set to 1KHz for the first pad and 50KHz for the second pad.

CALCULATIONS

From the formular

$$F = 1/(1.1 RC)$$

For 1KHz, assume $C = 1\mu F$

$$F = 1/(1.1 RC)$$

$$R = 1/(1.1 FC)$$

$$R = 1/(1.1 \times 1000 \times 1 \times 10^{-6})$$

$$R = 10^6 / 1100$$

$$R = 909.0909091\Omega$$

$$R = 909.1K\Omega$$

A preferred value of $1M\Omega$ (variable resistor) was used.

For the detection bandwidth, using the formular

$$BW = 1070V_1 / f_0C_2$$

Where f_0 = center frequency

C_2 = low pass filter capacitor (μF)

V_1 = input voltage (V_{rms})

At a bandwidth of 50%,

$$0.5 = \frac{1070 \times 9}{1 \times C_2}$$

$$C_2 = 9630 / 0.5$$

$$C_2 = 19260F$$

$$C_2 = 0.019\mu F$$

$$C_2 = 0.02\mu F.$$

For 50 KHz, assume $C = 1\mu F$

$$F = 1 / (1.1RC)$$

$$R = 1 / (1.1FC)$$

$$R = 1 / (1.1 \times 50,000 \times 10^{-6})$$

$$R = 10^6 / 55,000$$

$$R = 18.18182\Omega$$

$$R = 18.2\Omega$$

A preset of 1K was used.

3.5.4 D-type flip-flop

The 7474 dual D-type flip-flop was employed because of its features. The set and reset are asynchronous active LOW inputs and operates independently of the clock input. Information on the data (D) input is transferred to the complementary Q output on the LOW-to-HIGH transition of the clock pulse. The D input must be stable one setup time prior to the LOW-to-HIGH clock input for predictable operation. Although the clock

It is level sensitive, the positive transition of the clock pulse between the 0.8v and 1.0v levels should be equal to or less than the clock to output delay time for reliable operation. [19] The output of the tone decoder is fed to the clock input of the flip flop.

6 Other passive components

Passive components are components, which cannot amplify power but require an external power source to operate. They include resistors, capacitors, inductors, transformers e.t.c. their application ranges from potential divider to control of current (as in resistors) filtration of ripple voltages and blocking of unwanted D.C voltages (as in capacitors) They form the elements of network circuit and are also used generally for signal conditioning in circuits. Their schematic diagrams and symbols are shown in fig 3.8 below:

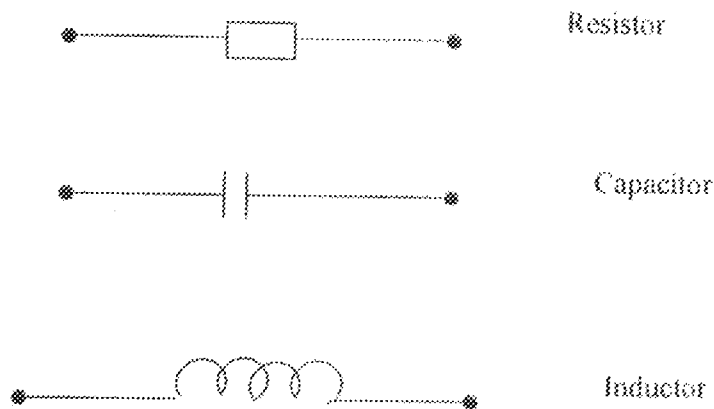
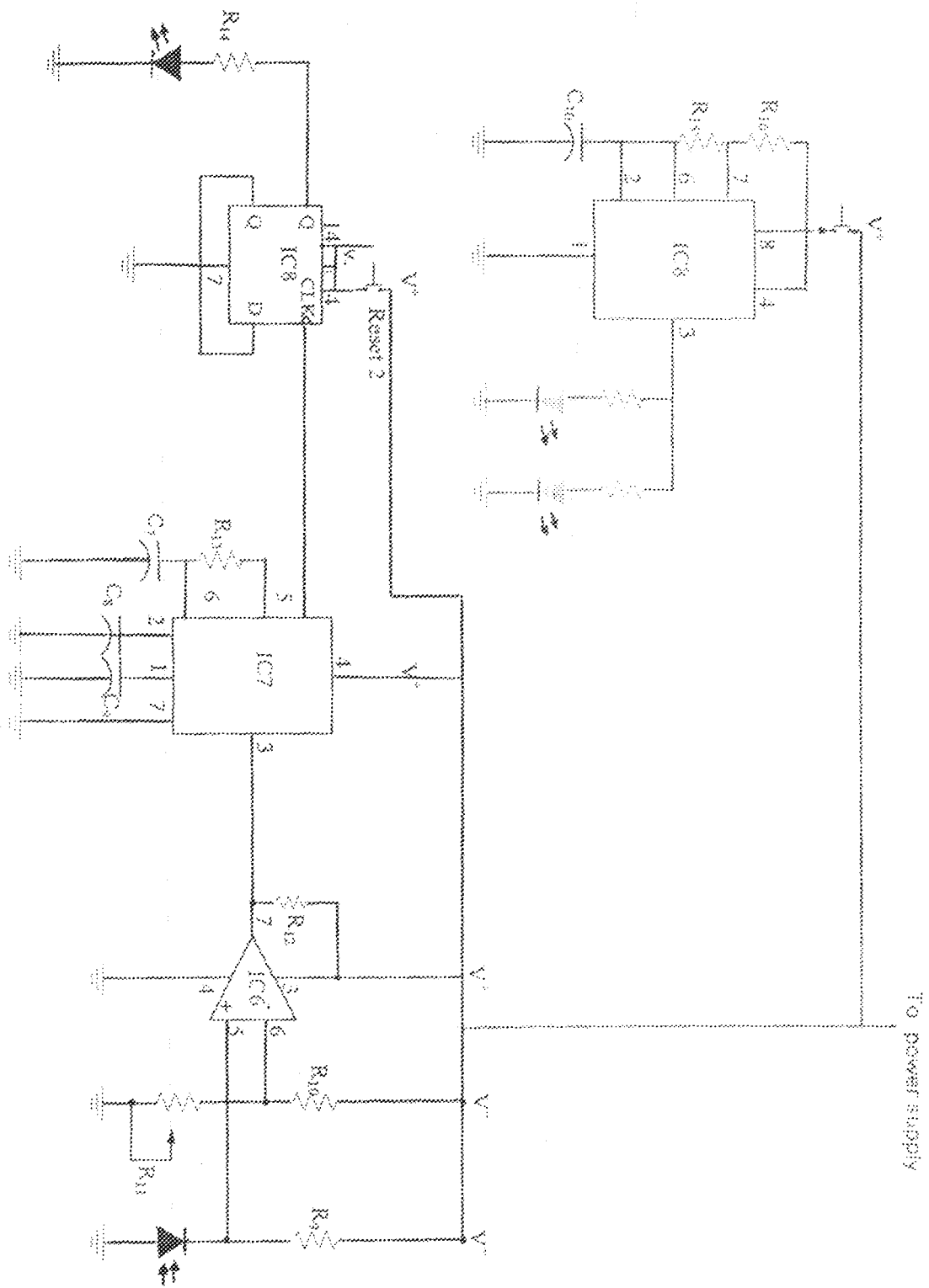


Fig 3.8 Schematics of passive component



TRANSCIEVER 2

CHAPTER FOUR

TESTS, RESULTS AND DISCUSSION

Physical realization of this device is vital as it is were the fantasy of the whole idea meets reality. After carrying out all the paper design and analysis, series of tests were made during the assembly of this device. This led to numerous changes being made to the initial design to ensure that it operates optimally. These include testing all the components before making use of them, measuring the outputs of the various blocks and adjusting the variable resistors to meet design specifications. Below are the results obtained after the series of tests were carried out.

• Power supply unit

220 volts from the mains was supplied from the mains as input and an output of 9.24 was gotten. This was before load was added, with the addition of load, it dropped to 9 volts.

• Frequency generator

The input voltage to the 555 timer IC was very low, approximately zero. Its output is a stream of symmetrical pulses after every 5 second at a frequencies of 1KHz, 50KHz, 100KHz and 200KHz

• Transmitter

The problem of the infrared emitter not emitting infrared rays for a long distant was encountered. Increasing the frequency range from hertz to kilohertz solved this problem as it increased the range from one meter to approximately 4 meter

• Receiver

The resistance measured from the photodiode when there was no transmission was

approximately 1 mega ohms which reduced to about 500 ohms on reception of infrared rays. During test, the input signal to the tone detector did not give the desired output i.e. that F_{in} was not equal to F_{out} indicating the presence of unwanted signal. This was overcome by placing a $1K\Omega$ resistor at its input to eliminate the unwanted voltage. As a result of the unwanted signals, the clock input of the flip-flop was not stable. This was solved by clamping the clock with a rectifying diode, which stopped the clock from oscillating since it conducts in one direction.

Radio interference and noise were experienced. This was solved by making adjustments to the bandwidth capacitor which is used to control the output of the tone detector. During test, the LED kept blinking on and off incessantly due to the infrared responding to white light. This was solved by placing the photodiode in a small rubber plastic and covering it with insulating tape so that light from the environment does not affect it.

CHAPTER FIVE

CONCLUSIONS/RECOMMENDATION

5.1 Conclusion

This project which is the design and construction of an Audience Response System (ARS), was designed considering some factors such as economy, availability of components and research materials, efficiency, compatibility, portability and also durability. The performance of the project after test met design specifications.

The general operation of the project is such that the transmitter and the receiver has to be in line of sight. The construction was done in such a way that it makes maintenance and repairs an easy task and affordable for the user should there be any system breakdown.

However, like every aspect of engineering, there is room for improvement and further research on the project.

5.2 Recommendation

I would recommend that further work be done on the following areas:

1. Radio Frequency (RF) module should be used which has the capacity of covering a wide range (300-500 feet) unlike IR which is limited to line of sight.
2. A projector driven by a computer software should be incorporated so that multiple choice questions can be woven into the lecture material with the audience being able to view responses.

3. Multiple base stations could also be used as this has the effect of increasing the infrared range

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