A

Project Report

On

TELEPHONE INTERCOM SYSTEM

By

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Under the guidance of

Prof. Mrs. S. D. Kale

In partial fulfilment of
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CERTIFICATE

This is to certify that during the academic year 2012-2013, following students of T.E. E&TC class have successfully completed the project entitled

'TELEPHONE INTERCOM SYSTEM'

Towards the partial fulfilment of the degree of Bachelor of Electronics and Telecommunication Engineering awarded by Pune University.

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ACKNOWLEDGEMENT

We take this opportunity to thank the teachers and senior authorities whose constant encouragement made it possible for us to take up a challenge of doing this project. We express our deepest sense of gratitude towards our Honourable Head of department Prof. A. N. Paithane for giving permission to use the college resources and his constant encouragement for this work.

We are grateful to Prof. Mrs. S. D. Kale for her technical support, valuable guidance, encouragement and consistent help without which it would have been difficult for us to complete this project work. She is a constant source of inspiration and information to us. We consider ourselves fortunate to work under the guidance of such an eminent personality.

We owe sincere thanks towards our Principal Dr. D. S. Bormane for his encouragement and guidance throughout the engineering course.

Last but not the least; we are thankful to our entire staff of Electronics and Telecommunication Department for their timely help and guidance at various stages of the progress of the project work.

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ABSTRACT

Our project is having a base of telecommunication system.

Telecommunication is a broad topic, covering telephone systems, data networks, and the ways the two can combine. Although few data or telephone networks are exactly alike, all share some fundamental technology.

Telecommunications involves the use of electrical devices such as the telegraph, telephone and teleprinter, as well as the use of radio, microwave transmission towers, fiber optics, orbiting satellites.

An intercom (intercommunication device), talkback or door phone is a stand-alone voice communication system for use within a building or small collection of buildings, functioning independently of the public telephone network. Intercoms are generally mounted permanently in buildings and vehicles. It has become quite easier now with the invention of excellent telecom systems to communicate at a long distance. An intercom system helps in providing comfort in communication at a shorter distance within a house, building, apartment, university or even a community center.

The telephone intercom system we designed here is a wired system which connects four telephones so that a communication can be established between them. The experience that powers this team includes multipurpose applications of such an intercom. This would allow exposure too many interesting, practical, and high tech features in telephones. However, most of these features can only be obtained separately and the ultimate goal was to implement an all-inclusive circuit.

The circuit needed certain qualities like, it needed to be easy to install and ready for operation after making only a few simple connections. In addition, ease of use was of high importance. This circuit would need to be easy to operate by anyone if it were to have a future as a successful product. Such a system could be installed for use in a house, or a university campus, or a community centre, etc. Finally, as any product does, it needed to have as low of a production cost as possible.

CHAPTER 1

INTRODUCTION

INTRODUCTION

An intercom is personal telecommunications device which facilitates the exchange of messages between two or more locations where standard vocal communication would be difficult or impossible due to distance or obstructions. Such a system also provides comfort and also helps in saving time.

Basic intercom systems have been in existence since about a decade into the twentieth century if you only consider designs reliant on that rather handy invention of Alexander Bell's; the telephone. Even earlier technologies, similar in concept if not execution to the modern intercom, were fairly widespread. They were particularly prevalent in large businesses, military installations and vessels, as well as stately homes and palaces where they were frequently used to convey instructions to out-of-earshot workers, locksmiths, soldiers and servants respectively.

Even such instruments as the telegraph and the familiar children's toy consisting of two cans or cups connected by a length of string can be said to have more in common with the modern intercom than the telephone in that they form a closed rather than open system of communication.

This project is basically a four line intercom from which you can call using 1 to 8 numbers. The circuit is simple and efficient, employing just two ICs, half a dozen transistors, and a handful of garden variety components. The circuit is also very easy to assemble and use.

The telephone intercom in our project is designed around two ICs. The first IC, i.e., IC1 is a dual timer chip, which is wired up to provide dial tone, ring tone and ring pulses for the ringer circuit attached to each individual telephone circuit. The other chip, i.e. IC2, is a decade counter, which is wired to count each train of dial pulses as they are received and buffered by a couple of optocouplers and their associated R/C networks. After appropriately counting the dial pulses, it switches the telephone line to the required telephone.

CHAPTER 2

LITERATURE SURVEY

LITERATURE SURVEY

As building sizes are becoming larger and the efficiency and reliability of home intercommunication is becoming a bigger challenge, the home intercom and security systems for buildings need to be redesigned. There are several designs for home intercom and security systems for buildings, such as a traditional analog system, an industry network, a PSTN network, an Ethernet or a wireless LAN.

So, we decided to choose the best from as many circuits we could go through related to the intercom. The main features that we wanted to compulsorily have in are intercom system were minimal cost, less circuit complexity, easy implementation, easy portability and establish as clear communication as possible.

So, first we surveyed for wireless telephone intercom systems. We did find an interesting circuit of M. Josie Ammer, Michael Sheets, Tufan Karalar, Mika Kuulusa, and Jan Rabaey from University of California, Berkeley. Two fully-operational ASICs, integrating custom and commercial IP, were used to implement the entire digital portion of the protocol stack. Combined, the chips consume 13 mW on average when three nodes are connected to the network. A high-level design methodology was used to define the protocol stack and communication algorithms, select architectures, and minimize energy. The intercom systems were excellent with disadvantages next to zero. But, the circuits were far too complex to understand. Furthermore, we didn't find the circuit cost-effective when implemented for a small scale basis of say, not more than 5 phones.

Secondly, we surveyed for the well-known Private Automatic Branch Exchange (PABX) system. PABX is a range of a multiline telephone systems typically used in business environments, encompassing systems ranging from small key systems to large scale private branch. A business telephone system differs from simply using a telephone with multiple lines in that the lines used are accessible from multiple telephones, or "stations" in the system, and that such a system often provides additional features related to call handling. Another big advantage with this system was we could also connect the telephone used for the intercom with the local telephone line like that of BSNL. But, this circuit was mostly to use of a business company are a huge industry, which wouldn't help us satisfy our objective. Plus, it was going far too heavy on the lines of cost of making. So, we rejected it.

Next, we searched for circuits as cheap in terms of cost as possible. So, we searched and found a completely transistorized circuit of a telephone intercom system by Mr. Emil P. Vincent. This circuit was very very old and we found a paper of this circuit on the IEEE website. This circuit though, is pretty old-fashioned. It, didn't provide an appropriate dial tone for the telephones and was a pretty heavy circuit to implement. So, it would have been a waste of time as well as money to implement such a ciruit.

Then, we finally found the right match we were looking for a circuit of telephone intercom system. Mr. Austin Hellier, a connoisseur himself in the field of intercom circuits, has published several papers on his priceless work in this field. We found a paper published by him on the electronics-lab website with a large bunch of appreciative remarks. The circuit as simple as alphabets in English for a good E&TC student. It used simple metro rotary dial phones along with a dual timer IC for the generation of the dial tone and ringtone for the circuit. It used a decade counter for pulse counting and switching purpose.

So, there it was. We found the perfect match of a cost-effective, easily implementable and easily portable circuit for telephone intercom system.

Then, it was time for a market survey to check the availability of rotary telephones, optocouplers, required ICs, etc. And, behold! All the component required were easily available in the market at a decnt electronic shop.

Hence, with a mutual discussion on the working and specifications with our respected Professor as our Project Guide, we got a nod for this project.

CHAPTER 3

AIM AND OBJECTIVES

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To design an intercom system which will have following features:-

1] The system can connect up to a minimum of 4 telephones at a time within the system and can establish a communication within the system between any of the two telephones.

2] The system should be an easy to use and easy to implement system.

3] The system should be one in which modifications can be easily made in future.

4] The system must be cost effective with minimal errors.

CHAPTER 4

BLOCK DIAGRAM

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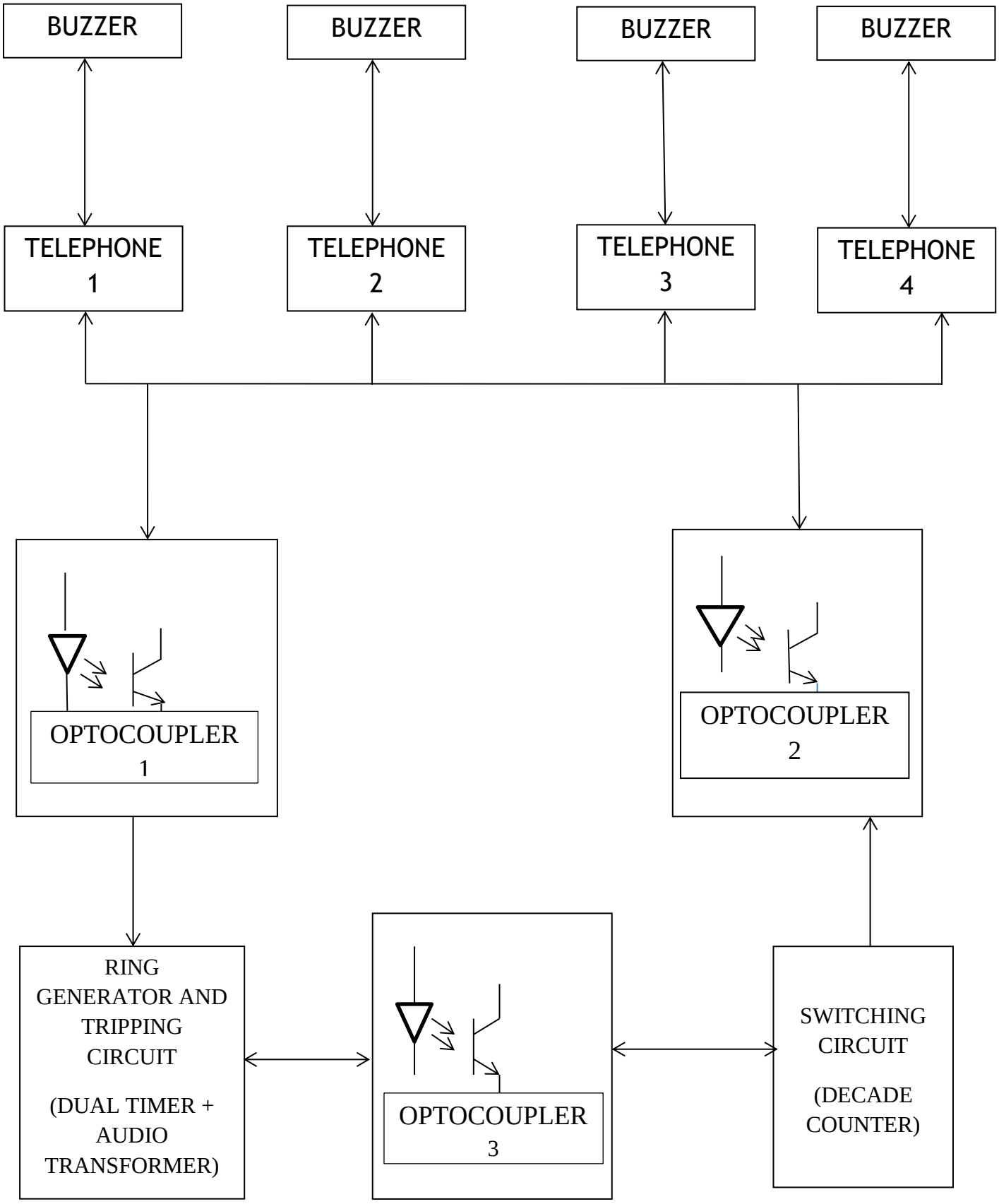

Figure 1: Block Diagram

As seen above, the circuit basically works on two major component circuits, namely: The ring generator and trip circuit, and, the switching circuit. Also, internal DC buzzers are separately mounted inside each telephone as deducible from the block diagram.

Ring Generator and Tripping Circuit:-

This circuit namely consists of a NE556 dual timer IC along with an audio transformer. The NE556 IC is used to generate dial tone, ring tone and busy tone for the telephones. Pins 9 and 14 of NE556 are used for this purpose.The dial tone is provided by one half of the NE556 while, the ring tone is provided by the other half of the IC.

Switching Circuit:-

This circuit consists of a decade counter. The IC is CD4017B. The counter counts the number of pulses as received from a telephone and then switches appropriately to the destination telephone.

Working:

Initially, when all the phones are ‘on hook’ ,i.e., on standby, the dual timer IC provides dial tone to the phone which are picked up, i.e., ‘off hook’. When a call is made from any one of the four telephones, its pulses appear at the cathode terminal of the LED in optocoupler 2. This optocoupler thus switches on and off in unison and hence the pulses appear at the clock inhibit input pin of the decade counter at short uniform time intervals. Thus the decade counter then counts these pulses, turning its output pins on and off inn unison, with the last dial pulse causing the counter to rest on the last output pin that is turned on. Hence the appropriate destination phone is switched on to a link with the dialing phone.

When the destination phone answers the call, the dial tone is tripped by a high gain transistor and thus, both the telephones can communicate with each other. Later, when both the telephones are kept back ‘on hook’, the optocoupler 3 is used to push back both the circuits to reset condition.

CHAPTER 5

HARDWARE DESIGN

HARDWARE DESIGN

POWER SUPPLY DESIGN:-

For the proper working of each and every component, the exact amount of voltage and current to be supplied to it. If the power exceeds the limit, it can be fatal.

Below is the circuit diagram of power supply which gives output of 12V, the requirement of our ICs and buzzers. Its circuit diagram and designing calculation are given below:

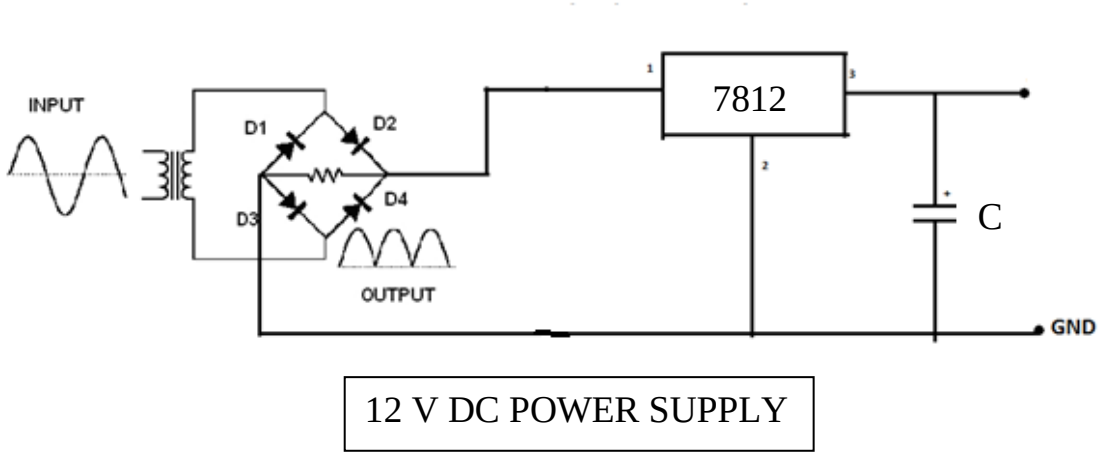

Figure 2 : Power Supply Diagram

The +12V power supply is based on the commercial 7812 voltage regulator IC. This IC contains all the circuitry needed to accept at any input voltage 8 to 18 V and produces a steady +12V o/p ,accurate within 5%(0.25V) . It also contains current limiting circuit and thermal overload protection, so that IC won't be damage in case of excessive load current: it will reduce its output voltage instead.

The advantage of a bridge rectifier is you don't need a center tapped transformer on secondary of the transformer. A further but significant advantage is that the ripple frequency at the o/p is twice line frequency (i.e 50Hz) and makes filtering easier. The use of capacitor C is to make the signal ripple free.

- Transformer Design:-

We require +12 V output

The drop out voltage of regulator is 2V(As per datasheet)

Vdc=12+2=14V.

So at the regulator input minimum 14V should be applied.

According to formula,

$Vdc=2Vm/\pi$

Assuming there is no ripple in the Capacitor

From, $Vm=Vdc.\ \pi/2$

$=14 \times 3.14/2$

$=21.98$

Vm=21.98V

During one cycle ,two diode are conducting.

Drop of vtg of one diode= 0.7V

Drop of vtg of two diode= 1.4V

Vim=Vm+1.4V

Vim=21.98+1.4=23.38V

$Vrms=Vim/\sqrt{2}$

$=23.38/\sqrt{2}$ =16.532V

Vim=23.38V

Vrms=16.532V

So we select transformer of standard 18V.

Similarly ,Im=Idc ×π/2

Im=400mA×3.14/2

=628 mA.

Irms=Im/√2

=628mA/√2

=444.06mA

Irms=444.06mA.

So we select transformer with current rating of 500mA.

Transformer=0-18V/500mA Step down transformer.

- Rectifier Design:-

PIV of Diode=Vm=23.38V

Im=628 mA

So we select 4 diodes 1N4001 for bridge rectifier with current rating 1.5A.

- Filter Capacitor design:-

R=Vdc/Idc

=14/400mA

=35Ω.

Vr=2(Vim-Vdc)

=2(23.38-14)

=18.76V

C=Vdc/(F×R×Vr)

=14/(100×35×18.76)

=2132.2µF

So for safe working we select capacitor 2200µF.

C=2200µF/35V

So the power supply made from the above mentioned components gives output of 12V.

- Voltage Regulator:-

The dual timer IC 556 and the decade counter IC CD 4017B require 12V to power them up. So, in order to obtain 12V, we have used the voltage regulator IC 7812. The capacitor of value 2200uF at the output terminal of 7812 is to improve the 'transient response'.

Features:-

1. Output current up to 1A and output voltage of 12V
2. Thermal overload protection.
    a. Short circuit protection.
3. Output transistor safe operating area protection.

Overview of the main circuit:-

The Link telephone intercom is designed around two ICs. The first, IC1, is an NE 556 dual timer chip, which is wired up to provide dial tone, ring tone (busy tone too, which will be explained along with a few add-ons to be mentioned later on) and ring pulses for the ringer circuit attached to each line circuit. The other chip, IC 2, is a CD 4017B decade counter, which is wired to count each train of dial pulses as they are received and buffered by the two opto-couplers, OC1 and OC 2 and their associated R/C networks.

Line Circuits**:-**

Each phone handset is connected by a four wire circuit from the 'black box'. Two wires (normally tagged 'white' and 'blue' here in Oz) are for speech and dialing functions, whereas the other two (tagged locally as 'red' and 'black') are for the ring pulses supplied by the ringer circuit to each DC buzzer inside the handsets. When a phone (eg: #1 for our discussion) is picked up in its 'off hook' condition, a DC loop is formed by the following components: DC circuitry inside the phone, the 1K winding of transformer TX, and back to 0V- earth. Taken from the +12 volts terminal, through the Leds inside OC1 and OC2 and back to the phone handset.

Making A Call**:-**

Dial tone is provided to the calling party's phone when the Link is in its 'reset' condition (no calls in progress) via capacitor C3 and the 8 ohm winding (8R) of TX to 0v- earth. This and the other service tones are generated by IC1a, while ring pulses are generated by IC1b. When a calling party's phone is 'off hook', the leds force the photo transistors to switch on hard, pulling pins 13 and 14 of IC2 to 0 volts ground. When the dial inside the phone handset is pulled back and released, the collector lead of OC2's transistor is held low at 0 volts by the slow release charging of C5. Pin 13 of IC2 is a CE (chip enable) input, and needs to stay at a logic low (near 0 volts) to enable pin 14 to count the dial pulses. So while 'impulsing' occurs, pin 13 stays low, and pin 14 alternates between logic high and low as the led emulates each dial pulse train, until the last pulse in the train is received.

Dialing Into The Register:-

When caller number #1 dials phone number # 4, those four pulses appear across the leds inside OC1 and OC2. The decade counter, acting as a Register (a storage device used in communications equipment for storing dialed digits) counts these pulses, turning its output pins on and off inn unison, with the last dial pulse causing the counter to rest on the last output pin that is turned on. The complete sequence for a maximum of ten pulses in the one pulse train, is (pin 3 is always at logic high at 'reset') 2,4,7,10, and then 1,5,6,9,11 and then finally pin 3. So when the number '4' is dialed, the counter would step through pins 2,4,7, and then land on pin 10, which is connected to phone #4's ringer circuit via Q4's base lead.

The Ringer Circuit:-

Each line circuit consists of the individual phone handset, the DC buzzer mounted inside it, the common connections to TX and the cathode of OC2's led, as well as transistors Q1 to Q4 and common driver transistor Q5. With pin 3 of IC2 at logic high on 'reset', diode D3 enables IC2a to provide a Dial Tone from pin 5. When a number is dialed, pin 3 of IC2 goes low on the first dial pulse, removing the logic high via D4 from pins 12 and 8 of IC1b, thus

enabling it to charge up C3, and produce ring pulses to IC1a via diode D5, (from pin 9 to pin 4). After about 2 seconds, ring pulses commence, and the modulated dial tone (which then by default becomes an interrupted Ring Tone to the caller) is produced at pin 5 of IC1a, indicating the progress of the call.

True Ring Trip:-

When the called party answers the call, transistor QX with trimpot R6, (adjusted to detect both phones being 'off-hook',) triggers the led and phototransistor inside OC3. This halts the ring pulses and ring tone supplied by IC1a and IC1b for the duration of that call, by supplying a logic high potential to pins 12 and 8 of IC1b via D6. When the call is over, and both parties have hung up their phone handsets (eg: back to the 'on-hook' status,) the DC loop formed by the handsets, TX and OC1/OC2 is broken. Pin 13 of IC2 returns to its reset potential of logic high, and extends this high to pin 15 (Reset) of the 4017 decade counter chip, which disables the output selected during the dialing operation, and enables pin 3 to high, thus restoring Dial Tone to the next caller via pin 4 of IC1a.

Resetting The Link:-

Thus the Link is fully reset and ready for another call. As you can see, it may seem a little complicated to follow the progression through a call, particularly if you haven't been involved with phones and logic chips much before. At the end of the day, you have some simple counting, pulsing and interfacing circuitry, which will perform all the necessary tasks of a basic intercom, and all at a reasonable cost. I used some formatted matrix board for the p.c.b and IC sockets for all ICs and OC/OC2. I also found that a heat sink fin for the 7812 regulator chip was unnecessary. A box could be used for housing the Link circuitry, and some kind of screw terminal block or ID block (like a small 10 pair KRONE junction box) could be used to terminate the wiring at the box to make it look more professional. Remember these two things. If you leave a phone 'off-hook' you will lock up the Link and if you pick up a phone when someone else is dialing, wrong numbers will result.

Circuit Diagram:-

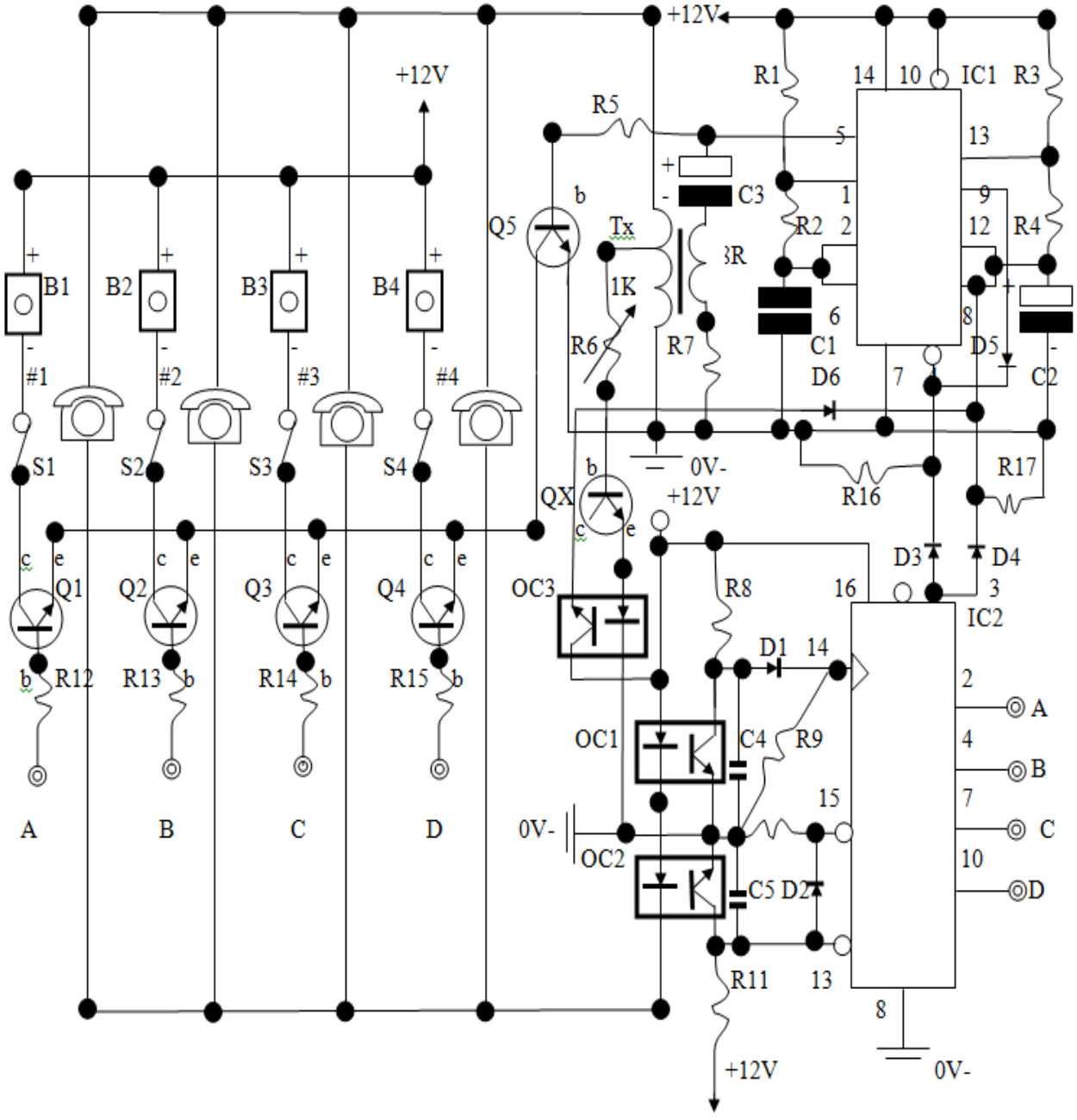

Figure 3 : Circuit Diagram

CHAPTER 6

TESTING AND RESULTS

TESTING AND RESULTS

The telephone intercom circuit was designed by us in parts, i.e., step by step. Initially the power supply was designed as shown above. It was then tested with an input of 230 V AC mains supply. The output earlier did fluctuate from 9V up to 13 V. It was then observed that the PCB was not itched very well at particular places. After successfully maintaining short line wherever required, we were successful to get a stable DC output of 12V from the supply with zero AC component.

Then we designed the ringer circuit for the phone. Since it could not be individually tested, it was followed by the design of switching circuit. After building the switching and ringing circuit, the four telephones were connected to the line. Initially it was observed that the dial tone wasn't getting tripped once the phone was taken 'off hook'. By adjusting the rheostat and a few resistors nearby the dual timer IC, this problem was solved. Then it was also observed that the buzzers did not work as required. So, appropriate capacitors were inserted near the Decade Counter IC and even this problem was solved.

The desired results were obtained by connecting all the four telephones to the circuit. The supply circuit was also giving an exact value of 12 V DC. By dialling the number for any one telephone, a communication was established between the pair. The dial tone was successfully tripped after answering the phone. The buzzers also did stop ringing once the telephone was answered.

CHAPTER 7

APPLICATIONS

APPLICATIONS

The telephone intercom systems are widely used in this modern day world. It has major applications where short distance calls are required to be easily made without much efforts and delay. The use of such an excellent system is never limited.

★ Household systems:

The intercom system is a great answer to all the doubts regarding security at any households, like, bungalows, villas, apartments, huge societies, etc. For example, if a person owns a huge villa and he wants to talk to any other person in any of the villa's rooms, then with the dial of a single digit number from his intercom telephone the person can easily communicate with whosever he wants to inside his villa. Also, if there's someone mocking his entry gate, then that person can simply make a call inside the villa to request for opening the gate instead of waiting outside for hours for someone to turn up.

★ Industries & Corporate Offices:

The intercom is used pretty extensively in industries and corporate offices. The main reason for such a frequent usage is that, with a good cost effective intercom system installed, one can communicate with any person in the office/industry without any need of physically walking up to the person for a communication. One can say you still can use your cell phones for such a communication, but that isn't a free communication! Intercom also helps to improve security of the industry or the corporate office by connecting the security cabin with the head office or the respective person.

★ Hotels and Motels:

The primary thing that is of utmost importance for any Hotel Management is the customer's comfort. Every hotel would like to make each of its customer as much comfortable as possible. An intercom system can come at help at this time. One telephone can be installed in each room of the hotel, and all such phones can be connected to each other as well as to the reception. This avoids the need of the customer to walk down every time to the reception to query about anything.

Similarly, there are vast applications to such a widely used system.

CHAPTER 8

CONCLUSION AND FUTURE SCOPE

CONCLUSION AND FUTURE SCOPE

- Conclusion:-

The desired results were successfully obtained from the telephone intercom circuit that we designed. A clear, distortion-free communication was established between any pair of the telephones. Thus, we successfully designed and implemented a setup for telephone intercom system.

- Future Scope:-

The intercom system we designed does not provide privacy on the calls made between a pair of telephones. So, an additional circuit can be merged with our current circuit that could enable privacy between the calls made by two telephones.

Secondly, the current setup covers just the general functions of any intercom system. Using a microcontroller, additional features can be incorporated to the setup like, displaying current date and time, telephone number of current call, etc.

Thirdly, with a great anticipation, one can also go for designing the wireless intercom system on a large scale with a great range of communication. One can also think of implementing a PABX system which can also addendum the local telephone line to the setup.

Someone could also try implementing things like messaging along with calling amongst the intercom system. This could be done using DTMF concept, AVR, etc.

CHAPTER 9

BIBLIOGRAPHY

BIBLIOGRAPHY

- A very prominent name in the field of intercom systems is that of Sir Austin Hellier from Brisbane, Australia. He is a great visionary scientist with a great research background in the telephone field. He has published several papers on the intercom systems.

  Our project is one of those acute collections of Mr. Austin Hellier. He is a great support to any fledgeling in the field of intercom projects. The paper we have chosen is available on the website www.electronics-lab.com . Sir Austin Hellier can be contacted personally via mail: austinhellier@gmail.com

- Few well known books that can be referred for intercom projects are :

1] Guide to Telecommunication Technology, By Tamara Dean.

2] Telephone Switching System and Networking, By T. Vishwanathan.

- People can also surf www.wikipedia.org .This web jungle also has acute information about intercom systems.

APPENDIX

A] List of Figures :

B] Datasheets :