# DESIGN AND CONSTRUCTION OF PUBLIC ADDRESS SYSTEM


By

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# DECLARATION

I hereby declare that this project is a genuine work carried out by me, under the supervision of Engr. S.NRumala of the department of Electrical and Computer Engineering, Federal University of Technology, Minna.

……………………………… ……………………

Engr.S.NRumala Date

# DEDICATION

This project is dedicated to my brother Paul Iliya and to the Almighty God.

# ACKNOWLEDGMENT

I will like to appreciate first of all the Almighty God for the grace He gave me to accomplish this project, My Parents Mr and Mrs. Iliya Habu for supporting me always, my supervisor Engr S Rumala; my lecturers; my friends, acquaintances and others to numerous to mention.

# CERTIFICATION

I certify that this project research was fully carried out by Mr. Iliya Christopher Habu, under the supervision of ENGR. S.N Rumala of the department of Electrical/Computer Engineering federal university of technology Minna.

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Iliya Christopher Habu Date.
Student.

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ENGR.S.N Rumala Date.
Supervisor

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ENGR M .N Nwohu. Date.
Head of department

..................................... .....................................
External Examiner. Date.

# ABSTRACT

This project 'the design of public address system 'shows the various components required for the construction of a public address system. The use of the circuit equivalent model and the h parameters were avoided and the rather simple Eber molls method were adopted It started with a brief history of the transistor since it is the major component used, though there was no explicit discussion on the semiconductor theory followed by  the power section and finally the amplifier circuit proper.

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# CHAPTER ONE

## 1.0 Introduction

The transistor is an active device that can amplify signals with the output containing more power than the input. The power is obtained from the power supply. This power gain distinguishes devices that can make oscillations from others. The transistor is the most essential component in every electronic circuit. Integrated circuits (IC's) are merely arrays of transistors with other few components. Power amplification seemed to be of importance to the designers of the transistor that they immediately powered a speaker nothing that the output power sounded louder than the input.

## 1.1 Literature review

The transistor was probably the most important invention of the 20th Century, and the story behind the invention is one of clashing egos and Top-secret research. This brief introduction outlines personalities and organizations involved in the history of the transistor. Bell Laboratories, one of the world's largest industrial laboratories was the research arm of the giant telephone company American Telephone and Telegraph (AT&T). In 1945, Bell Labs was beginning to look for a solution to a long-standing problem.

### 1.11 1907 - The Problem

AT&T brought its former president, Theodore Vail, out of retirement to help it fight off competition erupting from the expiration of Alexander Graham Bell's telephone patents. Vail's solution, transcontinental telephone service. In 1906, the eccentric American inventor Lee De Forest developed a triode in a vacuum tube. It was a device that could amplify signals, including, it was hoped, signals on telephone lines as they were transferred across the country from one switch box to another. AT&T bought De Forest's patent and vastly improved the tube. It allowed the signal to be amplified regularly along the line, meaning that a telephone conversation could go on across any distance as long as there were amplifiers along the way.

But the vacuum tubes that made that amplification possible were extremely unreliable, used too much power and produced too much heat. In the 1930s, Bell Lab's director of research, Mervin Kelly, recognized that a better device was needed for the telephone business to continue to grow. He felt that the answer might lie in a strange class of materials called semiconductors

**1.12 1945 - The Solution**

After the end of World War II, Kelly put together a team of scientists to develop a solid-state semiconductor switch to replace the problematic vacuum tube. The team would use some of the advances in semiconductor research during the war that had made radar possible. A young, brilliant theoretician, Bill Shockley, was selected as the team leader. Shockley drafted Bell Lab's Walter Brattain, an experimental physicist, and hired theoretical physicist John Bardeen from the University of Minnesota. Shockley filled out his Team with an eclectic mix of physicists, chemists and engineers. The group was diverse, yet close knit.

## 1.13 Laboratory

In the spring of 1945, Shockley designed what he hoped would be the

first

Semiconductor amplifier, relying on something called the "field effect." His device was a small cylinder coated thinly with silicon, mounted close to a small, metal plate. The device didn't work, and Shockley assigned Bardeen and Brattain to find out why. According to author Joel Shurkin, the two largely worked unsupervised; Shockley spent most of his time working alone at home. Ensconced in Bell Labs' Murray Hill facilities, Bardeen and Brattain began a great partnership. Bardeen, the theoretician, suggested experiments and interpreted the results, while Brattain built and ran the experiments. Technician Phil Foy recalls that as time went on with little success, tensions began to build within the lab group. In the fall of 1947, author Lillian Hoddeson says, Brattain decided to try dunking the entire apparatus into a tub of water. Surprisingly, it worked a little bit

Brattain began to experiment with gold on germanium, eliminating the liquid layer on the theory that it was slowing down the device. It didn't work, but the team kept experimenting using that design as a starting point Shortly before Christmas, Bardeen had an historic insight. Everyone thought they knew how electrons behaved in crystals, but Bardeen discovered they were wrong. The electrons formed a barrier on the surface. His breakthrough was what they needed. Without telling Shockley about the changes they were making to the investigation, Bardeen and Brattain worked on. On December 16, 1947, they built the point-contact transistor, made from strips of gold foil on a plastic triangle, pushed down into contact with a slab of germanium. When Bardeen and Brattain called Shockley to tell him of the invention. Shockley was both pleased at the group's results and furious that he had not been directly involved. He decided that to preserve his standing, he would have to do Bardeen and Brattain one better. His device, the junction (sandwich) transistor, was developed in a burst of creativity and anger, mostly in a hotel room in Chicago. It took him a total of four weeks of working pen on paper, although it took another two years before he could actually build one. His device was more rugged and more practical than Bardeen and Britain's point-contact transistor, and much easier to manufacture. It became the central artifact of the electronic age. Author Michael Riordan says Bardeen and Brattain got "pushed aside." That insult broke the team apart, turning a once cooperative environment into one that was highly competitive. The problems of whose names should be on the patent for the device, and who should be featured in publicity photographs, sent tensions higher still. Bell Labs decided to unveil the invention on June 30, 1948. With the help of engineer John Pierce, who wrote science fiction in his spare time, Bell Labs settled on the name "transistor"-- combining the ideas of "trans-resistance" with the names of other devices like thermistors. The invention got little attention at the time, either in the popular press or in industry. But Shockley saw its potential. He left Bell Labs to found Shockley Semiconductor in Palo Alto, California. He hired superb engineers and physicists, but, according to physical chemist Harry Sello, Shockley's personality drove out eight of his best and brightest. Those "traitorous eight" founded a new company called Fairchild Semiconductor. Bob Noyce and Gordon Moore, two of the eight, went on to form Intel money from their research. Nonetheless, Shockley's company was the beginning of Silicon Valley

Bardeen left Bell Labs for the University of Illinois, where he won a second Nobel Prize. Brattain stayed on for several years, and then left to teach. Shockley lost his company and taught at Stanford for a while, and then got involved in a notorious controversy over race, genetics and intelligence that destroyed his reputation. In the 1950s and 1960s, most U.S. companies chose to focus their attentions on the military market in producing transistor products. That left the door wide open for Japanese engineers like Masaru Ibuka and Akio Morita, who founded a new company named Sony Electronics that mass-produced tiny transistorized radios. Bell Labs' President Emeritus Ian Ross said that part of their success lay in developing the ability to quickly mass-produce transistors.

The transistorized radio changed the world, opening up the information age. Information could quickly be scattered to the ends of the Earth, to the point that historian Charles Stewart heard about the assassination of Martin Luther King Jr. from Bedouin tribesmen in the Sahara shortly after it happened. The original three met several times after their breakup: once in Stockholm, Sweden, to receive the 1956 Nobel Prize for their contributions to physics, and once again at Bell Labs in 1972 to commemorate the 25th anniversary of their inventions. They were celebrating something that they could not know when they first began working on the transistor -- that they were going to change the world.

# CHAPTER TWO

## 2.0 Transformer

A transformer is a passive device that has voltage gain but no power gain. It basically consists of two of two windings, the primary and secondary winding. Windings are basically of two types, shell and core types. The input electrical power (signal) is feed into the primary side while electrical power (signal) is drawn from the secondary side. When the output voltage is greater than the input voltage and the output current is less than the input current it is known as a step up transformer otherwise a step down transformer. It implies that the number of turns of the secondary is higher than that of the primary. In this way the power is conserved and the transformation occurs at the same frequency. This relationship can be expressed mathematically as

$$Es/Ep = Ns/Np = k$$

Where Es= the secondary voltage

Ep = the primary voltage

Ns = the number of turns of the secondary side

Np = the number of turns of the primary

K = the voltage transformation ratio

Transformers serve two main purposes:

(a) They isolate the electronic devices from the mains since the two winding are electrically insulated from each other and thereby provide a measure of protection

(b) Provide useful voltages (usually lower) for devices.

Power transformers come in a variety of output voltages and currents. There are power sections now a days that eliminate transformers but such could be lethal.

Transformers that are use for other applications also exit like those for audio and radio frequencies, which are made of special core material and construction to minimize core losses at high frequencies

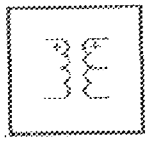

**Figure 2.1**

## 2.02 Diode

Diodes are passive non-linear circuit element. They are two terminal devices consisting of a p-n junction made of either Germanium or Silicon. Crystals. When forward biased, that is the p side connected to a positive battery lead, forward current flow from the p sided to the n side after the barrier potential have been overcome. When reversed biased only leakage current flow and reaches it's limit until when additional revered bias is added and the leakage current rises enormously.

In the forward region there is no current until the internal barrier voltage is over come which is about 0.6V for silicon diodes and 0.3V for germanium diodes. After there is an exponential rise in current which if not controlled could destroy the diode.

In the reverse region the leakage current quickly reaches it`s maximum and stays there until the reverse break down voltage is reached thereby the reverse current increase rapidly.

Due to conduction in one direction the diode has found application in rectification of ac voltage into dc. The ac signal is usually from a transformer (step down) and based on different configurations you could get a full wave or half wave rectification. Half wave and full wave rectifications implies that half and complete input voltages are rectified respectively. With a center tapped transformer and a bridge rectifier dual polarity full wave rectification is obtained. The out put voltage is not a pure direct current so it is furthered filtered with electrolytic capacitors. The peak inverse voltage (PIV) as obtained from the manufacturers data sheet, must be twice the output voltage from the transformer in this case. The diode must be able to pass the required current of the circuit without blowout.

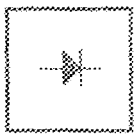

*Figure 2.1 Diode*

**2.2 Capacitors.**

Capacitors are also passive devices that are extremely important in circuits that involve changing voltages and current. When a layer of an insulating medium known as a dielectric separates two conducting surfaces, they form a capacitor. The conducting surfaces may take various forms: spherical or cylindrical, circular or rectangular.

The capacitor cannot dissipate power because the voltage and current are 90 degrees

Out of phase. It has found application in waveform generation, filtering, blocking and bypassing. It is also used in integrators and differentiators and with a combination of inductors can be used to make sharp filters. The ceramic and Mylar types are used for non-critical circuit applications: tantalum types are used where greater capacitances are required and the electrolytic types are used for power filtering.

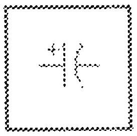

*Figure2.2 Electrolytic capacitor*

**2.3 Filters**

There are various types of filters but for this design the capacitor filter was adopted.

Capacitance choice;

$\Delta V$= ripple voltage = 2Vpp.

f= supply frequency = 50 Hz.

I load =1A

$$\Delta V = \frac{I_{load}}{2fC}$$

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

2 =1 /100C

200C =1

C=1 /200 =5000μF

The minimum capacitor value should be 5000 μF and 25 V.

### 2.4 Rectifier

The bridge rectifier consists of four diodes. From manufacturers data sheet, the IN4001diode with a breakdown voltage (PIV) of 50V at 1A was chosen for this design.

### 2.5 Transformer power rating.

Power rating (VA)

P = IV

P=1000mA X 12

P=12VA.

Peak input voltage =12 X 1.44=17.28

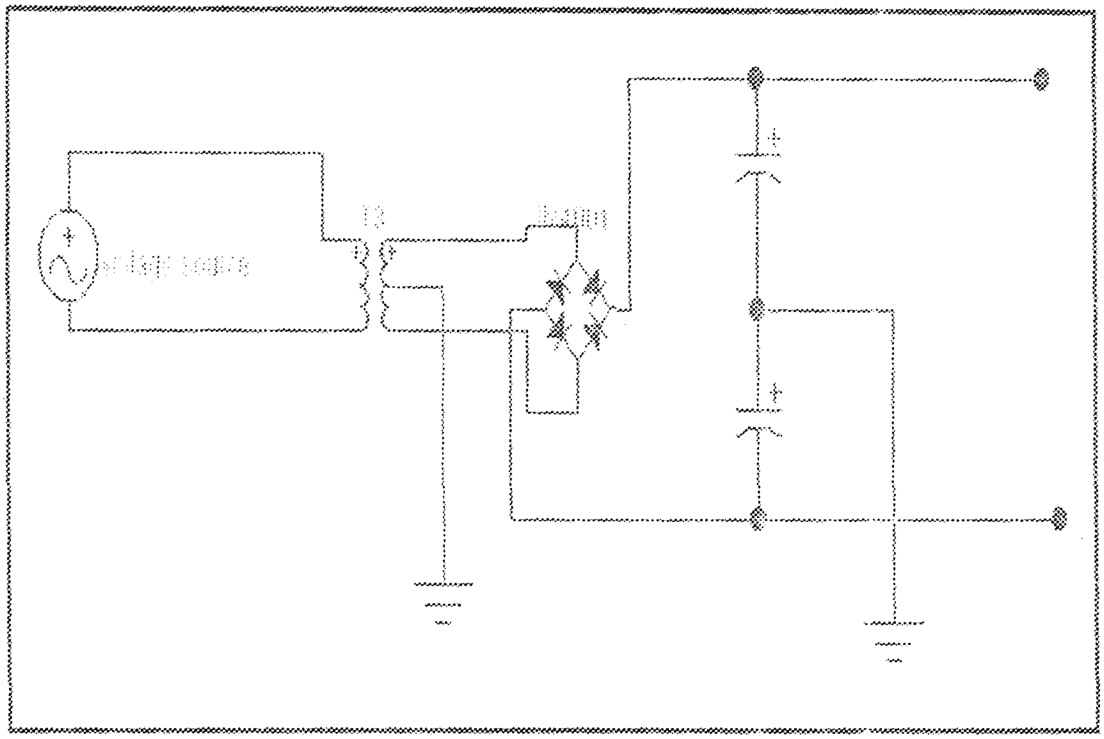

*Figure 2.5 Power supply unit*

**2.6 Amplifier**

An amplifier is an electronic device that increases the voltage, current, or power of a signal. Amplifiers are used in wireless communications and broadcasting, and in audio equipment of all kinds. They can be categorized as either weak-signal amplifiers or power amplifiers. Weak-signal amplifiers are used primarily in wireless receivers. They are also employed in acoustic pickups, audio tape players, and compact disc players. A weak-signal amplifier is designed to deal with exceedingly small input signals, in some cases measuring only a few nanovolts (units of 10-9 volt). Such amplifiers must generate minimal internal noise while increasing the signal voltage by a large factor. The most effective device for this application is the field-effect transistor. The specification that denotes the effectiveness of a weak-signal amplifier is sensitivity, defined as the number of micro volts (units of 10-6 volt) of signal input that produce a certain ratio of signal output to noise output (usually 10 to 1).

Power amplifiers are used in wireless transmitters, broadcast transmitters, and hi-fi audio equipment. The most frequently used device for power amplification is the bipolar transistor. However, vacuum tubes, once considered obsolete, are becoming increasingly popular, especially among musicians. Many professional musicians believe that the vacuum tube (known as a "valve" in England) provides superior fidelity. Two important considerations in power amplification are power output and efficiency. Power output is measured in watts or kilowatts. Efficiency is the ratio of signal power output to total power input (wattage demanded of the power supply or battery). This value is always less than 1. It is typically expressed as a percentage. In audio applications, power amplifiers are 30 to 50 percent efficient. In wireless communications and broadcasting transmitters, efficiency ranges from about 50 to 70 percent. In hi-fi audio power amplifiers, distortion is also an important factor. This is a measure of the extent to which the output waveform is a faithful replication of the input waveform. The lower the distortion, in general, the better the fidelity of the output sound.

**2.7 Amplifier classes of operation**

It may be desirable to have the transistor conducting for only a portion of the input signal. The portion of the input for which there is an output determines the class of operation of the amplifier. There are four major classes of amplifier operations. They are class A, class AB, class B, and class C. Others are D, G, H, and S although not regularly mentioned in engineering text. Efficiency increases form class A to class C while fidelity decreases form class A to C. Class B operation is of interest in this design

## 2.8 Class B Amplifier Operation

Amplifiers biased so that collector current is cut off during one-half of input signal are classified class B. The dc operating point for this class of amplifier is set up so that base current is zero with no input signal. When a signal is applied, one half cycle will forward bias the base-emitter junction and $I_C$ will flow. The other half cycle will reverse bias the base-emitter junction and $I_C$ will be cut off. Thus, for class B operation, collector current will flow for approximately 180 degrees (half) of the input signal, as shown in figure 2.8(C). For audio application it is required that the there is conduction for 360 degrees of the

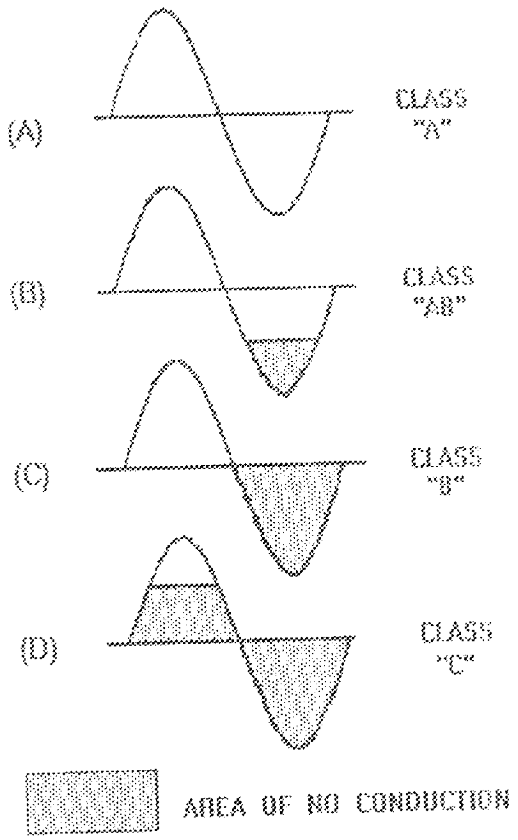


**Figure 2.8**

Input signal there for a push pull configuration was used. Class B operated amplifier is used extensively for audio amplifiers that require high-power outputs. It is also used as the driver- and power-amplifier stages of transmitter.

**2.9 Preamplifier**

Input sensitivity is the signal level at the input that is needed to drive an amplifier into its full capacity to just before it clip into nominal stated impedance, often 8 ohms. It is usually expressed as a voltage, either directly in V or mV or in dBu. Amplifiers sensitivity depends on the gain and swing of the amplifier. A preamplifier was incorporated to match the low level signal into the amplifier. The gain of the amplifier is obtained by dividing resistor xy with the $R_2$. This preamplifier provides excellent frequency responses. Frequency response is a measure of amplitude, or relative gain against frequency also known as bandwidth.

xy =33kΩ

R2 =330Ω

Gain= 33k /330

Gain =100.

For an input of 1m V the output is 0.1V.

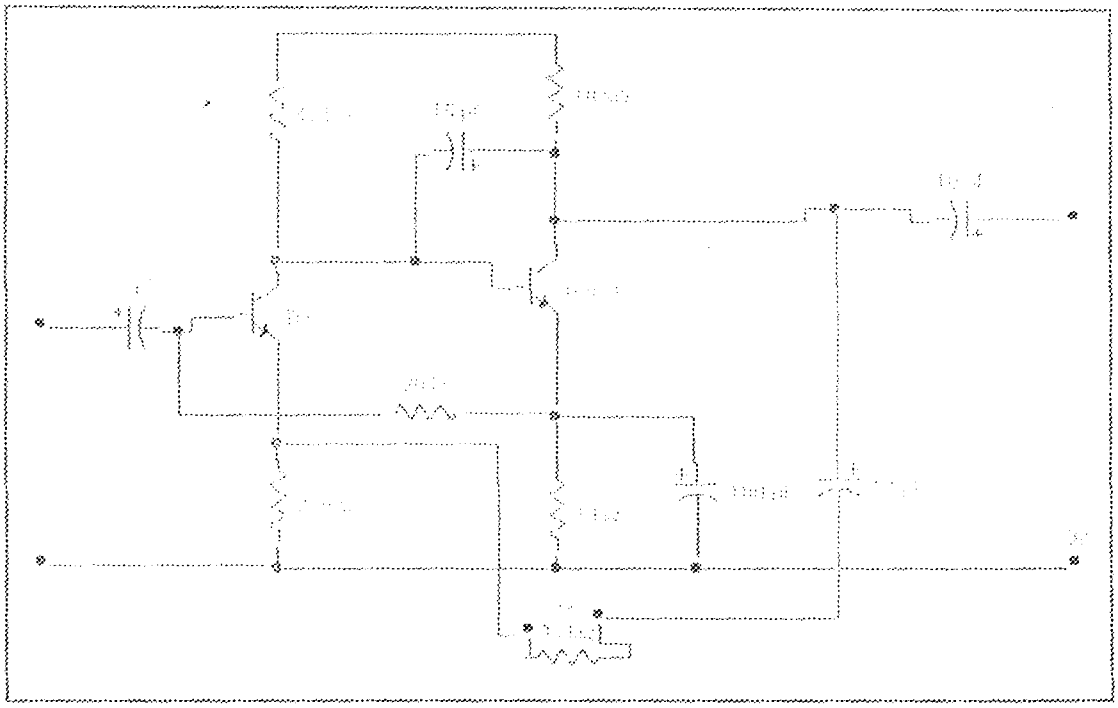

*Figure 2.9 Preamplifier circuit diagram*

## 2.10 Feedback

The µA 741 is an excellent operational amplifier with high open- loop gain, internal compensation, high common mode range and exceptional temperature stability which makes it ideal for this purpose. In this design negative feedback was employed to reduce the gain but improve linearity

## 2.11 Closed loop gain

For the inverting amplifier the closed loop gain is given by:

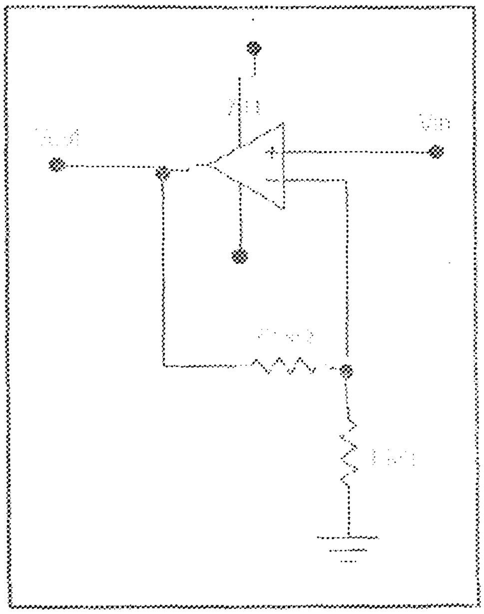


*Figure 2.11 Non-inverting amplifier*

Gain= Vout/Vin =1 + $R_2/R_1$

For this circuit with $R_1$= 1KΩ and $R_2$ =22kΩ,

The gain = 1 + 22/1

Gain = 23

## 2.12 Output stage

This is a push pull stage of emitter followers' configuration. The efficiency (ή) and maximum power dissipated is required

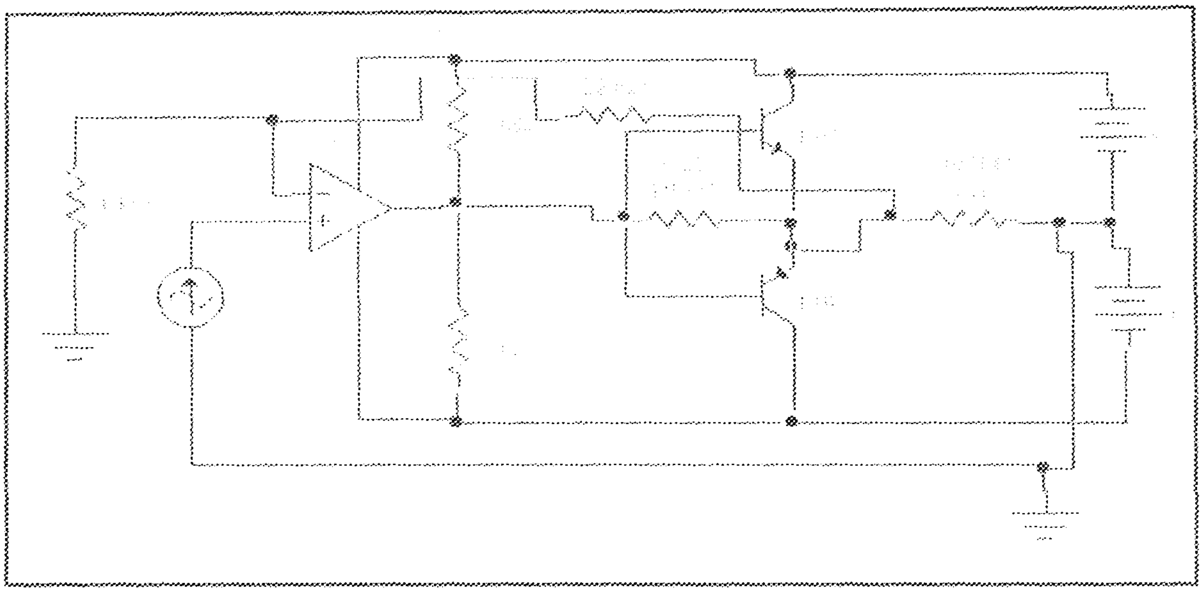

*Figure 2.12 Circuit diagram*

The biasing resistors values were chosen so that their parallel combination is far less than the product of the hfe and re.

$R_1/R_2$ ) ) Hfe X re

For Eber Molls equation

Vbe decreases by about 2.1mv/°C and the collector current increases by a decade for every 60 m V drop in Vbe.

Resistor R25 ensures that there is enough base current at cutoff

$$P_T = \frac{(V_{CC})^2}{4\pi^2 R_L}$$

$$P_{TMAX} = \frac{(12)^2}{4 X (3.142)^2 X 8}$$

$P_{TMAX}$ = 0.455 watts.

Power gain of emitter follower

Av = RL /(re +RL)

Av =8/(1+8)

Av =0.88

Vo =Vin X Av

Vo =10 X 0.88

Vo = 8.8Vp-p

ή = 4.4π /(12X4)

ή = 28.9 %

## 2.13 TRANSISTOR SPECIFICATIONS

Transistors are available in a large variety of shapes and sizes, each with its own unique characteristics. The characteristics for each of these transistors are usually presented on SPECIFICATION SHEETS or they may be included in transistor manuals. Although many properties of a transistor could be specified on these sheets, manufacturers list only some of them. The specifications listed vary with different manufacturers, the type of transistor, and the application of the transistor.

# CHAPTER THREE

## 3.1 DISCUSSION OF RESULTS

The calculated result for the efficiency was lower than that for the average push pull stages. This can be attributed to the AB class operation due to the placement of a resistor between the emitters and the base which ensured that there was enough current at crossover.

The transistors initially were over heating due to there low power rating. This could have been remodied in various ways, which include the use of heat sink, reducing the supply voltage and finally using transistors with higher power rating. In this design the higher rated transistor was used. The project target was achieved.

## 3.2 CONCLUSION

A public address system could be designed with minimal cost. The use of computer simulation has brought a new dimension to design, which if exploited appropriately could reduce errors, save time and give the designer a pictorial view of circuit behavior even before actual construction. The circuit will be more reliable.

## 3.3 RECOMMENDATION

This design can be improved upon in so many ways. The resistors for the microphone, tape and magnetic pickup mode could be made fixed and a switch used to select the mode of interest. The design of a low impedance microphone and an efficient transducer (speaker) could be embarked upon as another project The government should encourage young Engineers to embark on this type of project that can help reduce over dependence on foreign consumer electronics and stimulate job creation.

### 3.4 Reference

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4. http:// www.howstuffworks.com.
5. Http://www.101.science.com.

# General purpose operational amplifier

# μA741/μA741C/SA741C

## SCRIPTION

e μA741 is a high performance operational amplifier with high en-loop gain, internal compensation, high common mode range d exceptional temperature stability. The μA741 is ort-circuit-protected and allows for nulling of offset voltage.

## ATURES

- nternal frequency compensation
- Short circuit protection
- Excellent temperature stability
- High input voltage range

## PIN CONFIGURATION

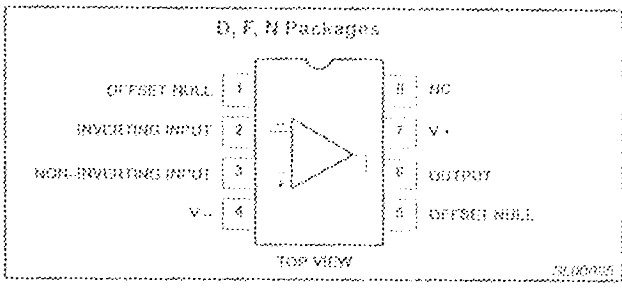


Figure 1. Pin Configuration

## RDERING INFORMATION

| DESCRIPTION | TEMPERATURE RANGE | ORDER CODE | DWG # |
|---|---|---|---|
| -Pin Plastic Dual In-Line Package (DIP) | -55°C to +125°C | μA741N | SOT97-1 |
| Pin Plastic Dual In-Line Package (DIP) | 0 to +70°C | μA741CN | SOT97-1 |
| -Pin Plastic Dual In-Line Package (DIP) | -40°C to +85°C | SA741CN | SOT97-1 |
| Pin Ceramic Dual In-Line Package (CERDIP) | -55°C to +125°C | μA741F | 0580A |
| -Pin Ceramic Dual In-Line Package (CERDIP) | 0 to +70°C | μA741CF | 0580A |
| Pin Small Outline (SO) Package | 0 to +70°C | μA741CD | SOT96-1 |

## BSOLUTE MAXIMUM RATINGS

| SYMBOL | PARAMETER | RATING | UNIT |
|---|---|---|---|
| $V_S$ | Supply voltage | | |
| | μA741C | ±18 | V |
| | μA741 | ±22 | V |
| $P_D$ | Internal power dissipation | | |
| | D package | 780 | mW |
| | N package | 1170 | mW |
| | F package | 800 | mW |
| $V_{IN}$ | Differential input voltage | ±30 | V |
| $V_{IN}$ | Input voltage[1] | ±15 | V |
| $I_{SC}$ | Output short-circuit duration | Continuous | |
| $T_A$ | Operating temperature range | | |
| | μA741C | 0 to +70 | °C |
| | SA741C | -40 to +85 | °C |
| | μA741 | -55 to +125 | °C |
| $T_{STG}$ | Storage temperature range | -65 to +150 | °C |
| $T_{SOLD}$ | Lead soldering temperature (10sec max) | 300 | °C |

NOTES:
1. For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.

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## ELECTRICAL CHARACTERISTICS

...25°C, $V_S$ = ±15V, unless otherwise specified.

| ...YMBOL | PARAMETER | TEST CONDITIONS | µA741 | | | µA741C | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | Min | Typ | Max | |
| ...s | Offset voltage | $R_S$=10kΩ | | 1.0 | 5.0 | | 2.0 | 6.0 | mV |
| | | $R_S$=10kΩ, over temp. | | 1.0 | 6.0 | | | 7.5 | mV |
| ...s/ΔT | | | | 10 | | | 10 | | µV/°C |
| | Offset current | | | 20 | 200 | | 20 | 200 | nA |
| | | Over temp. | | | | | | 300 | nA |
| | | $T_A$=+125°C | | 7.0 | 200 | | | | nA |
| | | $T_A$=-55°C | | 20 | 500 | | | | nA |
| .../ΔT | | | | 200 | | | 200 | | pA/°C |
| ...S | Input bias current | | | 80 | 500 | | 80 | 500 | nA |
| | | Over temp. | | | | | | 800 | nA |
| | | $T_A$=+125°C | | 30 | 500 | | | | nA |
| | | $T_A$=-55°C | | 300 | 1500 | | | | nA |
| ...ΔT | | | | 1 | | | 1 | | nA/°C |
| ...UT | Output voltage swing | $R_L$=10kΩ | ±12 | ±14 | | ±12 | ±14 | | V |
| | | $R_L$=2kΩ, over temp. | ±10 | ±13 | | ±10 | ±13 | | V |
| ...OL | Large-signal voltage gain | $R_L$=2kΩ, $V_O$=±10V | 50 | 200 | | 20 | 200 | | V/mV |
| | | $R_L$=2kΩ, $V_O$=±10V, over temp. | 25 | | | 15 | | | V/mV |
| | Offset voltage adjustment range | | | ±30 | | | ±30 | | mV |
| ...RR | Supply voltage rejection ratio | $R_S$≤10kΩ | | | | | 10 | 150 | µV/V |
| | | $R_S$≤10kΩ, over temp. | | 10 | 150 | | | | µV/V |
| ...RR | Common mode rejection ratio | | | | | 70 | 90 | | dB |
| | | Over temp. | 70 | 90 | | | | | dB |
| | Supply current | | | 1.4 | 2.8 | | 1.4 | 2.8 | mA |
| | | $T_A$=+125°C | | 1.5 | 2.5 | | | | mA |
| | | $T_A$=-55°C | | 2.0 | 3.3 | | | | mA |
| | Input voltage range | (µA741, over temp.) | ±12 | ±13 | | ±12 | ±13 | | V |
| | Input resistance | | 0.3 | 2.0 | | 0.3 | 2.0 | | MΩ |
| | Power consumption | | | 50 | 85 | | 50 | 85 | mW |
| | | $T_A$=+125°C | | 45 | 75 | | | | mW |
| | | $T_A$=-55°C | | 45 | 100 | | | | mW |
| ...UT | Output resistance | | | 75 | | | 75 | | Ω |
| | Output short-circuit current | | 10 | 25 | 60 | 10 | 25 | 60 | mA |

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