CONSTRUCTION OF 100W AUDIO AMPLIFIER

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CONSTRUCTION OF 100W AUDIO AMPLIFIER

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IN PARTIAL FULFILMENT OF THE AWARD OF NATIONAL DIPLOMA (ND) IN COMPUTER ENGINEERING.

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CERTIFICATION

This is to certify that this project was carried out by **KEHINDE OLUWATOBI SUNDAY** with Matriculation number **17-03-0019** of the department of Computer Engineering, Abraham Adesanya Polytechnic, Ijebu Igbo, Ogun State, Nigeria.

The Project has been duly supervised and approved by;

MR.BANJO A.O
(Supervisor)

14th Nov. 2019
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14-11-2019
DATE/SIGN

DEDICATION

This project is dedicated to Almighty God and my beloved Parents.

ACKNOWLEDMENT

im using this opportunity to express my gratitude to Almighty God for his grace d everlasting life given to me throughout my stayed in Abraham Adesanya lytechnic.

must not for forget to pay my debt of utmost appreciation to my able supervisor R BANJO A.O who out of his tight schedule, painstaking worked on this project oroughly and made appropriate corrections, suggestions and criticism where cessary. I will live to remember and God will perfect everything that concerns u Amen.

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would like to extend my special thanks of gratitude to my parents Mr. & Mrs. ehinde for their support, morals, spiritual guidance during the course of this oject and for their moral support towards my programme. May Almighty God are there life to eat the fruit of their labour.

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ABSTRACT

This paper reports the design and implementation of a 100Watt audio amplifier. The system features also include an LCD. The circuit analysis is presented and procedures for implementation are described. Before implementation, circuit simulation was carried to ensure that simulated results corresponded with the analysis already carried out. Simulation results showed an open-loop gain of about 2600V/V while the result from the amplifier analysis was 2937V/V. This satisfactory results agrees with the required open-loop threshold of >1000V/V for optimal operation. The simulated closed-loop gain was 10V/V which also agreed with design specifications and analysis. The overall result obtained indicates a satisfactory performance.

Keywords---Audio, Amplifier, Transistor, Gain, PSPICE. I.

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Amplifiers are electronic devices that boost or strengthen an input signal, in other words, they provide amplification. The nature of the signal could be of any type such as voltage, current or power of a circuit. There are many forms of electronic circuits classed as amplifiers, from operational amplifiers and small signal amplifiers up to large signal and power amplifiers . Amplifiers can be thought of as a simple box or block containing the amplifying device, such as a Transistor, Field Effect Transistor or Operational amplifier (op amp), with the output signal being much greater than that of the input signal showing voltage amplification. Output signal Input signal 1.5volts AMPLIFIER 30volts An Amplifier receives a signal from some pickup transducer or other input source and provides a larger version of the signal to some output device or to another amplifier stage. An input transducer signal is generally small (a few mill volts from a cassette or CD input or a few microvolt from an antenna) and needs to be amplified sufficiently to operate an output device (speaker or other power handling device). The term audio means the range of frequencies which the human ear can hear. The range of human hearing extends from 20 Hz to 20 kHz. Therefore, audio amplifiers amplify electrical signals that have a frequency range corresponding to the range of human hearing, i.e. 20 Hz to 20 kHz, to a level suitable for driving loudspeakers. Early audio amplifiers were based on vacuum tubes (also known as valves), and some of these achieved notably high quality (e.g., the Williamson amplifier of 1947-9). Most modern audio amplifiers are based on solid state devices (transistors such as BJTs, FETs and MOSFETs). Audio amplifiers based on transistors became practical with the wide availability of inexpensive transistors in the late 1960s . This paper reports the design of a 300 watt transistor-based audio amplifier. A practical amplifier always consists of a number of stages that amplify a weak signal until sufficient power is available to operate a loudspeaker or other output device. There are four basic types of amplifier in electronic field: the voltage amplifier, the current amplifier, the Trans conductance amplifier, and the Trans resistance amplifier. The output power of the power amplifier is 300Watt.

1.2 AIMS AND OBJECTIVES

The goal or objectives of which the designed device is expected to accomplish is to build a 300w audio amplifier. In this project amplifiers are use to increase the input of an audio signal, some of the objectives are

i. To design a 300w amplifier

ii. The objective is to make a audio amplifier by adding an amplifier using operational component

iii. It is used in wireless communication and broadcasting

iv. Amplifier is used to design and build innovative

1.3 SCOPE OF THE PROJECT

During the history of audio registration and reproduction, which started more than a century ago, there has been a steady improvement in quality. The first record player, which was in fact a rotating drum, used only the mechanical excitation of the needle to produce sound. The movements of the needle were transferred to a diaphragm in a horn, thus, forming a true 'audio amplifier'. Later in time, the movements of the needle were first transformed into electrical signals. These signals were amplified by means of vacuum tubes and fed to a loudspeaker. With the introduction of the transistor, vacuum tubes were replaced by transistors, and later by integrated circuits. These developments led to audio amplifiers with less weight, using less power and sounding better. O.P.T system is used to appear the sound from the output transformer to the output speaker. To get the good quality sound, push-pull system can be used in the output system. O.P.T system is constructed input, driver and output.

1.4 LIMITATION TO THE PROJECT

Limitations of switching amplifiers in the previous sections, the main building blocks of switching amplifiers have been discussed. To summaries the limitations that were encountered, it is easy to start with an important audio amplifier specification: low distortion. With feedback directly from the switched output, very good high power PWM signals can be generated. The output filter, however, introduces additional distortion and deviations of the specified frequency transfer when non-resistive loads are connected. Feedback after the filter is difficult, and high feedback factors cannot be realised. Even when these problems are overcome, the filter prevents further integration because for sufficient suppression of the carrier frequency, typically a fourth order filter is necessary. It is not possible to eliminate the external two coils and two capacitors without introducing a much larger switching residue.

1.5 METHODOLOGY OF THE PROJECT

This section discusses the analysis, design and implementation of the 100W amplifier. Factors such as availability and accessibility of materials, durability, robustness and functionality of the design such that the desired result is obtained at any time the system is energised. The steps that were taken to design this project includes: (i) Selection of components (ii) Analysis of the amplifier (iii) Simulation of audio amplifier circuit (iv) Design of the printed circuit board (PCB) (v) Circuit construction and testing. Selection of Components for Audio Amplifier Circuit The components for the 300W audio amplifier were chosen based on the requirements of the amplifier; the first step is to design a power supply unit for the amplifier circuit. A 300W amplifier would require about ±70V power supply on the rails. This is achieved by coiling a transformer for that purpose using the well-known transformer equation that relates number of turns to voltage and current, expressed below: The next issue is to proceed to rectify and smoothen the stepped-down AC output of the transformer to achieve a dc output. The bridge configuration of four diodes, 6A each is used for rectification and smoothening is achieved with the use of capacitors. This removes the AC (unwanted) ripples from the DC signal in order to achieve a pure DC voltage fed to the system. Fuses can be added for current protection. The power supply circuit. BR1 240V/70V G2SB60 +70V C4 1000u C5 1000u Figure 3. Dual voltage power supply -70V Next thing is to progress to design the stages in amplifier operation, brief description of the stages in the amplifier is presented below while the analysis of the audio amplifier is discussed in the next section. A. Input stage As described earlier, it boosts the input signal coming directly from the source (phone, radio, tv etc) before it can be further amplified by the power transistors for final output to the speaker. The pre amplifier stage comprises of 1.5kΩ resistor, BC558 PNP transistors, 10µf/50V capacitor (de-coupling capacitor) for filtration. All these components make up the pre amplifier stage. B. Voltage Amplification stage This stage consists of component of class A and component of class B amplifier respectively. It sums up to what is called class AB amplifier. This system is so designed with this combination concept in order to achieve maximum efficiency. The class A amplifier consist of Tip 41 and Tip 142(darlington pair transistor) and class B amplifier consist of Tip 147 power transistor (darlington pair transistor). The combination of these power transistors from both classes result to a PUSH-PULL topology of class AB amplifier. C. The Feedback stage In this stage, the output power of the system is compared with the input power from the pre amplifier stage using BC558 PNP transistor and 22kΩ resistor. This system is built to produce a maximum power output of 300W. If this requirement should be violated, the feedback stage will be signaled to and cautious effort would be made by the voltage divider between 22kΩ and 220Ω resistor, else the system will get spoilt. D. The Output Stage The output stage consists of 300W rated speaker. The speaker is made up of coil wound round a magnet bar. .

1.6 PROJECT REPORT ORGANIZATION

The organization of this project report is well detailed and vast in its coverage it covers all the activities encountered during the research work. The first chapter of this work took care of the introduction, aims and objective, scope, and the project report organization. Chapter two highlights on literature review chapter three highlight on description of the system and some of the components used were emphasized chapter four highlight on the system design and implementation, construction, testing and packaging of amplifier. Chapter five is all about the conclusion problem encountered recommendation and cost of the construction.

1.7 ORGANIZATION OF THE PROJECT

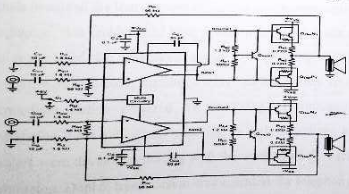


Fig. 1:A circuit diagram of organization of the project

CHAPTER TWO

LITERATURE REVIEW

2.1 HISTORY OF THE PROJECT

The first practical device that could amplify was the triode vacuum tube, invented in 1906 by Lee De Forest, which led to the first amplifiers around 1912. Vacuum tubes were used in almost all amplifiers until the 1960s–1970s when the transistor , invented in 1947, replaced them. Today, most amplifiers use transistors, but vacuum tubes continue to be used in some applications.

De Forest's prototype audio amplifier of 1914. The Audion (triode) vacuum tube had a voltage gain of about 5, providing a total gain of approximately 125 for this three-stage amplifier.

The development of audio communication technology in form of the telephone, first patented in 1876, created the need to increase the amplitude of electrical signals to extend the transmission of signals over increasingly long distances. In telegraphy , this problem had been solved with intermediate devices at stations that replenished the dissipated energy by operating a signal recorder and transmitter back-to-back, forming a relay , so that a local energy source at each intermediate station powered the next leg of transmission. For duplex transmission, i.e. sending and receiving in both directions, bi-directional relay repeaters were developed starting with the work of C. F. Varley for telegraphic transmission. Duplex transmission was essential for telephony and the problem was not satisfactorily solved until 1904, when H. E. Shreeve of the

American Telephone and Telegraph Company improved existing attempts at constructing a telephone repeater consisting of back-to-back carbon-granule transmitter and electrodynamic receiver pairs. The Shreeve repeater was first tested on a line between Boston and Amesbury, MA, and more refined devices remained in service for some time. After the turn of the century it was found that negative resistance mercury lamps could amplify, and were also tried in repeaters, with little success.

The development of thermionic valves starting around 1902, provided an entirely electronic method of amplifying signals. The first practical version of such devices was the Audio triode, invented in 1906 by Lee De Forest, which led to the first amplifiers around 1912. Since the only previous device which was widely used to strengthen a signal was the relay used in telegraph systems, the amplifying vacuum tube was first called an electron relay . The terms amplifier and amplification , derived from the Latin amplificare, (to enlarge or expand), Were first used for this new capability around 1915 when triodes became widespread. The amplifying vacuum tube revolutionized electrical technology, creating the new field of electronics, the technology of active electrical devices. It made possible long distance telephone lines, public address systems , radio broadcasting , talking motion pictures, practical audio recording , radar ,television , and the first computers . For 50 years virtually all consumer electronic devices used vacuum tubes. Early tube amplifiers often had positive feedback (regeneration), which could increase gain but also make the amplifier unstable and prone to oscillation. Much of the mathematical theory of amplifiers was developed at Bell Telephone Laboratories during the 1920s to

1940s. Distortion levels in early amplifiers were high, usually around 5%, until 1934, when Harold Black developed negative feedback; this allowed the distortion levels to be greatly reduced, at the cost of lower gain. Other advances in the theory of amplification were made by Harry Nyquist and Hendrik Wade Bode .

2.2 REVIEW OF RELATED WORK

An audio power amplifier (or power amp) is an electronic amplifier that amplifies low-power electronic audio signals such as the signal from radio receiver or electric guitar pickup to a level that is high enough for driving loudspeakers or headphones. Audio power amplifiers are found in all manner of sound systems including sound reinforcement, public address and home audio systems and musical instrument amplifiers like guitar amplifiers. It is the final electronic stage in a typical audio playback chain before the signal is sent to the loudspeakers. The preceding stages in such a chain are low power audio amplifiers which perform tasks like pre-amplification of the signal (this is particularly associated with record turntable signals, microphone signals and electric instrument signals from pickups, such as the electric guitar and electric bass), equalization (e.g., adjusting the bass and treble), tone controls, mixing different input signals or adding electronic effects such as reverb. The inputs can also be any number of audio sources like record players, CD players, digital audio players and cassette players. Most audio power amplifiers require these low-level inputs, which are line level.

While the input signal to an audio power amplifier, such as the signal from an electric guitar, may measure only a few hundred microwatts, its output may be a few watts for small consumer electronics devices, such as clock radios, tens or hundreds of watts for a home stereo system, several thousand watts for a nightclub's sound system or tens of thousands of watts for a large rock concert sound reinforcement system. While power amplifiers are available in standalone units, typically aimed at the hi-fi audiophile market (a niche market) of audio enthusiasts and sound reinforcement system professionals, most consumer electronics sound products, such as clock radios, boom boxes and televisions have relatively small power amplifiers that are integrated inside the chassis of the main product.

2.3 COMPONENTS USED FOR THE STUDY

2.3.1 CAPACITOR

A capacitor is a device that stores electrical energy in an electric field. It is a passive electronic component with two terminals. The effect of a capacitor is known as capacitance. While some capacitance exists between any two electrical conductors in proximity in a circuit, a capacitor is a component designed to add capacitance to a circuit. The capacitor was originally known as a condenser or condensator. The original name is still widely used in many languages, but not commonly in English.

The earliest forms of capacitors were created in the 1740s, when European experimenters discovered that electric charge could be stored in water-filled glass jars that came to be known as Leyden jars. In 1748, Benjamin Franklin connected a series of jars together to create what he called an "electrical battery", from their visual similarity to a battery of cannon, which became the standard English term electric battery. Today, capacitors are widely used in electronic circuits for blocking direct current while allowing alternating current to pass. In analog filter networks, they smooth the output of power supplies. In resonant circuits they tune radios to particular frequencies. In electric power transmission systems, they stabilize voltage and power flow. The property of energy storage in capacitors was exploited as dynamic memory in early digital computers. The physical form and construction of practical capacitors vary widely and many types of capacitor are in common use. Most capacitors contain at least two electrical conductors often in the form of metallic plates or surfaces separated by a dielectric medium. A conductor may be a foil, thin film, sintered bead of metal.

Figure 2.1: A diagram representing capacitor

2.3.2 TRANSFORMER

A transformer is a passive electrical device that transfers electrical energy between two or more circuits. A varying current in one coil of the transformer produces a varying magnetic flux, which, in turn, induces a varying electromotive force across a second coil wound around the same core. Electrical energy can be transferred between the two coils, without a metallic connection between the two circuits. Faraday's law of induction discovered in 1831 described the induced voltage effect in any coil due to changing magnetic flux encircled by the coil.

Transformers are used for increasing or decreasing the alternating voltages in electric power applications, and for coupling the stages of signal processing circuits.

Since the invention of the first constant-potential transformer in 1885, transformers have become essential for the transmission, distribution, and utilization of alternating current electric power. A wide range of transformer designs is encountered in electronic and electric power applications. Transformers range in size from RF transformers less than a cubic centimeter in volume, to units weighing hundreds of tons used to interconnect the power grid .

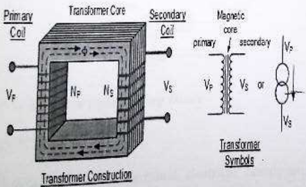


Figure 2.2: A diagram representing transformer

2.3.3 DIODE

A diode is a two- terminal electronic component that conducts current primarily in one direction (asymmetric conductance); it has low (ideally zero) resistance in one direction, and high (ideally infinite) resistance in the other. A diode vacuum tube or thermionic diode is a vacuum tube with two electrodes, a heated cathode and a plate, in which electrons can flow in only one direction, from cathode to plate. A semiconductor diode, the most commonly used type today, is a crystalline piece of semiconductor material with a p–n junction connected to two electrical terminals. Semiconductor diodes were the first semiconductor electronic devices. The discovery of asymmetric electrical conduction across the contact between a crystalline mineral and a metal was made by German physicist Ferdinand Braun in 1874. Today, most diodes are made of silicon, but other materials such as gallium arsenide and germanium are used.

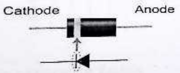


Figure 2.3: A diagram representing Diode

2.3.4 RESISTOR

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses. High-power resistors that can dissipate many watts of electrical power as heat, may be used as part of motor controls, in power distribution systems, or as test loads for generators. Fixed resistors have resistances that only change slightly with temperature, time or operating voltage. Variable resistors can be used to adjust circuit elements (such as a volume control or a lamp dimmer), or as sensing devices for heat, light, humidity, force, or chemical activity.

Resistors are common elements of electrical networks and electronic circuits and are ubiquitous in electronic equipment . Practical resistors as discrete components can be composed of various compounds and forms. Resistors are also implemented within integrated circuits.

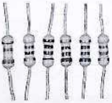


Figure 2.4: A diagram representing Resistor

2.3.5 LOUD SPEAKER

A loudspeaker (or loud-speaker or speaker) is an electro acoustic transducer ; a device which converts an electrical audio signal into a corresponding sound . The most widely used type of speaker in the 2010s is the dynamic speaker, invented in 1924 by Edward W. Kellogg and Chester W. Rice. The dynamic speaker operates on the same basic principle as a dynamic microphone , but in reverse, to produce sound from an electrical signal. When an alternating current electrical audio signal is applied to its voice coil , a coil of wire suspended in a circular gap between the poles of a permanent magnet, the coil is forced to move rapidly back and forth due to Faraday's law of induction , which causes a diaphragm (usually conically shaped) attached to the coil to move back and forth, pushing on the air to create sound waves . Besides this most common method, there are several alternative technologies that can be used to convert an electrical signal into sound. The sound source (e.g., a sound recording or a microphone) must be amplified or strengthened with an audio power amplifier before the signal is sent to the speaker.

Where high fidelity reproduction of sound is required, multiple loudspeaker transducers are often mounted in the same enclosure, each reproducing a part of the audible frequency range (picture at right). In this case the individual speakers are referred to as "drivers" and the entire unit is called a loudspeaker. Drivers made for reproducing high audio frequencies are called tweeters, those for middle frequencies are called mid-range drivers, and those for low frequencies are called woofers. Extremely low frequencies (16Hz-~100Hz) may be reproduced by detached subwoofers. Smaller loudspeakers are found in devices such as radios, televisions, portable audio players, computers, and electronic musical instruments. Larger loudspeaker systems are used for music, sound reinforcement. Speakers come with rated impedance, which is the amount of resistance they offer to current flowing through them. For example, there are 4 ohm, 8 ohm, 16 ohm, and 32 ohm speakers. A speaker is often referred to by its impedance, such as an 8 ohm speaker.

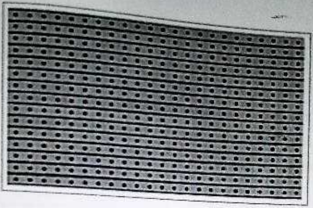


Figure 2.4: A diagram representing vero board

CHAPTER THREE

3.0 COMPONENTS USED

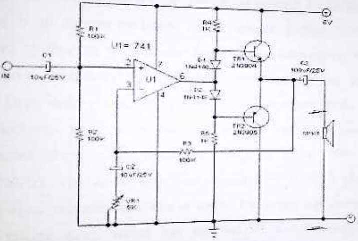
This chapter describes the activities involved in each of the stages of the construction of 100w audio amplifier. The project is a system that were incorporated with many component. This is list the of components used in construction of 300w audio amplifier.

Quantity	components used	Rate
5	Capacitor	25v,100microf,2.2μF
1	Speaker	100w
1	Audio card	
2	Resistor	22kohms, 50ohms
1	Transformer	2Amp
1	Diode	
2	Ic	TDA 2030
1	Vero board	Adriono board
1	TEA2025	Amplifier chip

Table 3.1: A table representing the list of components used

3.2 STEP BY STEP CONSTRUCTION OF THE PROJECT

Simulation of audio amplifier circuit was carried out using Proteus 8 Professional® software. Observations from the simulated outputted signals were used to determine the theoretical and calculated result. The calculated results were similar to simulated results and the system was designed based on the simulated circuit. The circuit simulated is shown in Figure 4.



The audio amplifier system is also equipped with an LCD display that shows the name and registration number of the authors. This was also incorporated in the circuit model and implementation. The LCD is controlled from a PIC microcontroller. The program code for the microcontroller is presented in the appendix. ARES, a part of Proteus software, was used to design the printed circuit board. The circuit was printed using a laser jet Printer on "glossy paper". This paper is used because it can release the laser on the surface when heated at a certain temperature. The next step is the heating of the glossy paper. The glossy paper is placed on the surface of a copper chloride board and an electric iron was used to heat the glossy paper for some minutes. After that, the board was placed into a bowl of water for cooling and unwrapping (peeling off). The board was placed into a bowel of ferric chloride for etching. The copper which were not photo resisted are etched. The next process is to remove the lasers on the copper surface. These lasers are removed by cleaning with thinner obtained from local stores, it is also used to remove point stains from materials. Holes were drilled into the PCB using 1mm drilling bits, for placement of component parts. The circuit was soldered properly to the board and air gaps were prevented. The constructed circuit was tested by plugging it to the AC mains (220V/50Hz). The audio input was connected to a GSM phone and the output signal was attenuated due to noise. The noise was introduced due to faulty volume tuner, which was replaced and a better output signal was obtained. In other to improve the output signal, the system had to undergo several optimization processes such as filtration using capacitors with satisfactory results. The circuit board implementation is shown in Figure 5.

CHAPTER 4

4.0 SYSTEM ANALYSIS, PREFORMANCE AND RESULT

After the design and implementation phase, the system built has to be tested for durability and effectiveness and also to ascertain if there is need to modify the design. All the components used were carried out at various stages to ensure proper functioning of each component.

The performance of the system varies with power supply and availability of the loud speaker.

4.1 TESTS FOR POWER OUTPUT

Power Output of an amplifier can be roughly defined as the maximum power an amplifier can deliver per channel before distortion begins to impair the audio (music, etc.). Unfortunately, there is wide disparity in how much distortion different people will accept. Therefore, the most meaningful power output figures are obtained when the output is plotted against the amount of harmonic and intermediation distortion. Power measurements can be performed in many ways. A common procedure is to measure the continuous RMS output power of an amplifier for at least 30 seconds (to account for changes due to heat, power supply sag, etc.). Power measurement of stereo amplifiers is then made for each channel with both channels driven.

4.2 TEST FOR FREQUENCY RESPONSE

Frequency Response is a measure of the amplifier's ability to pass a wide range of frequencies in the audio spectrum. Ideally, one would strive to achieve a flat response; that is, all frequencies would pass through an amplifier with equal amplification. A Hi-Fi amplifier may have controls to modify the response. These may include tone controls (bass and treble), rumble and hum filters (low frequency rolloff), scratch filters (high frequency rolloff), and a variety of tailoring devices such as the RIAA, FM de'emphasis, and tape head equalization filters. The frequency response test should provide response information of the amplifier in the flat position and should also represent the limits and interaction of the tone controls and filters. Response of a modern Hi-Fi system is generally measured from below 20 Hz to well beyond the 15 kHz audible limit. It is measured in dB of deviation across the audio spectrum.

4.3 TEST FOR SENSITIVITY

Sensitivity checks determine how much signal (in volts) must be applied to each input terminal to drive an amplifier to its rated or some reference output. The overload point for each input is usually determined while making the sensitivity checks.

4.4 TEST FOR DAMPING FACTOR

Damping Factors is measure of output impedance versus frequency relative to a constant load R. It is an indirect measure of an amplifier's ability to remain stable while encountering speaker impedance changes (at different frequencies). A simple way to measure damping factor is to measure the ratio at maximum power of the loaded output voltage to the unloaded output voltage. Care must be exercised during this measurement because some amplifiers cannot be driven to maximum power with a no load condition for more than a few seconds without damage.

4.5 HARMOMIC DISTORTION

Harmonic Distortion or THO (total harmonic distortion) is determined by measuring and summing the amplitude level of the various harmonics that occur when a single, pure tone is passed through an amplifier.

Harmonic distortion is generally plotted against frequency at different power levels across the audio spectrum. The following procedure describes one method of measuring harmonic distortion. Procedures

CHAPTER FIVE

SUMMARY CONCLUSION AND RECOMMENDATION

5.1 SUMMARY AND CONCLUSION

In the previous chapters, test signals have been defined, an overview of high efficiency audio amplifiers has been given, and some new amplifier topologies have been introduced. Especially in a practical research area like this, it is important to know how this work relates to other work in the field, both in industry and at universities. The next section deals with such a comparison. In the last section, the tendencies are extrapolated, and some educated guesses are made concerning the future developments of high efficiency audio amplifiers.

5.2 PROBLEMS ENCOUNTERED

During the course of designing this system there were series of problems uncounted during the experimentation which came on the way of achieving the desired goals of this project.

5.3 RECOMENDATION

I strongly recommend that government should set up industries for production of basic electronic component locally and to establish a research centers in each Universities, Polytechnics, College of education and other institutions to enable students have a good sound partial knowledge on the usage of electronic components and their operation given enough in sight on how to fabricate some component in other to fulfill their means

Also, the government should be able to make indefinite friendship to all concerns center for learners.

I finally recommend that this frame work should be implemented for the use at all levels.

[9] Matti Otala, Jorma Lammasniemi "Intermodulation at the amplifier loudspeaker interface", Wireless World, pp. 45-7 Nov. 1980 and pp. 42- 4 Dec. 2006.

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