# GRAPHIC EQUALIZER AND POWER AMPLIFIER

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This Report Is Submitted In Partial Fulfillment of Requirements for the Bachelor of Electronic Engineering with Honours (Industrial Electronic)

Fakulti Kejuruteraan Elektronik Dan Kejuruteraan Komputer
Universiti Teknikal Malaysia Melaka

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FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

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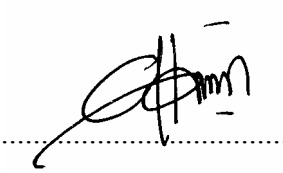

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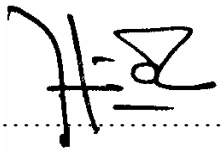

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Date : 27 APRIL 2007

*Special dedicated to my beloved family who always beside me the entire of my life*

*A million thanks to all of u….*

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## ABSTRACT

Commercial audio amplifiers are now technologically advanced. An audio amplifier system consists of subsystems such as pre amplifier, graphic equalizer and power amplifier.

This part of project is to design, and constructs a graphic equalizer and power amplifier suitable for used in such an audio amplifier system.

The graphic equalizer is a circuit for adjusting the tonal quality of the audio signal that passes through it. For this project a 6 band graphic equalizer was designed and constructed.

An audio power amplifier was also constructed. It was designed to amplify the signal output of the graphic equalizer and make it suitable for driving an 8 ohm loud speaker. The power amplifier that was constructed and designed rated is 25 watt.

The graphic equalizer and power amplifier will be combined with a pre-amplifier and a power supply unit to complete the audio amplifier design.

# ABSTRAK

Penguat sistem audio komersial dengan reka cipta teknologi terkini amat canggih. Ianya dilengkapi dengan pelbagai subsistem seperti pra penguat, pengimbang bunyi grafik, penguat kuasa, dan litar pengurangan bunyi hingar.

Projek ini adalah bertujuan untuk merekabentuk sebuah pengimbang bunyi grafik dan penguat kuasa yang terdapat dalam sistem penguat audio. Kedua-dua peralatan ini bertujuan untuk mengolah dan menukar gelombang keluaran dan mengeluarkan bunyi seperti yang dikehendaki oleh pengguna.

Pegimbang bunyi grafik adalah litar yang digunakan untuk mengubah frekuensi audio mengikut kehendak pengguna. Setiap frekuenci yang diubah akan menghasilkan bunyi yang berbeza dari system penguat audio. Bagi projek ini 6 penapis frekuensi jalur direkabentuk sebagai satu pengimbang bunyi grafik. Litar pengimbang bunyi ini diuji, dianalsis dan dibina.

Penguat kuasa pula adalah litar yang digunakan untuk membesarkan isyarat keluaran dan membolehkan bunyi yang kuat dihasilkan. Penguat kuasa yang direkabentuk juga adalah sesuai untuk mengeluarkan isyarat keluaran yang sesuai untuk dikendalikan oleh alat pembesar suara 8 Ω.

Litar pengimbang bunyi dan penguat kuasa yang direka akan digabungkan dengan litar pra penguat dan bekalan kuasa yang sesuai untuk melengkapkan rekabentuk sistem penguat audio.

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| | |
|---|---|
| IC | Integrated circuit |
| CD | Compact disk |
| FET | Field effect transistor |
| MOSFETS | Metal-oxide-semiconductor field effect transistor |
| dB | Decibel |
| DVD | Digital video decoder |
| Hz | Hertz |
| AC | Alternative current |
| DC | Direct current |
| DTS | Digital theater system |
| EQ | equalizer |
| DPL | Digital pro logic |
| PCB | Printed circuit board |
| TR | Transistor |

## LIST OF APPENDIX

# CHAPTER I

# INTRODUCTION

## 1.0 PROBLEM STATEMENT

An audio amplifier is a necessity to our everyday life. It has become a tool for entertainment and relaxation. Audio amplifiers are used in computer systems, home music systems, home theater systems and for amplifying sounds from musical instruments such as guitar, organ and other computer related instruments.

Because of this a reliable high fidelity audio amplifier should be made easily available. Commercial amplifiers are technologically advanced. Knowledge into the design of such an amplifier should be emphasized. The overall aim of this project is to study and design an audio amplifier system

## 1.1 THE AUDIO AMPLIFIER

An audio amplifier is an electronic amplifier that amplifies low-power audio signals (signals composed primarily of frequencies between 20 hertz to 20,000 hertz, the human range of hearing) to a level suitable for driving loudspeakers and is the final stage in a typical audio playback chain.

The preceding stages in such a chain are low power audio amplifiers which perform tasks like pre-amplification. Equalization, tone control, mixing/effects, or audio sources like record players, CD players, and cassette players. Most audio amplifiers require these low-level inputs to adhere to levels.

Early audio amplifiers were based on vacuum tubes also known as valves. Most modern audio amplifiers are based on solid state devices like transistors, FETs and MOSFETs, but there are still efficient who prefer tube based amplifiers, as they have a 'warmer' sound due to a more linear V/I curve characteristic. Audio amplifiers based on transistors became practical with the wide availability of inexpensive transistors in the late 1960s.

In the new era, the digital circuits have been leading the way. From this more modification are being introduced and implemented. By taking many advantages from the digital circuits, designers are trying to design more sophisticated and better audio amplifier. Old analog control is being replaced by the powerful digital control system progressively. Nowadays, audio amplifier systems come out with many outstanding features, specifications and performance. Dolby noise reduction circuit has been incorporated to achieve superior signal to noise ratio, graphic equalizer for frequencies compensation and surround sound system for better stereo imagination and reality. Additional functions such as karaoke, mixer, sing along, benchmark of singing are provided in certain audio amplifier depends on its application.

The important applications of audio amplifiers are in public address systems, home and car sound systems. The sound card in a personal computer contains several audio amplifiers (depending on number of channels), as does every stereo or home-theatre system. Example of audio amplifier suitable for home used shows in figure 1.

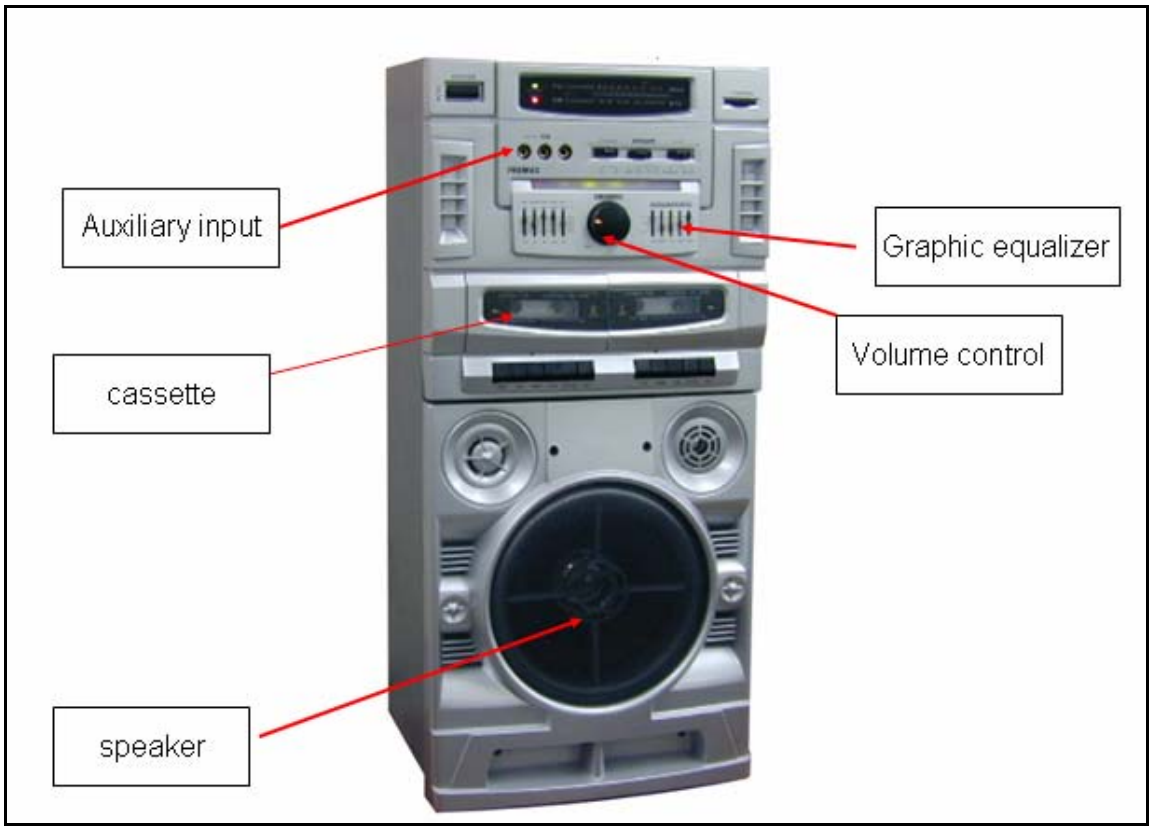


**Figure 1** *Audio amplifiers system*

The current amplifier solves the output problem by following the voltage amplifier with a circuit which gains the current (and hence, load driving capacity) without internal voltage gain. The current amplifier is low in noise because of the absence of internal voltage gain. It is also low in distortion because of its high speed. It will get all of the speed and power out of transistors that they can handle.

## 1.2 OPERATION OF THE AUDIO AMPLIFIER

The general purpose of design amplifier is to amplify the signal output from signal input through speaker. The block diagram below show basic audio amplifier system:

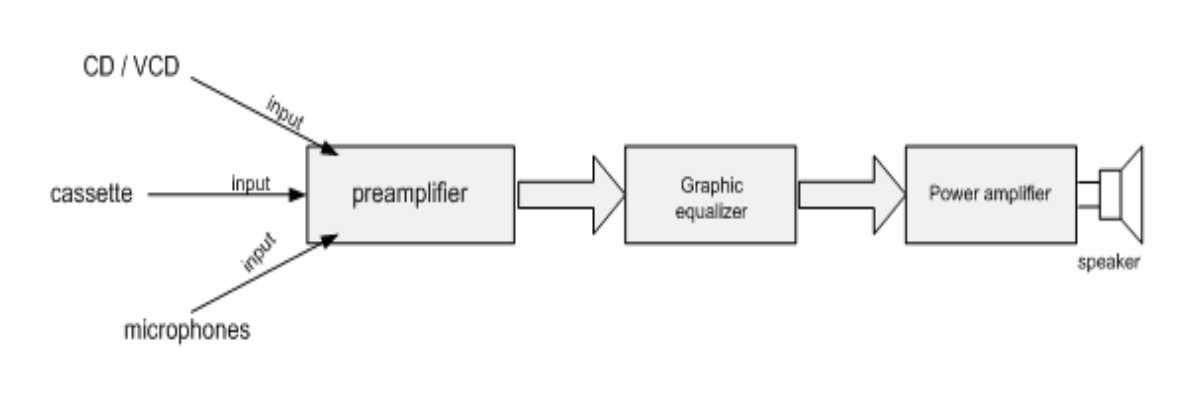


**Figure 1.2** *Block diagram for audio amplifier system*

Refer to figure 1.1, the block diagram show a subsystem in an audio amplifier system. The function of pre amplifier is to boost signal to graphic equalizer. After that, the graphic equalizer controls the signal by adjusting the frequency response. A power amplifier was function to increase the strength of the audio signal from graphic equalizer through the loud speaker. The speaker is function to convert audio signal to sound.

The terms amplify basically means to make stronger. The strength of a signal (in terms of voltage) is referred to as amplitude. There are 3 types of amplification for amplifier:

- Voltage amplifier- an amplifier that boosts the voltage of an input signal
- Current amplifier- an amplifier that boosts the current of a signal
- Power amplifier - the combination of the above two amplifiers

Key design parameters for audio amplifiers are frequency response, gain, noise, and distortion. These are interdependent, increasing gain often leads to undesirable increases in noise and distortion. While negative feedback actually reduces the gain, it also reduces noise, and distortion.

### 1.2.1 General characteristic of amplifier

**i) Power gain**

The gain is the ratio of output power to input power, and is usually measured in decibels (dB). (When measured in decibels it is logarithmically related to the power ratio: G (dB) =10log (Pout/Pin)).

**ii) Output dynamic range**

Output dynamic range is the range, usually given in dB, between the smallest and largest useful output levels. Since the lowest useful level is limited by output noise, this is quoted as the amplifier dynamic range.

**iii) Bandwidth and rise time**

The bandwidth (BW) of an amplifier is usually defined as the difference between the lower and upper half power points. This is therefore also known as the −3 dB BW. Bandwidths for other response tolerances are sometimes quoted (−1 dB, −6 dB etc.).

The rise time of an amplifier is the time taken for the output to change from 10% to 90% of its final level when driven by a step input.

**iv) Settling time**

Time taken for output to settle to within a certain percentage of the final value. This is usually specified for oscilloscope vertical amplifiers and high accuracy measurement systems.

**v) Slew rate**

Slew rate is the maximum rate of change of output variable, usually quoted in volts per second (or microsecond).

**vi) Noise**

This is a measure of how much noise is introduced in the amplification process. Noise is an undesirable but inevitable product of the electronic devices and components. It is measured in either decibels or the peak output voltage produced by the amplifier when no signal is applied

**vii) Efficiency**

Efficiency is a measure of how much of the input power is usefully applied to the amplifier's output. The efficiency of the amplifier limits the amount of total power output that is usefully available. Note that more efficient amplifiers run much cooler, and often do not need any fans even in multi-kilowatt designs.

**viii) Linearity**

An ideal amplifier would be a totally linear device, but real amplifiers are only linear within certain practical limits. When the signal drive to the amplifier is increased, the output also increases until a point is reached where some part of the amplifier becomes saturated and cannot produce any more output; this is called clipping, and results in distortion.

Linearization is an emergent field, and there are many techniques, such us feed forward, pre-distortion, post-distortion, and many more in order to avoid the undesired effects of the non-linearity.

### 1.2.2 Audio Amplifier Controls

These fall into a variety of categories:

- Gain controls needed to adjust the signal level between source and power amplifier stages
- Tone control used to modify the tone characteristic of the signal chain
- Filters employed to remove unwanted parts of the incoming signal, and those adjustments used to alter the quality of the audio presentation, such as stereo channel balance or channel separation control

#### 1.2.2.1 Improving High fidelity

**Digital-to-digital transmission technology**

Clearly high-resolution sounds (multi-channel and 2-channel) from DVD-Audio and SACD have enhanced the realism of listening to music at home. But some of the fine details are lost in the digital-to-analogue conversion and subsequent analogue transfer from the player to the amplifier, where possibly an additional analogue-to-digital conversion is performed for extended digital signal processing. Now, the VSA-AX10i-S includes the very latest I. LINK interface, the new industry standard for digital-to-digital audio transmission. Paired with a specialized 'Mercury' chipset co-developed with Texas Instruments Inc., I. LINK supports device-to-device digital audio data transfers including operational commands. With pure digital transfer where without data loss we will hear information from recordings as never before. Simply stated, this advanced digital audio processing translates into one digital cable instead of multiple analogue cables. I. LINK-equipped component, for example a DVD-Audio/Video/SACD player, to handle multi-channel DVD-Audio and SACD discs, not to mention digital audio from DVD-Video and CD, in all compressed and uncompressed formats for the first time in the entire history of audio amplifier.

Advantages using ILINK connectivity:

- **Professional-quality 32-Bit Digital Signal Processing**

It uses 32-bit Sharc and 24-bit double precision where it is equivalent to 48-bit Motorola DSP engines, such as those found in pro audio equipment. These devices process the data with extreme precision, enhancing multi-channel sound decoding and processing.

- **Ideal DVD Audio Converter**

Highly accurate 96 kHz/24-bit A/D converters on all eight channels individually to precisely reproduce DVD-Audio and SACD sound sources when using players with 6-channel analogue outputs. For two-channel analogue sources, four A/D converters are used for each channel. This ensures truly superb 2-channel stereo reproduction for the very best high fidelity performance. Of course, directly routing the analogue input to the power amplifier is equally possible.

- **Innovative Frame Design Concept For Superior Support**

This revolutionary chassis design fixes all parts to a 3-D frame instead of the weaker 2-D frame. So the unit has the strength to support the 10 kg transformer, as well as allow optimum functionality of each part. In addition, the chassis is copper-plated to suppress signal interference between circuits and reduce impedance.

- **Concentrated Direct Construction Design**

To minimize signal interference, each circuit is separated – allowing a more direct signal route. This concentrated direct construction works simultaneously with the 3-D space frame to create an extremely pure signal transmission with an open and fresh sound.

- **Easy Connection And Simple Conversion**

With this flexible video converter feature, hooking up video components is foolproof. There is no need to connect every terminal to the amplifier because it converts the input video signal to all available video output terminals except component to S-Video or composite video. With a selection of connection options