1. Revised Objectives

The IPRO 344' objective is

1.1 Study commercially available Class D amplifiers with a focus of audio quality and noise.

1.2 Study and comparison of commercially available conventional Class AB/B amplifiers with similar specifications and constraints.

1.3 Build a Class D amplifier using readily available circuits/subsystems.

1.4 Continue research on an observation of voltage requirements in Class D amplifiers

1.5 Examine McDonald's current audio environment and apply the obtained knowledge to help provide a global business solution to their drive through ordering systems

2. Result to Date

2.1 CLASS D Amplifiers and their Benefits

The Amplifiers are classified into letter grades based on how the original waveform is amplified. Class A amplifiers' output devices are conducting for the entire period of the cycle, which means there is always bias current flowing in the output devices even when they do not really need it. This brought inefficiency, but gives linearity into the device. The output devices of Class B amplifiers only conduct for half the sinusoidal cycle. Thus no input signals, no current flows in the output. However, this has some issue with linearity at some point. Class AB amplifier is a combination of the Class A and B types, and one of the most common types of power amplifier. Non-linearity of Class B and the efficiencies of a Class A design has improved. Efficiency for Class AB amplifiers is about 50 % and up to 75% at its maximum. In Class D amplifier, the switches are either fully on or fully off, theoretically making power dissipation zero in the "off" state. Efficiencies more than 90% – as shown in Figure 1- are possible. With a PWM carrier signal which drives the output devices, the audio signal will be modulated, and a low pass filter will remove the high frequency PWM carrier frequency in

the last stage. Due to its high efficiency, Class D amplifier reduces heatsink requirements dramatically. Therefore they do not need heavy heatsinks such as big aluminium extrusions to keep the electronics relatively cool. The loading on the power transformer is also reduced, allowing the use of a smaller transformer for the same power output. Thus Class D amplifiers are lighter and smaller than an equivalent Class AB amplifier. Historically, the usage of Class D amplifiers has been limited by their complexity compared to other amplifier types, and their sensitivity to Electromagnetic noise. However, thanks to recent improvements and design methods with faster switches, Class D amplifiers are regarded as a more attractive alternative of audio amplifiers.

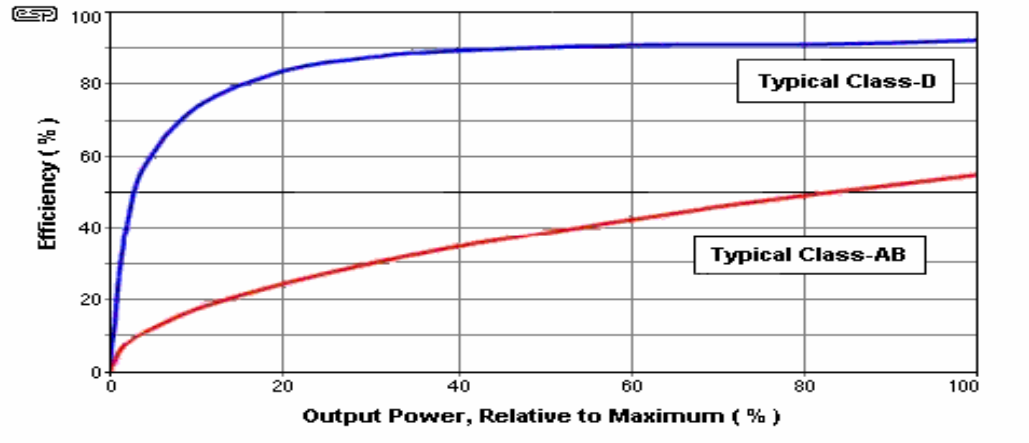

Figure 1. The efficiency for Class AB and Class D amplifier.

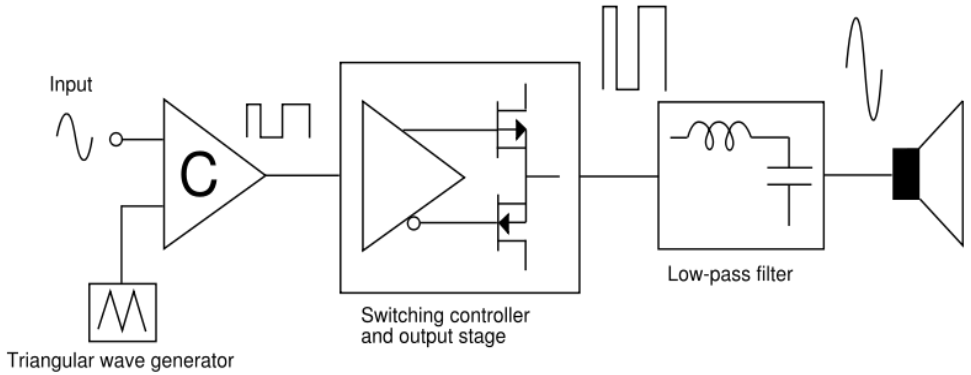

Figure 2. Functional Block Diagram of a class-D Amplifier.

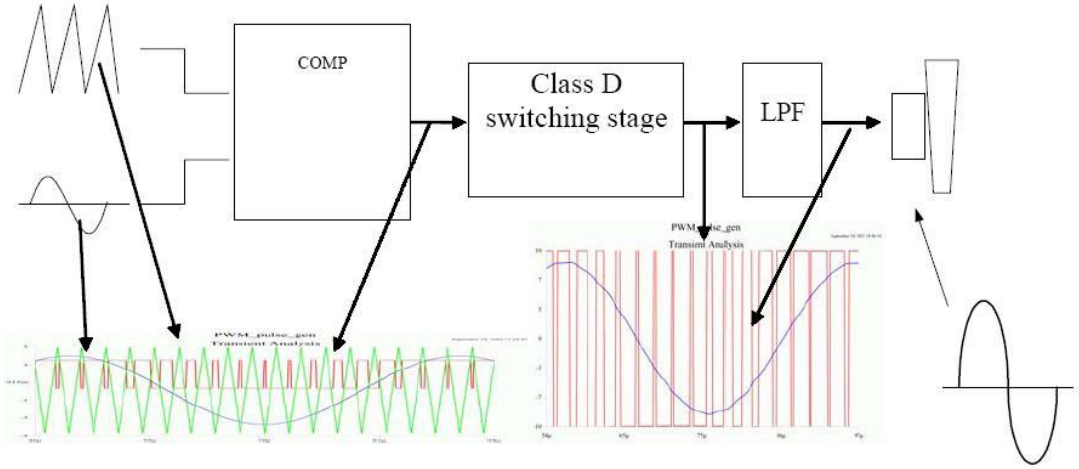

Figure 3. Class D amplifier waveforms

2.2 The Importance of Microphones –Noise Reduction

After carefully consideration, we prefer Shure WL185 Microphone (Figure 3), because it is good for general purpose sound reinforcement applications requiring good rejection of ambient noise. Also it has pretty good frequency response and relatively economical price. We highly recommend using of windscreen whose pickup angle is 130 degrees. Much more research will be done after visiting the Shure Radio Company.

Our Selection of equipments is:

- Shure WL185 Microphone
- Breadboards
- Post-Amplification Filter
- Harmonic Distortion Unit

Figure 3. Shure WL185 Microphone

We have Pre-Amplifier Design (Figure 4) and Filter Design (Figure 5).

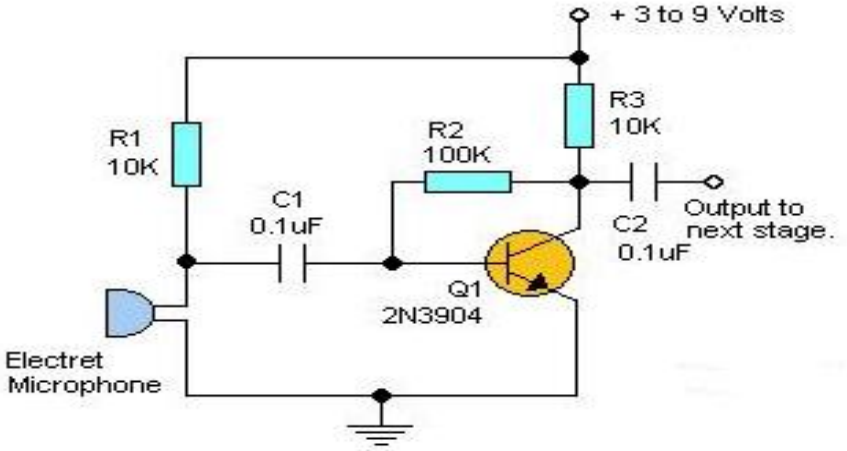

Figure4. Schematic of Pre-Amplifier

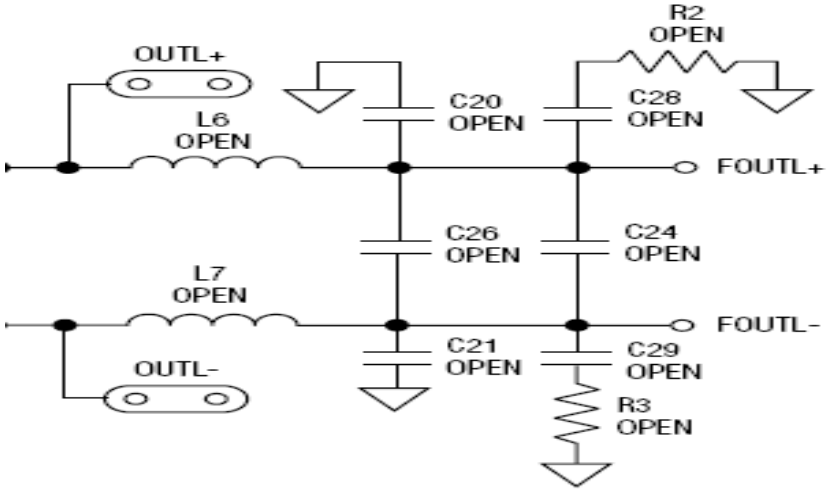

Figure5. Schematic of Filter

3. Revised Task / Event Schedule (Table 1)

3.1 IPRO Deliverable	Start	Finish
Project Plan	01/24/2008	02/22/2008
Code of Ethics	02/15/2008	03/07/2008
Midterm Presentation	03/03/2008	03/13/2008
Midterm Report	03/03/2008	03/14/2008
Final Report	04/21/2008	05/02/2008
Website	04/14/2008	04/25/2008
Abstracts	04/21/2008	04/25/2008
IPRO Poster	04/14/2008	04/25/2008
IPRO Day Presentation	04/21/2008	04/25/2008
Team Debriefing	05/05/2008	05/15/2008
Meeting Minutes	01/24/2008	04/18/2008

3.2 Milestones

Research	01/24/2008	04/22/2008
Parts Purchase	02/18/2008	03/28/2008
Filter/Preamplifier Design	02/05/2008	03/28/2008
Circuit Implementation	02/05/2008	04/22/2008
IPRO Day Preparation	04/14/2008	05/02/2008

Task Name	Start	Finish
IPRO Deliverable	Fri 1/25/08	Thu 5/15/08
Project Plan	Thu 1/24/08	Fri 2/22/08
Code of Ethics	Fri 2/15/08	Fri 3/7/08
Midterm Presentation	Mon 3/3/08	Thu 3/13/08
Midterm Report	Mon 3/3/08	Fri 3/14/08
Final Report	Mon 4/21/08	Fri 5/2/08
Website	Mon 4/14/08	Fri 4/25/08
Abstracts	Mon 4/21/08	Fri 4/25/08
IPRO Poster	Mon 4/14/08	Fri 4/25/08
IPRO Day Presentation	Mon 4/21/08	Fri 4/25/08
Tema Debriefing	Mon 5/5/08	Thu 5/15/08
Meeting Minutes	Thu 1/24/08	Fri 4/18/08
Milestones	Thu 1/24/08	Tue 4/22/08
Research	Thu 1/24/08	Tue 4/22/08
Parts Purchase	Mon 2/18/08	Fri 3/28/08
Circuit Design	Tue 2/5/08	Fri 3/28/08
Circuit Implementaion	Tue 2/5/08	Tue 4/22/08

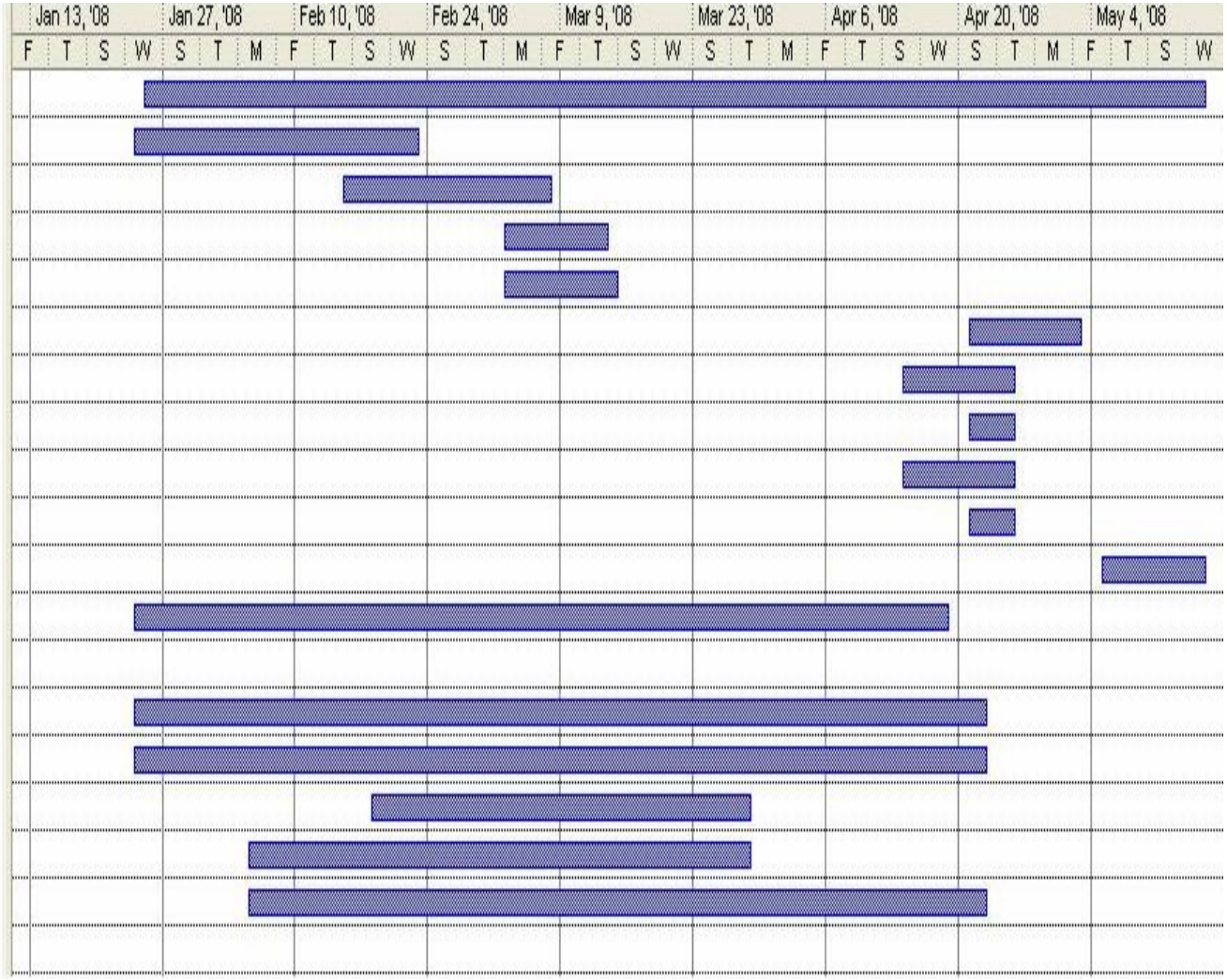

Table 1. IPRO 344 time table

4. Team members and Sub-team

Research Team

Gil-su Choi, Michael Mikulka, Hwansung Cho, Govind Wakhlu

The Research sub-team has completed their task of research in relevant fields of study of the different types of amplifiers. Based on the research, Class D amplifiers' many benefits has presented with comparison of Class AB and the other amplifier types.

Webpage Team

Jarrod Godfrey, Donald Spears, Yujin Park, Cheng Sun

Documentation Team

Yu Zhang, Noh Hyup Kwak , Nastasja Terry, Donald Spears

Purchasing Team

Michael Mikulka, Nastasja Terry

Implementation Team

Chang Do Song, Jarrod Godfrey, Hwansung Cho, Govind Wakhlu, Gil-su Choi, Noh Hyup Kwak, Michael Mikulka

The Implementation team has started their work from the beginning of this project in this semester. They have learned how to run the whole audio system from the previous team members. After building the preamplifier for the microphone and filter of the Class D amplifier during spring break or right after spring break, they would be able to analyze their performances.

Tools and Media Team

Cheng Sun, Yu Zhang, Donald Spears

Poster Team

Yujin Park, Yu Zhang, Govind Wakhlu, Hwansung Cho

Logistics & Attributes Team

Nastasja Terry , Govind Wakhlu