IPRO 344
Improving Energy-Efficiency and Offering Quality Audio in Mobile Devices
Objectives

• Study commercially available audio amplifiers
  • Efficiency
  • Audio Quality

• Things to focus on to improve efficiency in amplifiers
  • Voltage Regulation
  • Pre-amplifier Design

• McDonald’s Drive Thru Audio System
  • Research (Field Trips, Schematics)
  • Feedback (Microphones, Class D Speaker Design)
Team Introduction
Sub Teams

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Tools and Media Team
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Logistics & Attributes Team
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Presentation
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“Why worry about energy efficiency?”

- Apple reports cumulative sales of over **110 Million IPods**.

- Over **2 Billion Cell Phone** subscribers worldwide.

- US Households consumed over **1600 GWh per year** with portable rechargeable devices.

- ‘Vampire’ electronic behavior on the rise i.e. leaving electronic equipment powered up long after its usage.
Components of an Audio System

**Sampler**
This section uses a technique called sample and hold in order to create a quantized version of the original signal.

**PWM Generator**
This uses a comparator to compare the sampled signal against the above ramp function. When the sampled signal is less than the ramp, the comparator turns on.

**Class D Amplifier**
This low pass filter is required in order to convert the PWM signal to its original sinusoidal shape. It also has the effect of filtering out any high frequency noise that may have been introduced along the signal path.

**Class AB Amplifier**
Unlike the filter in the class D amplifier, this low pass filter is not required, although most designers incorporate it in order to wipe out any high frequency noise in the signal.

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Pre-amplification Stage  Amplification Stage  Filter Stage
**Advantage of Class D Amplifier**

### Traditional Amplifiers

- Since the traditional amplifiers have output devices that conduct even when “off.”
- This dissipates power, which means there is zero percent efficiency during this time.
- Class A/B has efficiencies of 25% to 50%.

### Class D Amplifiers

- Class D amplifiers operate in switching fashion.
- Power dissipation is theoretically zero. In the “off” state, current through the device is zero.
- Less power from the power supply, and this requires smaller heat sink.
- High power levels and small design.
- Efficiencies up to 97%.
• Reduction in size and weight of the amplifier
• Reduced power waste as heat dissipation
• Reduction in cost due to smaller heat sink and compact circuitry
• Very high power conversion efficiency, usually ≥ 90%.
Semester’s Achievements
The Components Used/Built - Microphone

• After carefully consideration, we prefer **Shure WL183** Microphone

• Omnidirectional (pick up angle is **360 degrees**)

• Low pick up noise

• Perfect for Drive Thru system where the position of the microphone is rendered unimportant.
The Components We Used/Built - PreAmplifier

- Used to amplify weak input electrical signals
- Active device
- Provide relatively significant voltage gain of
  ~ 27dB (23mv)
- Quality of sound retained; volume increased
Efficiency and Gain when R Load = 8 Ohms

Efficiency and Gain when R Load = 4 Ohms
The Components We Used/Built - Amplifiers

- Amplifiers increase the loudness of the sound. The gain of an amplifier is measured by $G(\text{dB}) = 10 \log\left(\frac{P_{\text{out}}}{P_{\text{in}}}\right)$.

- Efficiency is the amount of input power that is useful to the power output.

- In more efficient amplifiers there is less loss of energy so in turn less heat.

- Noise is also increased (linearly) with amplification, so more gain means more noise.
The Components We Used/Built - Filter

- A filter ‘allows’ sound at certain frequency to pass while restricting others.

- This restricts noise that is usually found at certain frequencies

- It also modulates the sound attenuating frequencies that might have had a large signal level.

- Insertion Loss is defined as the ratio between the signal level entering the filter to the signal level leaving the filter.
Accomplishments

- Procurement of essential amplifiers and circuitry
- Building Pre-Amp
- Building filter for amplifier
- Touring SHURE Labs to select appropriate microphone
- Modular design for components
  - Protected circuits
  - Interchangeable
- Code of Ethics established
  - Focusing in efficiency with low price for the community
  - Reporting all transactions
  - Putting Safety first at all times
  - Working with respect of others and putting effort
Future Opportunities

• Dynamic power source
• Speech recognition
• Filter/Preamp Optimization
• McDonald’s as possible sponsor
  • Improving Drive-Thru Experience
  • Increasing order efficiency
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Thank You