EECE 142
Fall 2002

EECE 142 - Laboratory #5
Discrete and IC Audio Amplifier

Purpose:

1. Design, build, and test an audio amplifier circuit to meet or exceed design specifications using discrete transistor technology.
2. Build and test a LM1875 audio amplifier.

Preparation:

1. What does "audio amplifier" mean or imply?
2. What does "discrete" mean or imply?
3. Design an audio amplifier using discrete transistors to interface between a 0.5 volt peak to peak sinusoidal input source and an 8 Ω - 7 Watt speaker. The amplifier should have a bandwidth of at least 100 kHz with a lower cutoff frequency no greater than 50 Hz. In addition, the amplifier should be able to provide at least 1 Watt of power to the speaker (at maximum volume).
4. Why design an audio amplifier with 100 kHz bandwidth if the human ear can not detect frequencies above 20 kHz?
5. What peak to peak voltage must be supplied to the 8 Ω speaker to deliver 1 watt of power?
6. What is the effect of the input resistance of the LSA on the operation of the SSA?
7. What is the overall TRANSFER FUNCTION for the designed amplifier? (See Sedra & Smith, 4th edition, Section 7.2, equation 7.9.)
8. Develop a procedure to BUILD, DEBUG and TEST the circuit(s).
9. Do PSpice or EWB simulations appropriate to the design of the discrete amplifier.
10. Obtain a data sheet on the LM1875 audio amplifier in your component kit. Review the application drawings and the information regarding thermal protection and heat sinking.

Experiments:

1. Build the audio amplifier using the discrete components.
2. Measure bias point values for all transistors in the circuit. *This can be a very important debugging/troubleshooting step, but only if you have documented that which you expect to achieve.*
3. Measure the amplifier's voltage gain as a function of frequency. Use a 10 Ω power resistor as the load (speaker).
4. Measure/calculate the power delivered to the load.
5. Measure/calculate the efficiency of your LSA stage.
6. Obtain a hard copy printout of the oscilloscope traces for input and output voltages at some frequency in the audio range which documents the maximum output voltage the amplifier can provide. This will show whether the desired output power can be obtained.
7. If the "total" amplifier does not appear to be working, it is VERY IMPORTANT to test (and document test results) for each stage of the amplifier. *This too can be a very*

important troubleshooting stage. If your SSA-LSA cascade does not work "together" then test and document that each stage works properly by itself.

8. Connect the input of your amplifier to an audio source[1] and the output to an 8Ω speaker[2]. Adjust the volume of the audio source and make a qualitative judgement of the sound quality.
9. Build the audio amplifier using the LM1875 IC. Repeat steps 4, 6, and 8.

Post-Lab Questions:

1. With respect to the discrete amplifier
   a. Tabulate the designed (for) and measured bias point values and the % difference between desired and achieved. Comment.
   b. What was the measured power delivered to the load? How does the measured value compare to the designed value?
   c. What was the efficiency of LSA amplifier stage? How could this efficiency be increased?
   d. Plot $|A_v(f)|_{dB}$ for the discrete transistor amplifier.
   e. QUANTITATIVELY compare the results from your measured data with the expected response from your design and simulations. What is the midband voltage gain for the amplifier as constructed? How does that compare with the expected midband voltage gain? What are the lower and upper cutoff frequencies for the amplifier as constructed? How do the values for these frequencies compare with the expected values?
   f. Write the TRANSFER FUNCTION for the amplifier as constructed. How does that compare with the expected TRANSFER FUNCTION for the amplifier?
   g. Does the audio amplifier meet (or exceed) the stated design specifications? If the amplifier (as built) does not meet specifications, discuss possible reasons why that is so and propose modifications that might be used to bring the amplifier into compliance with stated specifications. Show a revised schematic for the next round of testing.
   h. Describe a method that could be used to actually test the "sound quality" of the discrete transistor audio amplifier.
   i. Using the 0.5 volt peak to peak input, describe how a volume control could be incorporated into your design.
2. Compare the discrete and the IC audio amplifier.

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[1] A tape player, a small radio, or a CD player with a suitable output jack.

[2] 8Ω speakers are available in the lab.

Written Report:

Due: October 24, 2002

Write a report concerning the amplifiers designed, built, tested, and evaluated in Labs 3, 4 & 5. Assume that the audience for this report is a group of your peers (Electrical Engineering students). Follow the report outline given below.

Title Page

Separate page with report title, names, date, TA, Professor, lab section number, and course number.

Abstract

The Abstract summarizes the report. It should provide a concise description of the purpose or objective, the most important results, and the main conclusion(s). The Abstract should be understandable by itself; that is, it should stand alone. It is recommended that the Abstract be written after the main body of the report is finished.

Table of Contents

Separate page. The Table of Contents should list all the first and second level headings and the page on which they occur.

Problem Statement

The Problem Statement accurately describes the objectives. All constraints are also included in this section.

Procedures

This section describes how the amplifiers were designed, built, and tested. Alternative designs should be discussed. Emphasize important issues such as impedance matching, effect of component variations, and distortion.

Results

Data should be presented in the most efficient and illustrative manner. Graphs, tables, hard copy, and/or discussions can be used. Comparisons between expected and actual results should be provided. (It is expected that this report will use materials that are included in your Laboratory Notebook. It may be appropriate to state conclusions in the written report while referencing detailed calculations or data which is located in this Notebook.)

Conclusions

Conclusions should directly address the Problem Statement and should be supported by the Procedures and Results. Be sure to distinguish between "global" and "case specific" statements. Recommendations, extensions, and/or improvements to the design should be included here.

References Document sources of published materials.

Appendixes Attachments.