ECE 212 Spring 2017 M / Th / F Names: _____

Circuit Analysis II Group A / B _____

# Lab 3: Building a Power Supply and a Stereo Amplifier

## Objectives

In this lab exercise you will build a regulated variable-voltage power supply and a 10-watt stereo amplifier. The power supply will be tested to ensure proper operation, and it will be used to power the stereo amplifier. A number of measurements will then be performed to ensure that the amplifier behaves as expected.

## Pre-Lab Instructions

*Readings*

1. Read the *Soldering Instructions* in the Appendix for a description of proper soldering techniques. (These instructions were for a digital multimeter kit, so ignore any mention of a multimeter.) Good soldering connections will be vital in the construction of the power supply and the stereo amplifier.

*Gain Calculations for the Stereo Amplifier*

1. In PSpice, simulate the circuit shown in Figure 1. Print the waveforms of the input and output voltages, $V_{in}$ and $V_{out}$, as well as the circuit schematic. (**NOTE: Your name must appear in the filename at the top of all waveform printouts!**)

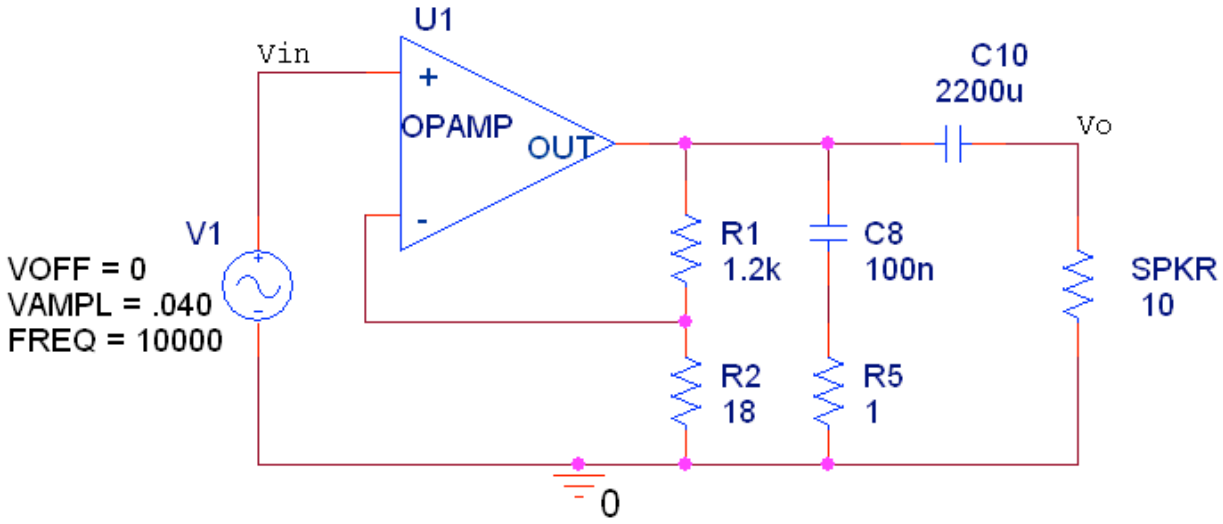



*Figure 1: Simplified Schematic for One Channel of the Stereo Amplifier*

2. Record the amplitude of the output voltage and find the gain (Vo/Vin).

Vo: _____

Vo/Vin: _____

## In-Lab Instructions

*Part One: Constructing the Regulated Variable-Voltage Power Supply*

1. Each group will be given a power supply kit. This kit will contain an instruction manual. Following the instructions carefully, build the power supply. Here are some notes to aid in the correct construction of the power supply:

- Read the instructions carefully.
- Make sure the LED, capacitors, and diodes are all facing the correct way.
- Bend the legs of the IC away from each other, so they do not get soldered together.
- When connecting the power cord, make sure the heat shrink tubing is slid onto the wire before soldering. Also, make sure to slide the cord through the hole in the face plate before soldering.

Before enclosing the power supply in its housing, have a TA check the wiring and the soldering. Once the wiring has been approved, place the power supply in its case and plug it in.

**** DO NOT PLUG THE POWER SUPPLY IN BEFORE THE TA HAS CHECKED IT. ****

2. Using the digital multimeter, record the output voltage when the voltage knob is turned to "MIN."

$V_{min}$ _____

3. Using the digital multimeter, record the output voltage when the voltage knob is turned to "MAX."

$V_{max}$ _____

*Part Two: Constructing the 10W Stereo Amplifier*

1. Each group will also be given a stereo amplifier kit. Unlike the power supply kit, this kit does not have a step-by-step instruction manual. Instead, it has a list of parts, a picture of the completed design, and a circuit board that is marked to show which part goes where. The advice given in the manual is to solder the shortest elements first (the resistors, smaller capacitors, etc.) before soldering in the taller elements. Also, **do not overheat the IC**, since it is sensitive to heat and may be damaged. You may want to solder only one or two pins at a time and then wait for the chip to cool down before soldering additional pins in order to minimize the amount of heat going into the IC. **NOTE: You will <u>not</u> be using the 56 ohm resistors the kit comes with**; **use the 18 ohm resistors instead. As before, have a TA check the circuit before proceeding.**

2. Set the power supply you built in the previous section to 12V (as measured on the digital multimeter), and then unplug the power supply. Attach the outputs of the power supply (+ and –) to the input voltage terminals (V+ and GND) on the stereo amplifier. Connect a 4V peak-to-peak sine wave at 1000Hz from the function generator to the input of the voltage divider (Vin) as shown in Figure 2. The stereo amplifier has two channels. Channel 1 contains an IN1 and a corresponding OUT1. Likewise, Channel 2 has an IN2 and OUT2. The output of the voltage divider will be the input into the first channel (IN1) of the stereo amplifier (the ground from the function generator should be connected to the INPUT GND terminal). Connect a 10Ω, 10W resistor across the output of the stereo amplifier (i.e., from OUT1 to the output ground). Plug in the power supply and record the peak-to-peak output voltage.

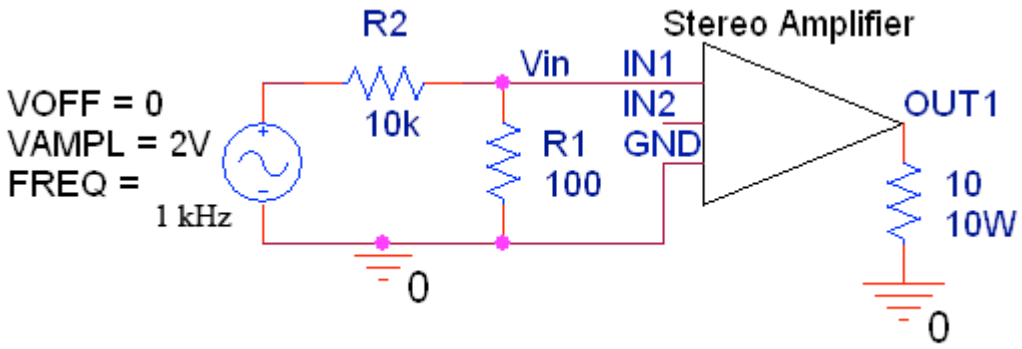



*Figure 2: Circuit for Determining Gain of Stereo Amplifier*

$V_{out}$ (peak-to-peak) _____

3. The gain of the amplifier will be the peak-to-peak output voltage divided by the peak-to-peak input voltage. Calculate the gain.

Gain ($V_{out}/V_{in}$) _____

What is the percent error from the expected gain of 68?

Percent Error _____

Gain can also be specified in decibels. To find the gain in decibels take the base 10 logarithm of the ratio of output to input voltages found above, and multiply the result by 20, i.e., Gain (dB) = 20 $\log_{10}$ (Gain ($V_{out}/V_{in}$)).

Gain (dB) _____

Is there any phase shift between the input and output voltages?

4. Unplug the power supply and switch the output of the voltage divider to the second input channel (IN2). Do not forget to switch the output to OUT2 as well. Now that the stereo amplifier is running on channel 2, plug in the power supply and record the peak-to-peak output voltage, the gain, and the percent error of the gain (from the expected value of 68).

$V_{out}$ (peak-to-peak) _____

Gain ($V_{out}/V_{in}$) _____

Percent Error _____

5. When looking at the circuit diagram included with this kit, what purpose do the resistor/capacitor pairs C8/R5 and C9/R6 serve? (Hint: Read the operation section of the stereo amplifier.)

When you have completed the lab, sign and print your names below and have a TA initial next to each name.

Names TA

_____ _____

_____ _____

**Skills Assessment (5pts)**

Everybody must demonstrate that he/she can perform certain lab skills, as described below.

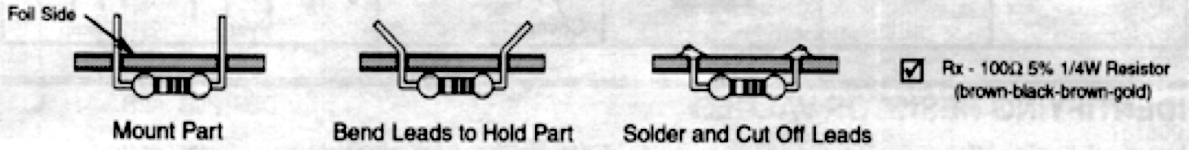
Fill in your names in the spaces provided. A TA will initial the appropriate space when a skill has been successfully demonstrated.

| | Name #1 | Name #2 |
|---|---|---|
| | _____ | _____ |
| 1. Show that the tip of the soldering iron is at the proper temperature for lead-free solder. | _____ | _____ |
| 2. Demonstrate how to solder the pins on an IC and the power wires. | _____ | _____ |
| 3. Explain why to keep the tip of the soldering iron tinned. | _____ | _____ |
| 4. Show how to keep the tip of the soldering iron tinned. | _____ | _____ |
| 5. Demonstrate how to desolder and how to use a copper wick. | _____ | _____ |

## Appendix: Soldering Instructions

### Assemble Components

In all of the following assembly steps, the components must be installed on the top side of the PC board unless otherwise indicated. The top legend shows where each component goes. The leads pass through the corresponding holes and the board is turned to solder the component leads on the foil side. Solder immediately unless the pad is adjacent to another hole which will interfere with the placement of the other component. Cut excessive leads with a diagonal cutter. Then, place a check mark in the box provided next to each step to indicate that the step is completed. Be sure to save the extra leads for use as jumper wires if needed.

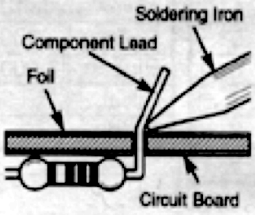



### Soldering

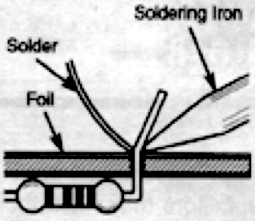
The most important factor in assembling your digital multimeter is good soldering techniques. Using the proper soldering iron is of prime importance. A small pencil type soldering iron of 25 - 40 watts is recommended. **The tip of the iron must be kept clean at all times and well tinned.** Many areas on the PC board are close together and care must be given not to form solder shorts. Size and care of the tip will eliminate problems.

For a good soldering job, the areas being soldered must be heated sufficiently so that the solder flows freely. Apply the solder simultaneously to the component lead and the component pad on the PC board so that good solder flow will occur. Be sure that the lead extends through the solder smoothly indicating a good solder joint. **Use only rosin core solder of 60/40 alloy.**
**DO NOT USE ACID CORE SOLDER!** Do not blob the solder over the lead because this can result in a cold solder joint.

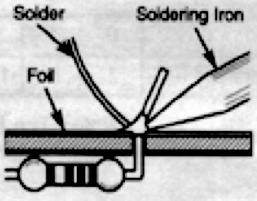
1. Solder all components from the copper foil side only. Push the soldering iron tip against both the lead and the circuit board foil.




2. First apply a small amount of solder to the iron tip. This allows the heat to leave the iron and onto the foil. Immediately apply solder to the opposite side of the connection, away from the iron. Allow the heated component and the circuit foil to melt the solder.




3. Allow the solder to flow around the connection. Then, remove the solder and the iron and let the connection cool. The solder should have flowed smoothly and not lump around the wire lead.

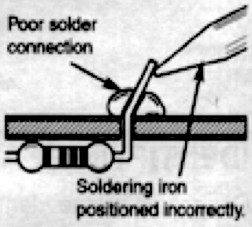



4. Here is what a good solder connection looks like. Cut off excess leads.

### Example 1

Poor solder connections occur when the lead is not heated sufficiently. The solder will not flow onto the lead as shown. To correct. reheat the connection and, if necessary, apply a small amount of additional solder to obtain a good connection.

Solder does not flow onto the lead. A hard rosin bead surrounds and insulates the connection.




### Example 2

A solder bridge occurs when solder runs between circuit paths and creates a short circuit. This is usually caused by using too much solder. To correct this, simply drag your soldering iron across the solder bridge as shown.