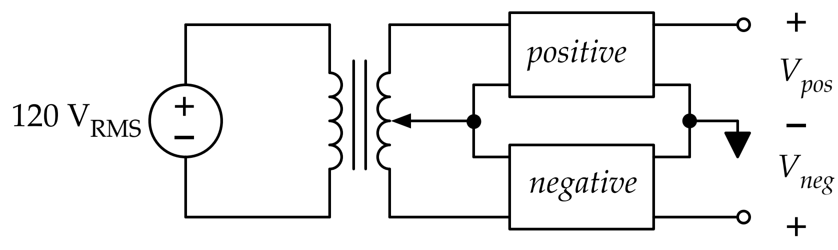
Power supply mini-project

This week, we finish up 201 lab with a short mini-project. We will build a bipolar power supply and use it to power a simple amplifier circuit.

1. power supply block diagram



2. Transformer

Transformers are available in the lab. These are 10:1 center-tapped step-down transformers, giving a secondary (output) voltage of about 12 V_{RMS}. By being center-tapped, the output is also available as two 6.0-V_{RMS} sinusoids. We will use the center-tapped feature to make the bipolar power supply.

The transformer is in a protective plastic case so that you don't electrocute yourself. You will need to steal a power plug from one of the other instruments on your lab bench to connect a 120 V_{RMS} outlet to the *primary* of the transformer. (The power cord from the older triple-output supply is a good candidate.) Once the transformer is plugged in, you must flip the switch to connect the power the secondary side of the transformer.

Check the voltages on the secondary side. There are three connectors there. Use the voltmeter to measure between the outer two connectors – it should be approximately 12 V_{RMS}. (Without any load to the secondary, the voltage is probably a bit higher — maybe 13 V_{RMS}.)The center connector is the center tap on the secondary. Measure between the center connector and each of the outer two connectors. Both should measure approximately 6 V_{RMS} — or a bit more.

Note: The transformer kit has a fuse. It is not unusual for the fuse to have been burned out by the previous (probably incompetent) users of the transformer. If you have connected the power cord and flipped the switch, but there is no AC voltage at the outputs, it is likely that the fuse is blown. Ask your TA to replace the fuse or take the entire transformer to the electronics shop and have someone there install a new fuse.

Observe the secondary voltages on the oscilloscope and confirm the 60-Hz frequency and the 12- and 6-V_{RMS} amplitudes. Don't be surprised if the waveforms are a bit deformed — transformers can introduce some distortion into the sinusoid. Record o a 6-V_{RMS} signal to include in your report.

3. Peak rectifiers

Build two peak rectifier circuits that will provide positive and negative DC voltages using the two 6-V_{RMS} secondary outputs from the transformer. You can use either half-wave or full-wave rectifiers. The center-tap connection will serve as the common connection (ground) for two DC voltages. You will have to arrange your diodes correctly so that you obtain a positive DC voltage from on side and negative DC voltage from the other. Also, be sure to connect the electrolytic capacitors with the correct polarity. (Spend a little bit of time thinking about proper polarities so that you you don't have to waste time running to the shop for replacement parts.)

To test the supplies, connect 1-kΩ resistors at each DC output. Measure the DC value of each source using the voltmeter. Then observe the positive source output with the oscilloscope and measure the ripple voltage. (You may need to change scales and zoom in to see the ripple voltage clearly.) Make sure that the ripple voltage is less than 10% of the peak voltage, $V_{ripple} \leq V_{peak}$. If the ripple is too big, change your circuit to reduce the ripple. Once the ripple is less than 10%, record an oscilloscope screen shot showing the ripple waveform. Repeat the measurement and adjustments for the negative side. Record a screen shot of the negative-supply ripple.

Use the voltmeter to record the DC voltages for both of the supplies. Then switch the voltmeter to AC volts and measure an RMS value of the ripple of each supply. (Since the ripple voltage is not a sinusoid, the value given by the meter will not be the same as the value using the oscilloscope. However, the voltmeter value is a quick measure for comparing the size of the ripple in different situations.)

When finished, remove the 1-kΩ load resistors.

4. Power an amplifier

Now build an inverting amplifier with a gain of -10 using an LM324 chip. Use your two DC supplies from above to power the op amp. Be careful with polarities so that you don't burn out the op-amp chip.

Connect the function generator – set to produce a sinusoid – to the input of the amplifier. Set the frequency at 1 kHz and set the amplitude to 0.25 V_{RMS}. Observe the amplifier input and output together on the oscilloscope. Slowly increase the input voltage amplitude until the output just begins saturate at the power supply limits, and then back off slightly so that the output sinusoid is at it maximum value without being distorted. Record a trace showing the input and output sinusoids together.

Use the multi-meter to measure the DC and AC voltages on each of sources with the amplifier circuit in place. Note any changes from the previous measurements where the supplies were loaded with just the 1-kΩ resistors.

Finally, attach a 1-kΩ resistor between the amplifier output and ground to serve as load. Re-check the sinusoid of the amplifier output. If needed, adjust the input amplitude so that the output is at its maximum value without being distorted. Then use the multimeter to measure the

DC and AC voltages on each of the supplies. Note any changes from the previous measurement when the amplifier output was not loaded.

Whoo hoo! You've made complete working circuit using just basic components. In EE 230 and later classes, you will refine all the parts of this voltage-supply/amplifier combination to make circuits that start to approach professional quality.

5. Report

Use the report template (available on the web site) to write a short report. Turn in the report before you leave the lab room. If you think you will need more time to finish the report, you should make arrangements with the grader for your section to turn the report later.