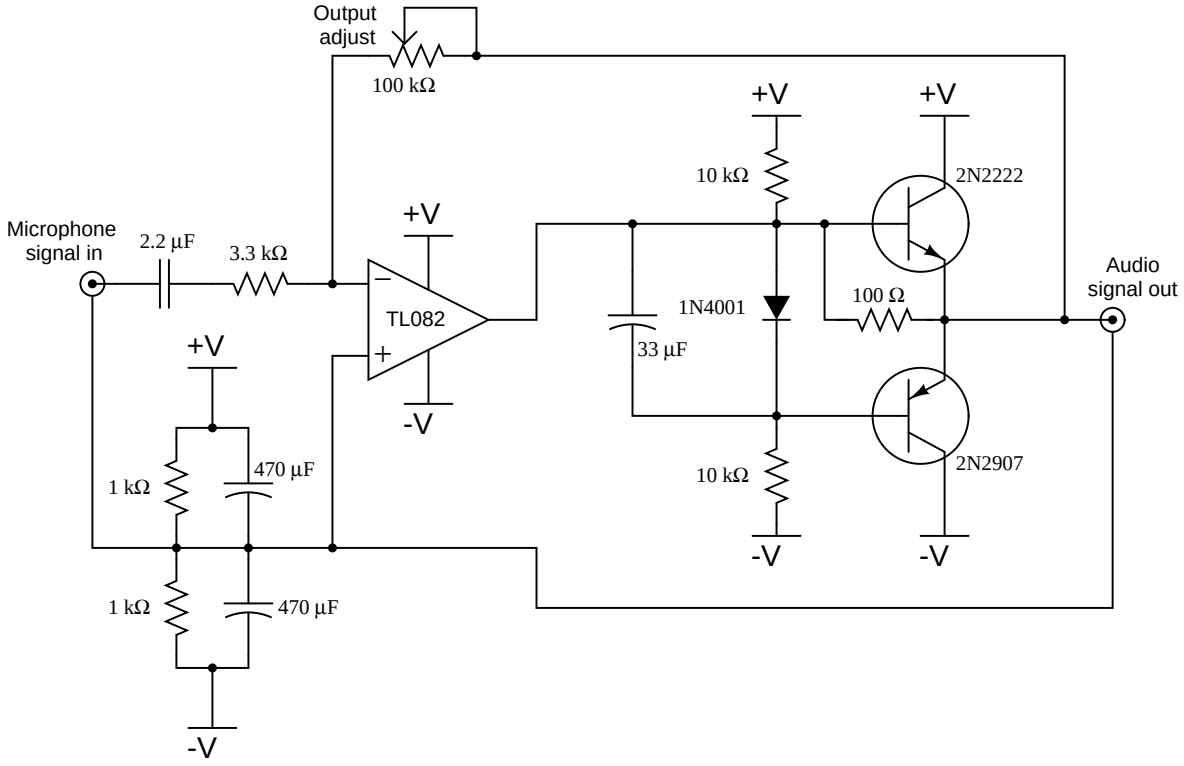
Design Project: audio media-based signal generator

Inexpensive audio media players (CD-audio, MP3, etc.) are capable of outputting high-quality sine wave signals throughout the audio frequency range, and therefore are capable of performing as part of a signal generator system useful in the testing of audio circuits. All you need is a recording of several sine wave tones of different frequencies, and an amplifier circuit to boost the media player's output to a voltage level reasonable for experimental work (at least a couple of volts RMS).

The following schematic diagram shows a suggested amplifier circuit that will work well for this purpose:



I have used power supply voltages of 12 volts (+V = +6 volts ; -V = -6 volts) and 24 volts (+V = +12 volts; -V = -12 volts), both with good success. Of course, you are not restricted to using this exact design – feel free to modify it!

Deadlines (set by instructor):

- Project design completed:
- Components purchased:
- Working prototype:
- Finished system:
- Full documentation:

Question 1

Identify some different ways you can create the sine-wave audio tracks necessary to turn the media player into a signal generator.

file 02269

Answer 1

Some computer programs will generate "wave" files (`.wav`) according to the wave-shape, amplitude, and frequency specified. Using a program such as this is one of the best ways to obtain the necessary audio tracks.

Notes 1

There are other ways to obtain good audio tracks, including recording the output of another signal generator. I have had such good success with the computer method, though, I can't imagine that recording an analog source – no matter how good that source may be – would do much better.

Incidentally, the program I use is a Linux application called `sox`. It is a general-purpose sound file converter utility that also happens to have a "synthesizer" mode where it can generate audio tracks. Using this utility, I created twenty sine-wave tracks and then burnt them to a CD-R, where I could then play the tracks using a cheap ($17.00, 2004 U.S. currency) CD-audio player. I found the best wave quality to be when the player's "anti-skip" mode was turned *off*.

Question 2

No ground symbols are seen anywhere in the schematic diagram, yet there are "+V" and "-V" labels for the two poles of the DC power supply. Where is ground in this circuit, and what establishes its potential?

file 02267

Answer 2

The voltage divider circuit comprised of two 1 kΩ resistors establishes the ground point.

Notes 2

Of course, this circuit could have been built with a "split" supply of +V/Gnd/-V, but it is much easier to find or build a simple "single" power supply!

Question 3

What purpose does the 1N4001 diode serve in this circuit?
file 02268

Answer 3

The diode serves to establish a small bias voltage between the two transistors' bases, to minimize the amount of crossover distortion.

Notes 3

Theoretically, the op-amp should be able to handle the "handoff" between the two transistors even with no bias voltage, but since no op-amp has an infinite slew rate, there will be some crossover distortion under load (such as when driving am 8 Ω speaker). Placing a bit of DC bias voltage between the two transistor bases helps push them closer to ideal class-B operation, giving the op-amp an easier time of managing the crossover periods.

Question 4

It may be important to *decouple* the power supply rails in this amplifier circuit, just as it is important to decouple the power supply rails in a variety of circuits where fast $\frac{dv}{dt}$ rates can exist, and/or when electrical noise is problematic. Explain what "decoupling" is, and what it does.

file 03967

Answer 4

To "decouple" the power supply means to place capacitors between the power supply rails to stabilize the DC voltage, shorting out AC noise and transient voltage spikes from interfering with the normal operation of the circuit.

Follow-up question: where do you think decoupling capacitors would be the most effective, located back at the power supply, or close to the power terminals of the operational amplifier and power transistors? Explain your reasoning.

Notes 4

I have seen the addition of decoupling capacitors turn a useless circuit into a flawless performer. In the case of an audio amplifier, DC power supply rails that are not properly decoupled may serve as feedback paths for unwanted signals, causing oscillations. These oscillations, if unchecked, may even *damage* the circuit!