Natural Radio

News, Comments and Letters About Natural Radio

July 2004

Summer has arrived in Illinois with thunderstorms, sferics and a record crop of mosquitoes that swarm about the E-Field antenna producing their own version of non-ionospheric chorus. Solar activity has been low as we are heading on the downward slope to solar minimum, and although I don't expect to hear much chorus, whistlers can still pop up at any time, especially with the increased thunderstorm activity.

On the web this month, Renato Romero has updated his website (http://www.vlf.it/) with some interesting articles: A construction project for a *Floating Solar Receiver*, an article on Earthquake Precursors, and an article on Earth Dipoles. As always, these articles are very worthwhile reading.

I am planning to monitor the Perseids meteor shower in August to see if I can detect the VLF sounds of meteors as reported by Colin Price and Moshe Blum in their paper at http://leonid.arc.nasa.gov/MS025.pdf. Also see my Natural Radio column in the February 2002 *Lowdown*. Price and Blum reported spheric like signals that came from the shower. The signals were about 10 ms. long as opposed to 1 ms. for distant spherics and about 20 db quieter than lightning induced spherics.

7 Tips For Using the LM386 Headphone Amplifier – Most of the available information on Natural Radio receiver design concentrates on the front end and filtering circuitry without much discussion of the headphone amplifier. The standard chip for the audio output stage in most commercial and homebrew receivers seems to be the National Semiconductor LM386 amplifier, and circuitry for using this chip is quite straightforward. However, based on my own experience and some discussions that came up on the web this week, it's easy to build a circuit that is prone to feedback and instability, especially when using voltage gains greater than 20. So, here is some information on the chip and 7 tips to avoid problems when you are

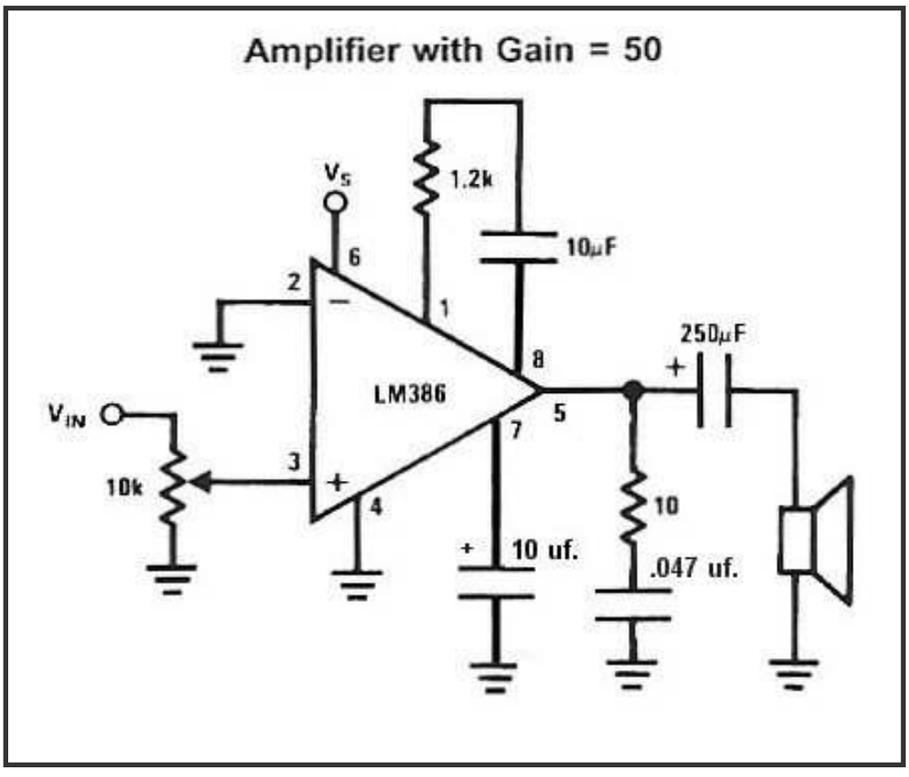

Figure 1 – Typical LM386 Amplifier Circuit

incorporating it into one of your projects.

This readily available chip runs on a supply voltage of 4 to 12 volts and typically can deliver 330 milliwatts of power to a speaker or set of headphones. It also has a bandwidth of 300 kHz., which means one must be careful about high frequency instability. Figure 1 shows a typical amplifier schematic from National's Application Notes.

This amplifier circuit has a voltage gain of 50. The components between Pins 1 and 8 on the chip set the gain of the circuit.

If Pins 1 and 8 are left open, the default voltage gain of the circuit is 20. If these two pins are connected with a 10 µf. capacitor, the maximum gain of 200 is selected. A resistor in series with the capacitor sets the gain between 20 and 200.

You can also tailor the frequency response of the amplifier. For more detailed information the data sheet is available for viewing or download on National Semiconductor's website at www.national.com/pf/LM/LM386.html, or simply search the web for "LM386".

Tip #1 – Bypass the power supply. It is important to bypass the power supply at Pin 6 on the chip. Typically, use a 250 µf. electrolytic in parallel with a .047 µf. monolithic or ceramic capacitor. The electrolytic bypasses the audio frequencies that may be present on the power supply line while the smaller capacitor bypasses the high frequencies that might not be shunted through the electrolytic due to its higher internal inductance. Again, keep these parts as close as possible to the chip.

Tip #2 – Bypass Pin 7 of the chip to ground with a 10 µf. electrolytic. This capacitor is shown as optional in the Application Notes, but it's worth using to gain additional isolation from the power supply, especially when using higher gains.

Tip #3 – Use as little gain as possible in the amplifier circuit. It is usually the best design procedure to distribute the total gain of the circuit over several stages. If you are getting sufficient headphone volume with the volume control one quarter of the way open, you have too much gain in the power amplifier stage. Using the minimum gain necessary will help greatly in avoiding feedback and instability.

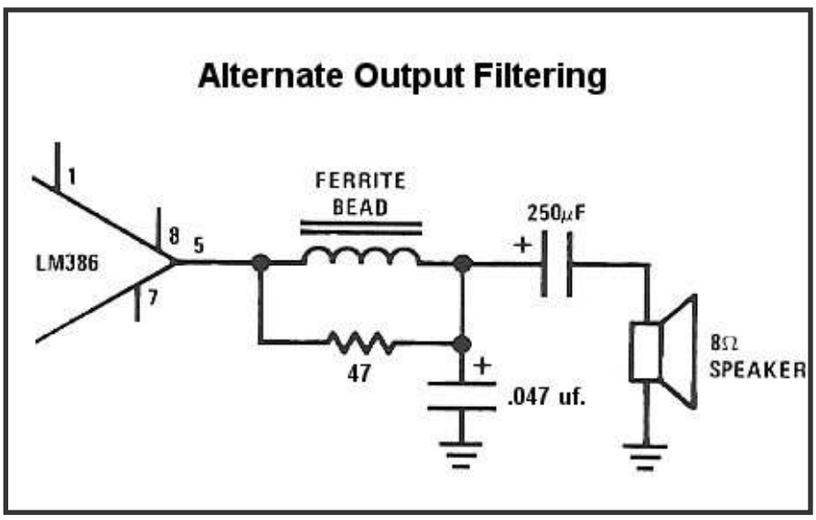

Figure 2 - Alternate Output filtering

Tip #4 – Use the suggested RC filter on Pin 5, the speaker output of the chip. This consists of a 10 ohm resistor in series with a .047 µf. capacitor placed between the output of the chip and ground. If you are still having problems, use the more

aggressive filtering technique shown in Figure 2. The inductor is a ferrite bead wound with three turns of wire.

Tip #5 – Keep all wiring short and keep the output leads away from the input leads. Take some time when you are designing the physical layout of your project to position the components so that all audio leads as short as possible. Position the headphone jack near the output of the chip, and keep the volume control and input circuitry away from the output leads.

Tip #6 – Return all external grounds to a common point near Pin 4 of the chip. The ground from the input, the battery, the output jack and the volume control should all be tied to a common point near the LM386. Do not "daisy-chain" your grounds. This could cause a "ground-loop" and possible feedback and instability.

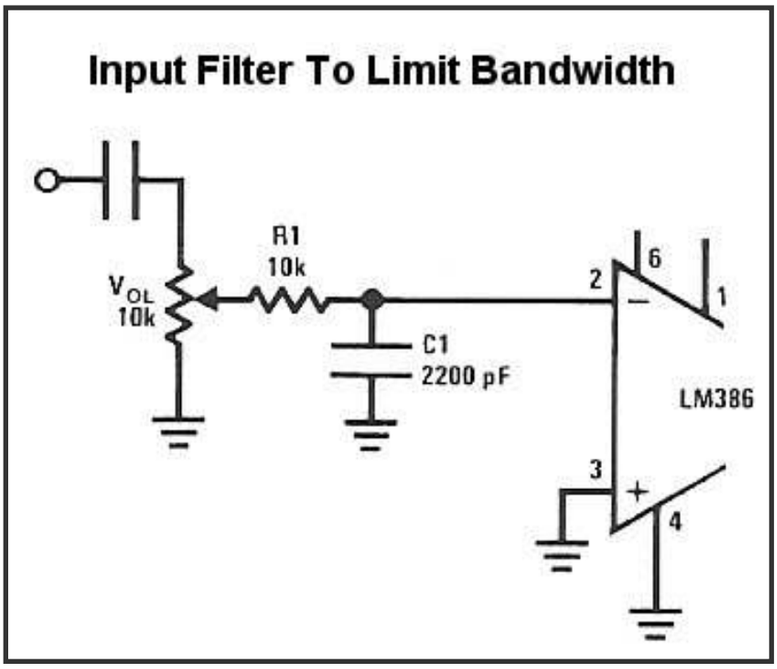

Figure 3 - Input Filter To Limit Bandwidth

Tip #7 – Filter the input signals to limit the bandwidth if necessary. If you are using high gain or if interfering signals are getting in on the front end, additional filtering may be necessary. Use the circuit shown in Figure 3 to limit the bandwidth of the amplifier and reject high frequency signals.

A Commercial LM386 Amplifier – If you don't feel like building your own LM386 amplifier, the Radio Shack #277-1008 unit is a low-cost solution. This unit is a bargain at $12.95 and contains an LM386 amplifier with a transistor front end for additional gain.

Figure 4 - Radio Shack Mini Amplifier

The unit operates on an internal nine volt battery and includes a jack for an external power source. There is a 1/8 phone jack for the input and another 1/8 phone jack for an external speaker or headphones. This jack disables the internal speaker. There is a combination volume control and power switch on the other side.

Adding a FET front end to this unit would be a quick way to build a simple Natural Radio Receiver.