An Audio Tone Indicator for Tuning or Antenna Measuring
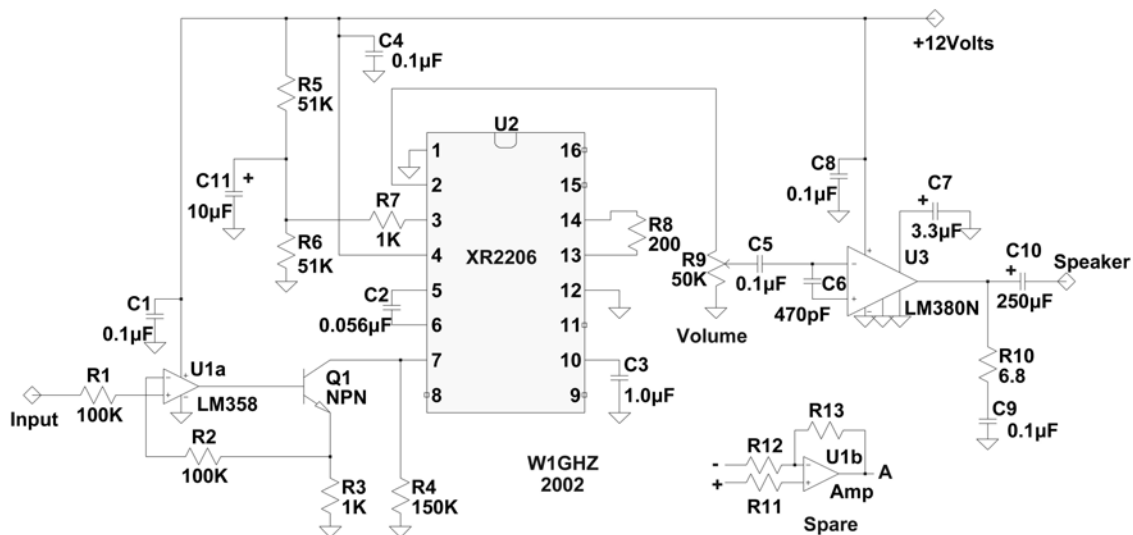
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While measuring antennas years ago, we found that it is difficult to point a large antenna and watch a meter simultaneously. I eventually made a box which converted the meter output into an audio tone whose frequency was proportional to the meter reading. This allowed peaking by ear, listening for the highest pitch. It worked very well, for all except a few tone-deaf individuals.

Last year, I was "snowflake" tuning a surplus microwave amplifier, sliding tiny bits of metal around the circuit to retune it to 10 GHz. Here again, it was hard to watch the meter while looking through a microscope to move the flakes. It occurred to me that the audio tuning box might help – but I couldn't find it. Since I have passed on the antenna measuring fun and equipment on to others, the box probably went along. I continued trying to tune the amplifier, but finally slipped while I was looking at the meter and let the smoke out.
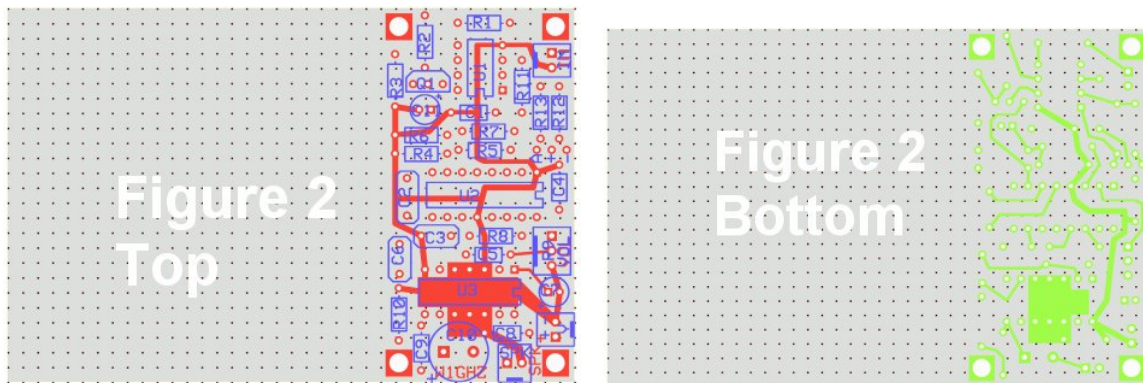
It was time to build a new audio tuning box. I found the schematic in an old notebook, dated 1977. The integrated circuits I used are still available 25 years later, but are better ones available now? Not really, unless we are trying to do something fancier, like a computer interface. For a simple circuit, the old stuff is fine.

I found data sheets on the web for the parts and made a few improvements to the circuit – I have learned a few things in the intervening years. The major improvement is a heftier audio amplifier. The original amp was in an 8-pin DIP package and would fail after a few hours at full volume in the hot sun. A 16-pin DIP package version has several pins for heat-sinking to the PC board and a higher power rating. The schematic diagram is shown in Figure 1.
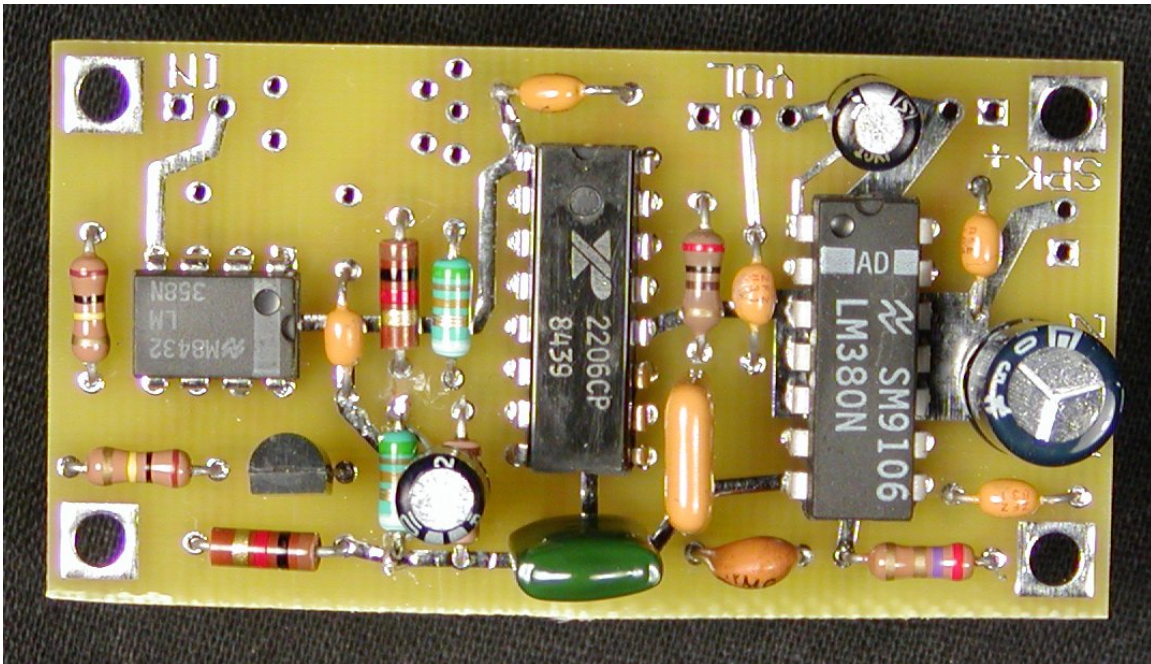
The heart of the circuit is the U2, the XR2206 waveform generator. The output is a nice sine wave, with frequency set by C2. The charging current for C2 is controlled through pin 7, which we vary to change the frequency. An op-amp, U1a, and a transistor, Q1, translate the input voltage to a current through R3 of one milliamp per volt. R4 provides a small leakage current to set the minimum frequency, since we can't hear zero. Resistor R7 sets the output AC from U2 to a voltage that won't overdrive U3, the audio amplifier, though it distorts a bit at max volume. R9 adjusts the volume, and C6 rolls off the highs — the best value depends on the speaker. R10 and C9 keep the audio amp from oscillating at dog-whistle frequencies, but the resistance isn't too critical if you can't find the exact value. The other half of U1 is available for experimenting; possible uses might be a peak indicator, or expanding part of a meter range for fine tuning.
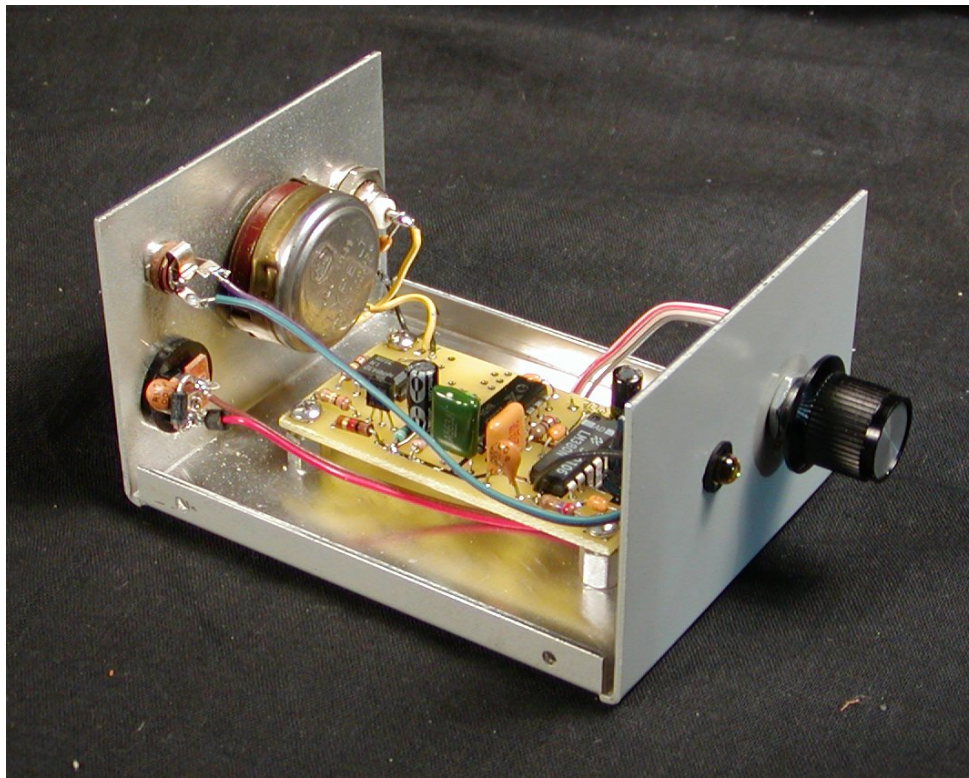
Since I've promised this circuit to a number of hams over the years, but never had an extra PC board, it was time to do a new layout. I recently used the ExpressPCB free software and quick prototype service (www.expresspcb.com) to make PC boards for the "Miniverter[1]," a bare-bones transverter. The circuit in Figure 1 is pretty simple, so the layout on a double-sided board isn't hard. All the components are on the top and the signal wiring on the bottom, except for a couple of short crossovers. The common ground wiring is on top, allowing direct connection with no ground loops – a good idea for RF or audio. The board layout and assembly diagram is shown in Figure 2; only about a third of the standard size board is required. Since the minimum order is three standard-size boards, it makes sense to use the whole board area, either for multiple copies of this circuit or for some other circuit. See the "Free software" section for some hints.

Construction is simple, with no tiny parts or surface-mount assembly. Just stick the leads through the holes and solder them in. The completed board is shown in Figure 3, and a complete unit in a box is shown in Figure 4.

The final adjustment depends on the input. Many surplus test instruments have an output of 0 to 1 Volt for a chart recorder, while older tube instruments might have a 10-volt output. The 100K pot at the input is adjusted to provide a good pitch for a full-scale reading on the test meter, so that the output goes from a low growl at zero reading to that pitch at full scale, allowing peaking by ear.

Free Software

Design software used to be expensive and hard to use. This project was completed using only free software, downloaded from the Internet and run on a PC. All the files I generated are available at www.w1ghz.org/tonemeter.zip, and you may modify them as you please.

The schematic, tonemeter.asc, was generated using SwitcherCAD III software from www.linear-tech.com, a circuit simulation tool. I also used the software to simulate operation of the voltage-to-current converter. This file is v_to_i.asc; just load it and click the run button to see it go. Play with the software to modify the schematic, add parts, and move them around.

The PC layout used the ExpressPCB software mentioned above. The completed layout file is tonemeter.pcb; open it with the software and it pops up on the screen, with the bottom side in green, the top in red, and the parts in yellow. Play with it: select a part and slide it around — the wiring follows. Add parts, modify the wiring, cut-and-paste the whole circuit to make multiple copies. If you make a mistake, just Undo.

When the board is complete and triple-checked, pull down the "Layout" menu and click on "Order Boards Via the Internet." They will arrive in four days!

The tonemeter circuit only fills a small part of the area. To fill it up, I added other patterns – in this case, four small boards to mount Anderson Powerpole connectors inside my projects for DC power connections, to match the connectors on the "RIGrunner" (www.westmountainradio.com). The combo layout is in the tone_ppole.pcb file.

Summary

We have described a quick-and-easy project that is not only useful, but demonstrates what we can accomplish with free design software. Even if you don't build it one, play with the software and see what you could design.