

# ELECTRONOTES

WEBNOTE 55

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ENWN-55

## A Poor-Man's Guide to Displaying Low-Frequency Acoustic Hum

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A good deal of energy has gone into investigating a phenomenon known as “The Hum”, particularly here [14] and in a series of Webnotes [1-13]. This involves an apparent perception of low-frequency (pitch 30-130 Hz) and low level (barely audible) sound which few people actually seem to “hear”. Speculation is that the phenomenon is most likely of two natures, of vastly different origins, usually separately occurring: (1) possibly a real external acoustic “buzzing” such as a power-station vibration, a pump, or an idling engine, or (2) as an apparent Hum that is internally generated in the middle/inner ear which afflicts relatively few individuals as a form of Low-Frequency Tinnitus (LFT) that is unrelated to a much more prevalent high-frequency tinnitus (say 5 kHz) better known as “ringing in the ear”. Any LFT seems widely variable among afflicted individuals, and any real acoustic hums (Environmental) are seemingly even more variable although likely “clustered” (as perhaps, many due to power substations).

We should be able to apply audio techniques to display (as with an oscilloscope) or even record real acoustic sounds. LFT if it occurs as an apparent sensation to an afflicted individual is probably not recordable as a standard issue. In this webnote we concern ourselves only with DISPLAY of a real acoustic signal. In addition we are using only the most basic (less ambiguous) of electronic devices. In addition we hope that “experts” in audio do not get carried away before trying the simplest things first.

### THE PLAN

(A) First step in identifying the source of an environmentally-caused (external) hum is for the perceived effect to **fail one or more tests for** the internal Hum (Low-Frequency Tinnitus - LFT) as check-listed here:

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<http://electronotes.netfirms.com/ENWN53.pdf>

(For example, perhaps everyone on the block hears the hum, suggesting an external source to look for.) If however these indications are that one does suffer from a personal LFT (the Hum) there is of course no real point in looking for an acoustic source for a humming noise. But, going through the checklist-tests forces a person to actively exercise significant observational tasks that he/she might have been overlooking, or just never got around to considering. Do this first.

(B) It is a mistake to suppose that the goal of investigating an environmental source is to achieve a “recording”. If a sound, in its original form, is marginally low-level and low-frequency, how is a questionable recording:

<http://electronotes.netfirms.com/ENWN54.pdf>

going to be better?

Instead the goal is to achieve a visual “display” (even a hand sketch of an oscilloscope trace would be great).

(C) No fancy equipment is required, or even desirable. What you do need is a simple oscilloscope, a function generator, two stereo speakers (large old-style wooden cases), and a simple breadboard with a few electronic components. An ability to understand and run the equipment is necessary, but no “expert level” ability is. The specific basic technical information required is just that which is suggested below.

## (D) The Procedure

(1) First do your best to make sure your current hum experience is typical of what you generally experience. If at all possible, try to hum along with the pitch heard. It would be great if you have already pitch-matched using an online tone generator and/or your stand-alone function generator [see step (2)].

(2) Now connect one of your stereo loudspeakers directly to the function generator (FG). The FG has about a 600 ohm output impedance and it is driving what is probably an 8 ohm speaker. You do NOT need an amplifier. You might suppose that you wouldn't hear a thing, but the ear has a fantastic dynamic range and you don't want loud sounds. You can adjust the frequency to about 440 Hz (the orchestra tuning pitch) and a comfortable volume. Then try lower frequencies. You will need to turn up the amplitude in order to hear the lower frequencies comfortably. You have two purposes here: first to verify a pitch match and second, to be able to create a real acoustic test signal comparable to the prevailing hum.

(3) It is a good idea to connect your scope to verify the signal at the FG/speaker junction. First you do this to assure yourself that the signal looks proper and secondly (more importantly) to verify that you have mastered the proper relationship between frequency and cycle-time (FG dial and scope time-base). For example, a 70 Hz frequency should have about a 14 millisecond (0.014 sec) cycle. It would be a good idea to adjust the amplitude and frequency to at least approximate your hum. Record these settings for the pick-up experiments.

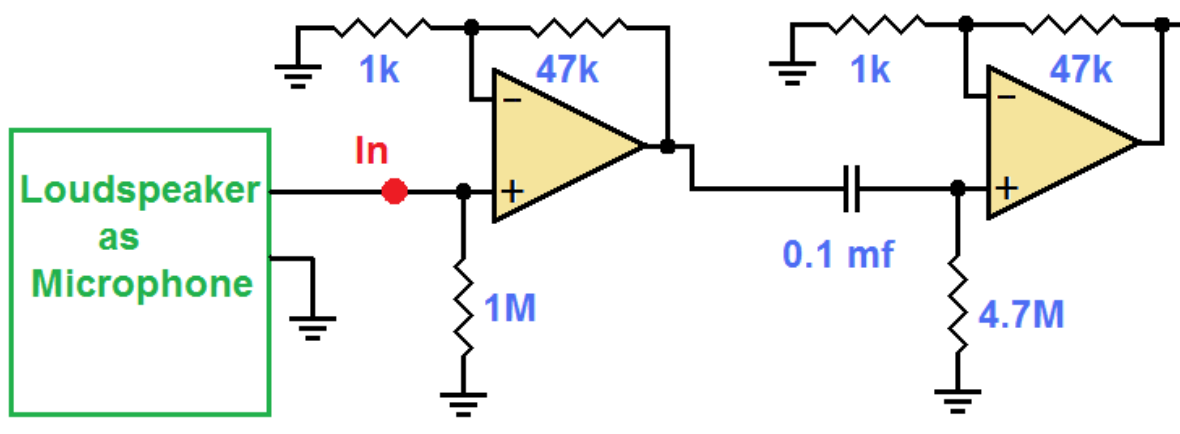
(4) You are going to use your second stereo speaker as a microphone. Electro/magnetically/mechanically they are much the same, and you need a large collection area. There is some danger of picking up a direct 60 Hz magnetic field from the field coil of the loudspeaker, but you are going to check for this. There is NO danger of picking up a 60 Hz electric field in the 8 ohm voice coil.

(5) As with any microphone, a pick-up amplifier is needed, and a simple one suited to the stereo speaker is shown. It has a gain of about 2300, with direct coupling (first stage), and low-frequency coupling down to 0.3 Hz (second stage). This is the exact amplifier I used in an earlier report.

<http://electronotes.netfirms.com/ENWN38.pdf>

You will not need the notch filters of the earlier report. (In fact, you may be specifically looking for 60 Hz and/or 120 Hz.) The parts cost is probably about \$5. The annoyance of needing the amplifier is having something to build it ON (a white plug-in plastic “breadboard”, perhaps \$18. or perhaps a universal circuit board) and the need for a power supply. Two 9-volt batteries ( $\pm 9$  instead of  $\pm 12$  or  $\pm 15$ ) can be used and might well be preferred, to minimize nearby transformers.

(6) Connect up your second speaker to the amplifier input and the output to your scope – leaving the scope settings as they were for verifying your FG operation. Moment of truth here! What do you see? Talk or sing. Stomp your foot to possibly see room resonance ringing. If you see any 60 Hz, move thing around (like move your scope and FG away from your microphone). Turn off things you don't need. Keep in mind that what you see on the scope could be a real acoustic hum.



(7) Reacquire your hum. Sing it. Does your singing display correctly? Does anything of that pitch remain after you stop singing? Now hold off on the singing and try to adjust the FG frequency and amplitude so what seems to you to be a good approximation to the hum that annoys you. Experiment with settings. Turn the FG off and on and observe the artificially generated signal as compared to your hum. Take notes and/or images. You are now basically on your own as we can't guess what you will find.

## OUTCOMES

A happy outcome might be a 120 Hz scope trace. Now knowing there is an external source, and being much more familiar with the pitch, you wonder about your house outside and notice that a power transformer on a pole is buzzing abnormally. You call the power company and they replace the deteriorating transformer (happy to do so).

Another possibility with a defined outcome might be seeing nothing that is particularly large (relative to talking, say) or looking at all periodic. This suggests LFT and if you go back to the checklists, you may decide that you did pass a test or two for an internal source. Welcome to the club!

Far too likely, you will find the result ambiguous. You of course go back to the beginning and repeat and refine the procedures. At some point you may converge on a finding that was more-or-less there all the time. At worst, you have a much better list of things you have tried, which may suggest additional investigations, and/or questions to ask.

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