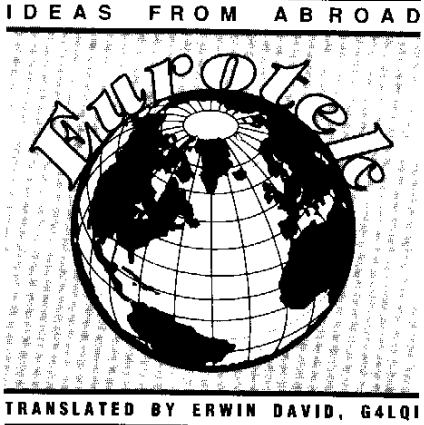
IDEAS FROM ABROAD



TRANSLATED BY ERWIN DAVID, G4LQI

FROM ELECTRON (NL), AUGUST 1990

Have your ears been insulted by the poor sound quality of the mini-speaker in the top or bottom of your transceiver, and have you been put off by the price of a 'matching external speaker'? Here is what you can do about it.

A LOUDSPEAKER FOR VOICE COMMUNICATION

Original article by Herbert L Rutgers, PA0SU

A SPEAKER FOR VOICE communication in its cabinet must be reasonably matched to the audio amplifier driving it, and have no resonances between 300 and 3000Hz, preferably between 200 and 5000Hz.

Most solid state audio amplifiers, including those in transceivers, are designed for a 4Ω or 8Ω speaker. While a 4Ω speaker would overload an 8Ω amplifier, an 8Ω speaker is suitable for either amplifier. So a speaker with a *nominal* impedance of 8Ω is wanted. As the 'unmounted speaker' curve (**Fig 1a**) shows, it will have an impedance near 8Ω in *mid-range*, say 1000Hz. At higher frequencies, toward 10kHz, the impedance increases due to the self-inductance of the voice coil. With so-called *full range* speakers, ie those designed for listening to music, this is of no importance at speech frequencies. At the low-frequency end, note the *self-resonance* peak, which may be as high as ten times the nominal impedance.

SELECTING A SPEAKER

A round 4" (103mm) diameter full-range single-cone speaker, without built-in tweeter, would serve our purpose.

Likely sources are junked TV sets and broadcast radios for home, portable or car use. Its self-resonance should be below 200Hz.

MEASURING THE SPEAKER IMPEDANCE

Fig. 2 shows the set-up. The voltage across the speaker is proportional to the impedance *if* fed from a current source. If the audio generator has a low-impedance output, as is usually the case, a 470Ω series resistor will turn it into a current source. The AC voltmeter across the speaker must have a frequency range of 50 - 5000Hz or better, and must be sensitive enough to give a readable deflection on less than 2% of the maximum output voltage of the audio generator. Assuming 1V max. from the generator, the voltage across an 8Ω speaker would be only 1x8/(470+8) = 17mV approx. An audio millivolt meter or a 'scope would be ideal, of course, but many digital multimeters on their 200mVAC range will do. A less sensitive ACV meter can be used if preceded by an audio amplifier.

Use an 8Ω resistor instead of the speaker to check out your instrumentation. Set the generator to 1000Hz and full output and see that you get a usable reading on the meter. Vary the generator frequency and check that the meter reading remains within 10% or so. It is handy to adjust the generator output to get a reading of 8, or 80, across the 8Ω resistor. If the generator output is not touched thereafter, the meter will be direct-reading in Ohms.

Place the speaker on the bench, face (cone) up. Connect it in place of the 8Ω resistor and start measuring at 1000Hz. The impedance should read approx. 8Ω. Then try 5000Hz. The impedance will be higher but, with a half-way decent speaker, not over 15Ω. Then, at the low-frequency end, find the frequency where the impedance is maximum and note that impedance: 50Ω near 150Hz would be typical.

THE CABINET

Take it from me that the speaker will sound best if completely enclosed in a cabinet. An inside volume of 2 litres (122 cu. ins) is adequate. A cube shape is best but any shape up to a ratio of 3:1 between the longest and the shortest side will do. The cabinet can be built of plywood or chip board with a minimum thickness of ⅜" (16mm) to keep the panels from rattling. The self-resonance of the speaker mounted in the empty cabinet must be below 300Hz (**Fig 1b**).

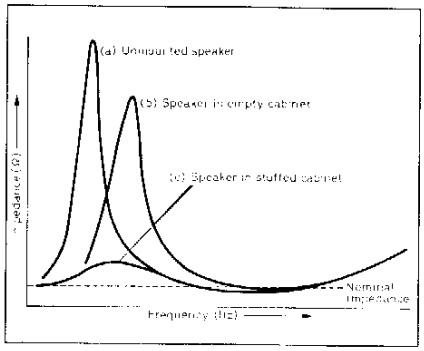


Fig. 1 The speaker impedance as a function of frequency of the a) unmounted speaker, b) speaker in the empty cabinet, c) speaker in the stuffed cabinet.

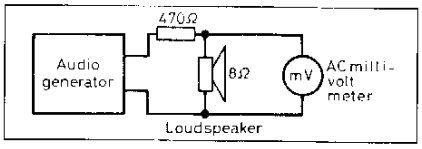


Fig. 2 The test circuit to measure speaker impedance as a function of frequency, 50 - 5000Hz.

CONSTRUCTION

The six panels must be accurately cut to avoid gaps. Suspend a panel from a string and strike it with a hard object. It should not resonate. If it does, the panels must be lined inside or out with glued-on sound deadening material such as lino or roofing felt. Assemble the box with good wood glue, using clamps. If none is available, use glue and screws; do not use nails. The hole for the speaker is dimensioned to mount the speaker from the outside. It will later be cemented in with its rim against the panel. I do not like to screw it on to avoid an errant screwdriver poking through the cone!

TUNING AND TESTING

First the speaker is temporarily mounted on the empty cabinet, eg with glueing clamps, and the resonant frequency and impedance measured. The frequency will be somewhat higher than that of the unmounted speaker, but the impedance peak less high (fig. 1b). Next, the cabinet is loosely stuffed with sound damping material so that the air in the cabinet, together with the speaker cone, no longer resonate. The damping material may be rock wool, glass wool, absorbent cotton, even a shredded wool sweater! Fill, but do not compress, and ensure that the stuffing does not touch the speaker cone; glue gauze to the back of the speaker if touching cannot be prevented without it.

Now measure again. The quantity of the stuffing requires some experimentation. What is left of the reasonance peak should be between the two previously measured frequency peaks and approx 18Ω for a nominally 8Ω speaker; below 15 or above 25Ω is not acceptable (**Fig 1c**). When satisfactory, fix the speaker into the opening with silicone cement; that is strong enough but can be undone if necessary. Fill any remaining gaps between cabinet and speaker, and the hole through which the connecting wires pass, with more cement and test for air leaks before the cement has set. Carefully push the cone inward by finger pressure near its centre. Hold it there for a few seconds, then release. If the cone slowly returns to its rest position all is well. If it jumps back, find the leak and seal it.

When the cement has cured a final test is in order. Connect the audio generator through an amplifier capable of a watt or two to the speaker. At a moderate sound level, listen for resonances as you vary the frequency 50 - 5000Hz. No rattle is tolerable. Place a finger on each panel of the cabinet in turn and make sure that no panel vibrates at any frequency. Plug the speaker into your hi-fi and listen to a voice broadcast. No trace of resonance should be heard. There will not be much bass but what is reproduced should sound clean and smooth. Now plug the speaker into your communication receiver and listen, especially under QRN conditions. You will be surprised!