BY FRANKLIN J. MILLER

Performing Our First Tests

A FEW MONTHS BACK, WE BUILT AN AUDIO OSCILLATOR. LAST TIME, WE BUILT A RESISTANCE-SUBSTITUTION BOX. THIS MONTH, WE'LL PUT THEM TO WORK TO PERFORM SOME BASIC TESTS. BEFORE WE START, THERE ARE A FEW ITEMS YOU'LL need to obtain. First off, you will need two sets of shielded leads. They should have dual banana plugs on one end and standard phono plugs on the other. You also should buy or make up a cable with dual banana plugs on one end and clip leads on the other. And phono-to-3.5-mm-monaural-plug adaptors will also be handy.

If you purchase those cables, make sure you get good quality items. There is nothing like taking the time to make a complicated test only to find one of the cables was no good. Some good advice from many years of experience is to test the cables periodically—say every three months.

You'll also need an audio voltmeter (an AC voltmeter optimized for use at audio frequencies). If you don't own or have access to an audio voltmeter, a future column will detail one you can build.

Measuring Frequency Response

For our first test, we will measure the frequency response of a power amplifier under load. Figure 1 shows the setup.

Note that the wattage of the load resistor must be equal to or greater than the power amplifier's rated output. It is always better to use higher-wattage loads if possible. It is also important that the resistor be a non-inductive type.

Before you begin, you will need some way to record the data you measure for future use. Since we will be looking at how the output level changes as output frequency changes, one of the most efficient ways of recording the information is to graph it. However, while doing research for this article I discovered that the kind of graph paper most appropriate for this type of work is nearly impossible to find; perhaps it is no longer being made as I could not get it from any of the standard sources (office supply stores, drafting stores, and catalogs).

Since I felt that it was important for record keeping, I designed two types of graph paper. The first type is Lin/Log, and it is used when the measurements are made in decibels (dB) versus frequency (the decibel is already expressed as a log function). The other is Log/Log and is used where the measurements are made in volts (or mV) versus frequency.

A sample of the Lin/Log paper is shown in Fig. 2; a sample of the Log/Log paper is shown in Fig. 3. Each includes an area in which you can detail the test itself and the setup you used (you should do your record keeping at the time of testing when all the details are fresh in your mind). The graph paper is available in pads of 25 sheets from the author as per the information in the Ordering Information box, or you can simply copy the artwork directly from this magazine and make your own graph paper; for convenience, it is shown full sized.

Now, back to our testing: Be sure that all equipment is plugged into the same AC outlet or power strip to avoid possible ground loops. If the power amplifier has a volume control, set it to maximum for this part of the test. Before you turn the power amplifier on, make sure the audio voltmeter has its range switch in the highest position and the

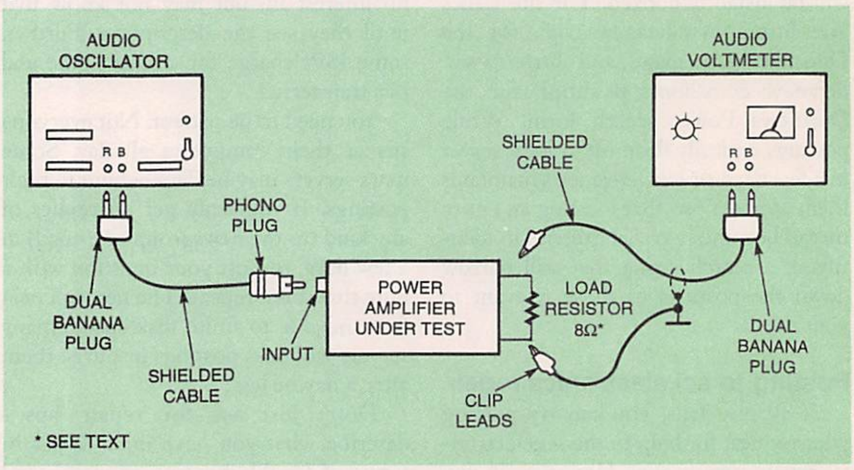

FIG. 1—TO MEASURE FREQUENCY RESPONSE VERSUS POWER, use this test arrangement. Make sure that the load resistor equals or exceeds the power rating of the amplifier being tested.

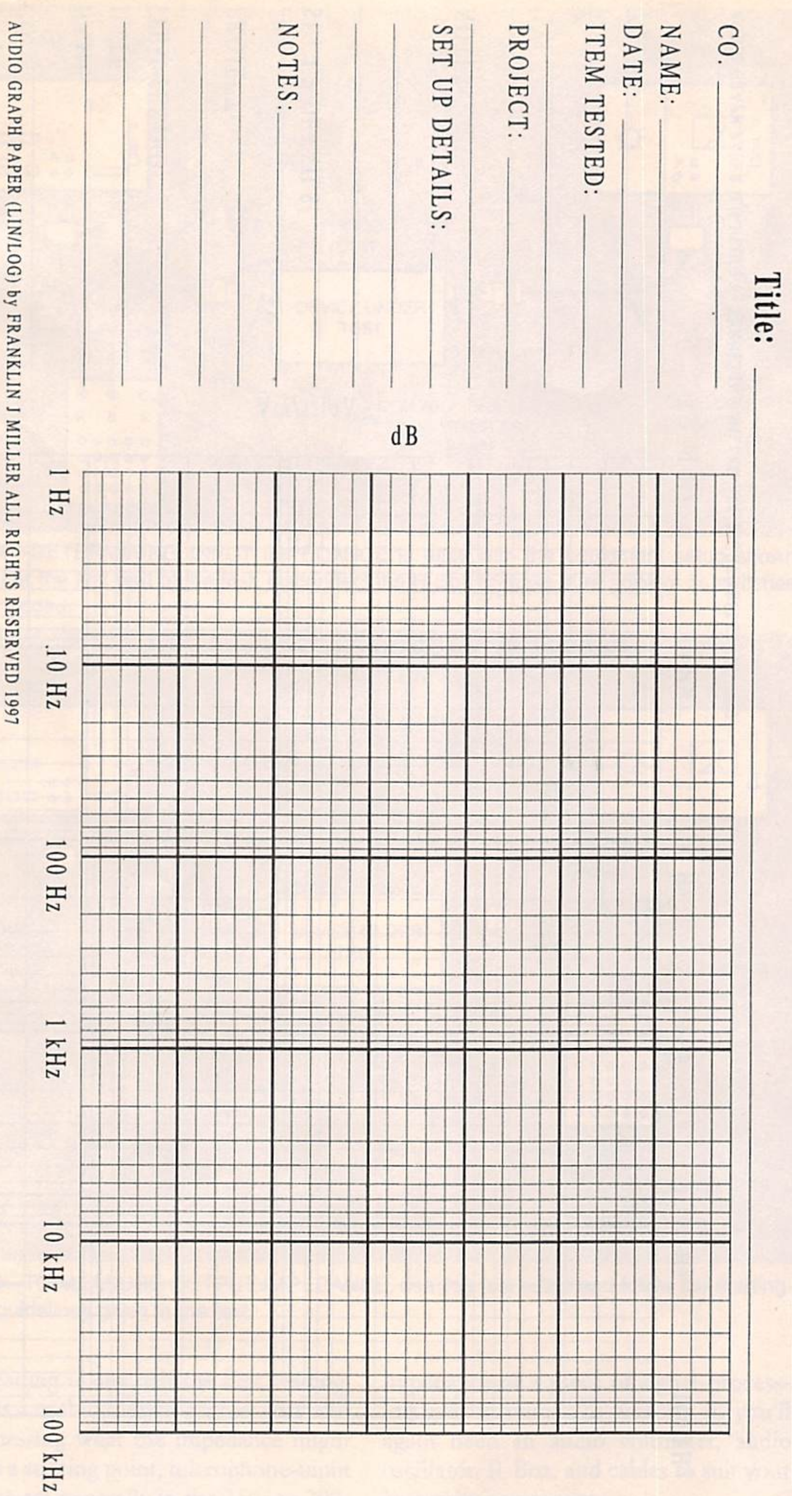

FIG. 2—LIN/LOG GRAPH PAPER is ideal for recording the measurements that are made in our first test.

audio oscillator is set for its lowest output and a frequency of 1 kHz. That is done so that you will not destroy your valuable test equipment!

While looking at the audio voltmeter's scale, increase the output of the audio oscillator from -56 dB to -10 dB. That should give you some reading on the audio voltmeter. Then reduce the setting on the audio voltmeter to a more sensitive scale. Continue doing that until the reading on the audio voltmeter is about 80% of the meter scale (which is usually the most accurate portion of the scale). Because that reading is done at 1 kHz, it becomes the reference point. Place that data on your test-data sheet. You can now make more measurements at different frequencies. Every time you change frequencies, wait several seconds for the oscillator to settle and write the data in their proper columns. Note that the lower frequencies take a longer time to settle than the higher frequencies.

The question most asked is "How many data points should I take?" The minimum would be 10 and the maximum should be no more than 100 points. About 30 data points make a really accurate and useful graph. Yes, this is a great deal of work, but it is worth the time in the end.

Determining the Input Impedance

To conduct this test, you will need an audio oscillator, an audio voltmeter, the R-Box, and cables to suit your particular equipment.

Set up equipment as shown in Fig. 4. Be sure that all of the equipment is plugged into the same AC outlet or power strip to avoid possible ground loops. If the unit you are testing has an input volume control, turn it to the maximum to avoid any false reading. Next, turn on the device under test. Then make sure that the audio voltmeter has its range switch in the highest position and turn it on. Last comes the audio oscillator. Set it so its output is in the lowest position and the frequency is at 1 kHz before turning it on.

The first step in this test is to set the audio-oscillator output voltage. If you are testing an input that is designed for microphone circuits, set the output switch to -56 dB. If the input is a line-level type (RCA or phono jack), set the audio oscillator at -10 dB. The last input type is the professional type, and its level is +4 dB. Be sure to notice if it is a balanced type. If it is, you must unbalance the input to do the

ORDERING INFORMATION

The following items are available from Franklin J. Miller, 2100 Ward Drive, Henderson, NV 89015: R-Box—A complete kit of all parts including pre-drilled aluminum case, front-panel label, all switches and colored switch buttons, all 1%, 1/8-watt resistors, printed-circuit board, and banana jacks; $70. Graph Paper—Pads of 25 sheets are available for $6.00 each; please specify Lin/Log or Log/Log. All prices include shipping inside the continental United States.

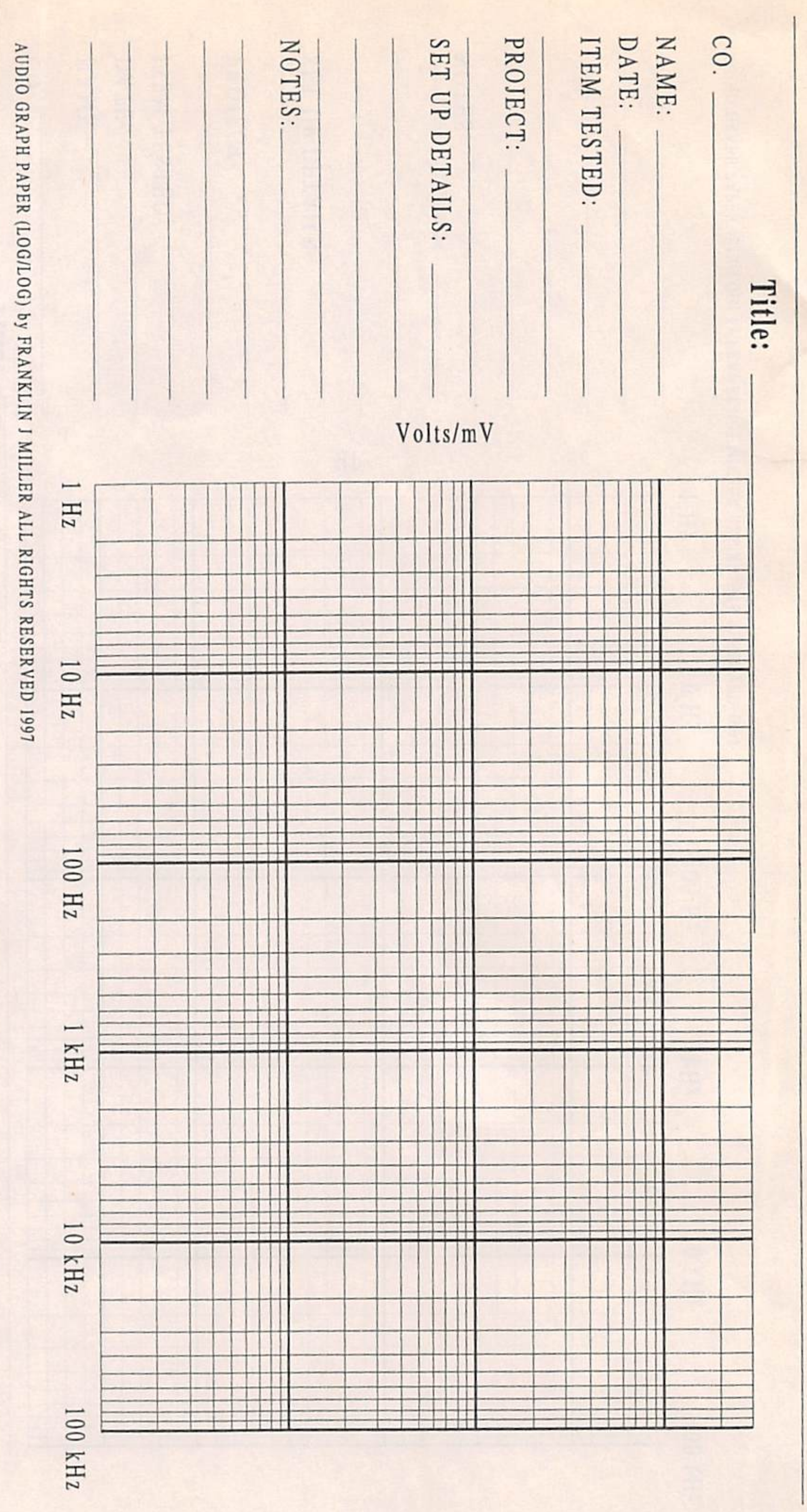

FIG. 3—LOG/LOG GRAPH PAPER is also handy for recording test data. You can purchase it or make your own using the full-size example shown here.

test. Usually an XLR 3-pin connector is used here. Pin 2 is the standard for the hot signal, and is connected to the center conductor of the cable. Next, pins 1 and 3 are tied together and then connected to the shield of the cable. Once that is done, we can begin testing.

Set the R-Box so that none of the buttons are engaged (infinite resistance), or disconnect it from the circuit completely, and read the voltage at the output of the device under test. Record that number on a piece of paper that you will save for later use. Next, set the R-Box so that the volt-

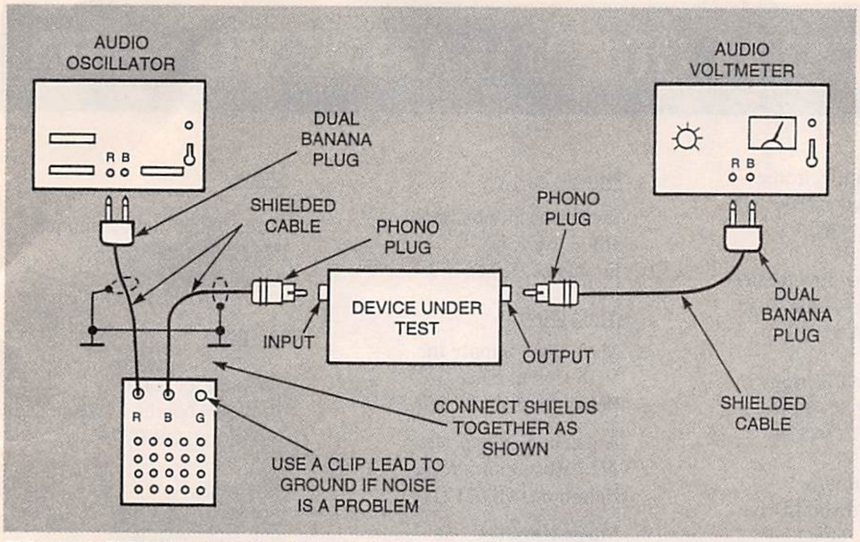

FIG. 4—DETERMINING INPUT IMPEDANCE is easy with the equipment setup shown here. For the first part of the test, disconnect the R-Box or make sure none of its switches are engaged.

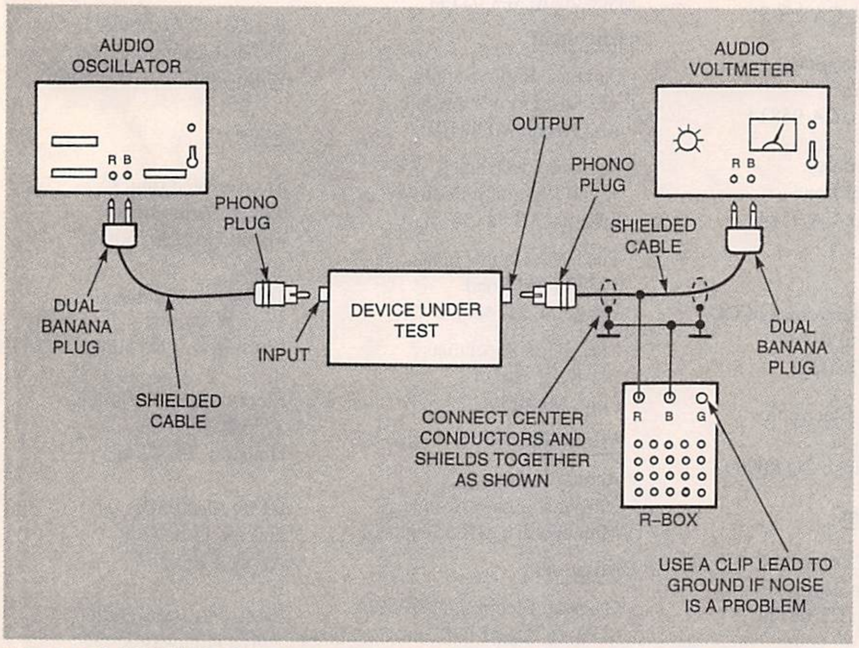

FIG. 5—TO MEASURE OUTPUT IMPEDANCE, use this test setup and follow the starting-point guidelines given in the text.

age reading is one half the first reading. This is a trial-and-error process that calls for guessing what the impedance might be. As a starting point, microphone-input circuits are generally in the 150- to 200-ohm range; line inputs in the better consumer products are generally around 10,000 ohms; and the professional inputs are either 600 or 10,000-to-15,000 ohms. Once the correct voltage reading is obtained, simply read the impedance from the front panel of the R-Box.

Determining the Output Impedance

This test will tell us the output impedance of a piece of signal-processing gear in ohms. To perform it, you'll again need an audio voltmeter, audio oscillator, R-Box, and cables to suit your particular equipment.

Start by arranging your equipment as shown in Fig. 5. Be sure that all equipment is plugged into the same AC outlet or power strip to avoid ground loops. If the unit has an input volume control, turn it to the maximum to avoid any false reading. First turn the device under test on, then the audio voltmeter (make sure its range switch is in the highest position,) and finally the audio oscillator with its output in the lowest position and the frequency set at 1 kHz. All of this should sound familiar by now!

First we need to set the audio-oscillator output voltage. If you are testing an input that is designed for microphone circuits, set the output switch to -56 dB. If the input is a line-level type (RCA or phono jack) set the audio oscillator at -10 dB. As in the previous test, if it is a balanced type, then you must unbalance the input to do this test.

Next, set the R-Box so that none of the buttons are engaged (or disconnect it from the circuit), and read the voltage at the output of the device under test. Record that number for later use. Adjust the R-Box until the output voltage is half the reading you noted. This process is partly guessing what the impedance might be. Line outputs in consumer products are generally 1000 ohms or higher, and the professional outputs are 600 ohms. This should give you a starting point. Continue until you get the required voltage reading and read the corresponding impedance directly from the front panel of the R-Box.

This wraps things up for this issue. Next time we will look at assembling a capacitance box that looks a lot like the R-Box we built. We'll also look at how you can put it to work in audio testing. **EN**

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