fold out

Antenna tuning with a noise bridge

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(Ed. note – We've had many requests for information on noise bridges, so we turned to Mr. Noise Bridge himself, Jack Althouse, K6NY, of Palomar Engineers.)

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The noise bridge

The noise bridge is a measuring instrument used to find the resonant frequency of an antenna, to tell whether to make an antenna longer or shorter to make it resonant, and to measure the antenna's resistance. Also it will measure the resistance and reactance on an antenna off-resonance and make other useful measurements around the amateur operating room.

It is not an antenna tuner; it is used with a receiver to make resistance and reactance measurements.

How it works

The R-X noise bridge contains a wideband noise generator and an RF impedance bridge. The "known" leg of the bridge has a calibrated variable resistor and a calibrated variable capacitor controlled by front panel knobs. The "unknown" leg of the bridge connects to the antenna to be measured. A receiver tuned to the measurement frequency is used as the detector.

When the noise bridge is first turned on, a loud noise from the noise generator will be heard in the receiver. The R and C knobs, controlling the variable resistor and capacitor, are then adjusted for a noise null. The R knob reads the antenna resistance.

The X knob, if it points at zero, says that the antenna is resonant. If it reads on the X_L side of zero, the antenna is inductive; that is, it is too long to be resonant at the measurement frequency. If it reads on the X_C side, the antenna is capacitive; that is, it is too short to resonate on the measurement frequency.

Tuning a dipole

Let us now use the R-X noise bridge to tune a dipole or inverted Vee to resonance. First, connect the "unknown" terminal of the noise bridge to the center of the dipole. Later in this article we'll explain how to make this measurement at the bottom end of the coaxial transmission line, but, for now, connect the noise bridge right up at the center of the antenna. Next, connect your receiver to the "receiver" terminal of the bridge through any convenient length of coaxial line.

Tune your receiver to the frequency on which you want the antenna to resonate. Turn off the receiver's AGC and place the speaker so you can hear the noise signal, or arrange to be able to see the "S" meter. Turn on the noise bridge and adjust the R and X knobs for null. The controls interact and must be adjusted alternately until a deep null is obtained.

If the X reading is on the X_L side, the antenna is too long. If the reading is on the X_C side, the antenna is too short.

Adjust the antenna length and take another measurement. Repeat this until the null is at X = O. The antenna is now resonant on the desired frequency. The R knob indicates the feed point resistance.

Trap dipoles

The noise bridge will give a null on each band that the trap dipole resonates. Connect the bridge at the center of your horizontal trap dipole or at the base of your vertical trap antenna.

Start with the highest frequency band and measure the resistance and reactance as described above. Adjust the center (or lower) section if necessary to resonate. Then repeat the procedure on the next lower frequency band. Work your way down in frequency until you have adjusted the lowest frequency section.

Beams

Connect the noise bridge to the driven element. Tune your receiver to the operating frequency and read the resistance and reactance. Adjust the element to resonance if needed.

Ladder is too short

Sometimes it is not possible to make the measurements at the antenna. Instead, the noise bridge can be connected at the bottom of the antenna's feedline. But beware! The readings you get at the bottom of the feedline may be completely different than those you got up at the antenna.

Why? Because the resistance and reactance seen at the bottom of the feedline change with the length of the line. The noise bridge measures what it sees.

But there is a magic feedline length, the half-wave line. If the feedline is an electrical half-wave, or a multiple of a half-wave, readings taken at the end of the line are exactly the same as those taken at the antenna. Of course, there is just one frequency where the line is a half-wave and all measurements must be made at this frequency. To cut your line to a half-wave use the formula in the Handbook, then check it with the noise bridge using the procedure described in this article.

More than likely, the distance between your antenna and your transmitter is not half-wave or anything close to it. What then?

If you know the electrical length of your line you can convert the readings taken at the end of the line to those you would read if you were at the antenna. This is done with the Smith chart. This is not something you can master in an evening but it's not all that difficult either. The procedure is described in the ARRL Antenna Book. Also see the March 1978 issue of *Ham Radio* magazine.

Transmission lines

The length of a half wave line is:

$$L\ (\text{feet}) = 492/f\ V$$

where f = frequency in MHz, V = velocity factor of the line.

V is about 0.66 for coaxial cables, 0.8 for foam dielectric coaxial cables, 0.82 for twin-lead cables.

You can cut the line to correct length using the formula but, because of different manufacturing methods and tolerances, the line you have may not have exactly the velocity factor listed above. If so, the formula will give you the wrong length, so you should check using the noise bridge.

The magic property of a half-wave line is that what you connect to one end of the line is what you read at the other end. If you put a short circuit at one end then you will read a short circuit at the other end. that is R = O and X = O.

Before making the measurement you should set the noise bridge by shorting the "unknown" terminal and adjusting the R and X knobs for null. The null will be at R = O and X = O but, using this procedure, you will be able to set the knobs more accurately than by reading the printed scales.

Now connect your half-wave line to the "unknown" terminal. Short the far end. Do not adjust the R or X controls. Find the half-wave frequency by tuning your receiver to noise null. Prune the line slightly, retune the receiver to null, and repeat the procedure until the desired frequency is reached.

Helpful hint: It is easier to cut the length of a line than it is to add to it. Start with your line a bit longer than the formula says.

Save that final

If you use an antenna tuner, you can use the noise bridge to set its controls without turning on your transmitter. Just connect the noise bridge to the transmitter side of the tuner.

Set the noise bridge controls to X = O and R = 50 ohms. Adjust tuner for null. Now the tuner input is 50 ohms resistive, just what your transmitter wants to see.

Caution: Remove the noise bridge from the line before transmitting.

If you have a dummy load you can tune your transmitter into it. Then connect the transmitter to the tuner and you are all tuned up and ready to transmit without ever having been on the air.

How nice it would be if everyone tuned up this way! We'd have no more of those interminable carriers that go on while someone is trying to find that magic combination of knob settings that loads his transmitter properly. Tubes last a lot longer, too; more damage is done to finals in tune-up than in many many hours of operating.

Test a balun

How do you tell if a balun is good? Not with an ohmmeter, because most baluns have all input and output terminals connected together at DC; you read a direct short whether the balun is good or not.

Instead, connect your noise bridge to the coax fitting of the balun. Then, if it is a 1:1 balun, put a 50-ohm resistor across the output terminals. If it is a 4:1 balun, put a 200-ohm resistor across the output terminals. A quarter or half-watt carbon resistor will do.

Now turn on the noise bridge and adjust it for null. You should read X = O and R = 50 ohms.

Tuned circuits

A dipole antenna looks like a series resonant circuit and the noise bridge is designed to find the resonant frequency. It's easy to see that you could connent any other series resonant circuit to the noise bridge and find its resonant frequency.

But there is one difference: the antenna has a radiation resistance of 50 ohmns or so; tuned circuits used in transmitters and receivers have very little resistance. So, to check a series tuned circuit, set the R knob and the X knob at zero. Tune your receiver to the frequency you want and adjust your tuned circuit for a noise null.

You can check parallel circuits the same way but they have to be connected to the noise bridge by a one or two-turn link threaded through the coil.

The noise bridge works better than a dip meter for this purpose because the frequency of measurement is determined by your receiver which is calibrated a lot better than a dip meter, and is more stable.

Noise bridge vs SWR meter

If you've been using your SWR meter to adjust antennas, you've been working with one hand tied behind your back. The R-X noise bridge is a lot more useful because it tells you which way to go; the SWR meter does not.

Suppose, for example, that you have a 25-ohm antenna and 50-ohm coax. SWR = 2. Suppose further that you have a 100-ohm antenna. The SWR = 2. In other words, the SWR meter can't tell the difference between a 25-ohm and a 100-ohm antenna, but the noise bridge can. If the antenna is 25 ohms it reads 25 ohms; if 100 ohms, it reads 100 ohms.

Also, the SWR meter can't tell if you are above or below resonance. The noise bridge can. It reads X_L above and X_C below.

For routine operating the SWR meter is great. Every amateur operating room should have one. But for antenna construction and test, and for many other jobs around the station, the noise bridge can't be beat. Try one, you'll be pleasantly surprised. □

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