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Making a Good Antenna Better

(Due to the vagaries of the U.S. Mail, this month's antenna column is a rerun of a never-ending subject of interest--how can we improve the antenna we've already got?!)

When we ponder the function of the antenna in our communication system, we realize that it is, quite literally, our interface with the rest of the communications world. The importance of an adequate antenna for your communications system cannot be overemphasized.

Our requirements may be well satisfied by a mediocre antenna system if our interests are limited to such non-demanding activities as monitoring local (and therefore strong) utility signals, or casually tuning the short-wave bands. But when we want to pick up distant weak signals or transmit to far-away QTHs, then antenna performance becomes an important factor in the overall performance of our system.

Antennas Can be Tuned!

Most of the antennas in use today are of the type that are designed to be resonant at the frequency or band of operation. For example, antennas such as the half-wave dipole, groundplane, Yagi-Uda, colinear, inverted-vee, and most other antennas you can think of are of the resonant type.

Non-resonant antenna types are much fewer in number and include the Beverage, rhombic and non-resonant vee (don't confuse this with the inverted vee). Since the non-resonant antennas tend to be very large, expensive and difficult to erect, most people reading this column are probably using some type of resonant antenna system.

If the antenna is resonant, it essentially functions like a tuned circuit at the frequency or band for which it is designed. When your rig, line and antenna are matched, this resonance tends to produce the maximum signal output to your receiver and also provides the antenna's "textbook" radiation pattern when transmitting.

Most of us use commercially manufactured antennas or antennas which we have constructed at home from instructions in a "how-to-do-it" publication. These antennas were designed for some theoretically "average" site, or perhaps for theoretically ideal conditions.

Since our station site will depart to some degree from either average or ideal conditions, the antenna will not be optimally matched to our specific site in the vast majority of cases. Not only will it probably not have quite the resonant frequency for which it was designed, its radiation pattern will likely not be as anticipated, it will likely not have the impedance its design specifies and will not, therefore, match the impedance of the coaxial cable which we use.

J.D. Wells has stated this problem as follows: "Most of the ... patterns you see in the handbooks are for an antenna remote from earth. And when they say remote, they mean RE-mote! The ground has considerable effect on ham antennas below 30 megacycles because we don't get five or six wavelengths from ground.

What this means is that the directivity pattern is not ideal, the impedance at the center is probably not 72 ohms, and the angle of radiation is most likely not what we would like it to be. Also you don't have a perfectly conducting ground under it and you may get combinations of effects that would defy description."(1) Well said, Mr. Wells.

So What?...

...you may ask at this point. Am I trying to prove that most of us have less than optimal antenna systems? Well, in a way, yes. Although the average antenna is probably functioning "adequately," most of us can improve the operation of our communication systems considerably if we take the trouble to tailor the antennas which we use to the site where they are erected.

If we decide that we want to do this, the question arises as to just how to accomplish the feat. Let's survey some of the approaches and equipment types that are used for this purpose.

Common Antenna Test Gear

The most common instruments used in adapting antennas to a specific site include: the noise bridge, the dip meter, the antenna impedance meter, the field strength meter (FSM), and the standing-wave ratio meter (SWR meter).

The first three of these instruments do not require a transmitter at the station under test; The last two instruments are generally used at sites which employ a transmitter because they are designed to assess a signal after it leaves the antenna (the FSM) or as it is fed to the antenna system (SWR METER).

Noise Bridge

The noise bridge is a means of generating noise across a wide band of radio frequencies, and then detecting the response of your antenna to these frequencies. With this instrument you can determine your antenna's resonant frequency and impedance; as well as make some useful transmission line measurements.

Dip Meter

The dip meter, the modern version of the tube-type grid-dip oscillator, is a resonance-indicating device. It consists of a small portable oscillator which is affected by nearby resonant circuits.

The effect is such that a change (dip) in current in the oscillator is caused when the oscillator is tuned to the resonant frequency of the nearby circuit. By coupling the oscillator to your antenna, you can determine the antenna's resonant frequency.

Antenna Impedance Meter

An antenna impedance meter, sometimes called an "antenna bridge," "antennascope" or "Z-scope," allows you to determine the feedpoint impedance of your antenna. By shortening or lengthening the antenna, you can bring the impedance to the proper value to match the feedline, allowing maximum power transfer.

Use of an antenna impedance meter requires a source of radio frequency signal; usually, this signal is furnished by a dip-oscillator, but other low-power oscillators may be employed.

Field Strength Meter

The field strength meter is essentially a simple receiver which presents its output visually via a meter movement which increases as the antenna's output increases. Some models give an audible output as an added convenience and also for use by blind operators.

During antenna adjustments, field strength meters can be used to indicate relative signal output strength. Some models are tunable and may be used to check for the presence of specific harmonic frequencies with the antenna may be radiating.

Standing-Wave-Ratio Meter

The SWR meter is probably the best known, and perhaps most misused, of the popular antenna test instruments. An SWR higher than one indicates that some power is being reflected from the load on the transmission line (the antenna in this case) back to the source (the transmitter). This sounds bad to us and we generally get the idea that the SWR should be as close to 1/1 as possible.

Theoretically, that's true, but we have it on good authority that ratios as high as 10/1 are not unacceptable on HF when we have low feedline losses. Values of 2/1 or even 4/1 are generally not cause for much concern as far as antenna system efficiency goes, but some solid-state rigs can't tolerate such SWR levels. Everyone should read discussions such as those by Bill Orr (2) or John Haerle (3) on the relative contribution of SWR level to signal output.

In an SWR meter is inserted in the transmission line between the transmitter and the antenna tuner, the tuner can then be used to adjust the SWR of the antenna system for more efficient operation. This won't correct for mismatches at the antenna and of the transmission line, but if your transmission line is relatively low-loss, your system is likely to perform well anyhow.

Summary:

It is not the intention of this column to make you suspicious of, or unhappy with, your present antenna system; it's probably doing a fine job. Just as we don't need finely-tuned race cars to get us around town, we don't all need to fine-tune our antennas.

But some of us are concerned at times with getting the best performance possible from our antenna systems. When the going is tough and we want to read those tantalizing weak signals, an optimized antenna system can make the difference.

Specifics on how to use the test instruments described above are included in their instruction manuals, and to one degree or another in references 2 through 7 below. If you have particular questions about antenna tests and measurement, drop me a line. If enough readers show an interest on a particular topic, I'll try and cover it in a future column.

REFERENCES

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