BY IRWIN MATH, WA2NDM

MATH'S NOTES

WHAT'S NEW AND HOW TO USE IT

A "Poor Man's" Method For Simple Antenna Pattern Measurements

The most common item besides the transmitter and receiver in (or outside, as is usually the case) the amateur radio operator's shack is, of course, the antenna. Many amateurs build and/or purchase and erect antennas of all sorts. Those who purchase usually rely on the manufacturer's instructions to get everything up and running. Those who build often have enough knowledge to measure and adjust until everything is working properly. This month's topic therefore is not intended to instruct how to measure SWR, or how to couple to the antenna. It is assumed that you already know how to do this. What we plan to discuss is how to measure the exact (or at least approximate) RF radiation pattern your antenna is producing. This is a measurement that is usually not done by the average amateur. Knowing the radiation pattern of an antenna, however, can give you some really important insight into just where your RF actually is going.

The technique, even without an elaborate antenna range, really is very simple. It is based on the fact that an antenna is a symmetrical device as far as RF is concerned. It transmits just as well as it receives. If you can determine its receiving pattern, you also will have a picture of its radiating pattern. Fig. 1 shows the test setup. A low-power signal souce, set to the frequency of interest, is placed a distance of a few wavelengths (at least) away from the antenna to be measured and in the plane of the antenna. The antenna is then connected to a receiver with a linear (or at least roughly linear) S-meter. Then, depending on the physical nature of the installation, either the antenna is rotated in front of the signal source, or the signal source is moved in an accurate circular path around the antenna. The received signal strength is then recorded as a function of rotational position. The result, as shown in fig. 2, is a curve of the radiation pattern of the antenna. The final accuracy of the measurement is based on how carefully the setup is constructed, how stable the signal source is, how much the surroundings alter the signal, and how accurately the data is taken.

The signal source may be a homebrewed oscillator or may be the output of a decent-quality signal generator coupled to a small amplifier. The absolute frequency stability of the signal source is not of prime importance, although it should be stable to at least a fraction of a percent. What is most important is the overall stability of the amplitude of the output. This cannot vary throughout the entire measurement interval, or the final results will be misleading. Also, the strength of the oscillator's output must be great enough to register on the receiver's S-meter.

Fig. 3 is a schematic of a simple but suitable oscillator. You will note that it is made of a quad NAND gate, a couple of common parts, and a crystal. As shown, using a surplus 3.58 MHz color-burst crystal, it can be used for both 80 meter measurements (at the fundamental) and 40 meter measurements (at the 7.16 MHz second harmonic). The output of the two-gate oscillator is coupled to the remaining gates, which serve as output amplifiers. The tuned circuits in the "final" are used to determine what frequency will reach the antenna. A small whip antenna, long enough to radiate enough signal for the receiver to receive, completes the signal source. The completed signal source is mounted in any available enclosure, such as a plastic or aluminum minibox, and is battery operated for convenience. A regulator is included to help stabilize the output amplitude. The oscillator is "tweaked" by connecting a scope through a 10× probe to the extended antenna and by adjusting the slug-tuned coil for maximum output.

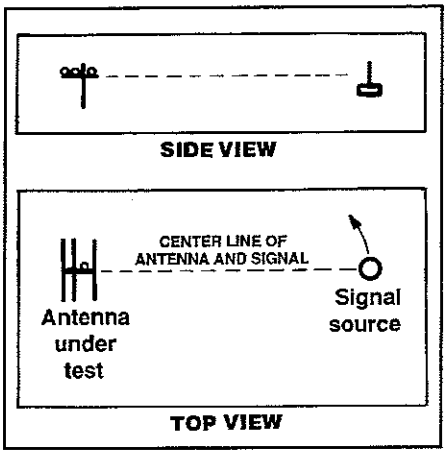

Fig. 1– Basic antenna radiation pattern test setup. Either antenna rotates and signal source is constant, or signal source is rotated around antenna as shown.

When making antenna measurements,

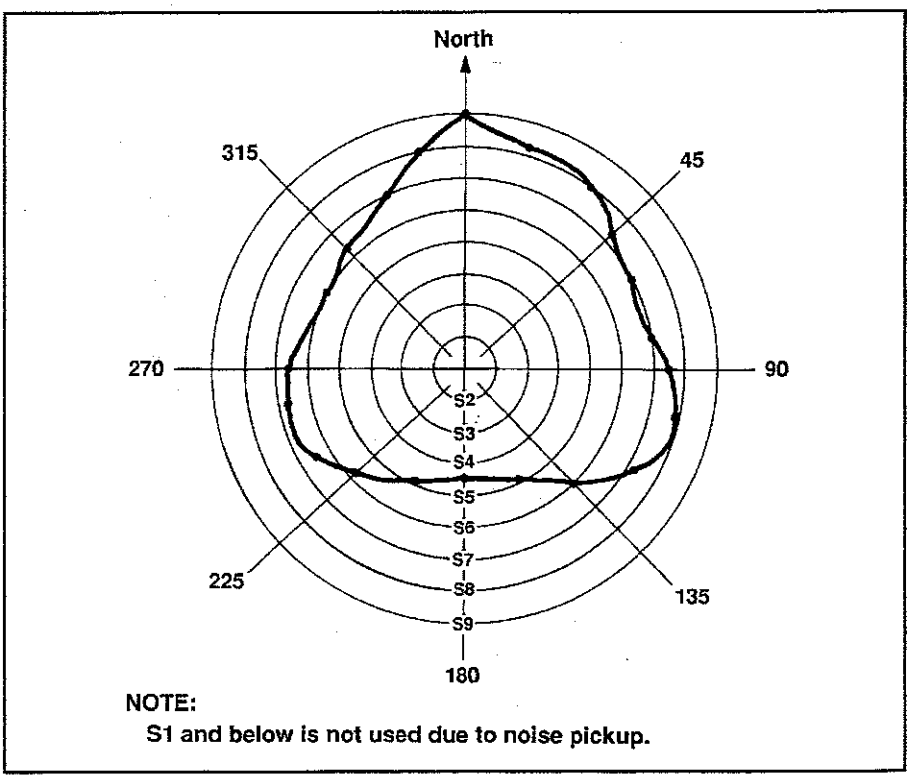

Fig. 2– Typical "homebrew" antenna radiation pattern.

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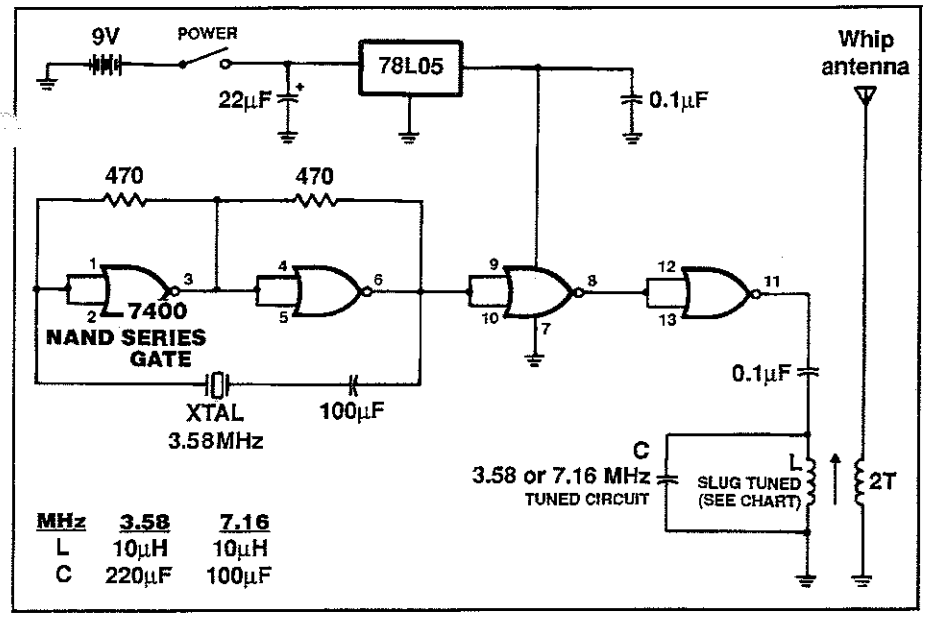

Fig. 3– Simple "one-chip" signal source.

It is useful to first find the point of greatest received signal strength and then to adjust the signal-source whip-antenna length so that the S-meter just indicates full scale. As you rotate the antenna, or move the signal source in as close to a perfect circular path around the antenna as possible, all other readings will be less and will allow the graph to be completed without much trouble. It is also helpful if the signal-source antenna is oriented so that it is in the plane of the antenna being tested. If a vertical antenna is being evaluated, leave the signal-source whip antenna vertically polarized. If a horizontal Yagi, dipole, or long wire is being tested, orient the signal-source whip antenna so that it is parallel and in the plane of the antenna being tested. If the antenna under test is on your roof, a holder made of a 2×4 may be adequate to raise the signal source to the correct height. If this is impractical, or if you live in an apartment, you will have to do the best you can.

The purpose of the above exercise, as initially stated, is to get an idea of what your antenna is doing, not to produce a sophisticated technical graph for an antenna laboratory. Whatever you can accomplish with the equipment and techniques described will at the very least make you more informed as to how your signal is being radiated.

Above all, be very careful when performing these measurements to be certain that you **do not allow anything to come in contact with live electrical wires.** Also, do not get so carried away that you put yourself in a physical situation that can be harmful. After all, an antenna can be replaced; a person can't.

73, Irwin, WA2NDM

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