ANTENNAS & THINGS

BY JOE CARR, K4IPV

SIMPLE ANTENNAS AND ACCESSORIES FOR SIGNAL IMPROVEMENT

Using the MFJ-247 VSWR Analyzer

For many decades the "typical" shortwave receiver antenna was a single wire, 50 to 100 feet long, connected to the back of the receiver. This antenna was said to work on all frequencies from the AM BCB to TV channel 2. But more advanced SWLs understand that a resonant antenna tends to provide better performance than random length wire antennas. Not only is the reception sensitivity better on the resonant band, such antennas tend to have predictable nulls and main lobes so that selected stations can be optimized and interfering stations be suppressed. The resonant antenna also works as if it were a random wire on other bands, so little or nothing is lost on the nonresonant bands.

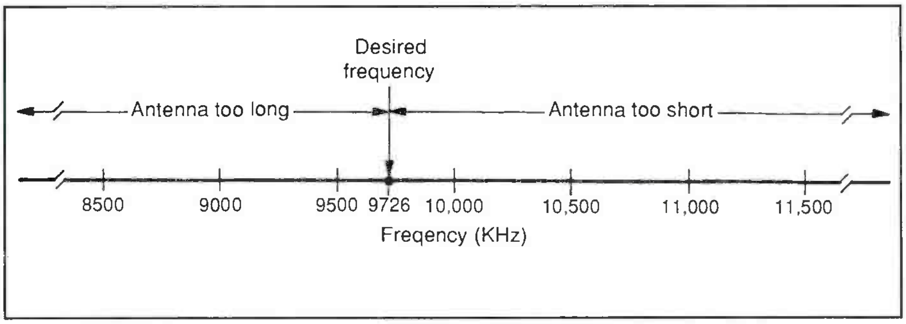

Fig. 1. Minimum VSWR example. If the actual resonant frequency, as indicated by minimum VSWR, is to left of the desired frequency, then antenna is too long; if it is to the right then antenna is too short.

An antenna being "resonant" implies that it is tuned some way. The *length* of the antenna element(s) is the factor that tunes the antenna to a specific frequency. Antenna books, and computer programs like *Antlers*, tell you what length to use as a starting point for any given antenna, but from there purely local conditions take over and some lengthening or shortening is needed to find the actual correct length.

One indication of resonance is the standing wave ratio (SWR), or voltage standing wave ratio (VSWR) as it is sometimes called. Space does not permit a detailed explanation of VSWR here, but I can state that on verticals and dipoles, and most other resonant antennas, the minimum VSWR will be found at the resonant point (there are some situations where this isn't true, but for most common SWL antennas it is true). A VSWR of 1:1 is perfect, and for most transmitter appplications under 1.5:1 or 2:1 is considered acceptable; above 3:1 and some serious thinking (or should I say "reflection"- get it?) needs doing. The goal is to get as close as possible to 1:1 in the center of the band of interest.

Figure 1 shows a 31-meter band example. Suppose you desire to cut a half wavelength dipole for 9750 KHz (9.75 MHz). According to the "standard wisdom" formula the overall length is 468/9.75=9.75 feet=117 inches. But local conditions tend to alter the actual resonant point, if the minimum VSWR is found to the left of the indicated point in Fig. 1, then the antenna is too long. Similarly, if it is to the right then the antenna is too short.

Measuring VSWR is relatively easy for amateur radio operators: they excite the antenna with their transmitters, and then measure the forward and reflected power levels. They can either calculate the VSWR from a standard formula (or look it up on a nonomograph), or they can use an RF power meter that is inherently calibrated in VSWR terms rather than watts (many are calibrated in both watts and VSWR). But SWLs are not allowed to use transmitters, and most low powered signal generators will not drive the typical ham-type VSWR meter or RF power meter. But MFJ Enterprises (P.O. Box 494, Mississippi State, MS, 39762; Phones 601-323-5869 (voice), 1-800-647-1800 (toll-free for orders/nearest dealer), and 601-323-6551 (FAX only) has produced a delightfully easy to use VSWR analyzer called the Model MFJ-247 (Fig. 2).

Built on a tradition of earlier self-contained VSWR analyzers (MFJ-207 and MFJ-208), the Model MFJ-247 combines a 1.75 MHz to 33.5 MHz signal generator, VSWR analyzer circuit, and a digital frequency counter all in one hand-held package. The digital frequency counter can be used separately to measure the frequency of signals other than those of the internal signal generator.

There are four controls on the MFJ-247: Range (i.e. bandswitch), Tune (selects exact operating frequency), Gate and Input. The latter two are pushbutton controls that do not appear on the early model shown in Fig. 1. The Gate control selects the time base gate duration for the frequency counter module. When the unit is turned on, the gate time is set to 0.01 seconds, but successively pressing the Gate button selects 0.1 sec., 1 sec. and 10 sec. before recycling back to 0.01 sec. The input selector determines whether the frequency counter sees the internal signal source or the external signal source (through a BNC jack next to the SO-239 antenna jack on top of the unit). Also on the unit is an analog meter that is calibrated in terms of SWR units. The MFJ-247 seems to work acceptably well with both 52-ohm and 75-ohm loads.

In normal operation, the MFJ-247 is connected to the receiver end of the coaxial cable feedline (Fig. 3) in place of the receiver. Set the range switch to the band of interest. For our 31-meter band example, select the 6.5 to 11 MHz position. Make sure the Input control is cycled to the internal position (as seen by a deflection of the SWR indicator meter), and then adjust the Tune knob for minimum deflection of

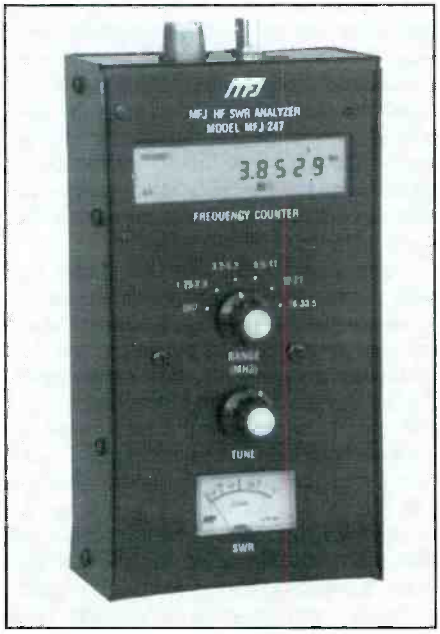

Fig. 2. Photo of the MFJ-247 VSWR/SWR analyzer.

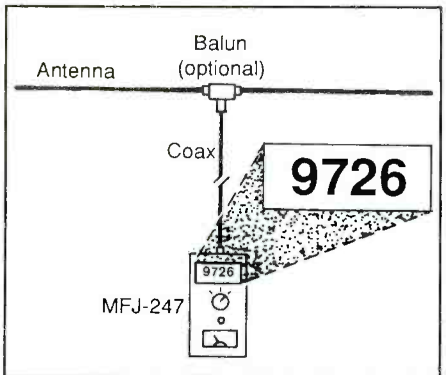

Fig. 3. Normal use of the MFJ-247.

the SWR meter (in ham terms: "dip it"). In most cases, the minimum point will be very near 1:1 unless there is something really wrong with the antenna. Next, read the frequency off the digital counter dial. If the frequency is lower than the desired design frequency, then shorten the antenna. Alternatively, if the measured resonant frequency is above the desired frequency then lengthen the antenna.

By the way, it should go without saying that you should not make any permanent connections on the antenna until after the antenna tuning is finished. I like to "rough in" the VSWR on the ground (with the antenna supported a few feet above ground), and then raise it into position. After two or three trips up and down, the correct point should be found, and the connections made permanent.

Bench Tests and Summary Conclusion

I make it a habit to test products that I recommend, so I took the MFJ-247 to Joe Carr's Basement Laboratory (actually a technorat's nest), and made some measurements. I have a low-powered dummy load calibrated for 12.5, 25, 50, 75, 100, 150, 200, 300 and 450 ohms with some pretty decent accuracy (<1%). Because VSWR/SWR is a function of the load impedance, I checked it at all these settings and calculated the "shouldabe" reading. In all cases the actual reading was precisely where the calculation said it ought to be (pretty good for a low cost instrument). Second, I measured the actual VSWR on a transmitting antenna using a very good, recently calibrated (in fact, new) Bird Electronics Model 43 RF watt-meter. I measured the forward and reverse power levels, and then calculated the VSWR at that frequency. Over a range of 1.2:1 to 2.7:1 (the cases I could generate with my multi-band vertical) the MFJ-247 tracked very closely to the SWR measured by the Bird Model 43. Therefore, I concluded that the MFJ-247 is a resonable instrument for both hams and SWLs...and the SWLs don't need to get a ham license to use it. Let me say to the MFJ folks: "Ya done good, guys!" ■