BETTER FEEDLINE-LOSS MEASUREMENTS WITH ANTENNA ANALYZERS

Various publications through the years have shown how the SWR measured on a shorted (or open) feed line can be used to calculate feed line attenuation. One of the claims made in the manual for my SWR analyzer is that it can be used in a similar fashion to measure feedline attenuation. While that claim is technically true, I found that those measurements are only feasible if the feed line has more than 3 dB of attenuation.

The practical concept behind the theory is simple to illustrate. We start with a transmitter feeding 1 W of incident power into a transmission line. That is, FWD = 1 in Eq 1.

If the line is shorted or open at the far end and the line attenuation is zero, 100% of the forward power becomes reflected power, making REF = 1 in Eq 1.

Since FWD = REF, the SWR calculated by the standard formula Eq 1 is infinite. (Actually any value divided by zero is undefined but in electronics, we bend the math rules to make undefined the same as infinity.)

\[
\text{SWR} = \frac{1 + \frac{\text{REF}}{\sqrt{\text{FWD}}}}{1 - \frac{\text{REF}}{\sqrt{\text{FWD}}}} \quad \text{[Eq 1]}
\]

For similar reasons, if the feed line had infinite attenuation, all of the incident power is attenuated before it can be reflected back to the wattmeter. As a result, REF = 0 in Eq 1, and the measured SWR would be 1:1.

Zero feed line attenuation manifests itself as infinite SWR and infinite feed line attenuation shows up as 1:1 SWR. Any other attenuation values show up as SWR values between 1:1 and 8:1.

As an example, consider that a 1 W transmitter feeds a line with 1/2 dB attenuation. The 1 W forward power is attenuated to 891 mW by the time that it reaches the open end. The 891 mW is reflected at the open end and further reduced by the 1/2 dB attenuation to 794 mW as it travels back to the wattmeter. Using Eq 1, an approximate SWR of 17.4:1 is measured; that is, 1/2 dB correlates to an SWR of 17.4:1. Table 1 shows some correlations between SWR and feed line loss.

Various charts have been created to convert SWR measurements to feed line attenuation. This was a handy method in the days when a wattmeter was a luxury and most hams only owned an SWR meter. (With a wattmeter, attenuation can be calculated directly from FWD and REF. There’s no need to calculate SWR.)

Unfortunately, when I tried to use my antenna analyzer for the same measurement, I ran into a significant flaw right at the point where theory meets practice. A 3:1 SWR is the highest usable value calibrated on my antenna analyzer; an SWR of 17.4:1 is beyond the useful range of measurement.

A 3:1 SWR corresponds to a 3 dB feed line loss. Since all of my feed lines are good quality, my feed line loss is less than 1 dB. The SWR measured using my analyzer always fell somewhere between 3:1 and infinity. This made reading and estimating my feed line loss difficult to impossible using my antenna analyzer.

My solution is reasonably simple. I happened to find a 4 dB attenuator for 50 Ω line in my junk box. I connected the attenuator to the SWR analyzer and the feed line to the attenuator. If a feed line has zero attenuation, the 4 dB attenuator alone will cause the measured SWR to be approximately 2.3:1. Let’s use a 1 W transmitter to prove that the reduction in SWR as measured at the transmitter is true. The 1 W FWD power is reduced by 4 dB to 398 mW when it reaches the open end. That 398 mW is reflected and then as it passes through the attenuator a second time it is reduced by an additional 4 dB to 158 mW before reaching the meter. Again using Eq 1, if FWD = 1 W and REF = 158 mW then SWR = 2.3:1. Any additional feed line loss causes the measured SWR to be reduced to less than 2.3:1 since it further reduces the REF power reaching the wattmeter.

The calculated SWR for some common attenuators and zero feed line loss is included in Table 2.

Now reconsider the original example using the 1 W transmitter connected to an open feedline with 1/2 dB of attenuation. Without the 4 dB attenuator, the SWR measured 17.4:1. The attenuator by itself reduces the measured SWR to 2.3:1. The 4 dB attenuator plus the additional 1/2 dB of feed-line loss reduces the measured SWR to approximately 2.1:1. This value falls within the usable calibration range of my antenna analyzer. Table 3 provides some comparison values.

By measuring the SWR with the line connected through the attenuator, I can now get a much clearer picture of feedline attenuation. Because all of my measurements now fall within the calibrated range of my analyzer, it is now much
easier to make reasonably accurate measurements of feed line attenuation.

One final point needs to be mentioned regarding the electrical length of the line being measured. Notice that an open or shorted feed line also acts as a resonant circuit. This phenomenon can affect the accuracy of your measurement. Make your measurement at a frequency where the line acts as an open circuit (maximum impedance).—Dan Wanchic, WA8VZQ, 1209 13th St N, St Cloud, MN 56303; wa8vzq@arrl.net

**WATER AND HYGAIN TH-7 TRAPS**

◊ After having my TH-7 in the air for almost a year, I began encountering a rising SWR during long, heavy rainstorms. At first, I suspected that water was getting into the BN-86 balun enclosure. So I lowered the antenna and inspected the balun, but it showed no signs of water having settled in it. After some head scratching, I raised the antenna back to the top of the tower. A few days later, another heavy rainstorm came along, and again my SWR rose to above 3 to 1 on 15 and 20 meters. This time I suspected that I was getting water into the traps of the dual driven elements. I again lowered the antenna; and when I pulled off one of the end caps from a trap, water came pouring out. I had found the problem, but how was water collecting in the traps when they have drain holes on the bottom? Furthermore, what would be the solution?

As illustrated below (see Figure 1), I surmised that water was collecting on the outside of the traps and that the droop of the element caused the traps to lay somewhat less than fully horizontal. Thus, any water that accumulated in the trap enclosure would settle toward the outside. The pitch of the trap made it impossible for all the water to make it to the drain holes. This was certainly the case; as all of the traps I inspected, the ones that showed signs of water collecting in them was always found to be on the outside half of the trap.

Actually, the solution is quite simple. At the bottom of each plastic trap cover, I drilled a 1/8 inch hole to drain any water. I did this to all of the traps throughout the antenna. Don’t be fooled into thinking that sealing the trap covers will solve the problem. If moisture accumulates in the trap, sealing will make it impossible for water to make its way out. If you do seal the covers, add the drain holes too. Since making this adjustment to my TH-7, I have had no problems with SWR during long, heavy rainstorms.—William J. Thomas, K1XT, 810 Selma, Webster Groves, MO 63119

**Figure 1—Element sag permits water to accumulate in traps away from the existing drain holes. By drilling an additional hole as shown, the trap can drain.**

**STORING THE “LOOSE SCREW” IN AN ICOM IC-706MKIIIG**

◊ When the ICOM IC-706MKIIIG mobile transceiver is being used with the optional OPC-581 front-panel separation cable, a small (2×5.5mm) screw is used to secure this cable to the transceiver. This leads to a problem: Where do I store this screw when this cable is removed, and will I remember where it is when required, possibly for use by other ham members of my family?

There is a perfect solution! On the backside of the front panel, just above the factory applied “caution” sticker there is a 6 mm diameter, 7 mm deep recess with a small screw beneath it. This recess is just the right size for storing the “loose” screw! To be completely below this surface, however, this screw needs to be placed in this recess with the head facing out.

To ensure that this screw is not lost when the front panel is removed, place a small piece of transparent tape over this hole to retain the screw. A small label identifies and points to this “loose screw” as a reminder! I printed the label on plain paper, and then glued it over the factory “caution” label with a small amount of rubber cement. I did not want to use a permanent self-adhesive label, in case I may want to remove it at some point. Rubber cement does not attack the plastic or the printing on the factory label. The new label does not interfere with the attachment of the front panel to the radio because the label area is recessed below the surface of the front panel.

Figure 2 shows transparent tape over the screw in the “storage” area and my new reminder label.—Karl T. Schwab, KO8S, 30752 Ridgefield Ave, Warren, MI 48088-3174; ko8s@arrl.net

**Figure 2—KO8S stores the cable retaining screw for his ICOM’s remote front panel kit in a recess on the back of the panel.**

**DATAPORT CABLE FOR YAESU FT-920**

◊ I discovered something that may be of interest to some Yaesu owners. My FT-920, and other models, use a five-pin DIN connector on the rear panel for the data port. A nice source for a five-pin DIN cable with a molded connector is an old AT/XT keyboard. These old keyboards are usually free for the taking wherever you can find them, because they are obsolete. Where I work, we had a storeroom of old junk computer parts with a stack of these keyboards. It does not matter whether the keyboard works or not; all you need is the cable. It is easy to open the keyboard and release the cable from its header connector. If you like, the header is also easy to remove from the circuit board to be used in your project, such as a homebrew sound card interface. The DIN pin out is easy to determine using an ohmmeter to check for continuity.—James Matis, K2TL, 11 Moss Haven Way, Howell, NJ 07731; k2tl@arrl.net

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