# The REPEATER

*The OFFICIAL newsletter of the Rogue Valley Amateur Radio Club*

**W7DTA**

**Volume 2011, Issue 1** **January 2011**



| | | | |
|---|---|---|---|
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## *Next Club Meeting*

**Thursday, January 6, 2011, 7:00 PM**
**Red Cross Building, 60 Hawthorne St., Medford, OR**
**Across from Hawthorne Park**
**Program: Swap Meet**

### President's Letter

Greetings from your newly 'elected' club president! I do hope that as this reaches you that you have had a pleasant holiday season with your family and loved ones.

The club leadership has met and attempted to come up with an interesting set of programs for the coming year.

With that, I would like to add a personal challenge to each of you to get on the air more, to try a new mode, to try a new technology (e.g. computer logging or antenna modeling software or …?), to visit a fellow club member's shack, or to become more technically up to date. As time and opportunity permits, I will be doing all of those myself in the coming year or two.

I would like to solicit ideas that would en-

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### Secretary's Report

MINUTES OF THE 2 Dec 10 ROGUE VALLEY AMATEUR RADIO CLUB MEETING

The meeting was called to order by President Herb Grey, W7MMI at 1820L in the banquet room of the China Hut restaurant in Medford, OR.

Herb announced that this being the annual Christmas dinner and gift exchange no ordinary business would be conducted. We will eat dinner first install officers and exchange gifts later.

After a fine dinner outgoing president Herb Gray announced that the new slate of officers, Allan Taylor, K7GT President, Scott Cummings, KD7EHB, Vice President, Jack Schock WA7IHU, Secretary and Lud Sibley KB2EVN, Treasurer were hereby installed.

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## President's Letter, Continued

*(Continued from page 1)*

courage each member to venture into one or more of these 'new' things

And once implemented, perhaps we can draw in some of the many local amateurs who are not aware of this club or have chosen to not participate. We have so much potential here in the Rogue Valley.

Allan

## Newsletter now paperless

The RVARC Repeater is paperless starting with the January 2011 issue.

You can receive a copy one of three ways:

1. Email. Make sure your email address is current with the club newsletter editor, ( n5eg@tapr.org ) and you will receive each issue via email.
2. Club web site. Each copy of the newsletter is available about a week ahead of the meeting on the club's webpage (see page 1 for the link). Additionally, an archive for all past issues since late 2008 is available (via the club web page).
3. A few paper copies will be brought to the club meeting for those without Internet access.

The electronic versions are in PDF format.

## Secretary's Report, Continued

*(Continued from page 1)*

Herb announced that the next meeting will be the annual January swap meet.

Herb's last official act was to pass the president's gavel to the new president.

Then Herb and Jack passed out the Christmas gifts.

Allan then adjourned the meeting.

Fourteen people attended this function.

Submitted by Jacob O. (Jack) Schock
WA7IHU secretary

## Broadband Wire HF Antennas and Feedlines

This article will look at some common HF wire antennas that are capable of covering multiple Amateur HF bands, and the use of coaxial and twin-wire feedlines for feeding these antennas.

One of the key considerations for multiband antennas is the amount of feedline loss. Feedline loss consists of two components:

- Intrinsic loss or cable loss — is loss due to the feedline itself, and

- Excess loss—which  is loss due to impedance mismatch at the termination point of the feedline.

While we often know (or should know) the intrinsic loss of the feedline, many times we do not consider what turns out to be the far more important excess loss.

At HF frequencies, the intrinsic loss of the feedline is due primarily to the gauge of the copper conductors comprising the feedline (the dielectric loss becomes more important at higher frequencies).

At HF, the skin-depth (the region of a conductor where most of the conduction takes place) is not too deep. For copper the skin depth is:

- 1 MHz—skin depth = 66 microns (about 0.0026 inch)
- 28 MHz—skin depth = 12 microns

In free space, the skin depth is actually less than above for closely-spaced conductors.

This means for RF that the central portion of the wire can be a poor conductor (such as steel) as long as the cladding portion of the wire is a good conductor (such as copper). Thus copper-clad steel is a popular material due to it's high strength and good RF conductivity.

If cost and strength are not primary concerns, then all-copper feedlines are a good choice.

For the purpose of this article, we'll look at two feedlines:

- RG8
- 14-gauge 450 ohm ladderline.

The loss of each of these feedline can be approximated quite well by a simple formula:

Loss in db = k1 * sqrt(freq) + k2 * freq.

Thus the intrinsic loss increases with frequency. For the two cable types, the following table shows the intrinsic losses (1:1 load SWR):

RG8 cable—100 feet
- 0.17 db / 100 feet  @ 1 MHz
- 0.56 db / 100 feet @ 10 MHz
- 1.00 db / 100 feet @ 30 MHz

450 ohm ladderline (14 gauge) 100 feet
- 0.04 db / 100 feet @ 1 MHz
- 0.15 db / 100 feet @ 10 MHz
- 0.28 db / 100 feet @ 30 MHz

At first blush, it would appear that these losses are small enough not to be noticeable, especially the ladderline.

However the excess loss (mismatched load) are higher.  The excess loss depends on the intrinsic line loss and the amount of mismatch. The total loss (8intrinsic + excess) can be computed from the following formula [(1) Orfanidis, equation 10.10.8]:

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$$10 \ Log \left( \frac{CL^2 - |\Gamma|^2}{CL \left(1 - |\Gamma|^2\right)} \right)$$

Note that CL is the Cable Loss in linear units (not dB). 3 dB = a linear loss ratio of 2, and gamma is the load reflection coefficient.

We can compute the loss for the RG8 and Ladderline table for some different values of SWR to illustrate how large the total loss can be:

*SWR of 1:1*

| Cable Loss | Excess Loss | Total Loss |
|---|---|---|
| 0.2 dB | 0.0 dB | 0.2 dB |
| 1 dB | 0.0 dB | 1.0 dB |

*SWR of 10:1*

| Cable Loss | Excess Loss | Total Loss |
|---|---|---|
| 0.2 dB | 0.73 dB | 0.93 dB |
| 1 dB | 2.43 dB | 3.43 dB |

*SWR of 100:1*

| Cable Loss | Excess Loss | Total Loss |
|---|---|---|
| 0.2 db | 5.01 db | 5.21 db |
| 1 db | 10.03 db | 11.03 db |

The problem of feeding an effective wire multiband antenna might be summarized as

> Minimizing the impedance mismatch to the feedline, and keeping the feedline loss low, all while maintaining reasonable antenna efficiency.

In general, ladderline has lower loss than coaxial cable, but as we will see, it's not always the only choice.

Our initial antenna for study is the doublet antenna. A resonant doublet is usually called a dipole antenna. Let's look at the loss trade-offs.

**An 88-foot long doublet antenna**
is placed 35 feet up at the center. It is fed with 150 feet of transmission line. What do the feedline losses look like when using RG8 and when using 400 ohm ladderline?

To answer this question, we first must compute the feedpoint impedance of the doublet over the frequency range of interest. The antenna was simulated in NEC2, and the input impedance computed from 1 to 30 MHz.

Next, the mismatch of that antenna was used to compute the cable loss and excess loss versus frequency.

At 3.5 MHz, the antenna feed has a 307:1 SWR to 50 ohm cable, and a 54.4:1 SWR to 450 ohm ladderline (I used 450 ohms for the calculation, but real ladderline is closer to 400 ohms—the difference is not too significant for this article).

As we can see, near where the doublet is resonant, at 5.5 MHz, 16.5 MHz, and 27.5 MHz, the SWR drops to a low value. Thus, it matches 50 ohm coaxial cable well (low SWR) at those frequencies. Similarly, it is near 450 ohms at 6.5 MHz, 17 MHz, and 28 MHz, having low SWR.

We can now combine the calculations of the cable loss, excess loss, versus frequency for this antenna.

Chart 1 shows the SWR versus frequency for 50-ohm coaxial cable and 450 ohm ladderline when feeding an 88 foot doublet antenna.

Chart 2 shows the cable loss plus excess loss (due to SWR) for 100 feet of RG8 and 450 ohm ladderline feeding that 88 foot doublet antenna.

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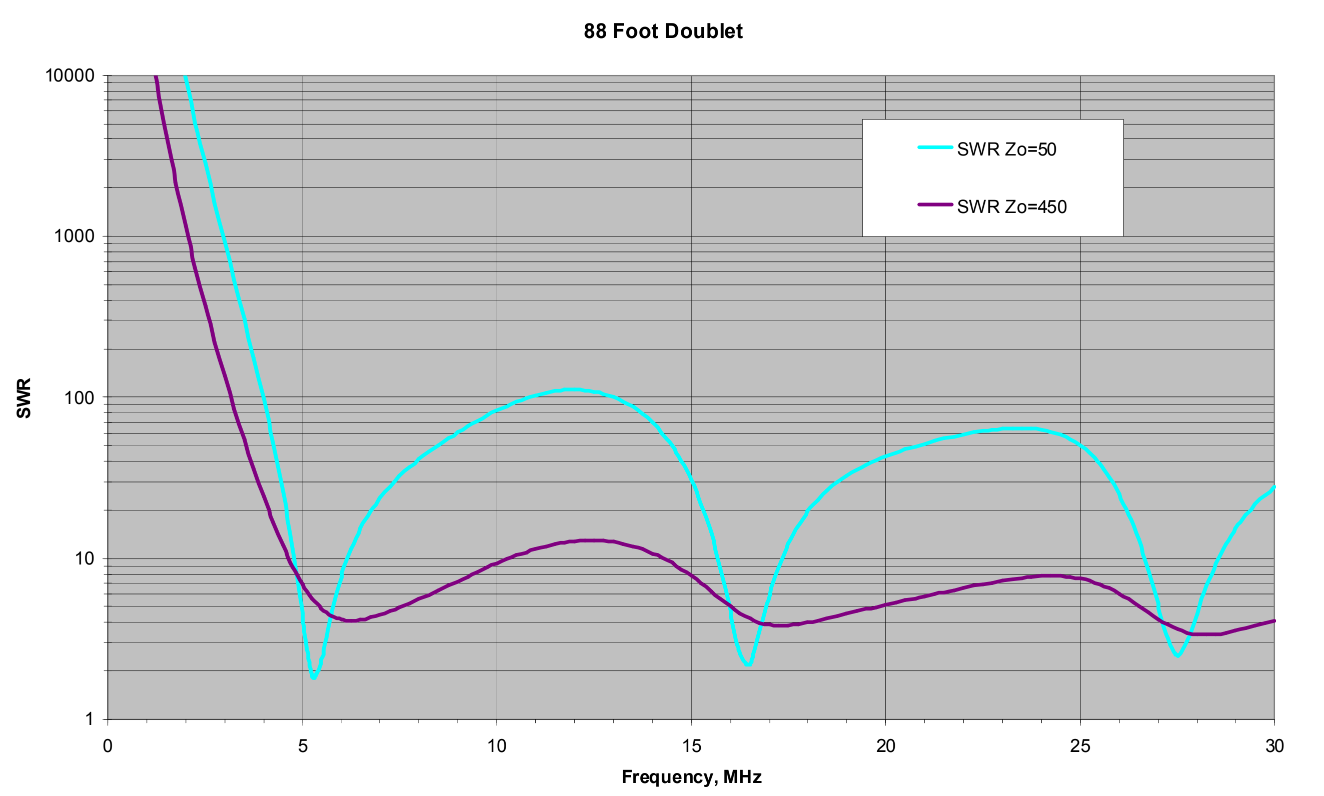
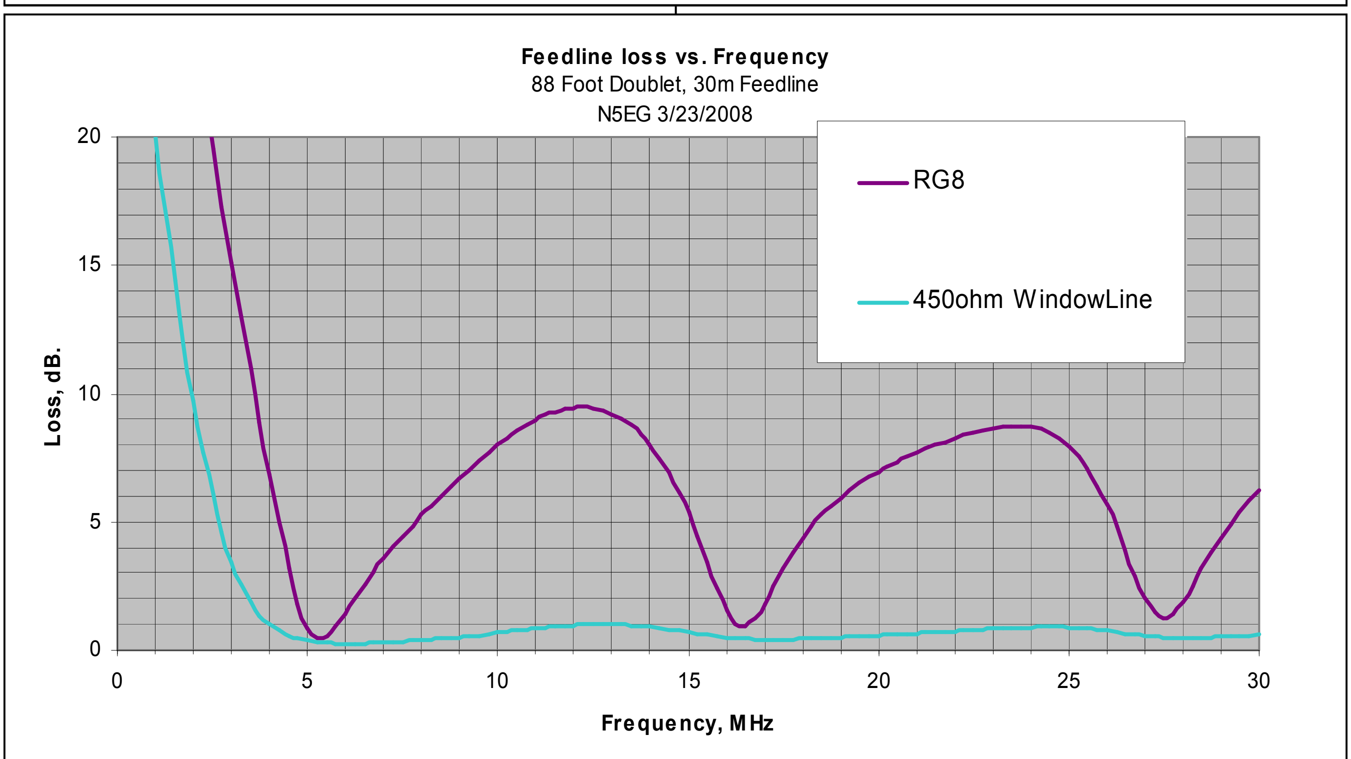
It can be seen that at the bottom end of 80 meters, the RG8 coaxial cable due to the

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very high SWR has about 12 dB of loss, while the 450 ohm ladderline has about 2 dB of loss. While neither is terrific, the ladderline is far superior in this application. The coaxial cable would be a good choice if operating this antenna at one of it's near-resonant points. Unfortunately none of those are near any amateur bands.

Thus for this particular case, ladderline would provide much lower loss over the range of the antenna except for 3 frequencies. We can see that the antenna is just a bit too short for 80 meters operation.

If this antenna is lengthened to about 100 feet, the ladderline loss is decreased by about 1 dB or so, but the coaxial cable loss is still excessively high.

Alternatively, the doublet antenna could be shortened to about 70 feet. In that case, its resonant points move up in frequency to 7 MHz and 21 MHz. this antenna could then be fed for those two bands with RG8 and it would work well. However, only ladderline would provide acceptable losses when trying to operate this antenna on 14 or 28 MHz.

### 144 foot Loop Antenna

Another alternative for a broadband antenna is the loop. One of the key characteristics of the loop is that it exhibits a low-impedance resonant point at every harmonic (rather than just the odd harmonics that the dipole does). The same charts of SWR vs. Frequency, and cable loss vs. frequency were created for a 144 foot circumference loop antenna. Charts 3 and 4 show the SWR and Losses respectively.

It can be seen that coaxial cable is a good match for this loop antenna on the harmonically-related amateur bands, but not for the 30 meter, 17 meter and 12 meter bands, where the RG8 would exhibit about 8 db of loss while the ladderline exhibits less than 1 db loss.

Additionally, the loop has the same problem as the doublet, namely that the SWR is very high on 80 meters, leading to excessive feedline loss, about 6 dB when using ladderline, and a whopping 20 dB when using RG8 coaxial cable. The loop needs to approach about 200 feet in circumference in order to start to get the feedline losses low enough on 80 meters to be reasonable.

### Conclusion

Feeding a multiband HF antenna takes a great deal of care in order to avoid catastrophic losses. Ladderline is a good choice, but not a cure all for antenna operation especially at low frequencies due to extremely high values of SWR.

### Next Month

Next month we will look at the antenna gain performance and patterns of some antennas over the various different amateur bands.

1. "Electromagnetic Waves and Antennas", 2008, Sophocles J. Orfanidis, p 442

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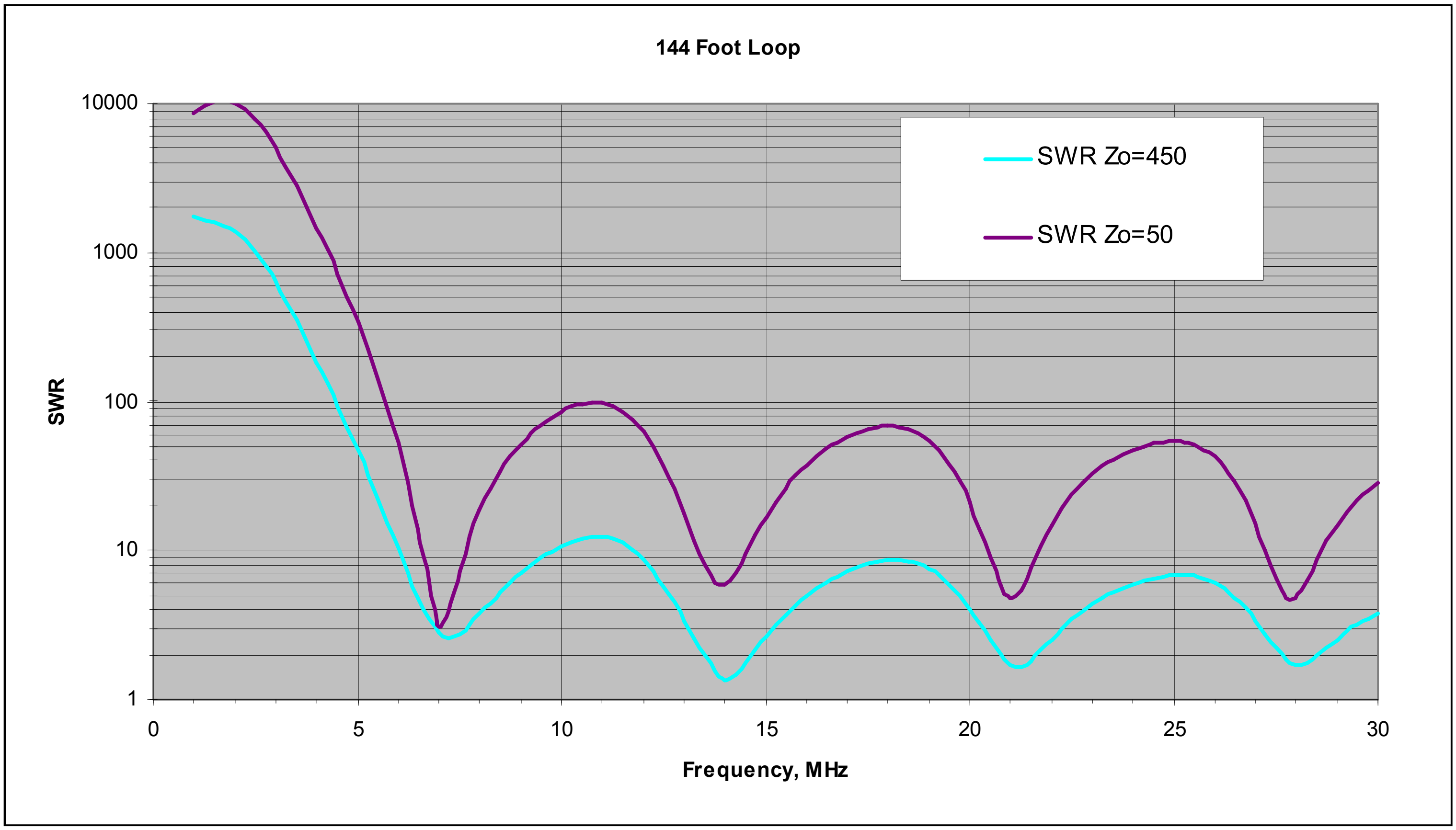
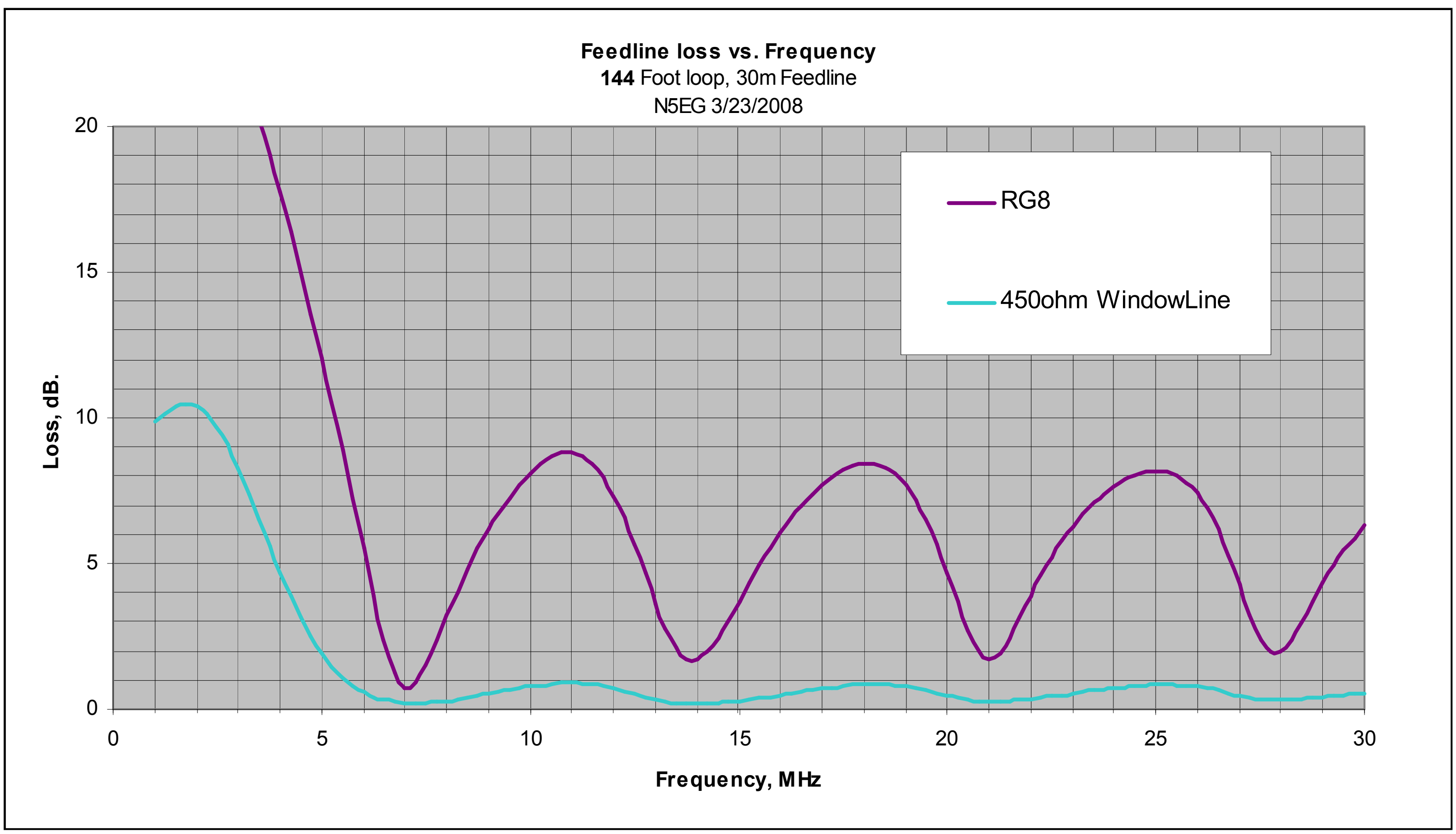

144 Foot Loop
SWR
10000
1000
100
10
1
0
5
10
15
20
25
30
Frequency, MHz
SWR Zo=450
SWR Zo=50


Feedline loss vs. Frequency
144 Foot loop, 30m Feedline
N5EG 3/23/2008
Loss, dB.
20
15
10
5
0
0
5
10
15
20
25
30
Frequency, MHz
RG8
450ohm WindowLine