antennas

BY KENT BRITAIN,* WA5VJB

Herringbone Log Periodics and Another AMSAT LEO Antenna

Some of you may have seen the first version of this AMSAT LEO antenna in *CQVHF* a few months ago. Since then I have had a chance to tweak the design and make it much lighter (photo A), and have it tested side-by-side test with other LEO antennas at the Dayton Hamvention®. Keith Pugh, W5IU, goes into this field testing in much greater depth in his AMSAT column in the Summer 2012 issue of *CQ VHF*.

Theory

A log periodic antenna like the one in photo B works very well over its design range. But when you look at the 3rd harmonic, that is, running a 145-MHz log periodic at 435 MHz, you get the pattern in fig. 1.

Ever look at most of your larger outdoor TV antennas? The longer elements are usually swept forward like the antenna in photo C. There is a very good reason for these swept elements. The old (analog) TV channels 2-6 covered the frequency range of 56 MHz to 88 MHz, while channels 7-13 covered 172–216 MHz. This put Channels 7-13 within the 3rd harmonics of Channels 2–6. Fifty years ago, it was found that if you sweep the elements of a log periodic forward about 30-40 degrees, the 3rd harmonic pattern really cleans up as in fig. 2. These swept-element versions are known as *herringbone* antennas. Now the TV antenna designers just had to make a good 54-88 MHz herringbone log periodic antenna and they knew they also had a good TV channel 7–13 antenna.

In short, a 145 MHz band log periodic is going to give you a pattern like fig. 1 on 435 MHz, but the herringbone log periodic will produce the pattern in fig. 2.

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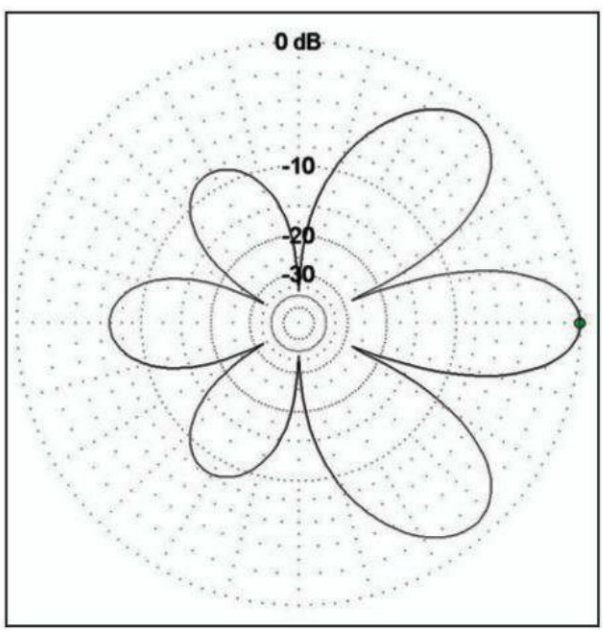


Fig. 1– Polar plot of a traditional log periodic on its 3rd harmonic.

Photo A– A herringbone log periodic for 2-meter/70-centimeter use.

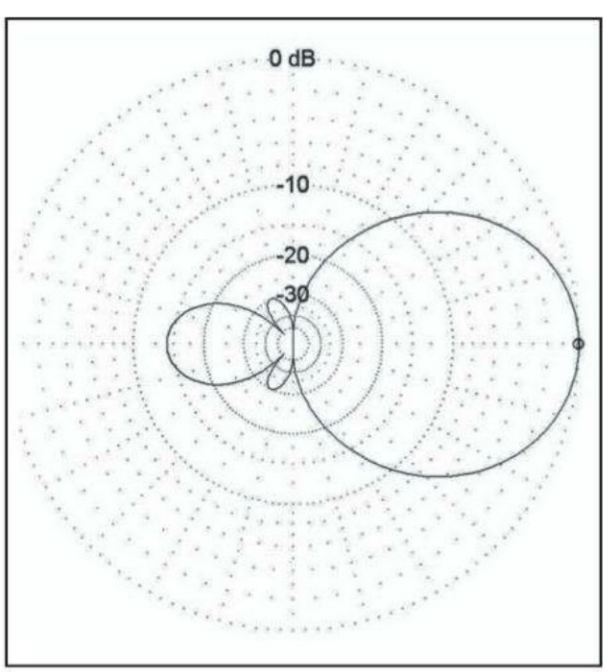


Fig. 2– Polar plot of a herringbone log periodic on its 3rd harmonic.

Photo B– Traditional log periodic.

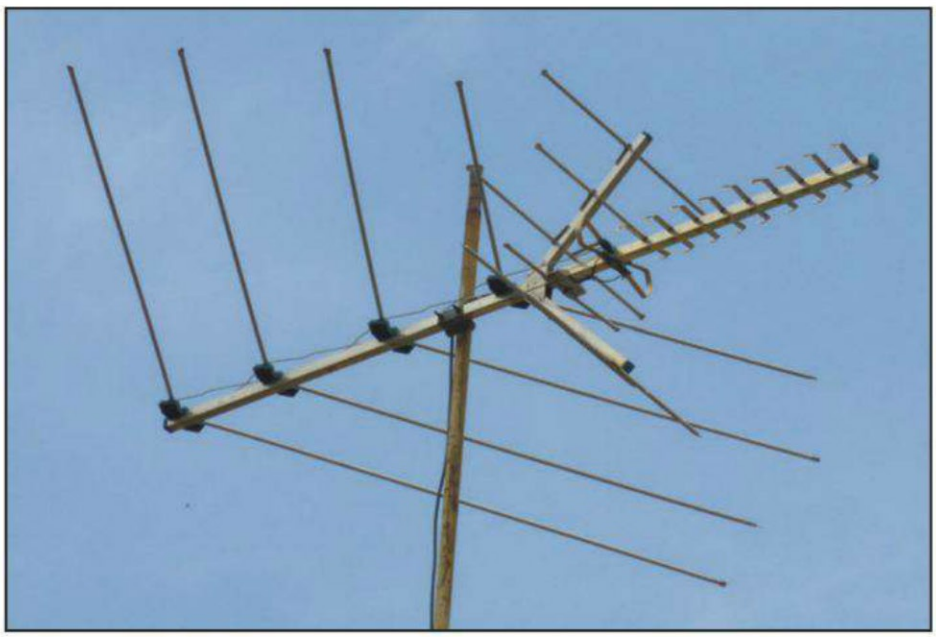


Photo C– Herringbone log periodic, often used for TV antennas.

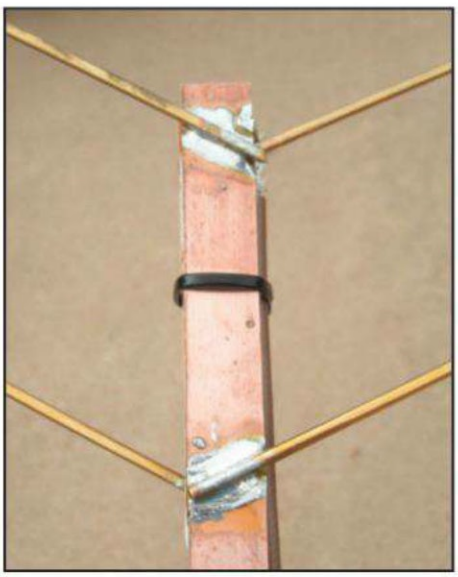


Photo D. Close up of the alternating elements.

For years I have tried making simple log periodics, but the booms have been the tricky part. On a log periodic the booms are a parallel transmission line, much like 300-ohm twinlead, but with an impedance in the 100-125-ohm range. With the right density of elements, this 100-125 ohm impedance is pulled down to 50 or 75 ohms depending on your application. Get the impedance of the boom right, get the density of the elements right, and you can directly solder 50-ohm coax to your antenna and with get a good SWR.

Construction

For the boom I used 1/2" × 1/2" square hardwood about 18 inches long. For the boom conductors I used .7" wide strips of PC board. The PC board was coated with construction adhesive and clamped to the wood overnight.

Again, the boom is a parallel transmission line and the impedance is important. With wood and fiberglass boom materials, you want the final dimensions to look like fig. 3, a 1:1 ratio for the width and separation.

You can experiment with different materials for the boom and transmission lines, but again, you want to keep that width/separation ratio about 1:1.

Elements

For the element material, I used bronze welding rod. It's strong and easy to solder. Some kind of template to help hold the 35–40 degree angle is helpful, but with some big pliers, you can bend the elements at the base a bit to help line them up after your solder job. I also suggest you bend the tips of the elements in a small circle as shown in photo F. This helps keep you from poking yourself with the elements.

The first antenna used .125" or 1/8" diameter welding rod. Strong, but a bit heavy. This antenna uses .062" or 1/16" diameter welding rod. A bit floppy, perhaps, but much lighter.

Another possible material would be hobby tubing. You can take two rods with diameters that telescope into each other to form a lighter element that is tapered.

See Table I for element lengths and spacing. Lengths are measured from the center of the boom. Spacings are measured from the back element. All elements are swept forward at a 35 degree angle. It doesn't have to be exactly 35.0 degrees, but between 30 and 40 degrees provides the best 435 MHz performance.

Note in the photos that the elements alternate top/bottom. So the back and 3rd elements would have the right side on top, and the left side on the bottom. And the 2nd and front elements would have the left side on top, and the right side on bottom. The #1 mistake I have seen in log periodic construction is getting the top and bottom elements out of sequence. On a proper log periodic, the

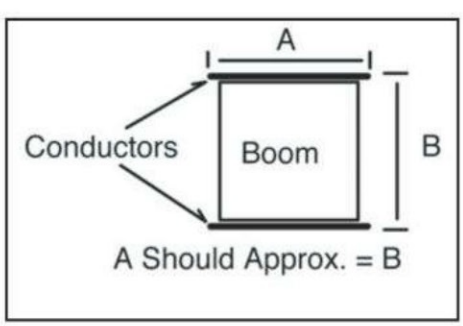


Fig. 3– Dimensions of the boom and parallel conductors (see Table I for element lengths and spacing).

Element	Spacing	Length
Back Element	0 inches	24.0 inches
2nd Element	3.5	20.5
3rd Element	7.0	19.5
Front Element	10.25	17.0

Table 1. Element length and spacing for herringbone log periodic. See text for additional details.

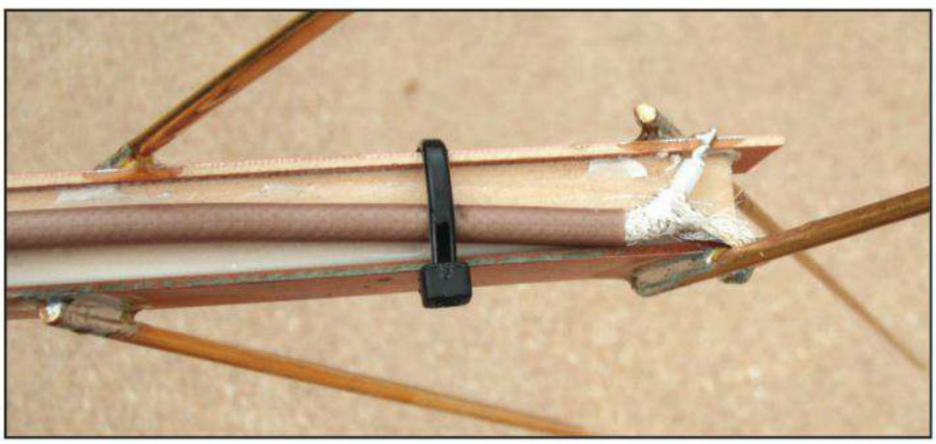


Photo E– Coax attachment.

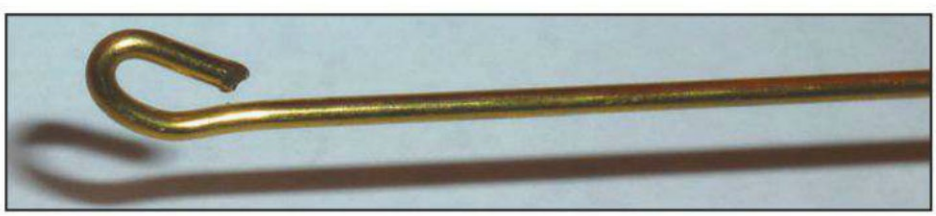
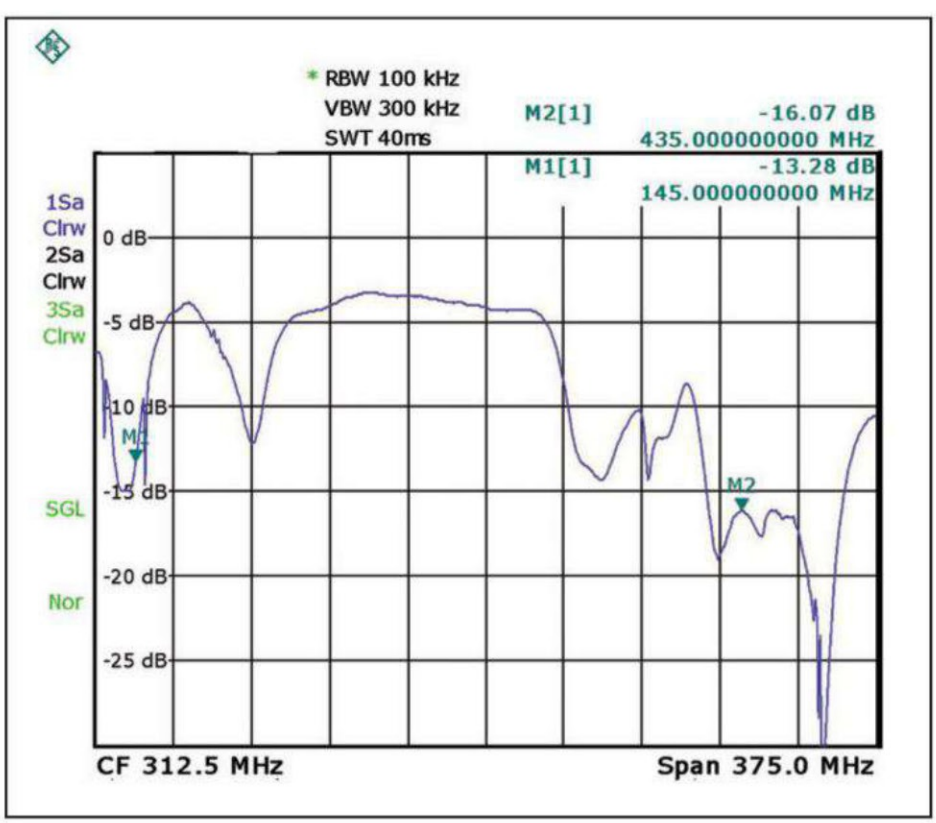


Photo F– Element tips should be rounded for safety's sake.



Plot 1– Return loss plot of the herringbone log periodic. (–10 dB = 2 to 1 SWR)

phase of each element reverses. Sometimes the transmission line is reversed at each element. In my case, I just alternated the elements top/bottom as in photo C to get the phase reversal on this antenna.

In photo E you can see the coax attachment is pretty simple. The coax center conductor goes to one side and the coax shield to the other side. A few cable ties or even duct tape can hold the coax in place.

Need something really portable? Build the antenna using bare #10 household copper wire for the elements. Now you can bend the elements against the boom for a very compact antenna. Then, when needed, just bend the elements sort of straight and to a 35-degree angle again. Not pretty, but very compact and portable. You can usually wad up the elements about a dozen times before they have to be replaced.

The original antenna was tested at the Central States VHF Society by WB0TEM on the antenna range. Gain at 144 MHz gain was 5.3 dBd, 435 MHz was 7.6 dBd. For the marketing folks, this would be 7.4 dBi at 144 MHz and 9.7 dBi at 435 MHz.

Going Up to 1200 MHz

A 435–1269 MHz version would be an easy project. I understand the KiwiSAT planned for launch in a year or so will be using these bands. Sounds like a future column. And from the frequency sweep in Plot 1, you can see the antenna is very broadbanded. If you are not into AMSAT LEO satellites, this herringbone log periodic can also make a nice antenna for that dual band 2-meter/440-MHz talkie.

Let's Hear From You

You guys come up with some really innovative ways to build or use these antennas. How about some feedback? Let us know what creative ways you have found to modify this design.

As always, we welcome antenna questions and column suggestions from our readers. Many a column topic has been suggested by our readers. E-mail to <wa5vjb@cq-amateur-radio.com> or <wa5vjb@amsat.org> will work. And for several dozen other antenna projects, you are welcome to visit <www.wa5vjb.com> and look in the Reference section.