LISTENING TO A DREAM

Don Moman, VE6JY

When someone mentions a high frequency log periodic antenna, one thinks of massive arrays on embassy buildings or at government and military monitoring stations. They are also used by the maritime and aeronautical services, as well as by anyone with the need to communicate over a variety of distances and frequencies in the HF spectrum. They maintain their gain and other electrical properties more or less uniformly over the design range of the antenna, without any need for traps, mechanical switching or antenna tuners. The log-periodic design is characterized by a logarithmic taper in both element length and spacing from one end of the antenna to the other. You can see many smaller examples of the log-periodic design if you live in an area where "all-band" TV antennas are popular.

Several years ago, most likely in the early eighties, I recall seeing an abandoned log-periodic antenna in an industrial area on the south side of Edmonton. It was massive, sitting on a wooden pole that must have been ninety feet tall and three feet across at the base. For someone with a small city lot and no supporting structure heavier than a collection of wooden poles, it was preposterous to even think about such a monster. Since it really was abandoned, I recall bringing a new receiver along one day and hooking it up to the severed coaxial cable. The receiver was the Radio Shack DX-300 and the result was complete overloading of the front end rendering the entire zero to thirty megahertz spectrum useless. All that accomplished was to convince me of the tremendous signal gathering properties of the log-periodic as well as the inadequacies of the DX-300.

Several years later, I found that a radio club in British Columbia had a very similar log periodic for sale. It had been donated to them by an oil company in Calgary and was too large for the tower the radio club had; so I wound up purchasing it. Without any paperwork or specifications, it's hard to be certain but evidence points to the antenna as being manufactured by Telrex and covering 9 to 16 mhz using a 46 foot long tubular boom. It was a start but what I really wanted was something that covered at least 6 to 30 mhz.

It was about then that I got real lucky! A local amateur acquired exactly what I had been dreaming about - a large log-periodic array covering the 4 to 30 mhz region. The boom length was over 60 feet, the largest element was over 80 feet long and the entire array weighed over 1000 pounds. It was not new but it had never been assembled, and was still in the original shipping crates with all the hardware and instructions. It even was complete with the matching rotator. The story I heard was that the antenna was originally ordered from Sabre Communications [1] by Imperial Oil as a replacement for a similar antenna which had just been destroyed by an ice storm in Alaska.

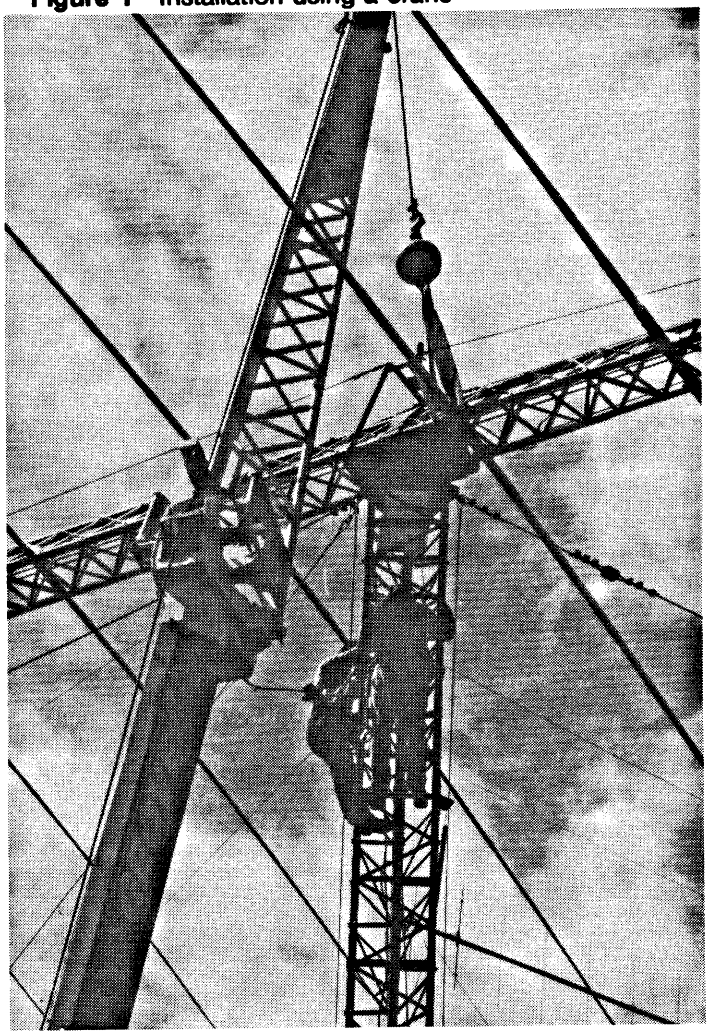
This was apparently the "foul weather" version, strengthened to survive under the worst conditions. The project then was cancelled and the antenna sat around in a warehouse in Edmonton for several years. To make a long story short, which isn't possible at this stage, I convinced him I needed the log-periodic more than he did and purchased it from him. The rotator stayed behind to turn a massive 50 Mhz Moon Bounce antenna array.

It's a good thing the blueprints were still enclosed because it really was a gigantic meccano construction set. The boom of the log-periodic is a 18 inch triangular tower, made entirely of aluminum and bolted together, not welded or riveted. Apparently the blueprints were not for the version I had, since they showed a welded boom. After a few trial and error sessions all 62.5 feet of tower/boom was assembled. Even at this early stage of construction, it was already too heavy to move about by hand. By the time one adds the 19 elements and the mounting hardware, the entire antenna weighs in excess of 1100 pounds. The log-periodic that failed in the arctic broke in half due to severe icing conditions. Even though mine was the heavy duty version, I decided it would be wise to install a truss support for the boom. The elements are not trussed so there is a fair bit of sag in the larger elements, but they are constructed of very substantial aluminum tubing, starting at 3 inch OD with .25 inch wall thickness and tapering down to .5 inch at the very ends. The first 4 elements use loading coils to increase their electrical length to resonate in the 4 to 6 mhz region. Overall, the first 5 elements are 82.5 feet long, with the other elements progressively shorter, with the nineteenth element only being about 6 feet long. In total, nearly 1000 feet of aluminum tubing is used in the antenna. You should stand under the tower with a stiff wind blowing and listen to the wind in the rigging!

Installation of such a heavy and cumbersome antenna is best accomplished with a large hydraulic crane. The manual shows a "simple" way to erect the log-periodic on an eighty foot tower with a winch and gin pole arrangement. It doesn't look that simple. In my situation, with the 120 foot tower already in place, the crane was the quickest, simplest and the safest. The log-periodic is bolted to a saddle arrangement that is bolted to a short section heavy mast. The crane picked up the entire assembly and merely lowered the mast into the thrust bearings already mounted in the tower. The process took less than 45 minutes, the culmination of weeks of preparation and years of dreaming. The log-periodic is installed 121 feet above ground level, on fairly high ground which provides a good takeoff angle in all directions. The tower is situated about 150 feet away from the house and the antenna is fed by 300 feet of 1/2 inch low loss heliax cable. All control and signal cables run underground from the tower to the radio room.

As one can imagine, a rotator capable of turning, stopping and holding this array has to be a substantial unit. The specifications indicate a wind area of 40 square feet, but that is for the original version. As mine uses much wider bracing material, plus with the added truss hardware, I'd estimate the wind area to be at least 50 or 60 square feet. Initially I used a large Wilson 1000 rotor, rated for 40 square feet, as a 8temporary measure. I kept shearing the bolt that either joined the two sections of mast inside the tower or the one that pinned the mast to the rotator. After shearing a 1/2 inch grade 8 bolt, I decided that the next thing to go would be the brake and gears in the rotor, so I got busy and installed the unit that is still in use now, and which has been essentially trouble free. A large worm gear with a 60:1 ratio was installed at the 80 foot level. It is driven by a 3/4 horse, reversible, electric motor and connected to the worm gear with some reduction pulleys. Overall turning speed is set to make one complete revolution in just over 2 minutes. No brake mechanism is required as the worm gear design provides its own braking action. The motor has plenty of torque to get the system turning, even at -30 degree temperatures with a 80 km breeze. Getting the performance at -30 degrees and even colder meant draining the oil from the gearbox and replacing it with kerosene!

Figure 1 Installation using a crane

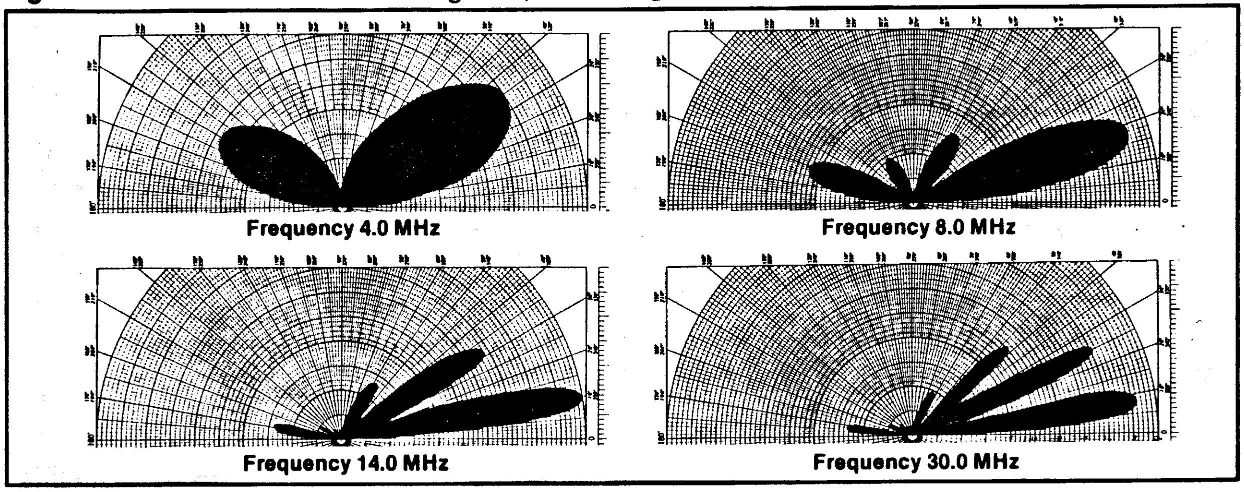


PERFORMANCE

According to the manufacturer's literature, the Sabre MLP-4 has a rated gain of 9 db at 4 mhz, increasing to 13 db at 8 mhz and above. Front to back ratio, never a strong point of the log-periodic design, is rated at an average of only 12 db. Since no db reference is given, such as dbi or dbd, one cannot compare these figures directly with other antenna specifications which are usually referenced to the gain of a dipole, dbd. I was told by someone knowledgeable about such things, that they usually added in a 5 or 6 db "ground reflection gain" to arrive at the above figures. The antenna is a compromise in both spacing and element length at the lower end of its coverage. The literature states that the "MLP-4 is a fore shortened log-periodic array covering the 4.0 thru 30 Mhz frequency band continuously with a reduced physical size of approximately one-half that of a full scale array."

The arrival angle of signals can have a dramatic effect on the performance of any antenna. Looking at the plot for the vertical radiation pattern at various frequencies one can see there is a main lobe at a fairly low angle plus, depending on the frequency, one or more other high angle responses. These plots are for an antenna 80 feet high, mine is at 120 feet so the main lobe of my antenna will be at a slightly lower angle. In between these are angles where the gain of the antenna is very low, and in some cases, the response of the beam in a certain direction might be better if the back of the antenna was pointed at the signal! In the real world I have noticed large variations in the front to back and front to side performance of the antenna, especially below 8 mhz. Sometimes the antenna can be rotated through 360 degrees and the signal hardly changes at all. Other times the signal will rise out of the noise floor to S9 plus, real armchair copy. It all seems to depend on the arrival angle, a difficult entity to measure or predict.

Figure 2 Vertical Patterns over average soil, Antenna @ 80 feet



As a good friend of mine is always telling me, having one antenna is like only having one idea - how do you know if it's any good? The log-periodic has been up since June 15, 1989. It has been compared and tested thousands of times against other antennas, both receiving and transmitting. Other antennas include: 5 element 20 meter monobander at 72 feet, Cushcraft ATB-34 10/15/20 meter triband beam at 50 feet, various wire antennas including 80 meter inverted Vees and delta loops, 160 meter inverted Vee, 132 foot transmitting vertical for 160 and 80 meters, a 60 meter sloping dipole oriented toward Africa, and assorted beverage antenna. All the wire Vees and dipoles were hung at various points off the 120 foot tower that also supports the log-periodic.

Going back through my logbook for the summer of 1989, I noticed I had jotted down a few quick signal comparisons. In the "Other" column I used whichever of my other beams and wire antennas that gave the best signal. Meter readings are from a reasonably well calibrated Kenwood TS-440 transceiver.

Station		Log	Other
2500	WWV	S2	S9+10
4880	S. Africa	S1-2	S1, poor (60m)
4890	PNG	S2	het, no audio
5020	Solomons	S9+10	S2, not listenable
		S2 with	beam at 90 degrees
6080	CKFX	S5	just detectable
6160	CKZU	S8	S1-2, noisy, fading
7255	Nigeria	S9+10	S7

Station		Log	Other
14918	Kiribati	S2	S2 (5 el 20m)
15010	Vietnam	S5	S7 (5 el 20m)
15084	Iran	S5	S2, noisy
15171	Tahiti	S7	S5 (5 el 20m)
15175	Denmark	S7	S6 (5 el 20m)
17705	New Zealand	S6	S1
21810	BRT Belgium	S4	S2 (triband)
25730	Norway	weak, clear	nothing

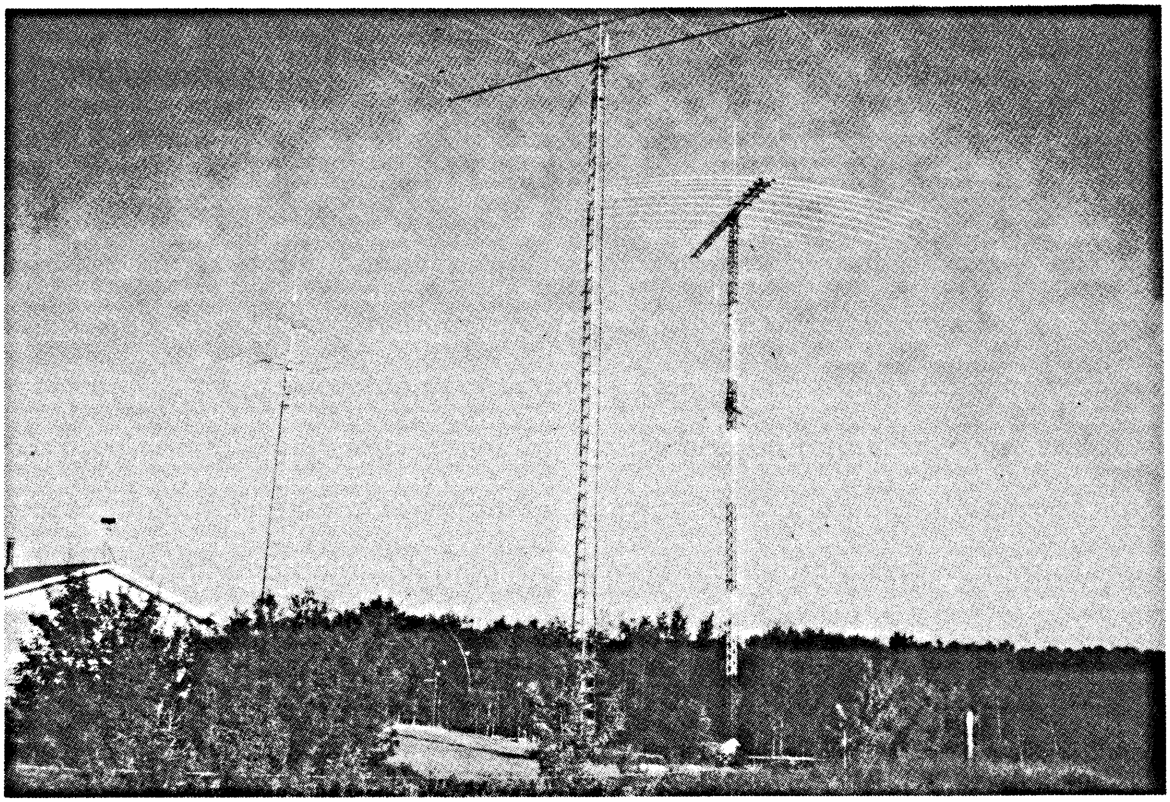
In many cases and especially so on the 60 and 49 meter bands, the advantage of the log-periodic is even greater than the simple advantage in S meter readings, due to the reduction in QRM and noise due to the directional characteristics. On the higher SWBC bands, the log-periodic is often able to separate two co-channel signals, as long as they are arriving from two directions differing by 60 degrees or more. The overall improvement in signal readability using the log versus other non directive wire antennas, is often enough to make the difference between comfortable listening and just being able to tell there is something there. Beams designed for the amateur bands usually perform well on adjacent SWBC bands, for example the 20 meter monobander performs very well on 19 meters. Trapped beams usually have more of a narrow response, the 10/15/20 meter tribander I have performs reasonably well on the 13 meter band but poorly on 19 meters.

The lower limit of the log-periodic is rated as 4 mhz and as such performs poorly on the 120 and 90 meter bands. Recently I have become keenly interested in 80 meter ham band DX, where the SSB DX window is around 3790 to 3800 khz. The log-periodic exhibits a very high SWR below about 3950 khz so I can't use it for transmitting down at 3800, but it does prove to be a superb listener there. It acts just like a beverage, the background atmospherics, static crashes and even local powerline noises are often reduced dramatically in relation to the desired signal. The log does exhibit a bit of directionality down this low, but with very minimal front to back. At this frequency, it's likely acting more or less as a rotatable dipole. About 99% of the time it is the best 80m DX receiving antenna I have. On rare occasions, the Vee or delta loop will exhibit the same signal to crud ratio as the log-periodic, but usually they are far noisier. On certain nights the beverages work well, and I remember only a couple of instances where they were superior to the log, hence the other 1% goes to them. For non DX 80 meter contacts the inverted Vee is usually the winner.

On the higher amateur bands, the log has proven to be a very good performer. No other 40 meter beams are presently in use here, but tests with other amateurs show comparable performance to other 2 and 3 element monobanders. On 20 meters, the log often gets compared to the 5 element monobander, which is at a lower height. The two are quite often even in performance but occasionally one or the other shows a significant advantage. This is most likely due to the difference in heights favouring a certain arrival angle. On 15 meters and especially on 10 meters, the log-periodic is often too high and is easily outperformed by the tribander at 50 feet! However on certain paths, or during unusual or transitional propagation conditions, the extra height helps. Although not a very scientific result, I seem to have noticed that while the received signal may be the same or even lower than the tribander, I am heard a lot better when using the log. This has been observed in many contest and pileup situations, after calling with no response many times on the other antennas, I'll rotate the log around and get through on the first or second call.

For those interested in pursuing their own dream antenna, the manufacturers [1],[2],[3] listed at the end of this article are among the ones that produce "small" log-periodic arrays with lower frequency limits of 6 Mhz.

Figure 3 Final Installation at 120 feet



Finding, installing and using the log-periodic has been quite an adventure, from the beginning to the present. It has also been quite an education! I had no significant formal or practical knowledge about erecting large guyed towers or dealing with rotating such a large array. I do now. Was it worth it all? Yes. Would I do it again? Yes, and I probably will. Lately, I've been thinking about what I could do with say, 160 acres of antenna land. Rosettes of beverages, arrays of rhombics..... then the dream ends. Or perhaps it is just beginning... again.

[1] Sabre Communications Corporation, 3400 Hwy 75 North, P.O. Box 536, Sioux City, Iowa 51102. (712) 258-6690 fax (712) 258-8250
[2] KLM/Mirage Communications, PO Box 1000, Morgan Hill, CA (408) 779-7363
[3] TELEX/Hy-Gain, 9600 Aldrich Ave So., Minneapolis, MN 55420