Circular Polarization – Is It Worth the Effort?
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In the past I've written about polarization three times in my WorldRadio Propagation columns (both the printed magazine and the on-line version). The first column was in the September 1998 issue, the second column was in the March 2007 issue and the third column was in the December 2010 issue.

The first column reviewed polarization observations on 10-Meters by G2HCG. He used a properly-phased crossed-Yagi array (each a 3-element Yagi). His most important conclusion (at least in my mind) was that the polarization of a received signal at his QTH was solely determined by the last encounter with the ionosphere.

The second column elaborated on polarization, and noted that the ionosphere is immersed in a magnetic field. The result of this on our HF bands is two circularly polarized characteristic waves propagating through the ionosphere – the ordinary wave and the extra-ordinary wave. Using Proplab Pro V3 ray tracing software, I showed that on 10-Meters both characteristic waves took essentially the same path through the ionosphere with equal ionospheric absorption, and that they were indeed circularly polarized. I also showed that on 160-Meters both characteristic waves took radically different paths through the ionosphere with the extra-ordinary wave incurring much more absorption, and that both were tending towards linear polarization.

The third column discussed early Amateur Radio efforts with circular polarization at HF. In the early 1960s, Space-Raider Antennas and Crank-Up Antennas offered crossed-Yagis on 10-Meters, 15-Meters and 20-Meters. See Figure 1, which shows a crossed-Yagi using horizontal and vertical elements fed with a phasing line – mechanically the preferred mounting is each Yagi at 45^{o} to make each Yagi symmetrical with respect to ground and the tower

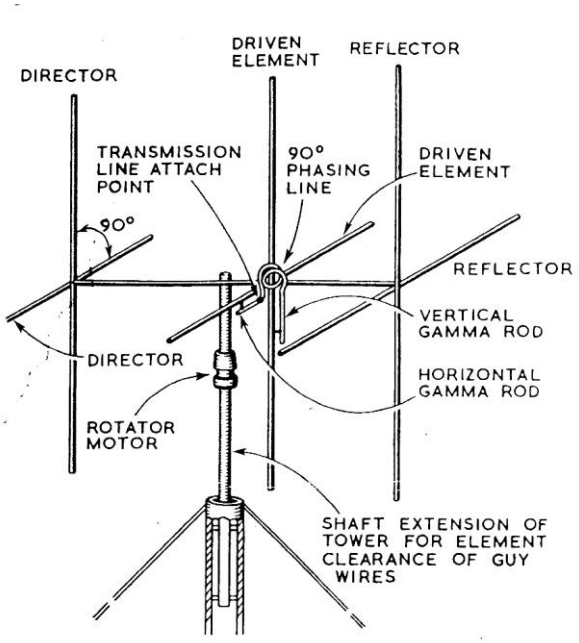

Figure 1 – Circular Polarization with Crossed-Yagis

In the mid 1960s, Telrex offered an interesting twist to achieve circular polarization – their multi-element VHF Yagi employed a progressive shift in element orientation from the reflector to the last director so that the last director was 90 degrees from the reflector. It was called a Spiralray for obvious reasons. See Figure 2. Note that Figure 2 shows a Yagi with ten elements – the minimum number of elements needed for reasonable circular polarization appears to be five based on my antenna modeling.

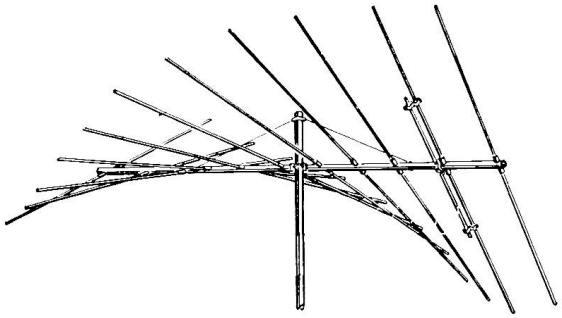

Figure 2 – Circular Polarization with Twisted Elements

Are crossed-Yagis and twisted elements the only way to generate circular polarization? No, there is another way. We can do it by using a helical antenna. See Figure 3.

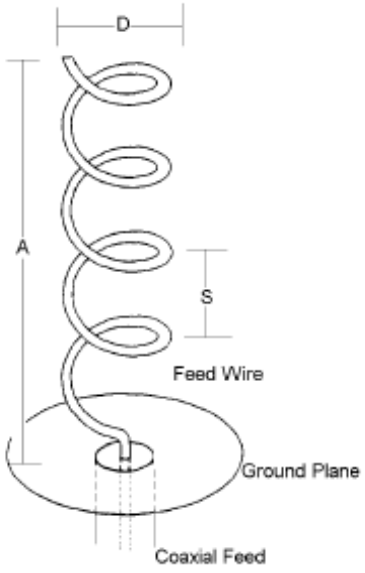

Figure 3 – Circular Polarization with a Helical Antenna

For a helical antenna to provide circular polarization, the circumference of the helix must be on the order of one wavelength. Thus the diameter of the helix will be around 10 feet on 10-Meters, 15 feet on 15-Meters and 20 feet on 20-Meters.

Now let's try to answer the question that is the title of this month's column – is circular polarization worth the effort? The original G2HCG article, the original Space Raider article and the original Spiralray article claimed circular polarization gave longer duration openings with less fading. This is the major 'pro' for circular polarization.

I also talked to Woody WW1WW. He has a 6-element crossed-Yagi array at 50 feet on 10-Meters. He brings equal length coaxes from each Yagi into the shack, and can lead or lag either one by 90^{o} to achieve left-hand or right-hand circular polarization. When I talked to him in early 2013, this antenna had been up for only a year and 10-Meter propagation was not great. Thus his observations were somewhat limited. He said he had observed up to 30 dB difference between left-hand and right-hand polarization under fading conditions, and it does not seem predictable. He did not offer any comments on the duration of openings or on fading.

As for 'cons' with circular polarization, the last paragraph highlights the fact that you need to be able to select either left-hand or right-hand circular polarization (which means only one of the characteristic waves may be propagating at any given time). Note that you can only do this with the crossed-Yagi. This selection process may be acceptable for DXing or casual QSOs, but I think this process would be a bother in a contest environment. I suppose you could electronically poll the signal strength from each antenna and have the best one selected automatically. But a good question to ask now is "does the selection of left-hand or right-hand when receiving at your QTH mean the same works best for transmitting from your QTH?"

Another 'con' that comes to mind is circular polarized antennas are three dimensional (regardless of whether it's a crossed-Yagi, a twisted-element Yagi or a helical antenna). If you've ever wrestled with an HF cubical quad antenna, you'll understand this comment. That third dimension (height) makes it a bit tougher to handle. I believe this is why the Yagi dominates our Amateur Radio activities on HF – it is simple and relatively easy to put up. And generally it stays up. Nowadays circular polarization is used mostly for VHF EME work.

In an effort to mitigate the need for left-hand / right-hand selection, I did an experiment. I mounted a horizontal 10-Meter dipole and a vertical 10-Meter dipole on a common non-metallic support. It looked like the driven elements of the array in Figure 1. I used equal lengths of coax going to a two-way in-phase combiner, and then ran that to the shack. My thought was maybe this would offer some polarization diversity without having to switch anything.

I compared this crossed-dipole array to another 10-Meter horizontal dipole that was physically aligned to minimize interaction with the crossed-dipole array. My limited observations on DX stations (mostly VKs and ZLs) gave no hint of any advantage of less fading of the crossed-dipole array over the horizontal dipole. So much for eliminating the left-hand / right hand selection.

In closing, it appears the only way to do circular polarization is to go full bore – in other words, be able to switch between left-hand and right-hand polarization. This necessarily says the only real choice is the crossed-Yagi. Whether this is acceptable from an installation aspect and from an operational aspect depends on your Amateur Radio goals.