Dielectric

Pylon Elliptical Polarization
Parasitic Dipole vs. Interleave Element

A Note From the Author

Over the last year I have answered numerous questions from broadcasters regarding the difference between the use of a parasitic dipole and fed interleaved vertical elements to produce elliptical or circular polarization on a pylon slotted coaxial antenna. This is not a new topic and a subject near to me. My first patent, “Variable circular polarization antenna having parasitic Z-shaped dipole” filed in 1988 and issued in 1990 was meant to correct the issues associated with the use of interleaved vertical elements. In promotion of the new parasitic technology, Broadcast Engineering magazine published the first of many of my papers related to the topic in May 1990. Since that time, Dielectric has shipped over 1000 slotted coaxial antennas with parasitic dipoles to add vertical component to the slots horizontally polarized transmission. To help understand the benefits of parasitic dipoles and the short falls related to interleaved elements, I have attached the article form 1990. I hope you find it helpful.

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VARIABLE CIRCULARLY POLARIZED UHF ANTENNA

John Schadler
Broadcast Engineering – May 1990

Circular polarization is common to most FM and many VHF TV stations but, until recently, UHF stations didn't pay much attention to the technology. The development of a slot-driven parasitic dipole, however, now makes this technology available to UHF channels as well. The first variable circularly polarized UHF antenna was installed in March 1989 at WYHS-TV, channel 69, in Hollywood, FL.

Antenna design

A coupled-slot cut into the wall of a coaxial, rectangular or circular waveguide, radiates the RF energy. This signal is polarized in the plane perpendicular to the long dimension of the slot. Arrayed vertically on a cylindrical pylon antenna, these slots radiate horizontally polarized signals. Dipoles placed above these slots couple a controlled amount of energy and radiate it as a vertical signal in phase quadrature with the horizontal signal. (See Figure 1.)

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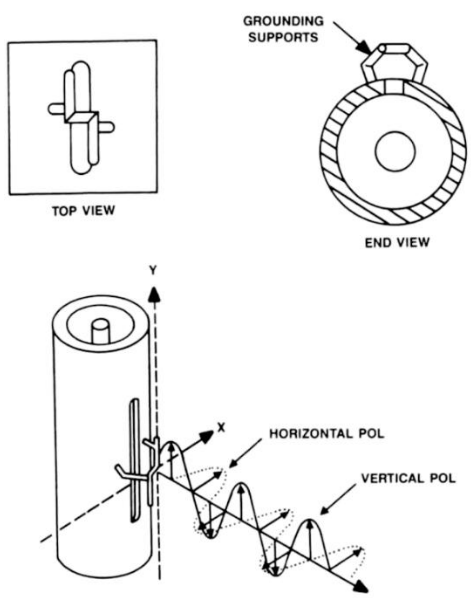


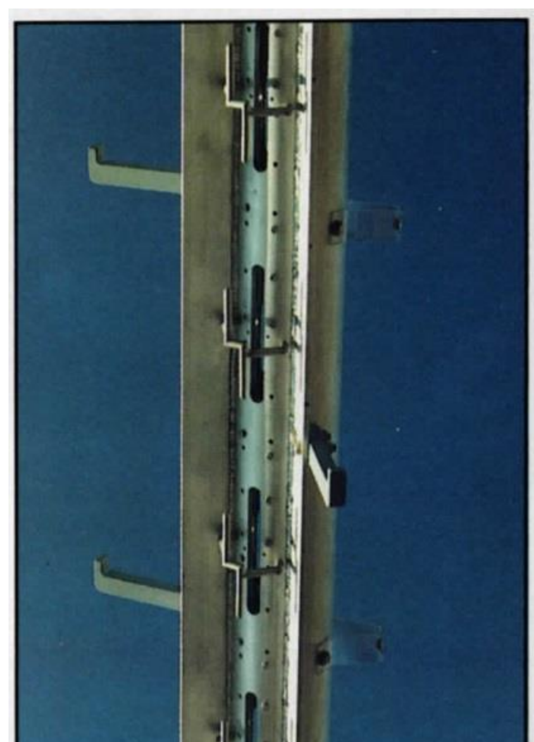
Figure 1. Circularly polarized pylon antenna. Z dipoles placed above radiating slots couple a controlled amount of energy to the vertical plane in phase quadrature.

Grounding the vertical radiating elements, or Z dipoles, to the pole above the slot circularly polarizes the antenna. The ratio between horizontal and vertical power is based on the amount of coupling between the slot and dipole. Coupling, in turn, varies with the slot and dipole.

Axial ratio

Axial ratio quantifies the figure of merit of circularly polarized TV antennas. It is expressed as the relationship between minimum and maximum voltage at the output of receiving dipole rotating perpendicularly to the radiating antenna. In a pure circularly polarized wave, this ratio is one. In a variable circularly polarized wave, it fluctuates with the polarization ratio of the horizontal and vertical components.

If a rotating test dipole indicated a voltage higher than that of the horizontal component or lower than that of the vertical component, the two components are not phased in quadrature. These conditions produce an axial ratio that is higher than the polarization ratio. The result is picture breakup caused by linear or rotational movement of the receiving antenna.



Note the Z dipole elements mounted in front of each antenna slot. These allow the amount of vertical radiation to be adjusted as desired in the manufacturing process.

Because the Z dipoles of the transmit antenna have the same phase centers as the slots, phase quadrature and axial ratio remain constant in all directions. Designs using interspersed slot and dipole radiators may be subject to deteriorating axial ratios as the angles of depression increase below the peak of the main beam. This deterioration results from the increase in space phase between adjacent radiating elements. (See Figure 2.)

For a typical spacing of ½-wavelength between interspersed radiators, the space phase differential in the first 6° of depression increases by almost 19°. This result is equivalent to a deterioration of 3dB in axial ratio, which is acceptable for most antenna designs. However, as the depression angle continues beyond 6°, the axial ratio deteriorates rapidly. When the depression angle reaches 30°, the space phase differential is 90°, resulting in an axial ratio of infinity. Beyond 30°, the axial ratio begins to decrease, but the sense of rotation of the circularly polarized wave reverses.

As illustrated in Figure 3, this rise/fall axial ratio and polarization reversal occur at each 30° cycle throughout the

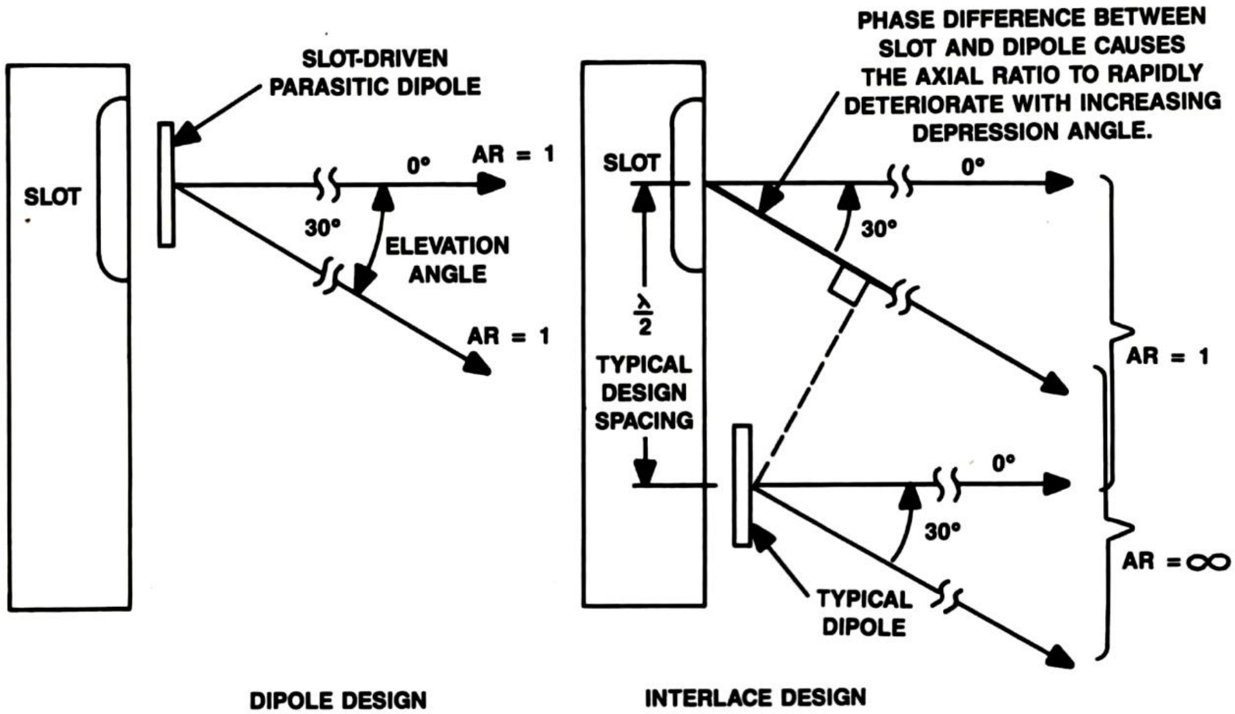


Figure 2. Dipoles and interlace antenna designs. The spacing between radiating slot and Z dipole in the interlace design creates a phase difference in the horizontal and vertical signals. This can cause the axial ratio to deteriorate with increasing depression angle.

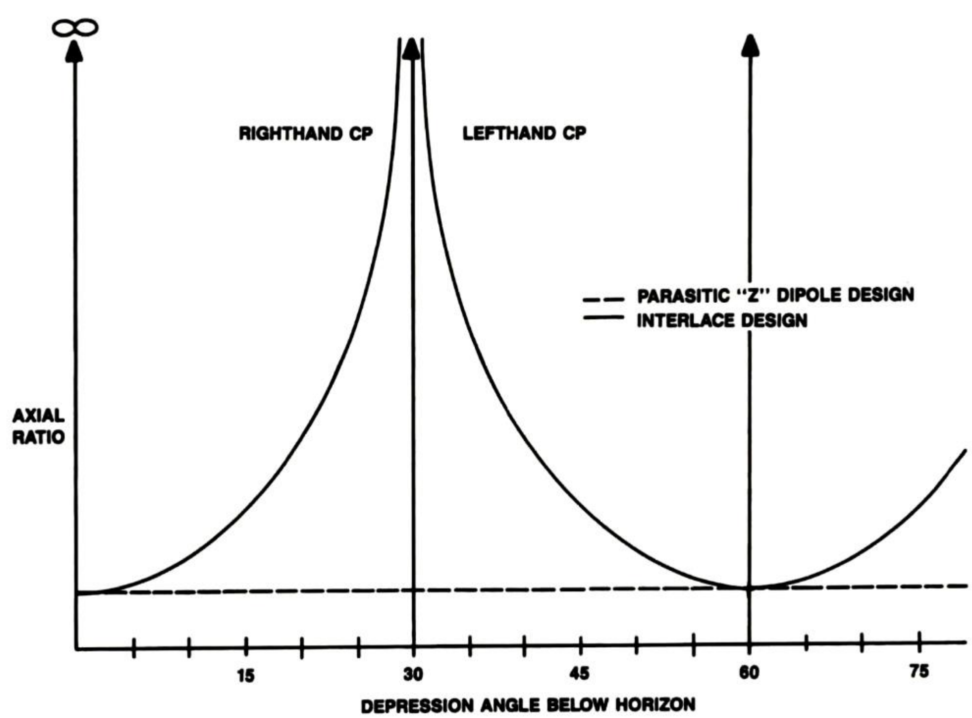


Figure 3. The rise and fall of the axial ratio and polarization reversal occur at each 30° cycle throughout the elevation pattern in an interlace-type antenna.

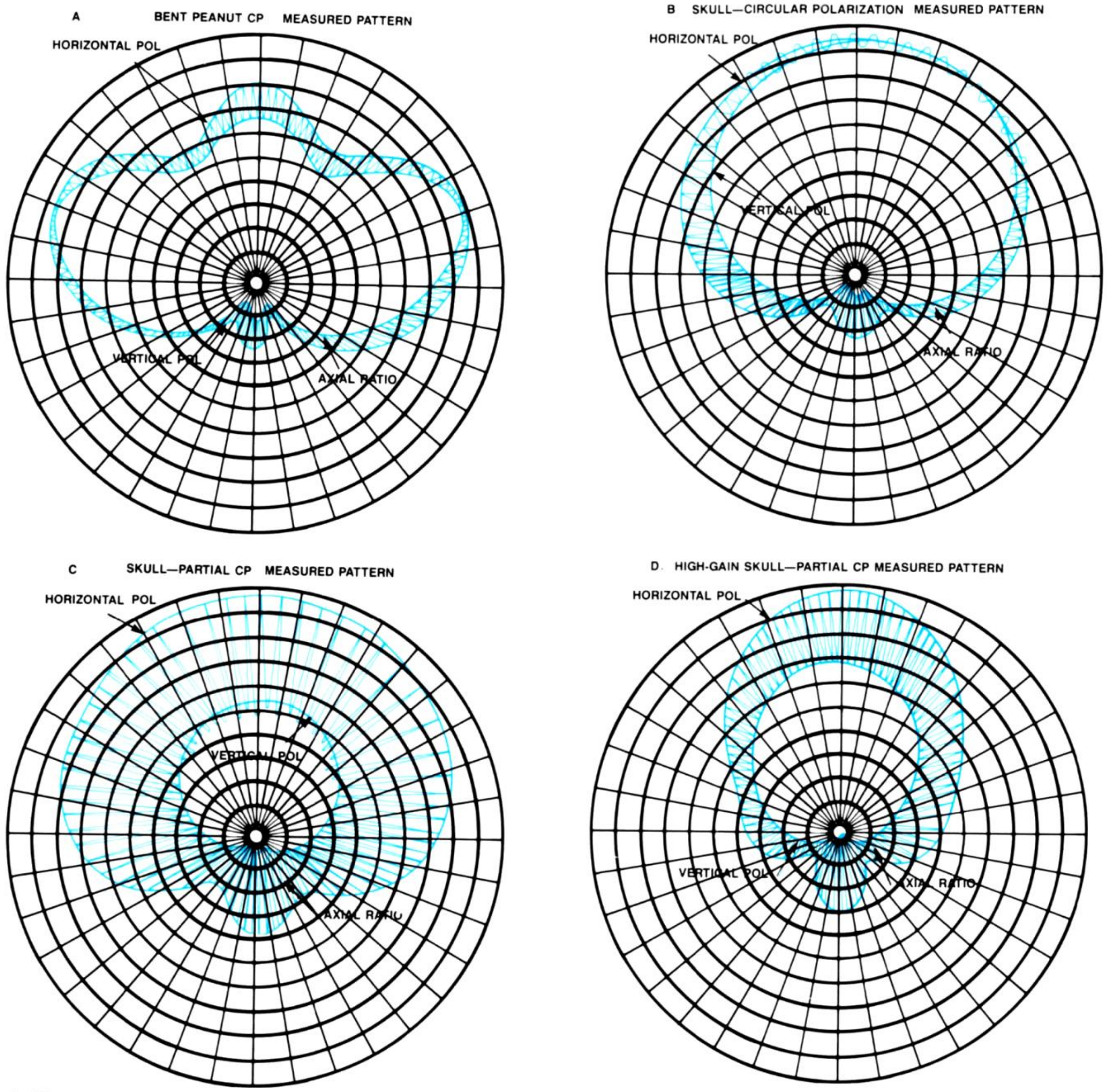


Figure 4. *Measured azimuthal patterns for the two linear components and axial ratios for full and variable circular polarization designs. Note that phase quadrature is maintained throughout the azimuth.*

elevation pattern. The slot-driven Z dipole design solves this problem by placing both the horizontal and vertical radiators in the same plane. This configuration eliminates phase delay between the elements and maintains constant axial ratio at all depression angles.

Measurement

Figure 4 illustrates four different antenna patterns. Each shows the measured azimuthal patterns for the two linear components, as well as axial ratios for full and variable circular polarization designs. These patterns show that phase quadrature is maintained throughout the azimuth.

If the axial ratio falls significantly below the vertical component (i.e. poor quadrature), orientation of the receiving antenna becomes a critical factor in obtaining good signal strength and picture quality. Because the axial ratio of the dipole over the slot is optimal, the new design eliminates this problem as well. The new circular polarization design is available in numerous vertical and horizontal pattern combinations to meet a wide range of broadcasting requirements. Factory-adjusted for vertical component, these antennas incorporate the same basic hardware as Dielectric's standard horizontally polarized UHF pylon antennas-slotted outer pipe, internal coupling, feed design and radome considerations.

Z dipole-type variable circular polarization antenna on the test bed in Gibbsboro, NJ.

The result is a simple, sturdy design that provides excellent performance. The antenna is insensitive to lightning and provides a true circularly polarized signal in both azimuthal and elevation planes.

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