

The Relationship Between Feed Arm Position and Input Impedance in Reflector Impulse Radiating Antennas

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For many years reflector Impulse Radiating Antennas (IRAs) were built with four feed arms positioned at $\pm 45^\circ$ to the dominant polarization (usually vertical). However, recent numerical (J. S. Tyo, *IEEE Trans. Antennas and Propagat.* 49, 4, 607-614) and experimental (L. H. Bowen *et al.*, Sensor and Simulation Note 450) investigations have demonstrated improved gain and crosspol performance when the feed arms were positioned at $\pm 30^\circ$ to vertical. Despite these results, there has been a belief that one could obtain a better TDR and lower return loss with feed arms positioned at $\pm 45^\circ$. Since a flat TDR is especially desirable in radar applications, designs with feed arms at $\pm 30^\circ$ have been slow to be accepted.

We compile here TDR data on several pairs of IRAs that are similar except for their feed arm positions. We begin this paper by reviewing the case for positioning the feed arms at $\pm 45^\circ$. We do so by reviewing some of the TDR data on large IRAs built by Giri *et al.* These antennas were built without splitter baluns and have very flat TDRs. All of the other antennas studied here have the standard feed which includes a balun. We then review the case for $\pm 30^\circ$ by reviewing gain and crosspol data on our two best 46 cm IRAs with feed arms at both $\pm 30^\circ$ and $\pm 45^\circ$. During the development of these two IRAs we found that distributed load resistors worked better for the $\pm 45^\circ$ case while resistors concentrated near the edges of the feed arms worked better for the $\pm 30^\circ$ case. Next, we examine the TDRs of four pairs of similar IRAs with feed arms at both positions. We do this to determine if designs with arms at $\pm 45^\circ$ really exhibit an improved input impedance match over designs with arms at $\pm 30^\circ$. Finally, we offer our analysis of the advantages of the two designs and the effect of resistor distribution. We show that in controlled comparisons, we find no appreciable advantage in the TDRs of IRAs with feed arms positioned at $\pm 45^\circ$. This suggests that the $\pm 30^\circ$ configuration is preferred because of its other advantages, which include increased gain, decreased crosspol, and a more equal beamwidth in the two principal planes.