Design of Twin E Plane Sectoral Horns for Power Division

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A simulated model and physical prototype is presented for the development of two E plane sectoral horns that will deliver directional and unequal power radiation for illumination of a cassegrain sub reflector and a primary feed horn from a WR42 waveguide within a frequency band of 20.22 GHz to 20.28 GHz. The two horns are designed to deliver a signal at 60 degrees and -70 degrees from a horizontal normal. The horn delivering the signal at -70 degrees is required to be –4 dB lower than the horn delivering signal at 60 degrees. The design of the device begins with an HFSS simulation of a straight section of WR42 waveguide that must divide the power as specified. A straight section of length 0.35 inches, accounting for waveguide attenuation of higher order modes, is modeled with an infinitely thin septum to achieve the necessary power division. Once the location of the septum is optimized, the septum is then modeled with a thickness that can be feasibly manufactured. The optimized septum width dimension is found to be 20 mils. The return loss of the straight WR42 waveguide section with the septum is seen to be less than -23 dB. As a result of the septum, the WR42 waveguide is divided into a large port and a small port. The two E plane sectoral horns must be matched to the reduced dimensions of the WR42 waveguide; this is done through a single step quarter wave transition [G. Matthaei, L. Young, and E. Jones, *Microwave Filters, Impedance-Matching Networks, and Coupling Structures* (1980)]. Each horn step transition is modeled, and the return loss is seen to be less than -45dB at the large port, and less than –43 dB at the small port. Two E plane sectoral horns are then designed to exhibit a pattern with side lobe levels of less than –8 dB below peak gain [C. Balanis, *Antenna Theory*, (1996)]. The horns are designed to match the same aperture dimensions, 0.112 inches by 0.42 inches. A full model is constructed consisting of the WR42 waveguide, septum, step transitions, and E plane sectoral horns. The return loss at the feed port is seen to be slightly less than -13 dB. To optimize the return loss of the entire system, HFSS is used iteratively to de-embed into the feed port of the system, and the impedance is viewed. It is found that at a distance of 0.13 inches the impedance can be matched using an inductive iris. Through iterative efforts using HFSS, an inductive iris of 40 mils by 35 mils by 420 mils is sufficient to yield a total system return loss of less than –37 dB. The prototype is fabricated as a mandrel that is processed through copper electro-formation. Figure 1 displays a wire frame view of the inner conductor geometry to which the prototype is fabricated. The radiation pattern of the prototype is measured in a primary focus antenna range. A comparison of the simulated and measured radiation patterns is displayed in Figure 2.

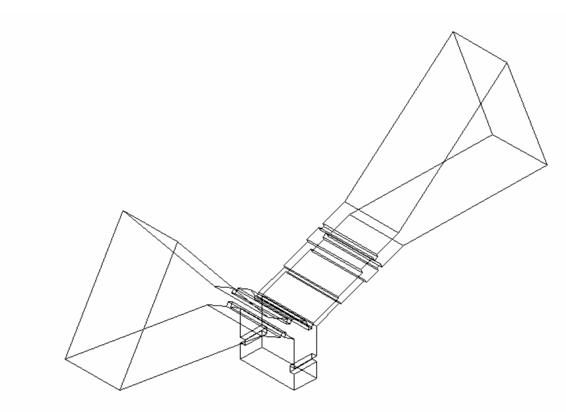

Figure 1

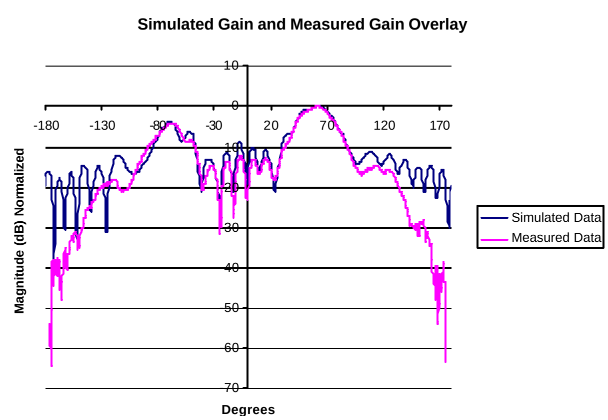

Figure 2