7.1.4 A 405-MHz, 5-BEAM PHASED ARRAY ANTENNA

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The Wave Propagation Laboratory has completed the design and construction of a phased array antenna for use at 405.25 MHz for atmospheric wind profiling. The steering geometry of the sequentially switched beam is shown in Figure 1.

The Yagi-Uda antenna elements are arranged on a square grid whose axes are 45° with respect to the cardinal directions. For a given steering angle this allows an element spacing $\sqrt{2}$ larger than that required for a broadside steered array. This feature helps minimize element interaction and reduces the number of elements required to populate a given aperture. This geometry is shown in Figure 2.

By constraining the phase difference between rows of identically phased elements to an even, integral submultiple of 360°, symmetries appear in the phasing maps which reduce the switching hardware. In this design, for example, the element spacing, X of Figure 2, is .91 λ and $\Delta\phi$ is 60° resulting in an oblique beam direction of 15° from vertical. Only 15 RF coaxial transfer switches are used to synthesize the required 18 phase combinations for north, east, south, and west steering. These 18 signals are labeled A through R in Figure 3.

The vertical beam is generated by switching around the four beam circuitry of Figure 3 resulting in identical phasing on all of the elements. Requiring 36 RF coaxial SPDT switches, the vertical beam alone is more expensive than the four cardinal beams.

After the 18 signals are synthesized they are split and distributed about the array while maintaining proper phasing because of the symmetries. Uneven power splitter/combiners are used for amplitude tapering. A schematic of the whole antenna is shown in Figure 4, and a map of the quasi-circular array in Figure 5 shows the placement of seven each of the 18 phases for a total of 126 elements. The antenna characteristics are listed in Table 1.

Computer simulations were employed in the design process. Antenna patterns from the simulations are shown for the north and vertical directions in Figure 6. Antenna pattern measurements by aircraft are planned to verify the performance.

A NOAA Technical Memorandum detailing the design and computer techniques is planned for 1986.

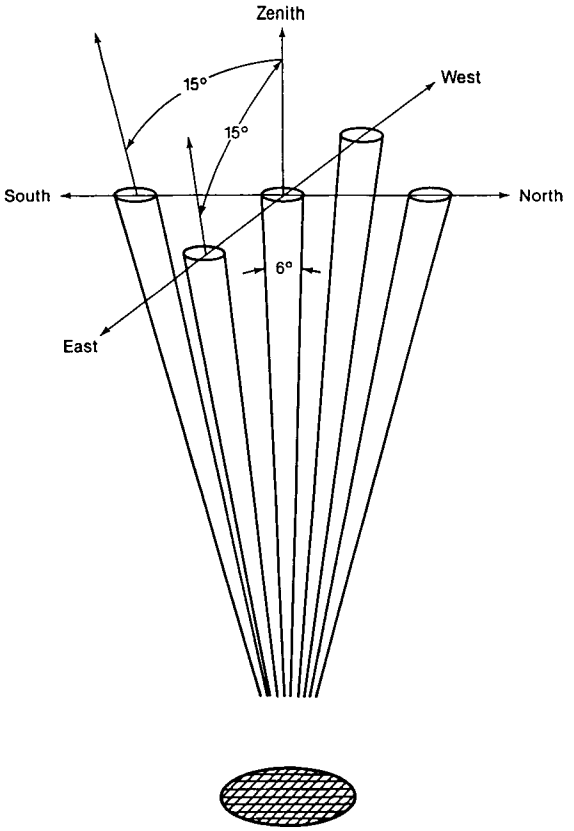

Figure 1.

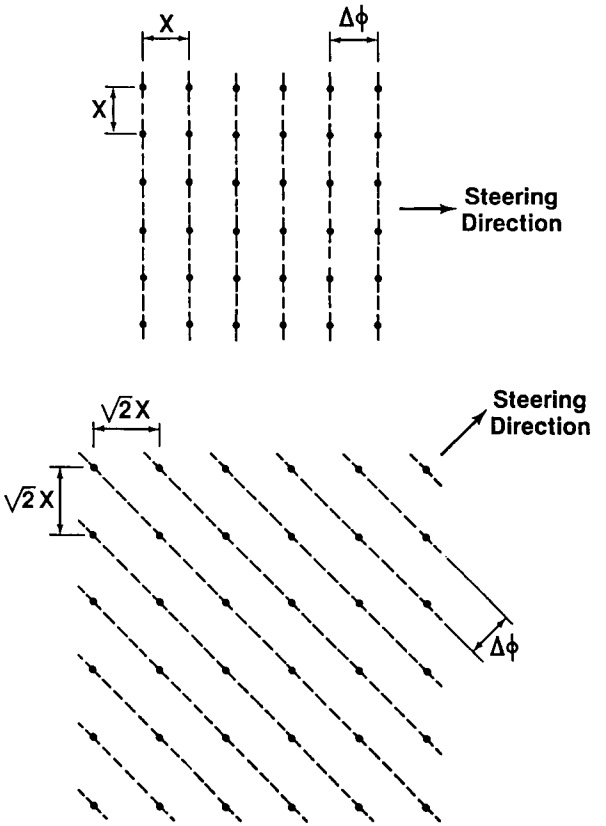

Figure 2.

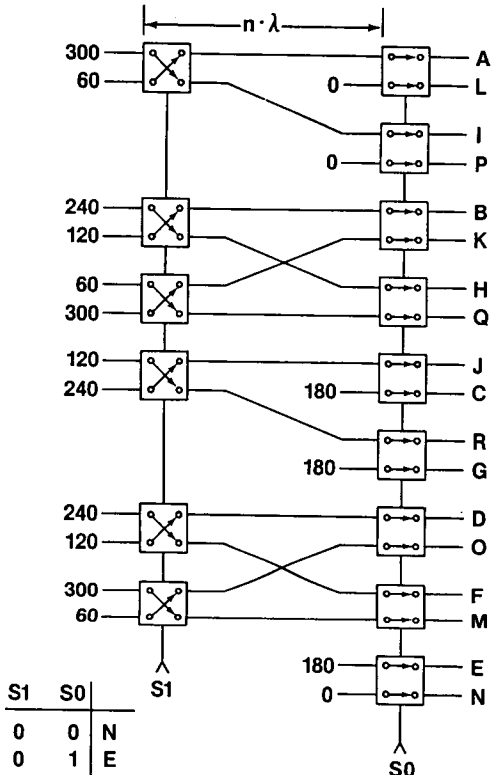

Figure 3.

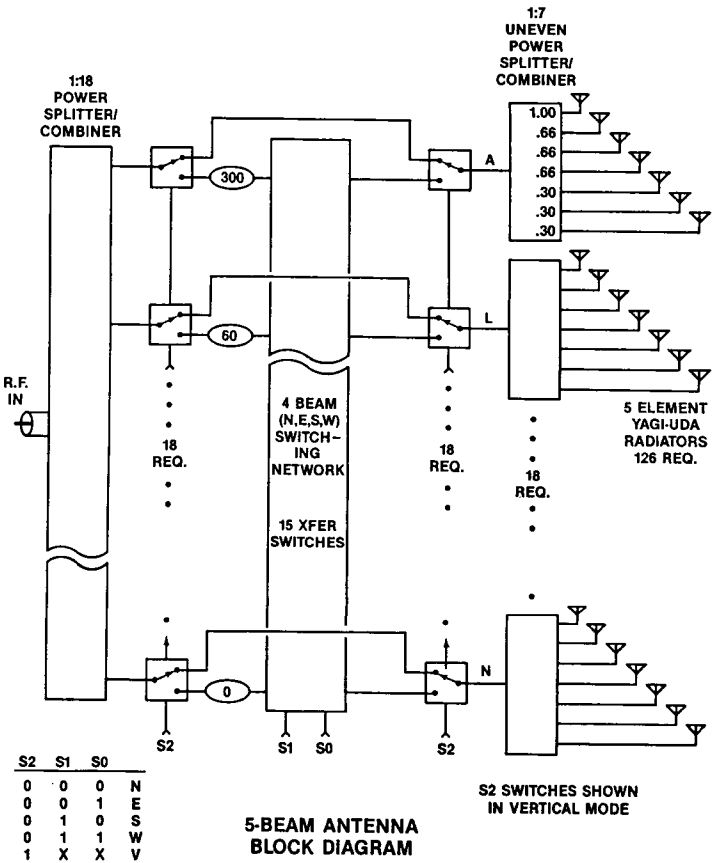

Figure 4.

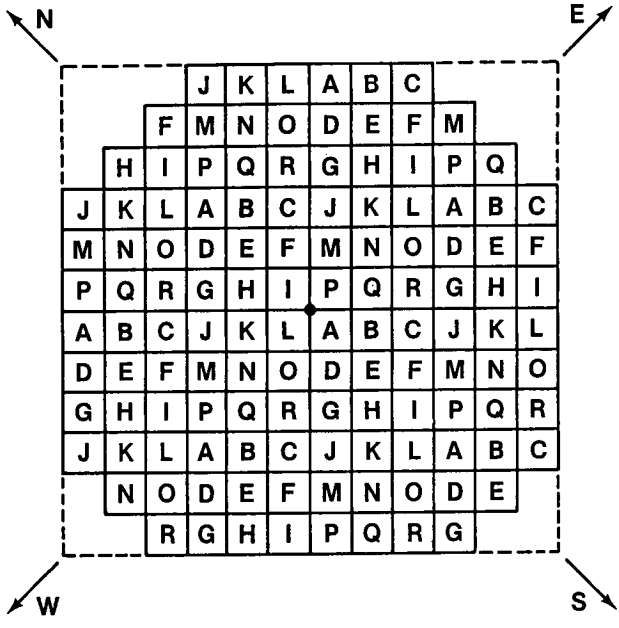

Figure 5.

Table 1

405-MHz phased array antenna

Number of steering directions:	5
Oblique beam directions:	4
Azimuth:	0°, 90°, 180°, 270°
Elevation:	75°
Gain:	30 dBi
One-way 3 dB beam width:	6°
Effective aperture:	44 m^2
Peak power:	60,000 W
Average power:	6,000 W
Technology:	126 5-element Yagi-Uda radiators
	51 RF coaxial switches with indicators
	1 1:18 high power reactive splitter/combiner
	18 1:7 uneven reactive splitter/combiners
	low loss foam distribution cables

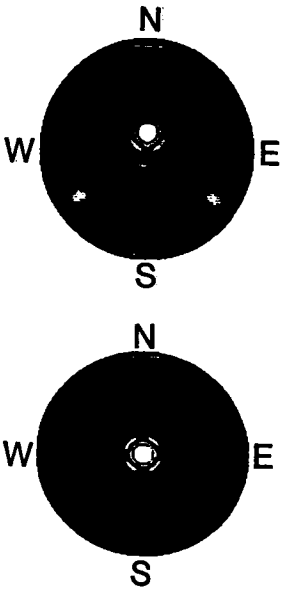

Figure 6.