

THE AN/TPS-59 ANTENNA ROW-BOARD DESIGN

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The development model of the AN/TPS-59, an advanced tactical air-defense radar, employs a planar array composed of a vertical stack of linear row-arrays. Azimuth scanning is by mechanical rotation of the antenna while phase controlled solid-state row-transmitters and row-receivers provide electronic scanning in elevation.

Each of the row-boards consist of a passive monopulse feed network in low-loss stripline with 24 dipole elements, sealed in a weathertight housing, and supporting ground-plane septa (see Figure 1). These septa divide the space between adjacent rows into two parallel-plate waveguides operating below cutoff. The result is a ground plane that is electrically solid, but mechanically open to reduce wind loads, and minimize ice formation. In addition to acting as a ground plane, the septa also stiffen the row-board permitting it to be used as a structural member and to withstand specified ice loads of 3.5 lbs/ft² with 75 knot winds. The outer-quarters of each row-board (wings) are connected to the center-section through an RF hinge so that they may be folded into the center for antenna transport.

Performance typical of the prototype row-board is illustrated by the sum and difference patterns in Figures 2 and 3. The fact that dipole excitation errors are small is evident from the symmetry of the patterns and the deep nulls between antiphase sidelobes. In order to suppress the effect of multipath interference on the patterns the row-board was mounted vertically, thus placing the broad H-plane fan beam in the azimuth plane. Slewing the row-board up in elevation recorded half of the main beam and sidelobe structure. The row-board was then rotated 180° and the process repeated to record the other half of the pattern.

A summary of the important row-board characteristics is presented in Table I.

Construction of the row-board is shown by the partially assembled center-section in Figure 4. The stripline circuitry is etched on copper-clad teflon-glass dielectric and centered between two ground planes by flexible polyethylene foam. One of the two ground planes is an aluminum-skin balsa-core panel with bonded Lexan spacers. The other ground plane is a crushed honeycomb panel attached by sealing screws at each of the Lexan spacers. The spacers serve to establish the ground plane separation after a slight compression of the foam to eliminate possible air entrapment.

TABLE I

PROTOTYPE ROW-BOARD CHARACTERISTICS

Length	8.0 ft (wings folded) 15.2 ft (wings extended)
Depth	14.5 in.
Frequency Bandwidth	14% (L-band)
HPBW (Design Freq)	3.2° az 65° el
Polarization	horiz
Directivity (Design Freq)	21.75 dB
RF loss	0.65 dB sum 0.85 dB difference
Peak Sum Sidelobe	-29.5 dB design, -25 dB measured
Peak Difference Sidelobe	-22.5 dB design, -20 dB measured

The feed network itself is basically a two hybrid corporate-fed type circuit having equal path lengths to all the dipoles. However, by means of a newly devised microwave component, the network has been modified to provide the sidelobe performance normally associated with a three-hybrid type network having six subarrays. This modification is illustrated by Figure 5.

The component connecting with the centermost pair of dipoles is termed a "meaner" since it has as its outputs the phaser mean of two input signals. For the sum excitation, the equiamplitude and equiphase signals at the meaner are unchanged. However, for the difference signals, which are equiamplitude and antiphase, the meaner outputs are zero. This extra degree of design freedom provides the key to improved difference pattern performance while retaining the size, weight and cost advantages of the simple two-hybrid network.

The array design work presented in this paper was accomplished under Contract No. N00039-72-C-0356 for the U.S. Marine Corps. The author also wishes to acknowledge the significant contributions of his colleagues: D. L. Binsley and H. K. Gardner.

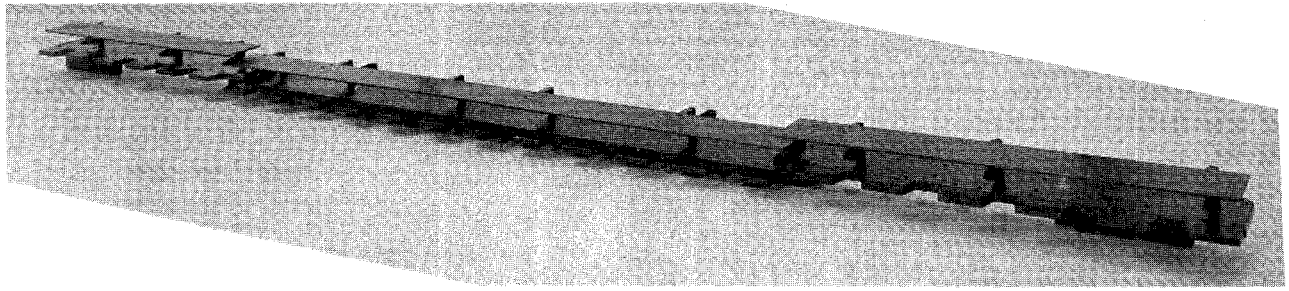


Figure 1. Row-Board Fully Extended

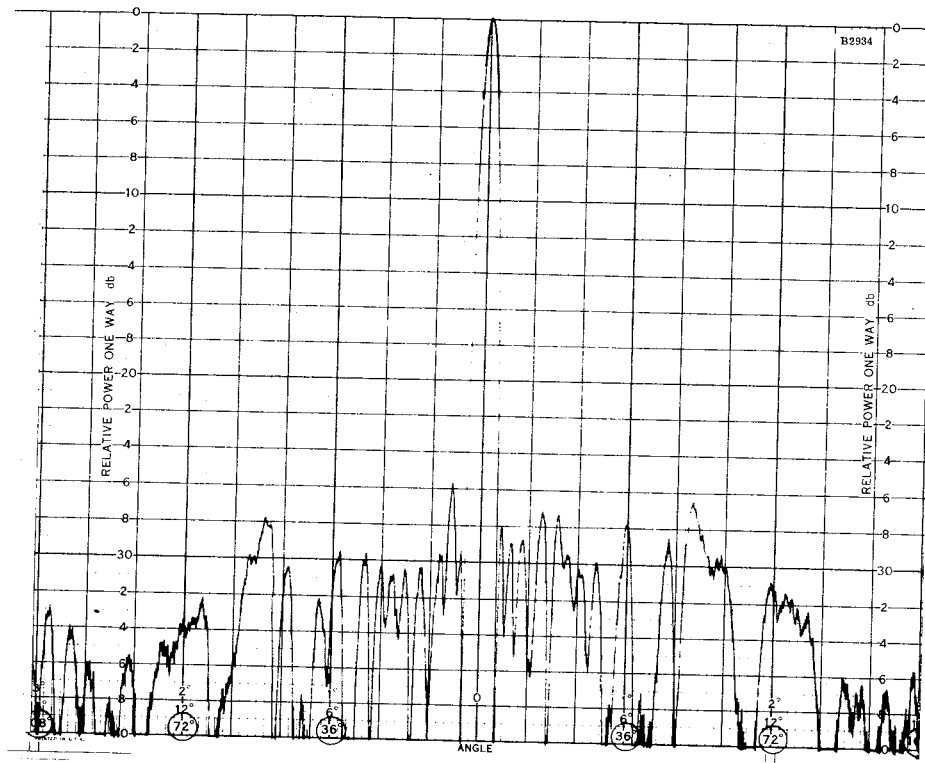


Figure 2. Prototype Row-Sum Pattern

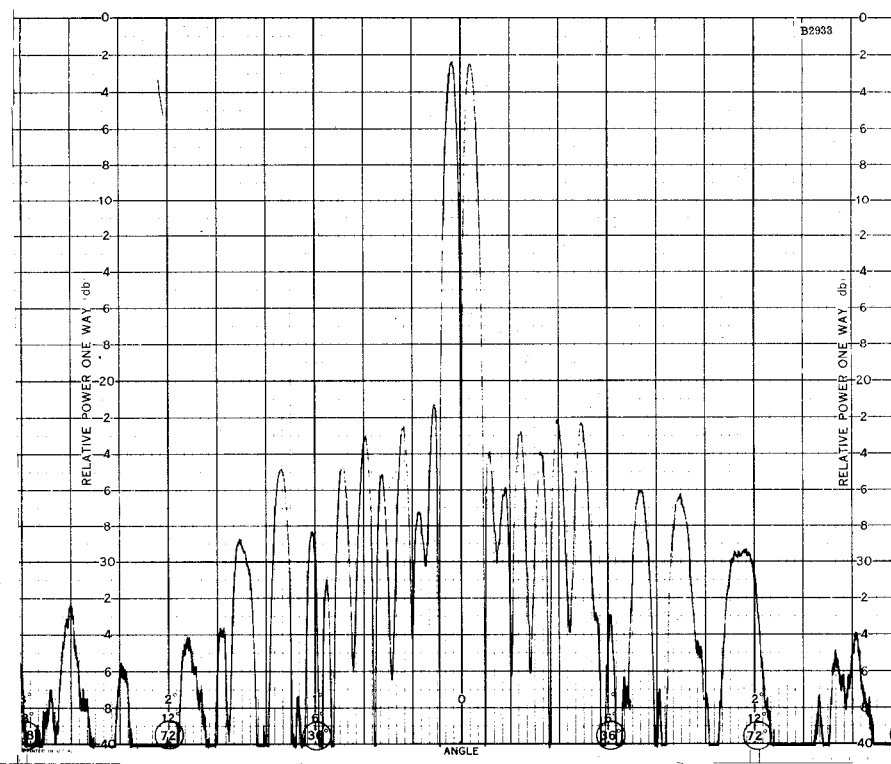


Figure 3. Prototype Row-Difference Pattern

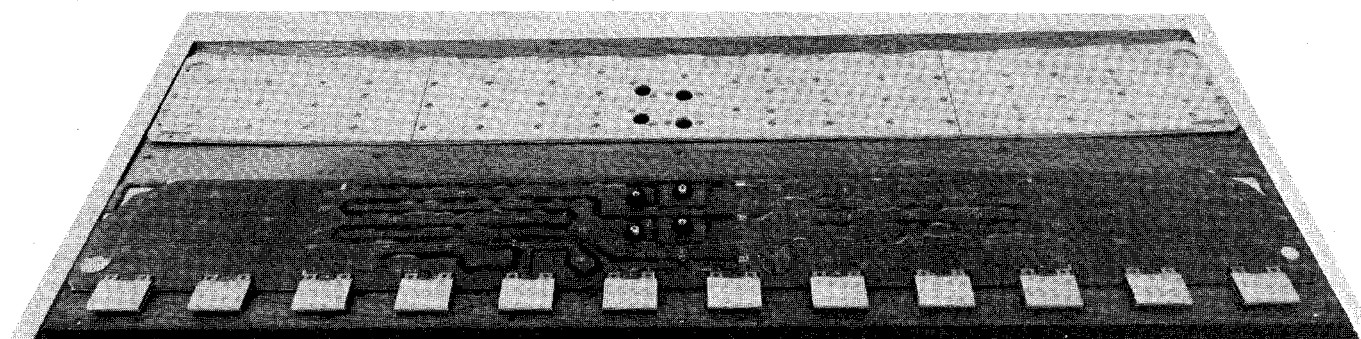


Figure 4. Center Section Row-Board Stripline

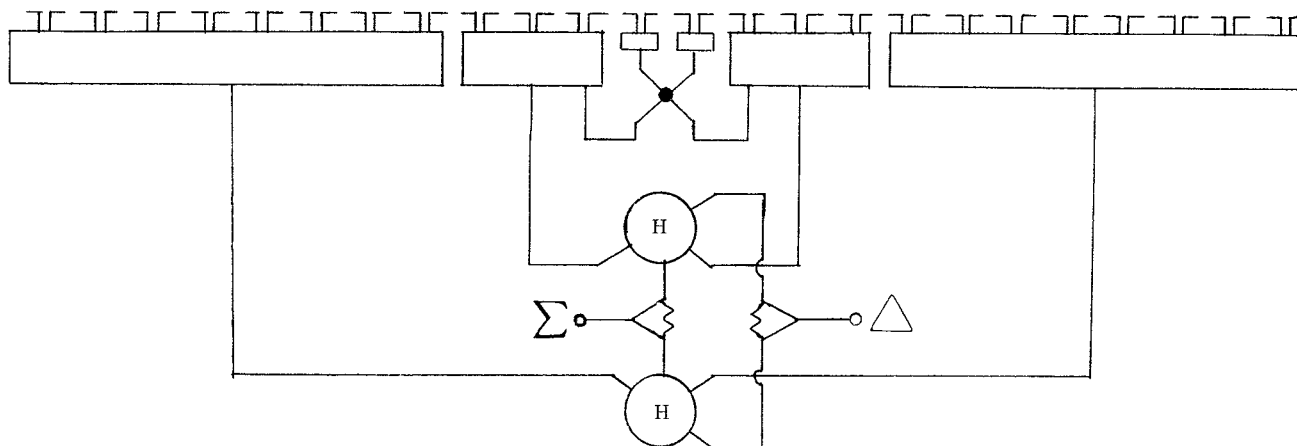


Figure 5. Simplified Network Schematic