NASA TECH BRIEF

Goddard Space Flight Center

Beam Squint Correction for a Diplex, Retrodirective Phased Array

Beam squint—the aiming error produced by a retrodirective phased array when the received signal phase is directly impressed upon a different-frequency transmitted signal—can be eliminated by using the received phase at each array element to control the transmitted phase at another element. The relative spacing of the two elements is determined by the ratio of transmitted to received wavelength.

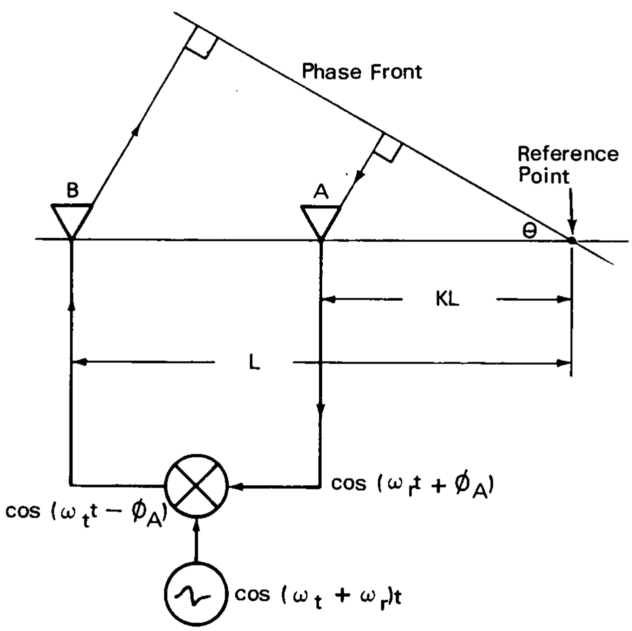

Figure 1. Squint Correction

In a simplex retrodirective system, the conjugate phase of the signal received at each element is applied to the transmitted signal of the same element. This generates a transmitted phase front identical to that received and focuses the transmitted beam back along the path of the received beam.

Such a system will perform well as long as the transmit and receive frequencies remain identical. However, it is frequently necessary to use a diplex system, in which the transmit and receive frequencies are different. Under these conditions, the transmitted beam will focus along a path different from that of the received beam; this abberation is called beam squint. For large-aperture, narrow-beam arrays, beam squint can greatly reduce system gain.

The simplest technique for eliminating beam squint (see Fig. 1) involves positioning the receiving (A) and transmitting (B) elements as shown, according to the ratio:

$$K = \lambda_r/\lambda_t \tag{1}$$

where λ_r and λ_t are the received and transmitted wavelengths, respectively. For a single phase front received at an angle θ, the phase angle ϕ_A of the signal received at element A is:

$$\phi_A = \frac{2\pi KL}{\lambda_r}\sin\theta \tag{2}$$

In order to establish the same phase front by transmission from element B, the necessary phase angle ϕ_B is:

$$\phi_B = \frac{2\pi L}{\lambda_t}\sin\theta \tag{3}$$

By substituting equation (1) into equation (2), it can be seen that $\phi_A = \phi_B$.

This method of squint correction can be extended to a multi-element array by using a ring structure such as that shown in Figure 2. In this design, the elements are radially positioned on a set of concentric circles. The radius of each successive circle is determined by equation (1) (i.e., R = KR'). To produce a squint-free, retrodirective array, the received-signal phases from elements at radius R are fed through conjugate phase networks to control

(continued overleaf)

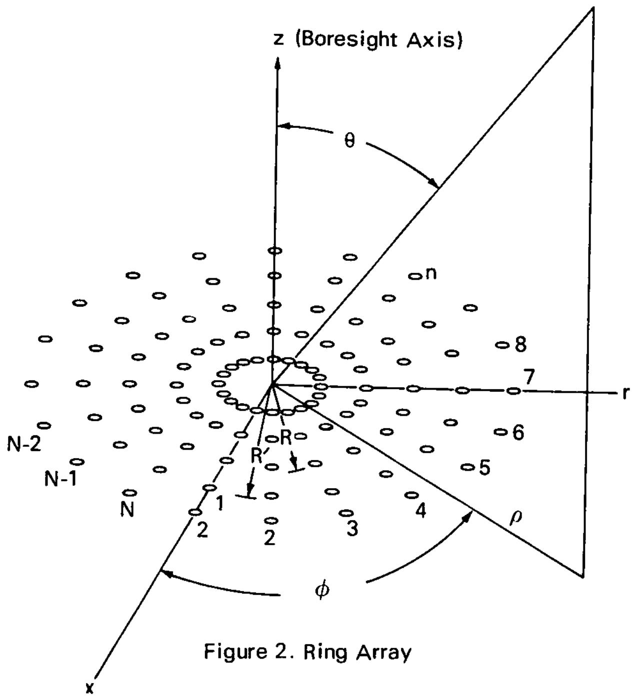

Figure 2. Ring Array

the transmitted-signal phases of corresponding elements at radius R.

Note:

Requests for further information may be directed to:

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No patent action is contemplated by NASA.

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