LOW SIDELOBE ACTIVE ARRAY ANTENNAS

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INTRODUCTION

Low sidelobe antennas are desirable and often necessary for modern radar and communication systems, as well as for other applications. The technology for low sidelobe phased arrays and reflector antennas has been well documented in recent years[1,2,3], but very little has been published on the application of low sidelobe technology to active aperture array antennas.

This paper considers some of the additional challenges encountered in achieving low sidelobes when designing active arrays having T/R (transmit/receive) modules containing RF amplifiers. For example, it is recognized that different considerations are necessary for the transmit and receive modes of the antenna, i.e. different methods must be used for achieving the tapered amplitude distributions necessary for low sidelobes.

SUMMARY

To achieve low sidelobes in any antenna, the desired (theoretical) amplitude and phase distributions must be produced across the aperture within close tolerances. These tolerances (allowable errors) are then subdivided into various categories according to an error budget, including the various systematic and random causes of amplitude and phase errors.

In the transmit mode of active arrays where power amplifiers in the T/R modules are involved and the number of elements can be as many as several thousand, it is highly desirable (and economically necessary) for all T/R modules to be identical. If this is so, a filled aperture will result in uniform amplitude and correspondingly high sidelobes. To

achieve lower sidelobes, several techniques have been recently proposed: (1) Numazaki, Mano, Katagi, and Mizusawa[4] use array thinning (density tapering) with a novel four axis method; (2) Lee[5] uses a quantized amplitude approach with five different power levels in optimized zones; and (3) Dufort[6] proposes using identical T/R modules with an efficient microwave network to achieve tapered distributions. These approaches will be compared and some fundamental considerations will be discussed.

In the receive mode, it is also desirable to use identical modules containing low noise amplifiers (LNA), but tapered amplitude distributions can be achieved either by the conventional method of designing feed manifolds (networks) and/or by using attenuators in the T/R modules. For monopulse systems with low sidelobe requirements in both the sum and difference modes, feed manifolds become more complex but achievable. A recent approach to simplify the feed architecture for active monopulse arrays has been described by Hrycak[7]. These approaches will be compared and discussed in terms of advantages and disadvantages.

Some recent active aperture arrays with low sidelobes have been built and tested with excellent results. They demonstrate that low sidelobe active arrays are not only feasible but offer some significant advantages over passive arrays.

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