SWITCHED FRAGMENTED APERTURE ANTENNAS

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1. Introduction

This paper introduces a reconfigurable aperture concept derived from fragmented aperture design where the configuration of the fragmented aperture may be switched by the user to obtain different functionalities. A fragmented aperture antenna is a patchwork of discrete conducting and dielectric units distributed over the specified aperture [1,2]. The arrangement of the units is determined using an efficient, multistage procedure that incorporates the genetic algorithm for optimization and the finite-difference time-domain method for the electromagnetic computation. Typically, the criterion for optimum performance has been broadband gain at a particular angle. The resulting antennas contain isolated scattering structures that are fragmented in appearance. For example, Figure 1 displays the predicted gain (including mismatch) of various 10" by 10" fragmented aperture designs and compares the performance to the directivity of a uniform distribution of current of the same size.

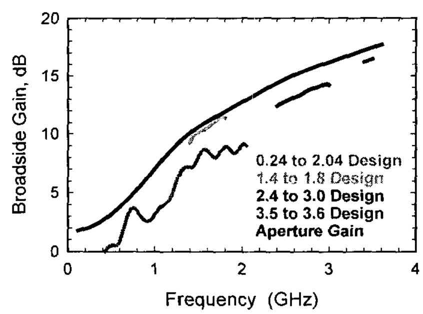

Figure 1. The predicted broadside gain (including mismatch) of 4 different 10" by 10" fragmented aperture designs.

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2. Reconfigurable Fragmented Aperture Antennas

The reconfigurable aperture derived from this new class of antennas consists of a matrix of conducting patches with switches between some or all of the patches. This reconfigurable aperture can change functionality (for example, instantaneous bandwidth and steering angle) by opening or closing different connections between these patches. Figure 2 shows a picture of a fragmented aperture and a drawing of the reconfigurable aperture in a particular configuration, illustrating the conceptual link between these two ideas.

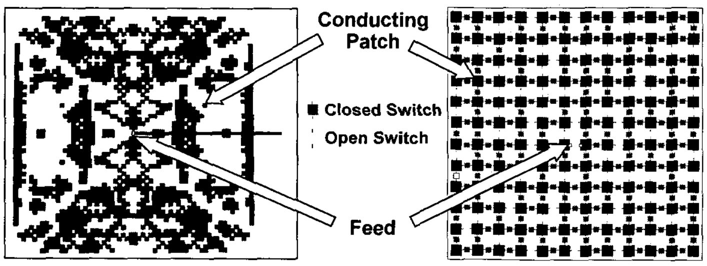

Figure 2. Picture of a fragmented aperture (left) and a conceptual drawing of a reconfigurable aperture (right).

In order to prove the feasibility of the concept, a number of experimental test beds are being developed; each test bed has a different level of sophistication. This paper discusses the optimization of the switch configurations, and the predicted and measured performance of the first two generations of test beds. The first of these test beds contains no actual switches but simulates open and closed switches with the presence or absence of a conductor. The second generation test bed, shown in Figure 3, uses magnetically activated reed switches as replacements for the FET or MEMS switches that will eventually be used in these antennas. Active or inactive magnets are manually placed at the sights requiring closed or open switch connections, respectively, to achieve a particular configuration.

We have performed a number of numerical designs to create switch configurations that demonstrate wide instantaneous bandwidth, band switching, and broadside to endfire beam steering. These designs have been implemented on the second-generation test bed. The predicted gains (with mismatch) of the broadside-steered configurations are compared with the ideal, uniform aperture directivity in Figure 4. An in-band measured antenna pattern for one of the configurations is also shown on the right of the figure. Figure 5 illustrates the broadside-to-endfire capability of the aperture by displaying the switch configuration for each steering angle and the resulting measured antenna patterns.

Future test beds will use FET or MEMS switches that are electronically activated via high resistance grid lines. Predictions for the performance of these future designs will be discussed.

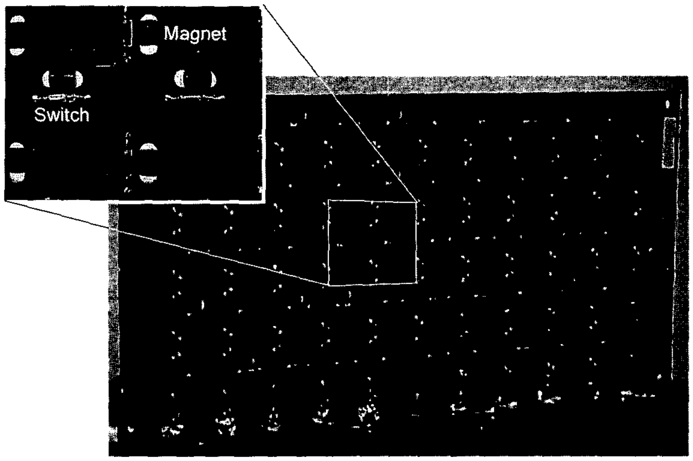

Figure 3. Second generation test bed.

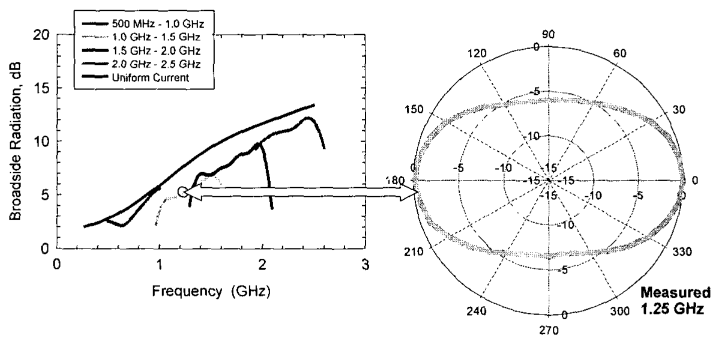

Figure 4. Predicted broadside gain for a variety of configurations of the second-generation test bed. The plot on the right is a measured pattern for one of the configurations.

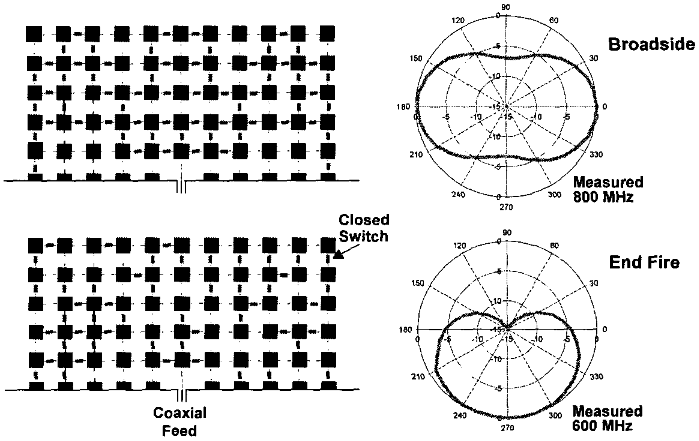

Figure 5. Configurations of switch closings and openings for broadside and endfire steering. Note that only the top half of each configuration is displayed because an image plane was used in the measurement of the test bed.

Acknowledgment

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References

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