ANALYSIS OF COMPACT RANGE REFLECTORS WITH SERRATED EDGES

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Abstract

The use of serrated edge treatment in the design of a compact range collimating reflector is one method of mitigating the effects of edge diffraction on quiet zone performance. In this note a physical optics analysis is applied to the serrated reflector. The computational procedure is described and several results are presented. In particular, computed results are presented for the Model 5755 compact range reflector and compared with experiment.

Keywords: Compact Range, Serrated Edges, and Physical Optics

Introduction

Serrated edge treatment has been employed as a means of mitigating the effects of edge diffraction associated with compact range reflectors. The purpose of the present work is to develop and apply an analytical tool with the intention of developing an improved serrated edge design. In particular we wish to examine:

1. Edge Geometry - Between the roots of the serrations and the tips the serrations can take on any shape e.g., a straight line. a cosinusoidal curve, and a exponential curve. The intention is to generate a smooth transition from a fully reflecting surface in the main body of the reflector to free space at the tips of the serrations.

2. Edge Slope - The direction in which the edges extend from the main body of the reflector. Diffraction cones will define an orientation such that extraneous energy in the quiet zone is minimized.

3. Electrical Size - In General, the larger the edge treatment. the better the diffraction control. It is desirable to minimize the overall physical size of a reflector for a given performance level.

The present effort consists of a computer simulation of compact range scattering and a comparison to measured results. Several models are appropriate for this type of simulation and have been used by others. A physical optics model is the basis of this work. Later, UTD will be examined as a complementary design tool.

The computer model utilized four basic steps to analyze a compact range reflector:

1. Perimeter Generation

2. Integration Patch Determination

3. Surface Current Determination

4. Field Evaluation at Observation Points

The perimeter of the reflector to be analyzed is represented by piecewise linear line segments whose endpoints are stored. These endpoints are then used to determine the integration patch locations and sizes. The integration patches are square as viewed along the paraboloidal axis (Figure 1 demonstrates the integration squares). The squares are projected onto the parabolic surface and defined to be locally planar, with their respective normals and centers corresponding with the parabolic surface. The size of the integration patches is varied from large at the center of the reflector to minimize computation time, to small at the edges to closely approximate the edge configuration. Surface currents at each of the patch centers are evaluated using an input feed pattern and the normals at each of the patch centers. The standard, conditions appropriate to physical optics are assumed to apply everywhere on the parabolic surface. A small improvement could be made in the model to account for the truncation effects of the edges on the surface current, but the size of the structure and edges does not necessitate this added complexity. Once all the surface current amplitude, phases and directions have been determined, the scattered field is evaluated making the assumption that the observation point is in the far field of the individual patch elements. An integration patch radiation pattern (closed form evaluated) as well as an obliquity factor are applied to give the individual contributions to the scattered field from each of the patches to each of observation points. The individual contributions are summed and the results are tabulated and plotted.

RESULTS AND MEASUREMENTS

Measured data available on a compact range reflector was used to compare with predictions from the physical optics model. This modeling was done at the lower frequency limit of the reflector (3-5 wavelengths of edge treatment) because this causes the quiet zone performance to be a strong function of edge treatment. Results for this comparison are shown in Figures II-A and II-B. In general, there is some smoothing of the measured data caused by the directivity of the probe horn which is not accounted for in the model.

SUMMARY

A physical optics model has been developed which gives results which compare well with measurements. It is easy to use and reasonably efficient in computational time. UTD analysis will be explored as a complementary tool to the present capability with the overall aim of designing improved serrated edge reflector configurations.

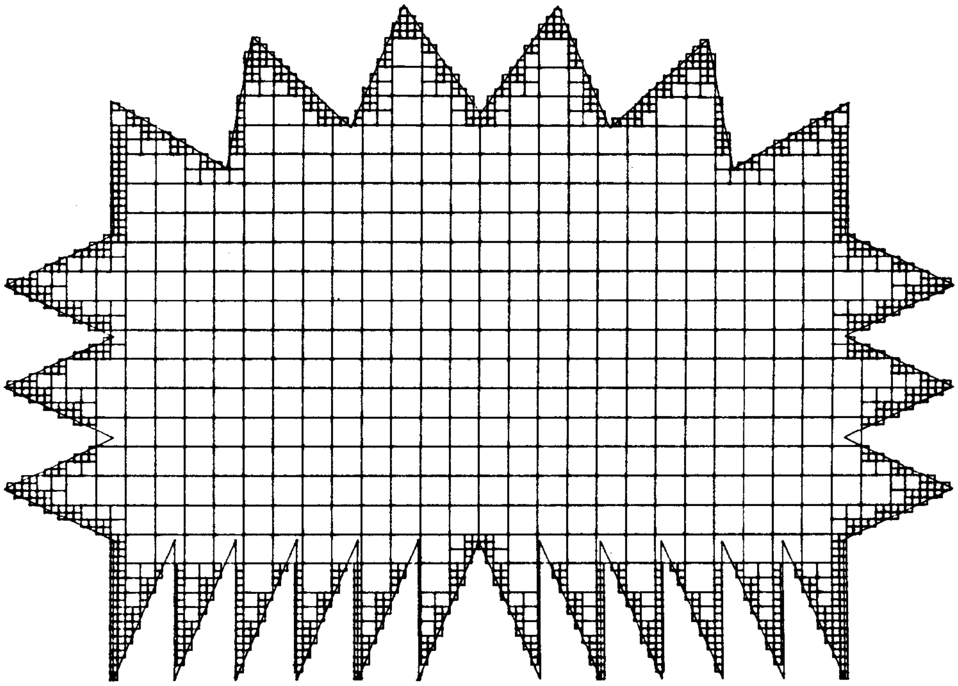

FIGURE I. REFLECTOR DIVIDED INTO INTEGRATION PATCHES 10" SQUARES MAXIMUM 2.5" SQUARES MINIMUM

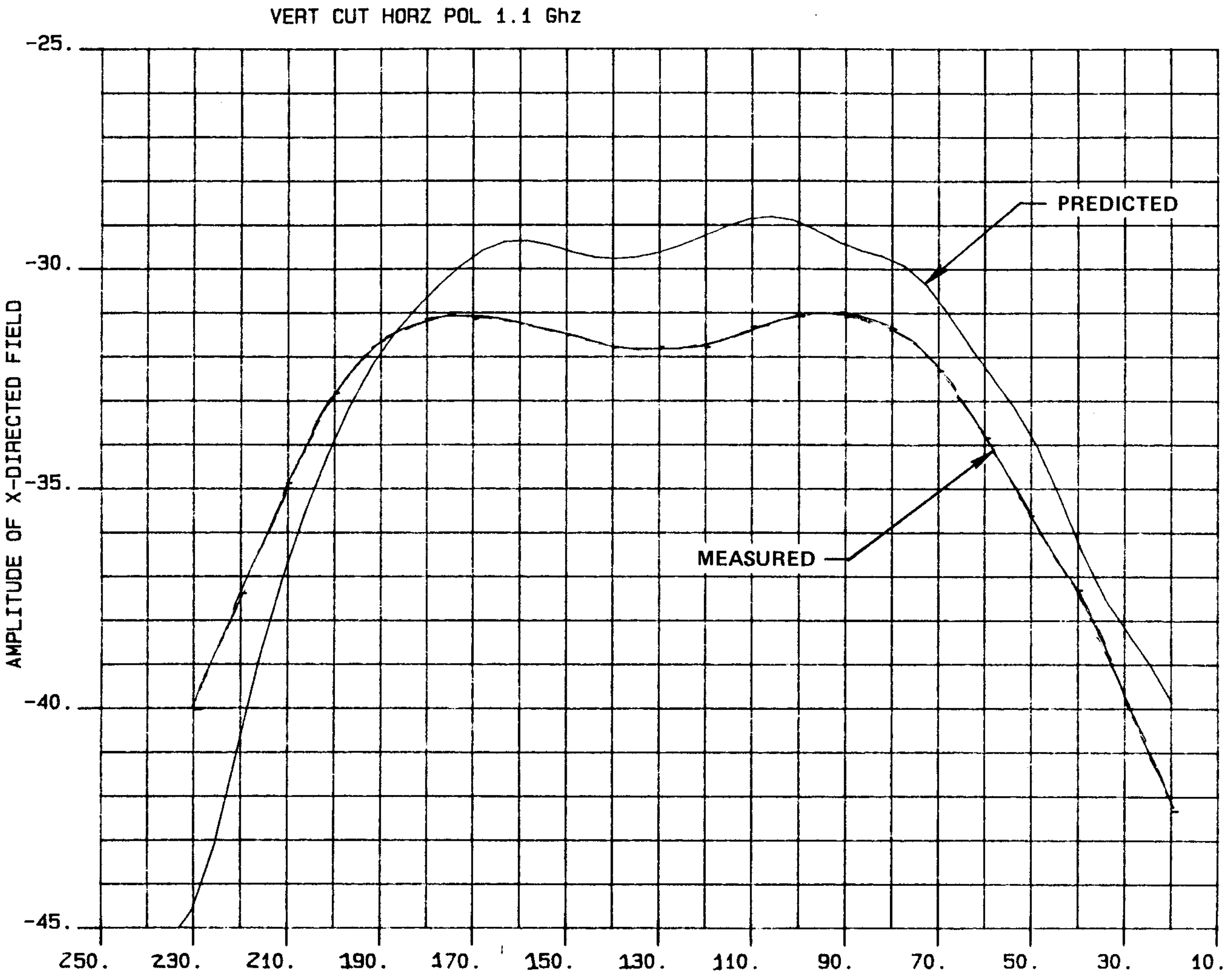

FIGURE IIA: DISTANCE FROM FOCAL AXIS OF RANGE (INCHES)

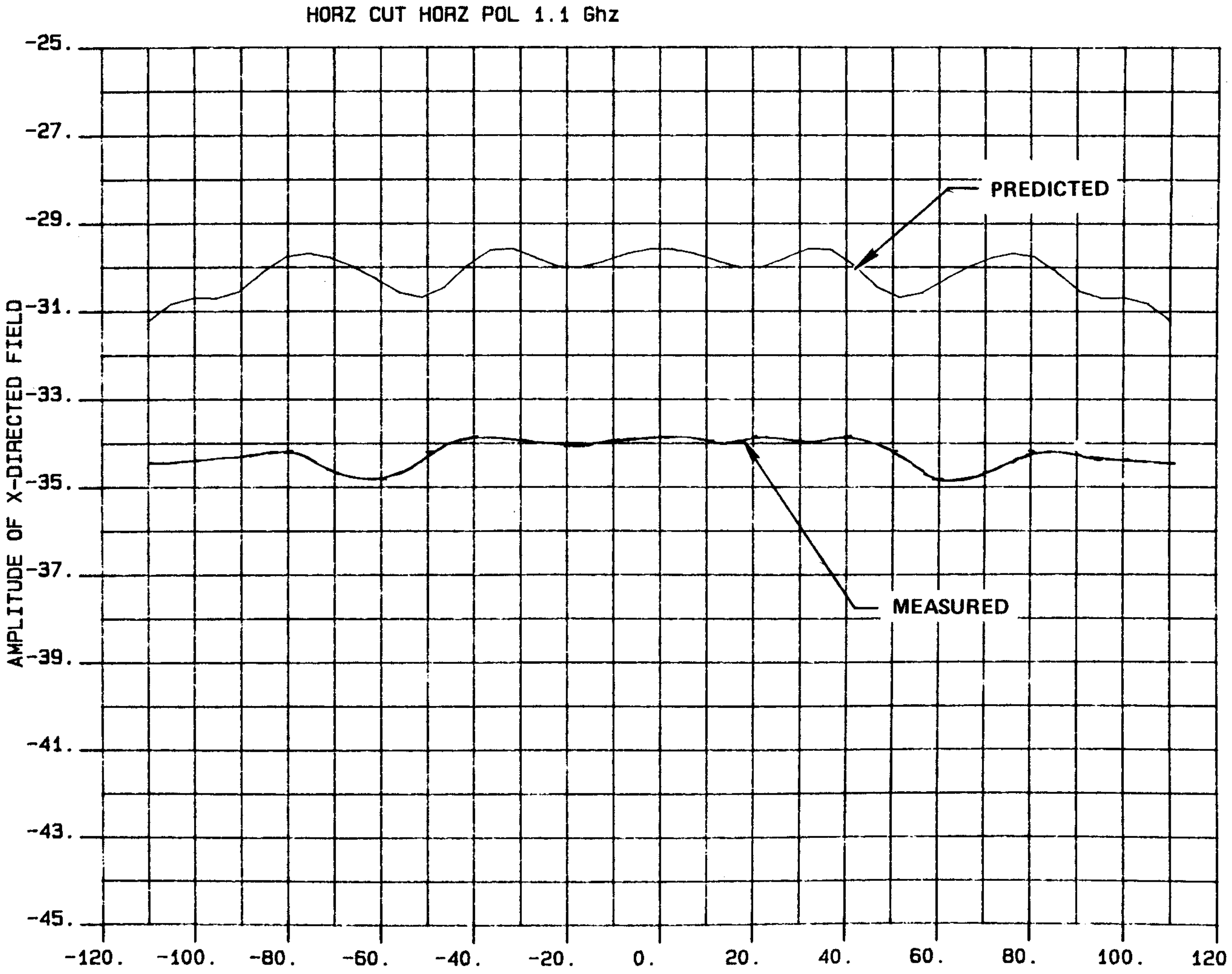

FIGURE IIB. DISTANCE FROM CENTERLINE OF RANGE (INCHES)