Variable aperture horn antenna for millimeter wave wireless communications

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***Abstract*— A variable aperture horn antenna, for flexible coverage area in point to multipoint at millimeter wave, is proposed. The antenna is intended to be implement in future 5G high capacity wireless backhaul networks to respond to traffic variations and coverage needs. Design and test results of the variable aperture antenna at scaled 35 - 40 GHz frequency band are reported.**

***Keywords*— Horn antenna, Variable aperture, 5G, Wireless communication, Backhaul**

I. Introduction

Antennas are important components for assuring the correct coverage in wireless communication. Point to multipoint wireless distribution is based on a transmission hub with a low gain antenna to cover a given area sector where a number of terminals are arbitrarily deployed [1]. European Commission H2020 TWEETHER "Travelling wave tube based w-band wireless networks with high data rate distribution, spectrum & energy efficiency" project develop the first point to multipoint wireless system at W-band for backhaul and fixed access [2-3]. However, the future 5G wireless backhaul systems demand flexible coverage to respond to the traffic variations. Such a requirements can be fulfilled by automatically adjustment of the horn aperture to produce a range of aperture angles, maintaining high quality radiation properties [4-6].

In this paper a variable gain and aperture angle horn antenna based on a movable ridge in antenna body is proposed. This proposed antenna is designed for use in the W-band TWEETHER system. As proof of concept, a first design and test have been made at Ka-band.

II. Design and Simulation

The variation of the horn antenna gain in the H-plane is function of the dimension Ax (Fig.1). To vary this dimension, without changing the body of the antenna, a metal sheet supported by two tuning screws, that can be moved by a microcontroller, is added to modify the antenna geometry to change the H-plane gain, maintaining the E-plane gain unaffected. The variable aperture horn antenna is shown in Figure 1.

CST-Microwave studio is used to design and simulated the proposed antenna in the frequency range 36 – 40 GHz. Figure 2 shows the radiation patterns for three different positions of

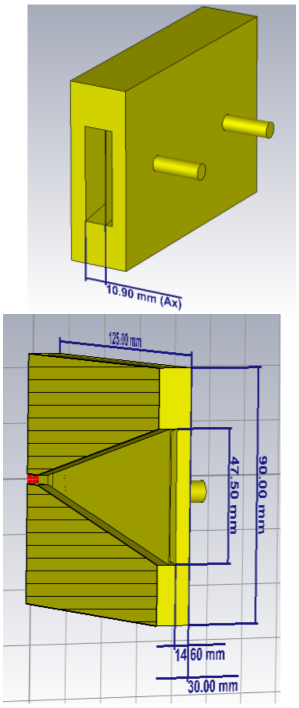

Fig. 1. Variable aperture horn antenna.

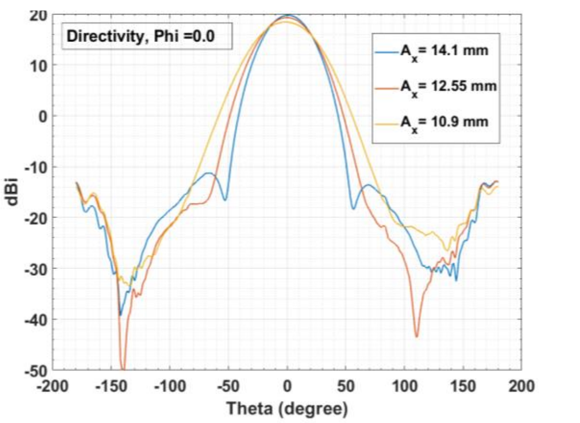

Fig. 2. 2D radiation pattern of the variable horn with adjustable aperture depths (A_x) of 14.1mm, 12.55mm and 10.9mm.

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the ridge. The three aperture angles, 35^0, 40^0 and 45^0 corresponding to 18.5 dBi, 19.3 dBi and 19.8 dBi antenna gain respectively, are achieved. The position of the adjustable metal sheet is 14.1 mm, 12.55 mm, and 10.9 mm respectively. The radiation patterns demonstrated excellent directivity with low side lobes for minimizing the interference.

III. Manufactruing And Testing

To validate the proposed design, a prototype of variable aperture horn antenna was manufactured by using CNC milling in Aluminum (Fig.3).

Fig. 3. Variable aperture horn antenna

A Rohde & Schwarz Vector Network Analyzer (VNA) was used to measure the reflection coefficient, S_{11}, of the manufactured antenna. The results clearly demonstrated very good performance in the 33 GHz - 40 GHz frequency range, with S_{11} better than -15 dB (fig. 4). This first prototype antenna demonstrates the validity of the approach based on the variable position metal sheet for achieving different apertures. The antenna gain was measured in far-field from a reference antenna. The far-field was taken to start at a distance $2D^2/\lambda_0$, where D is its larger dimensions at the opening of the reference horn, and λ_0 is the free-space wavelength. Wave reflections from the ground and other objects were not considered, as it is amount of power reflected to the test antenna minimal. Figure 5 shows the measured gain of the test antenna at a far-field distance of 40 cm from the reference antenna. It was noted that the gain is about 20 dB between the frequency 33 - 37.5 GHz.

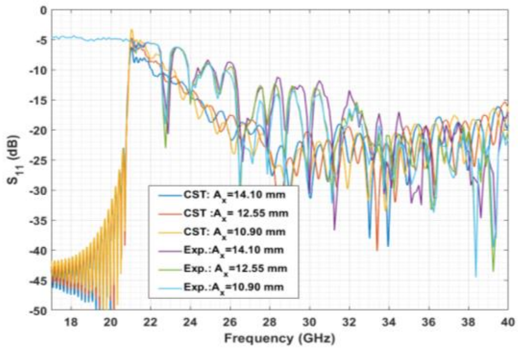

Fig. 4. Test results of S_{11} of the aperture horn antenna with adjustable aperture depths (A_x) of 14.1mm, 12.55mm and 10.9mm.

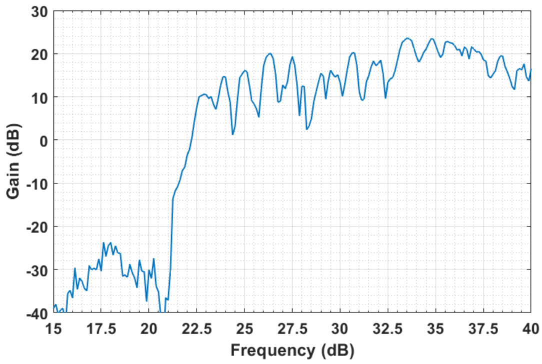

Fig. 5. Gain of the test antenna when A_x=14.1 mm.

IV. Conclusion

A novel variable aperture horn antenna has been successfully designed and tested. This antenna would provide a flexible coverage by variable angle sector remotely controlled.

Acknowledgment

The authors acknowledged Jonathan Gates for the great mechanical fabrication support.

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