High gain omnidirectional array antenna with low side lobe levels in the elevation plane

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***Abstract*—A novel high gain array antenna for operation in the X band (8-11 GHz) is proposed for applications that include point-to-multipoint communications and maritime radar. The antenna is a 16 element dipole array with a maximum gain of 12.8 dBi and -18 dB side lobe levels. The antenna was fabricated and simulation results were in good agreement with the measurements.**

Keywords—Omni-directional antenna; Low side lobe level array; printed dipole antenna

I. INTRODUCTION

High gain omnidirectional antennas can achieve 360^0 radiation pattern in the azimuth plane and a relatively narrow radiation pattern in the elevation plane [1]. Researchers have provided various approaches to design omnidirectional high gain antennas, including (1) coaxial collinear antennas; (2) printed dipole array antennas fed by balanced microstrip lines; and, (3) coplanar waveguide cross-fed antennas. However, all these works suffer from high side lobe levels [2]. Some applications require an omnidirectional radiation pattern in the azimuth plane but a significantly narrower radiation pattern in the elevation plane, such as to reduce effect of reflections from ground planes.

II. ANTENNA DESIGN

Therefore we present a novel antenna to reduce the side lobe levels in the elevation plane. The antenna consists of a 16 element dipole array, see Fig. 1 and Fig. 2., and a 1-16 Wilkinson power divider to feed the array elements, see Fig. 3. Each element consists of a printed dipole and a microstrip via-hole balun, which acts as an unbalanced-to-balanced transformer from the coaxial feed to two printed dipoles. Each element size is about λ /2, the elements' spacing is approximately $0.6\,\lambda$, the length of the dipoles and the balun are all approximately $\lambda/4$, at the center frequency of 10 GHz. In order to increase the gain of the antenna and reduce the beam width in the elevation plane, the 16 antenna elements have been arranged as a linear array. Another independent measure to reduce the side lobe levels in the elevation plane consisted in designing the array elements with Chebyshev amplitude tapering. This amplitude tapering is applied by means of fixed attenuators. The Yat-series of fixed attenuators from the company Mini-Circuits® were used to for this purpose. The maximum gain is 12.8 dBi and the side lobe level is about 18 dB below the maximum gain. The antenna is printed on a Rogers RO4003 substrate with the thickness of 0.3048 mm (12 mils). As shown in Fig 5 and Fig 6 the radiation pattern is omnidirectional in azimuth plane with the 13.6 dB antenna gain. Printed dipole antenna element and its balun dimensions are listed in Table I.

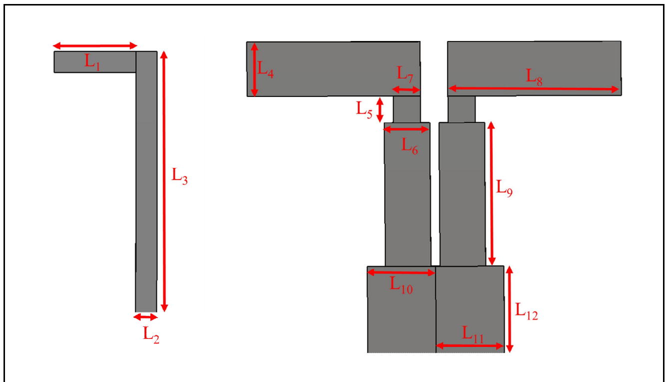

Fig 1. Element of the antenna (a) balun, (b) printed dipole

TABLE I. PRINTED DIPOLE ANTENNA AND BALUN DIMENSIONS

Parameter	L_1	L_2	L_3	L_4	L_5	L_6
Dimension (mm)	*2.6*	*0.7*	*8.3*	*1.7*	*0.8*	*1.4*
Parameter	L_7	L_8	L_9	L_{10}	L_{11}	L_{12}
Dimension (mm)	*0.8*	*0.3*	*4.6*	*2.1*	*2.1*	*2.8*

III. CONCLUSION

The whole structure was simulated with CST software and then fabricated. An excellent agreement between the measured and simulated results was observed.

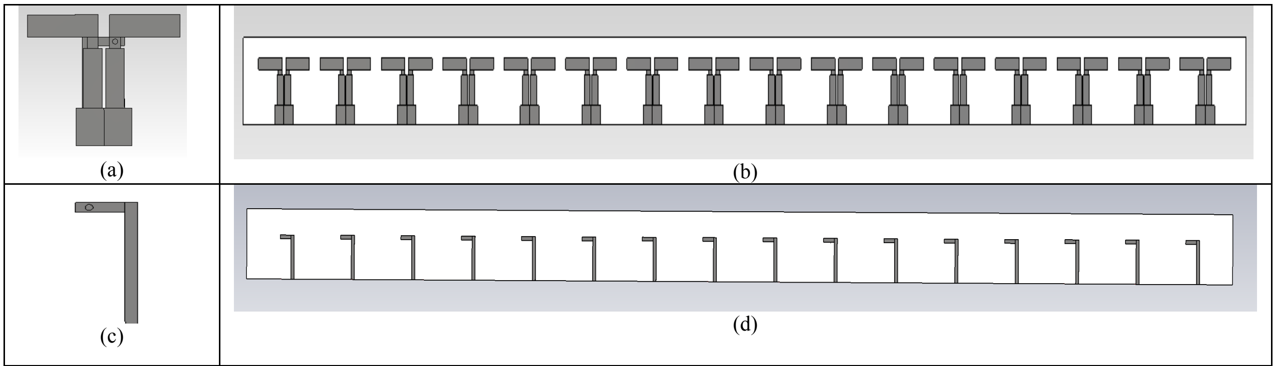

Fig 2. (a) Element of the array antenna, (b) Array antenna with 16 printed dipole elements, (c) element of the antenna balun, (d) 16 printed antenna balun to feed dipole elements.

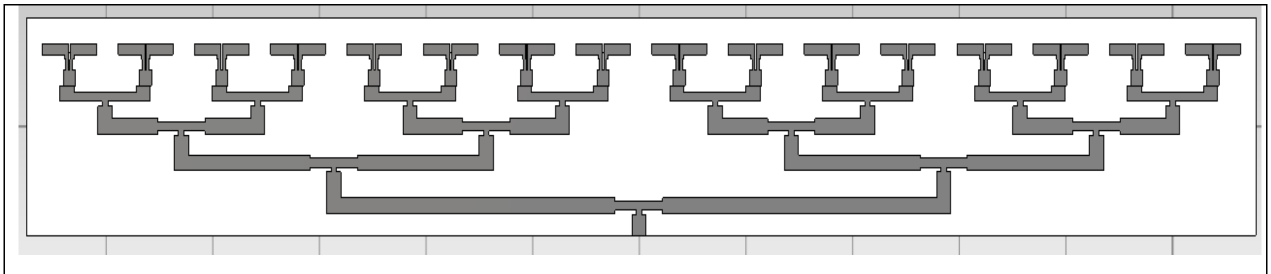

Fig 3. Wilkinson power divider to feed 16 array elements.

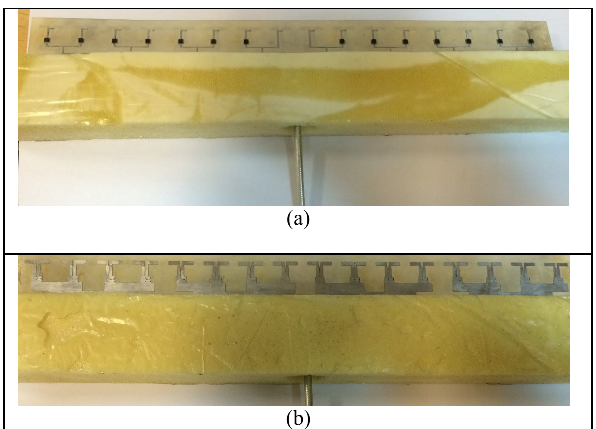

Fig 4. Photo of antenna array fabrication (a) back, (b) front view

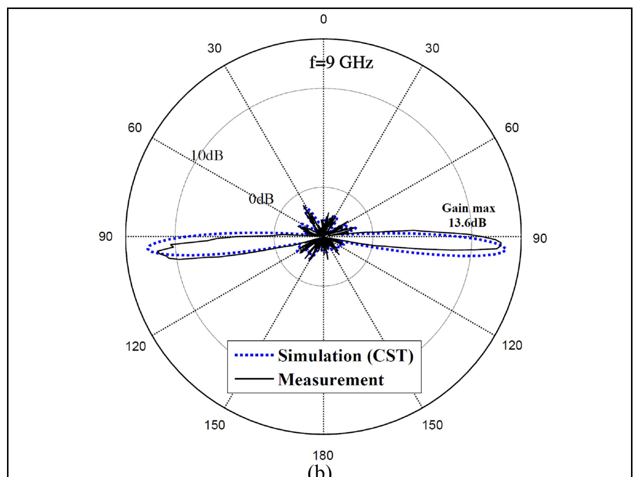

Fig 6. Simulated and measured radiation pattern at 9GHz frequency

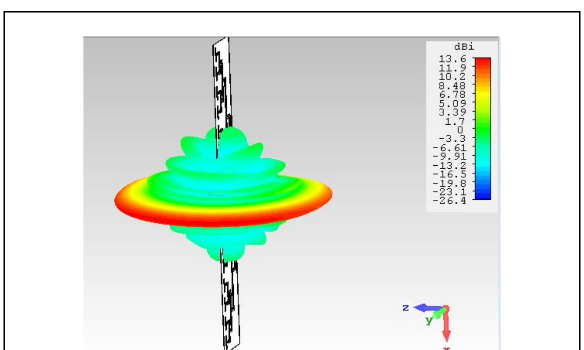

Fig 5. Simulated radiation pattern at 9GHz with CST.

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