Left-Hand Circularly Polarized Phased Array with High Gain for Mobile Satellite Communications

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Background

- It is an important method to realize full coverage of wireless communication and a critical guarantee for social stability and economic development to construct satellite communication systems.
- In the last decade, SATCOM-on-the-move concept for broadband communication has been applied in several frequency bands, such as L-, X-, Ku- and Ka-bands. However, with the increasing capacity of satellite communication systems, frequency band resources become saturated. The use of the Ku-band has become more frequent.
- Compared with mechanical scanning antennas, phased array antennas are small in size and light in weight.
- In this paper, the design and analysis of a 32X32 LHCP planar antenna array, operating over 13.75GHz-14.5GHz are presented.

Radiating element structure

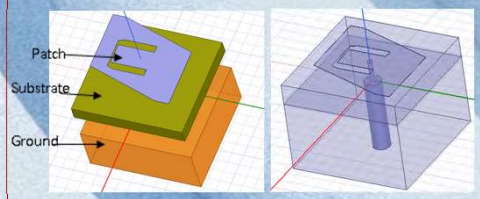

Fig. 1. Single radiating element.

As shown in Fig.1, single radiating element consists of a patch, metal ground and a substrate using Rogers RT/duroid 5880(tm) of 1.57mm thickness, $\varepsilon_r = 2.2$ and $\tan\delta = 0.0008$. And coaxial cable is chosen as the feeder.

Rotation group array

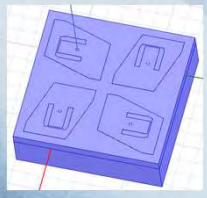

Fig. 2. Rotation group array.

As shown in Fig.2, the rotation group array consists of four radiating elements, which is the subarray of the phased array antenna.

Far field pattern

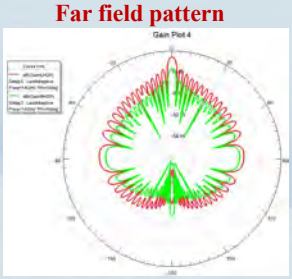

Fig. 3. Far field pattern of the 32X32 array in x-z plane of 14 GHz.

As shown in Fig.3, the radiation of designed 32X32 Array is left-hand circularly polarized.

Simulation of single element

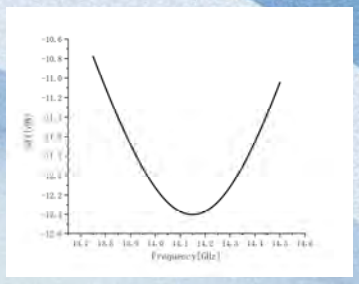

Fig. 4. S11 of single radiating element.

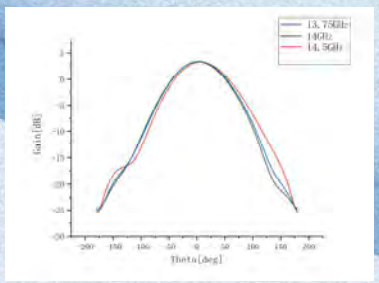

Fig. 5. Far field pattern of single radiating element.

From Fig.4, the simulated reflection parameter is below -10dB at the frequency band of interest (13.75GHz-14.5GHz). The simulated gain of the single radiating element is approximately 3.3dB as shown in Fig.5.

phased array antenna

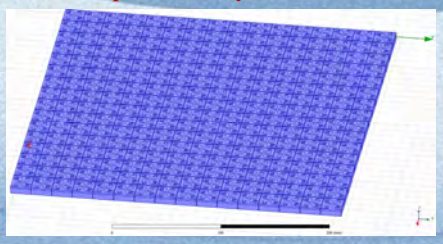

Fig. 6. 32X32 phased array antenna.

As shown in Fig.6, the developed antenna array consists of 1024(32 X 32) radiating elements and the single radiating element spacing is 19.32mm.

Simulations of the 32X32 antenna array

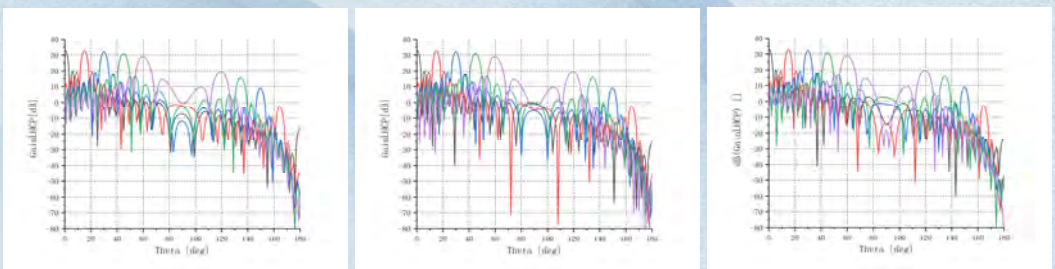

Fig. 7. Far field pattern of the array at different elevation scan angles in the y-z plane of 13.75GHz,14GHz, 14.5GHz

Axial Radio/dB \ Elevation Scan Angles/deg / Frequency/GHz	0	15	30	45	60
13.75	4.11	3.08	2.82	3.7	4.8
14	4.12	2.46	2.86	4.49	5.29
14.5	4.06	2.79	4.44	5.59	4.78

TABLE I. Axial ratio of different elevation angles.

As shown in the Fig.7, the maximum gain is approximately 33.43dB of elevation scan angle 0° , at 14.5GHz. The scan loss performance is approximately 4.18dB at 13.75GHz, 3.86dB at 14GHz and 14.5GHz from 0° to 60° .
Table I shows axial radios of the 32X32 array at different elevation scan angles and frequencies in the y-z plane, and they are all below 6dB.

Conclusions

In this paper, the design and simulation of single radiating element of a 3232 phased array antenna have been presented. The simulations of the LHCP array antenna operating in the frequency band of 13.75 GHz to 14.5 GHz have been discussed. This array structure has high gain, wide scanning range and good circular polarization performance, which makes it possible to realize low profile and high performance circular polarization phased array.

Acknowledgement

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