The Radial Line Concentric Slot Array Antenna

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***Abstract* – The circular polarization is useful for the telecommunication, the sensor, the broadcast, and so on. One of the antenna is the radial line waveguide0slot array antennas. This structure are made from two plate for radiating waveguide. In this research, based on the theoretical calculation of the hybrid feed structure composed of the circular waveguide and coaxial feed and ring slot, and patch structure and the radial line. And we simulates the hybrid feed structure using the electromagnetic field analysis simulator based on the finite element method. The rotation mode feeding structure realized the concentric array radial line slot antenna for the bore sight beam. The axial ratio is 0.037dB. When the slot pairs are increased from 4pair to 16pair, the circular polarization axial ratio is improved.**

***Index Terms* — RLSA, Rotation mode, Slot array antenna, Feed structure, Concentric arrangement, Circular-polarization**

1. Introduction

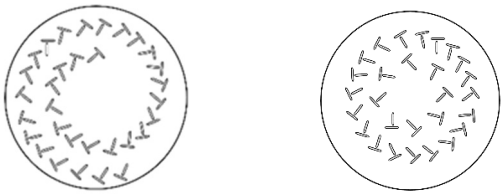
The waveguide slot array antennas have unique characteristics. For example, low loss wave propagation by waveguide structure. This structure can be transmitted closure in the inner space. Severed type of waveguide array antenna is manufactured. The longitudinal rectangular waveguide, the planar array waveguide, the radial line waveguide and so on are useful high frequency band. We research one of the type waveguide structure called the radial line waveguide [1]. The radiating waveguide have two radiates circularly polarized wave from slotted plate. The TEM wave propagates along with radial line. This stricter have two parallel metal plates consists of radiating waveguide. Slots are arranged orthogonally each other and these distance is shifted 1/4 lambda to produce the circularly polarization. To obtain circular polarization, the slot pairs designed equal amplitude and phase changing 90 degree. The two types of slot pair arrangement are needed the feed structures as shown in Fig.1. The SA-RLSA (Spiral Array Radial Line Slot Antenna) is adapted that the feed structure is a concentric phase wave source, the slot array arranged helically. In this case, the second one is the CA-RLSA (Concentric Array Radial Line Slot Antennas) is adapted that the feed structure produces the rotational phase mode. In this case the slot array are arranged in the concentric.

In this paper, we proposed the hybrid feeding structure for RLSA as shown in Fig.2 to produce rotation mode [2]. The resonant slot pair for exciting a phase difference 90 degree for circularly polarized radiation [3], is the same slot-shaped and concentrically arranged [4][5]. It is possible to simplify the slot array design. Because the load of analysis simulation is greatly reduced, it is possible to electromagnetic field analysis of whole RLSA structure which including the feed structure, radial line slot plate and the radiating slot pair using desktop computer. Also, it is possible to design minimum round slot array to realize an antenna having a maximum radiation directivity to bore-sight direction.

2. Hybrid Feed Structure

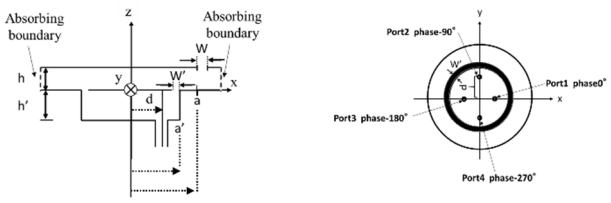
This hybrid feed structure consists of 4 parts. First one is the 50 ohm coaxial lines. Second one is the circular waveguide (height = h', radius = a', and the outer coaxial lines are contact with bottom plane). Third one is the circular patch antenna with 4 feed points along to each axis (+x, +y, -x, -y). Final one is the ring slot (width = W'). To produce good rotation mode, the 4 feed points are shown in Fig.2 (b). The feed point's phase relation are +x-axis is 0 degree, +y-axis is 90 degrees delay, -x-axis is 180 degrees delay, and -y-axis is 270 degrees delay.

In the case of the each radial lines with radiating circular polarization slot pair are good reflection characteristics. Fig.3 shows the relation of the each axis normalized position by the free space wavelength at 12GHz (lambda = 25 mm) and the amplitude of E-field. This shows good rotation mode.



(a) SA-RLSA (b) CA-RLSA

Fig.1.The slot arrangement is different from each feeding structures.



(a) side view (b) plane view

Fig. 2. The circular patch 4-point feeding hybrid structure.

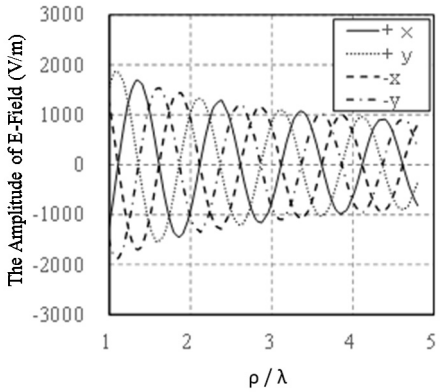
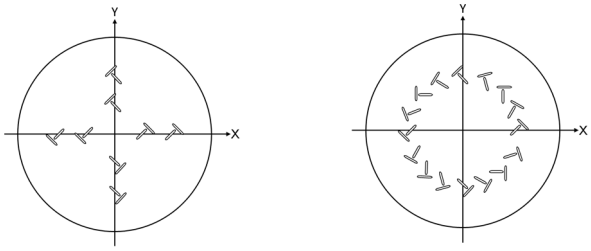


Fig. 3. The Amplitude of E-Field along with each 4-axis.

3. Radiation characteristics

Fig.4 shows the 2 loops have 16 elements of slot pair position on the radiating slot plate in the left of the shows figure represents and shows the 1 loops have 32 elements of slot pair position on the radiating slot plate in the right of the figure represents. The reflection characteristics of this hybrid structure is shown in Fig.5. The reflection characteristic S11 is -35.39 dB at the center frequency 12 GHz. In the case of the reflection characteristics is less than -13.98 dB, the frequency bandwidth becomes almost 200 MHz. Fig.6 (a) shows 16 elements and 32 elements the right-handed circularly polarized radiation pattern (co-polarization @12.0GHz). This concentric array radial line slot antenna has bore-sight main beam. This is the proof of success rotation mode at the feeding structure. Fig.6 (b) shows the 16 elements and 32 elements cross-polarization.



16 elements 32 elements

Fig. 4. The slot pair position on the radiating slot plate.

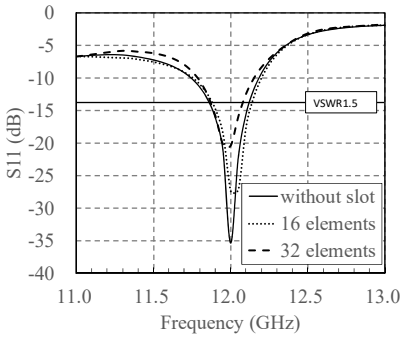
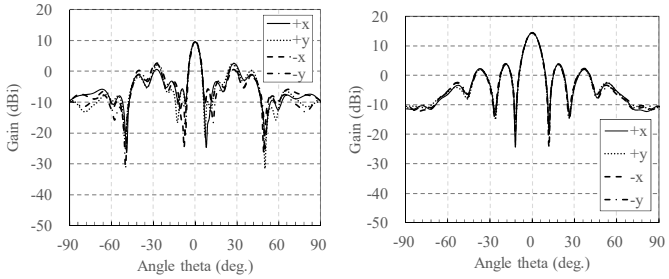
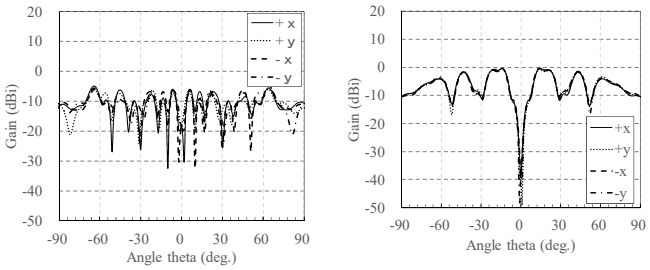


Fig. 5. The Reflection characteristics of Hybrid circuit.



16 elements 32 elements

(a) Co-polarization @12.0 GHz



16 elements 32 elements

(b) Cross-polarization @12.0GHz

Fig. 6. Radiation Pattern.

The axial ratio is improved by increase slot pair elements. In this case, 16 element Axial ratio = 0.393dB. And 32 element Axial ratio = 0.037dB.

4. Conclusion

We used the finite element method soft to design the good rotation mode feeding structure for concentric array radial line slot antenna. By comparing 16 elements and 32 elements we know It can be seen that designing a good parameter antenna than enough to increase slot.

Future study is the comparison of the measurement and calculation.

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